United States Organ Transplantation

OPTN/SRTR 2022 Annual Data Report

US Department of Health and Human Services
Health Resources and Services Administration

DATA REPORT 2022

U.S. Department of Health and Human Services
HRSA
Health Resources and Services Administration

SRTR
SCIENTIFIC REGISTRY OF TRANSPLANT RECIPIENTS

OPTN/SRTR 2022 Annual Data Report: Preface

This Annual Data Report of the US Organ Procurement and Transplantation Network (OPTN) and the Scientific Registry of Transplant Recipients (SRTR) is the 32nd annual report and is based on data pertaining to the period 2011-2022. The title *OPTN/SRTR 2022 Annual Data Report* reflects the fact that the report covers the most recent complete year of transplants, those performed in 2022.

This publication was developed for the US Department of Health and Human Services, Health Resources and Services Administration, Health Systems Bureau, Division of Transplantation, by the SRTR contractor, Hennepin Healthcare Research Institute (HHRI), and the OPTN contractor, United Network for Organ Sharing (UNOS), under SRTR contract HHSH75R60220C00011 and OPTN contract HHSH250201900001C.

As the SRTR contractor, HHRI, through its Chronic Disease Research Group (CDRG), determined which data to present, conducted the required analyses, created the figures and tables, and drafted the text. As the OPTN contractor, UNOS reviewed the draft report and contributed to the content. This report is available at https://srtr.transplant.hrsa.gov. Individual chapters may be downloaded.

1 Overview and Highlights

This Annual Data Report includes chapters on kidney, pancreas, liver, intestine, heart, and lung transplants, as well as chapters on deceased organ donation, vascularized composite allograft transplant, and COVID-19. The organ-specific chapters include information on such topics as the waiting list, deceased donor organ donation, living donor organ donation, transplant, outcomes, and pediatric transplant. When possible, similar data and formats are used for each chapter. However, this is not always possible because some data are not pertinent to all organs.

Graphical presentation of the data is emphasized: more than 600 figures (including any maps) and tables are included in the chapters. They may be copied and pasted from the HTML files into slides.

Maps in this report present data divided into quintiles. Figure 1 is a sample map.

Maps by donation service area (DSA) use DSA boundaries in effect at the beginning of 2021, after the merger of LifeChoice Donor Services and New England Organ Bank.

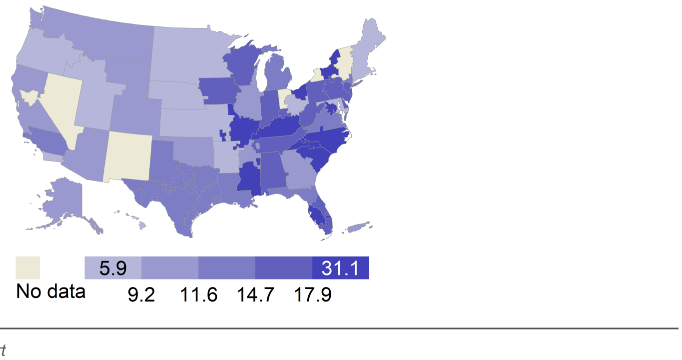

Figure 1: Example map. In this example, about one-fifth of all data points have a value above 17.9. Ranges include the number at the lower end of the range and exclude that at the upper end (eg, the second range here is 9.2 to <11.6). Numbers in the first and last boxes are the minimum and maximum of observed data.

Some DSAs include noncontiguous areas. If a DSA has no transplant program for a given organ or no listings during the map's timeframe, it is labeled "No data" on the map and shaded accordingly.

2 Milestone Dates in the Production of This Report

Data were cut: June 2023.

Data were analyzed: July 2023.

3 Methods

cPRA
For recipients of kidney and pancreas transplants performed on January 1, 2010, or later, panel-reactive antibody (PRA) at the time of transplant is the calculated PRA (cPRA) value.

For recipients of heart transplants performed from January 1, 2010, through March 30, 2015, PRA at the time of transplant is the minimum value between the most recently recorded PRA and the peak PRA. For recipients of heart transplants performed on March 31, 2015, or later, the cPRA value was used at the time of transplant. If that value is missing, we use the peak cPRA value known at the time of transplant.

Heart status groups
Starting on October 18, 2018, adult candidates were allocated hearts based on status

groups 1-6. Status 1 candidates have the highest waitlist mortality risk and status 6 the lowest. Before that date, candidates were allocated hearts based on status groups 1A (highest priority), 1B, and 2.

Incidence

Cumulative incidence of posttransplant outcomes (diabetes, posttransplant lymphoproliferative disorder, and acute rejection) are computed using survival methods.

Graft failure

Unless otherwise specified, “graft failure” refers to graft failure from any cause, including death and retransplant. For kidney failure, this also includes return to maintenance dialysis. “Graft survival” similarly refers to the absence of all-cause graft failure.

Patient survival

Posttransplant patient survival is not censored at graft failure. Thus, patient survival includes follow-up after graft failure, retransplant, and return to maintenance dialysis in the case of kidney recipients.

Transplant rates

Transplant rates include all waiting time (ie, active and inactive) in the interval described.

Pretransplant mortality

Pretransplant mortality rates include all waiting time, and patients are followed until the earliest date of transplant, death, transfer to another program, removal from the waiting list due to improved condition, or cohort censor date. Because we continue to follow candidates for death outcomes beyond removal (except removal due to improved condition), we do not include removal due to deteriorated condition as part of a combined outcome.

Rates by subgroup

When rates are shown by subgroup (ie, sex, race, or primary cause of disease), the numerator and denominator are computed exclusively within those groups. For example, for pretransplant mortality by race, the numerator for each race is the number of deaths in that group during the interval described. The denominator is the total waiting time within each race group in that same time interval. When a characteristic is subject to change over time (eg, model for end-stage liver disease [MELD], PRA), it is assessed at the earliest of transplant, death, removal, or December 31 of the year, and a candidate contributes waiting time and outcome only at that level. For example, age is assessed only once a year; therefore, a candidate contributes all of his or her waiting time to a single age category in a given yearly rate calculation but may change age categories over time. For example, a waitlisted candidate who was 34 years old on December 31, 2018, would be included in the 18- to 34-year age group in 2018, but if that candidate were still listed in 2020, he or she would be included in the 35- to 49-year age group.

Donor risk index

The kidney donor risk index (KDRI) and pancreas donor risk index (PDRI) are measures of donor quality based on donor factors.

KDRI[1] = $\mathrm{Exp}\{-0.0194 \times [\text{if age} < 18\text{ yrs}] \times [\text{age} - 18\text{ yrs}] + 0.0128 \times [\text{age} - 40\text{ yrs}] + 0.0107 \times [\text{if age} > 50\text{ yrs}] \times [\text{age} - 50\text{ yrs}] + 0.179 \times [\text{if African-American race}] + 0.126 \times [\text{if hypertensive}] + 0.130 \times [\text{if diabetic}] + 0.220 \times [\text{serum creatinine} - 1\text{ mg/dL}] - 0.209 \times [\text{if serum creatinine} > 1.5\text{ mg/dL}] \times [\text{serum creatinine} - 1.5\text{ mg/dL}] + 0.0881 \times [\text{if cause of death} = \text{cerebrovascular accident}] - 0.0464 \times [(\text{height} - 170\text{ cm})/10] - 0.0199 \times [\text{if weight} < 80\text{ kg}] \times [(\text{weight} - 80\text{ kg})/5] + 0.133 \times [\text{if DCD}] + 0.240 \times [\text{if HCV+}]\}$

PDRI[2] = $\mathrm{Exp}\{-0.1379 \times [\text{if female}] - 0.03446 \times [\text{if age} < 20\text{ yrs}] \times [\text{age} - 20\text{ yrs}] + 0.02615 \times [\text{age} - 28\text{ yrs}] + 0.1949 \times [\text{if creatinine} > 2.5\text{ mg/dL}] + 0.2395 \times [\text{if African-American}] + 0.1571 \times [\text{if Asian}] - 0.0009863 \times [\text{BMI} - 24] + 0.03327 \times [\text{if BMI} > 25] \times [\text{BMI} - 25] - 0.006074 \times [\text{height} - 173\text{ cm}] + 0.3317 \times [\text{if DCD}] + 0.2102 \times [\text{if cause of death} = \text{cerebrovascular accident}]\}$

[1] Rao PS, Schaubel DE, Guidinger MK, Andreoni KA, Wolfe RA, Merion RM, Port FK, Sung RS. A comprehensive risk quantification score for deceased donor kidneys: the kidney donor risk index. *Transplantation*. 2009;88(2):231-236. doi:10.1097/TP.0b013e3181ac620b

[2] Axelrod DA, Sung RS, Meyer KH, Wolfe RA, Kaufman DB. Systematic evaluation of pancreas allograft quality, outcomes and geographic variation in utilization. *Am J Transplant*. 2010;10:837-845. doi:10.1111/j.1600-6143.2009.02996.x

Complete versions of these indices also include transplant factors, but the donor-specific indices in this report are limited to donor-specific factors. Conversion of KDRI to a cumulative percentage scale (ie, KDPI) is done using the OPTN KDPI Mapping Tables. For donors with organs recovered January through May, the cohort 2 years prior was used to assign KDPI; for donors with organs recovered June through December, the cohort 1 year prior was used to assign KDPI. Kidneys recovered en bloc were counted once.

4 Notes

Population reported

Figure titles indicate adult or pediatric populations; if not specified, data include patients of all ages. In the past, lung data included patients aged 12 years or older with adults, and figure titles specified the age ranges. Since the 2019 report, we have classified all lung patients aged 18 years or older as adults and younger patients as pediatrics.

Unless otherwise specified, data in each organ-specific chapter include both isolated transplants and multiorgan transplants of the given type. For example, patients on the kidney transplant waiting list include those listed for an isolated kidney, kidney-pancreas, or any other organ combination that includes kidney.

Waitlist populations are no longer reported at the person level. If a patient is listed at more than one center, that patient is counted once per listing.

Age

Adult patients are defined as those aged 18 years or older for all organs. For waitlist figures, age is defined at the time of first listing, unless otherwise specified.

Race and ethnicity

Race and ethnicity are jointly reported by the OPTN in candidate and donor registrations. Unless otherwise indicated, in the Annual Data Report, White is defined as non-Hispanic White, and Hispanic is defined as Hispanic/Latino ethnicity with White race or no race reported. The Black, Asian, and Native American categories include persons reported as Hispanic. Asian is defined as Asian, Native Hawaiian, or other Pacific Islander. Native American is defined as American Indian or Alaska Native. When the Other category is shown, Other is defined as Native American, multiracial, or unreported race and ethnicity. The Other category was created to represent these groups when sample sizes are small.

Pancreas data

Pancreas data encompass the three types of pancreas waiting lists or transplants: simultaneous kidney-pancreas, pancreas after kidney, and pancreas transplant alone (ie, without kidney). Pancreata used for islet transplant are excluded.

MELD score

MELD scores shown in figures and tables are calculated MELD scores, not allocation MELD scores, unless otherwise specified.

Metropolitan and nonmetropolitan designation

Many data are displayed by the designation of a candidate's or recipient's permanent zip code as metropolitan or nonmetropolitan. We used rural-urban commuting area (RUCA) codes and defined metropolitan, micropolitan, small town, and rural areas. These were then collapsed into metropolitan areas, which include suburbs adjacent to major cities, and nonmetropolitan areas, which include cities, towns, and rural areas of fewer than 50,000 people.

5 Data Requests

Requests for data can be made to SRTR at http://www.srtr.org or to OPTN at http://optn.transplant.hrsa.gov.

6 Websites

http://www.srtr.org is a public website containing transplant program-specific reports, organ procurement organization (OPO)–specific reports, summary tables, archives of past reports, timelines for future reports, risk-adjustment models, methods, basic references for researchers who use SRTR data files, links to current and past Annual Data Reports and their supporting documentation and data tables, answers to frequently asked questions, and other information.

https://securesrtr.transplant.hrsa.gov is a secure website that provides access to the prerelease program- and OPO-specific reports, survival spreadsheets, and other useful information. All individual authorized users from transplant programs and OPOs have their own unique logins.

http://unos.org is a public website containing information on donation and transplant, data collection instruments, data reports, education materials for patients and transplant professionals, policy development, and other information. This website also links to the OPTN website.

http://optn.transplant.hrsa.gov is a public website containing news, information, and resources about transplant and donation, including transplant data reports, policy development, and related boards and committees. It also contains allocation calculators, a calendar of events, answers to frequently asked questions, and other information.

7 Contact Information

Research Inquiries

SRTR data requests: 877-970-7787 (toll free); srtr@srtr.org (email)

Media Inquiries
SRTR: 877-970-7787 (toll free); srtr@srtr.org (email)

Federal Program Inquiries
HHS/HRSA/HSB/DoT
5600 Fishers Lane
Parklawn Bldg, Eighth Floor West
Rockville, MD 20857
301-443-7577

8 Commonly Used Abbreviations in This Report

BMI: body mass index
CAKUT: congenital anomalies of the kidney and urinary tract
CAS: composite allocation score
CDC: Centers for Disease Control and Prevention
CDRG: Chronic Disease Research Group
CKD: chronic kidney disease
CMV: cytomegalovirus
COPD: chronic obstructive pulmonary disease
COVID-19: coronavirus disease 2019
cPRA: calculated panel-reactive antibody
DBD: donation after brain death
DCD: donation after circulatory death
DD: deceased donor
DM: diabetes mellitus
DOD: deceased organ donation
DoT: Division of Transplantation
DSA: donation service area
EBV: Epstein-Barr virus
ECD: expanded-criteria donor
ECMO: extracorporeal membrane oxygenation
ESRD: end-stage renal disease
eGFR: estimated glomerular filtration rate
FSGS: focal segmental glomerulosclerosis
GN: glomerulonephritis
HHS: US Department of Health and Human Services

HIV: human immunodeficiency virus
HLA: human leukocyte antigen
HMO: health maintenance organization
HRSA: Health Resources and Services Administration
HSB: Health Systems Bureau
HTN: hypertension
ICU: intensive care unit
KAS: kidney allocation system
KDPI: kidney donor profile index
KDRI: kidney donor risk index
LAS: lung allocation score
LD: living donor
LVAD: left ventricular assist device
MELD: model for end-stage liver disease
mTOR: mammalian target of rapamycin
OPO: organ procurement organization
OPTN: Organ Procurement and Transplantation Network
ORPD: organs recovered per donor
OTPD: organs transplanted per donor
PAK: pancreas-after-kidney (transplant)
PELD: pediatric end-stage liver disease
PDRI: pancreas donor risk index
PRA: panel-reactive antibody
PTA: pancreas transplant alone
PTLD: posttransplant lymphoproliferative disorder
SCD: standard-criteria donor
SGS: short-gut syndrome
SPK: simultaneous pancreas-kidney (transplant)
SRTR: Scientific Registry of Transplant Recipients
TAH: total artificial heart
UNOS: United Network for Organ Sharing
VAD: ventricular assist device
VCA: vascularized composite allograft

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- Chapter citation: [Authors]. OPTN/SRTR 2022 Annual Data Report: [chapter]. Accessed [insert date]. http://srtr.transplant.hrsa.gov/annual_reports/Default.aspx
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OPTN/SRTR 2022 Annual Data Report: Introduction

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Abstract

The *OPTN/SRTR 2022 Annual Data Report* presents the status of the solid organ transplant system in the United States from 2011 through 2022. Organ-specific chapters are presented for kidney, pancreas, liver, intestine, heart, and lung transplant. Each organ-specific chapter is organized to present waitlist information, donor information (both deceased and living, as appropriate), transplant information, and patient outcomes. Data pertaining to pediatric patients are generally presented separately from the adult data. In addition to the organ-specific chapters, the reader will find chapters dedicated to deceased organ donation, vascularized composite allografts, and the COVID-19 pandemic. The data presented in the Annual Data Report are descriptive in nature. In other words, most tables and figures present raw data without statistical adjustment for possible confounding or changes over time. Therefore, the reader should keep in mind the observational nature of the data when attempting to draw inferences before trying to ascribe a cause to any observed patterns or trends. This introduction provides a brief overview of trends in waitlist and transplant activity from 2012 through 2022. More detailed descriptions can be found in the respective organ-specific chapters.

Keywords: Allocation, outcomes, transplant, waiting list

1 Trends in Kidney Transplant

In 2022, there were 142,962 adult and pediatric candidates on the kidney waiting list at some point (Figure INT 1), an increase of 0.8% from 2021. This includes active and inactive candidates on the list at any time during the year. Over the past decade (2012-2022), the size of the waiting list peaked prior to the COVID-19 pandemic, with 146,637 candidates in 2019. The number of new candidates added to the kidney waiting list increased to 45,286 in 2022 (Figure INT 3), an increase of 5.7% from 2021 and the highest number of new kidney candidates added since 2012. This is likely a sign of recovery from the COVID-19 pandemic, which temporarily reduced the number of additions to the waiting list in 2020. The number of kidney transplants performed also increased in 2022 to 26,309, a 3.2% increase from 2021 (Figure INT 5) and the highest number of kidney transplants of the past decade. However, there is potential for an even higher number of kidney transplants being done, based on the increasing proportion of kidneys from deceased donors recovered for the purpose of transplant but ultimately not transplanted. In 2022, the proportion of kidneys from deceased donors recovered for the purpose of transplant but not transplanted increased to 26.6%, which is an increase of 8.4% from 2021 (Figure INT 7). These kidneys when recovered en bloc were counted once, whereas kidneys recovered separately were counted twice. With more than a quarter of all kidneys procured for the purpose of transplant not transplanted, this represents an opportunity to improve efficiency in the transplant system. Among transplant recipients from 2015 through 2017, 1-year and 5-year patient survival were 97.3% and 87.5%, respectively (Figure INT 8).

2 Trends in Pancreas Transplant

The demand for pancreas transplant alone has continued to decrease, as evidenced by a decline in the number of candidates listed for pancreas-alone or pancreas-after-kidney transplant over the past decade. The number of those candidates has declined from 1,661 in 2012 to 975 in 2022, which is likely due to improvement in medical management of diabetes (Figure INT 2). In comparison, the number of candidates waiting for a simultaneous pancreas-kidney transplant has declined to a lesser degree, from 3,611 in 2012 to 3,345 in 2022. Nonetheless, that 3,345 value represents a slight (4.2%) increase from 2021. Similar trends were seen in the number of new additions to the pancreas waiting list in 2022, with declines to 283 for pancreas-alone or pancreas-after-kidney and a slight increase to 1,489 kidney-pancreas additions to the waiting list, compared with 2021 (Figure INT 4). The total number of pancreas transplants performed in the United States was 918 in 2022, a 4.6% decline from 2021 (Figure INT 6). The proportion of pancreata from deceased donors recovered for the purpose of transplant but ultimately not transplanted increased to 28.6%, a 9.1% increase from 2021. This increase is likely due to organ procurement organizations being incentivized to obtain pancreata for research under the new Centers for Medicare & Medicaid Services (CMS) performance metrics for organ procurement organizations. Among all organs, pancreas has the highest proportion of organs recovered for the purpose of transplant but not transplanted (Figure INT 7). Among transplant recipients from 2015 through 2017, 1-year and 5-year patient survival were 96.3% and 88.7%, respectively (Figure INT 8).

3 Trends in Liver Transplant

The demand for liver transplants has continued to decline, likely due to improvements in treatment of hepatitis C. In 2022, the number of adult and pediatric liver transplant candidates on the waiting list declined to 25,328, a decrease of 2.6% from 2021. The total number of candidates has continued to decline since 2016, when the value was 27,839 (Figure INT 1). There has been a smaller increase in new candidates added to the waiting list during the same period. However, in 2022, 13,603 candidates were added to the waiting list, a decrease of 1.6% from 2021 (Figure INT 3) The number of transplants performed increased to 9,527 in 2022, a 3.2% increase from 2021, and this number has increased each year since 2012, when the value was 6,256 (Figure INT 5). Among the cohort of recipients from 2015 through 2017, 1-year and 5-year patient survival were 92.1% and 81.6%, respectively (Figure INT 8).

4 Trends in Heart Transplant

The year 2022 saw 8,707 candidates on the heart waiting list, an increase of 0.5% from 2021 (Figure INT 2). Of these candidates, 5,149 were newly added to the waiting list in 2022, which represents a 1.4% annual increase in new additions to the list from 2021 (Figure INT 4). The number of heart transplants performed in 2022 reached a record high of 4,162, a 7.7% increase from 2021, and has increased from 2,407 in 2012 (Figure INT 6). Among the cohort of recipients from 2015 through 2017, 1-year and 5-year patient survival were 91.7% and 81.1%, respectively (Figure INT 8).

5 Trends in Intestine Transplant

In 2022, there were 347 candidates on the intestine waiting list, a decrease of 4.7% from 2021 (Figure INT 2). Of these candidates, 146 were added to the waiting list in 2022 (Figure INT 4). The number of intestine transplants performed in 2022 was 82, a 14.6% decrease from 2021 (Figure INT 6). Thus, the demand for intestine transplants has continued to decline, likely due to improvements in medical management. Among intestine transplant recipients from 2015 through 2017, 1-year and 5-year survival were 82.4% and 61.7%, respectively (Figure INT 8). This represents the lowest 1-year patient survival among all solid organ transplants.

6 Trends in Lung Transplant

In 2022, there were 4,301 candidates on the lung waiting list, a 2.7% increase from 2021 (Figure INT 2). The year 2022 saw 3,208 new listings, an increase of 1.6% from 2021 (Figure INT 4). The 2,743 lung transplants performed in 2022 was a 6.8% increase from 2021. This a sign of a recovery from the COVID-19 pandemic, because the prepandemic number of lung transplants in 2019 was 2,759 (Figure INT 6). Among lung transplant recipients from 2015 through 2017, 1-year and 5-year survival were 89.0% and 60.5%, respectively (Figure INT 8). This represents the lowest 5-year patient survival among all solid organ transplants.

7 Summary

In 2022, the transplant system set another record for the number of solid organ transplants performed in the country. Over the past decade (2012-2022), the number of kidney transplants increased by 52%; liver transplants, by 52%; heart transplants, by 73%; and lung transplants, by 54%. During the same period, there was a decline of 12% and 23% for pancreas and intestine transplants, respectively, likely due to improvements in medical management for such patients. In 2022, the number of candidates on the waiting list increased for kidney, kidney-pancreas, heart, and lung transplants. In the same year, the number of candidates on the waiting list decreased for liver, intestine, and pancreas alone transplants. In 2022, the number of newly listed candidates increased for kidney, heart, intestine, kidney-pancreas, and lung transplants and decreased for liver and pancreas-alone transplants. The growth in transplants overall was outpaced by the waitlist additions, thereby highlighting the supply-demand imbalance in solid organ transplantation. The increase in the number of organs recovered for the purpose of transplant but ultimately not transplanted for kidney and pancreas also represents an opportunity for improving efficiency in the system. Each organ-specific chapter and the chapters dedicated to specific topics in this Annual Data Report present a more detailed look at the status of organ donation and transplantation in the United States.

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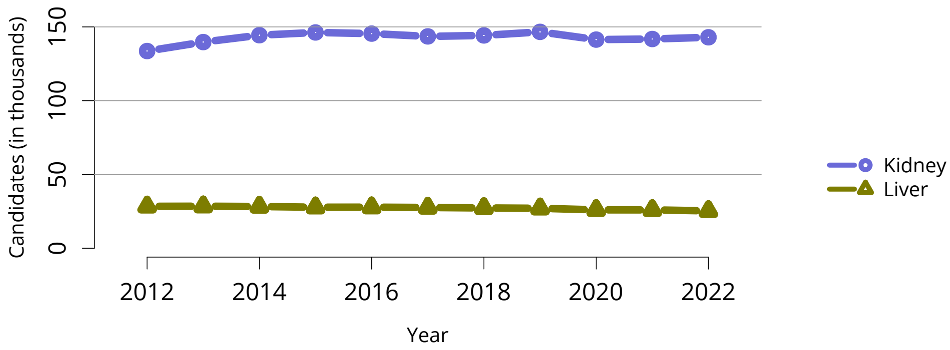
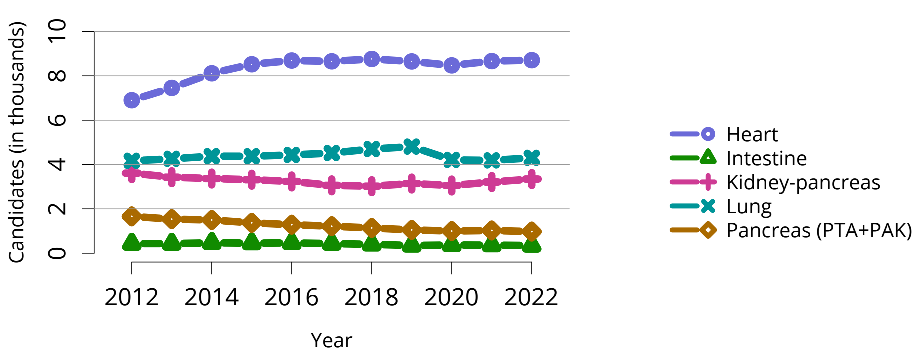


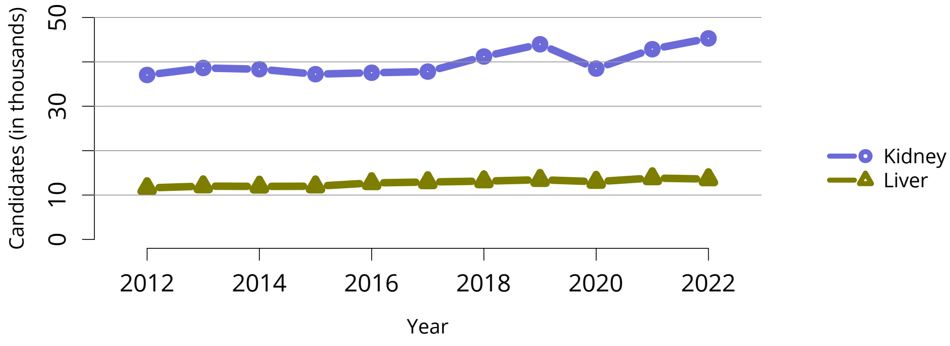
OPTN/SRTR 2022 Annual Data Report

Figure INT 1: All candidates on the kidney or liver waiting list. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the year.



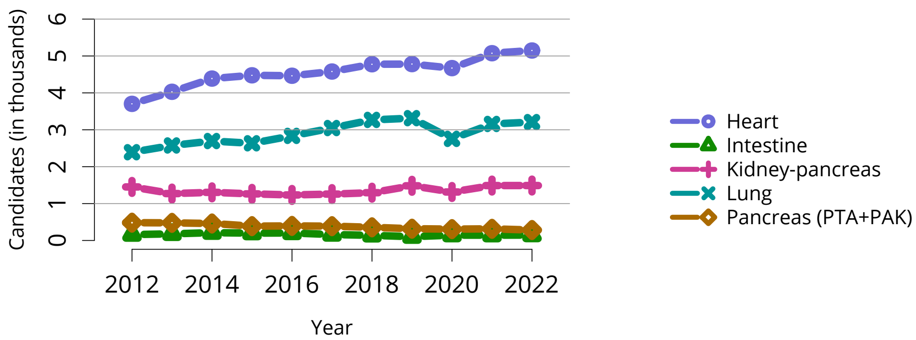
OPTN/SRTR 2022 Annual Data Report

Figure INT 2: All candidates on the waiting list for organs other than isolated kidney or liver. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the year. PAK, pancreas after kidney; PTA, pancreas transplant alone.



OPTN/SRTR 2022 Annual Data Report

Figure INT 3: New candidates added to the kidney or liver waiting list during the year. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure INT 4: New candidates added to the waiting list during the year for organs other than isolated kidney or liver. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included. PAK, pancreas after kidney; PTA, pancreas transplant alone.

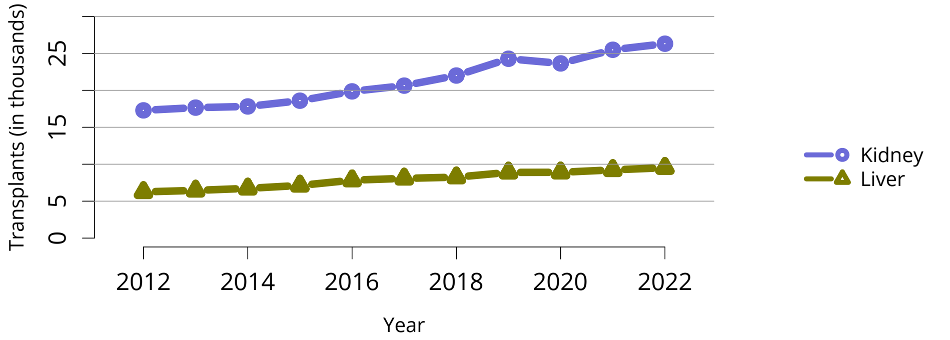


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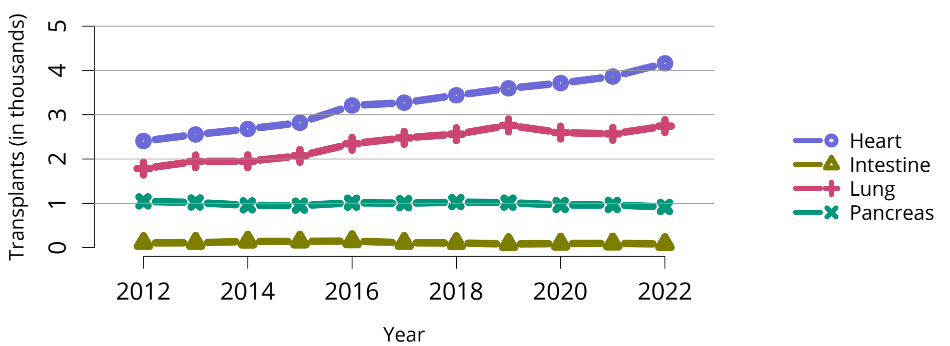
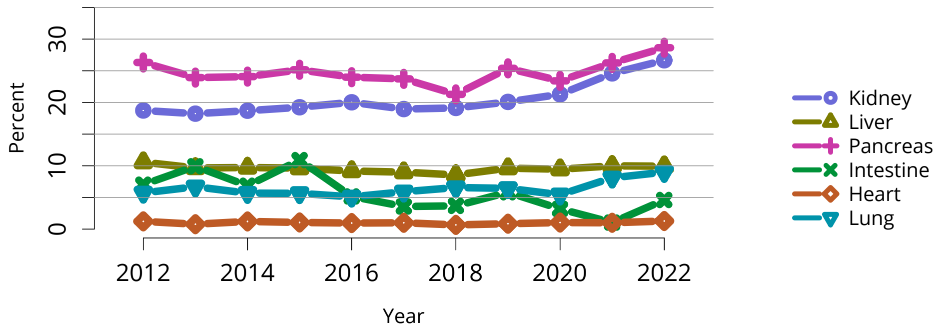
Figure INT 5: Total counts of kidney or liver transplants. Kidney: patients undergoing kidney or simultaneous pancreas-kidney transplant. Retransplants and multiorgan transplants are included.



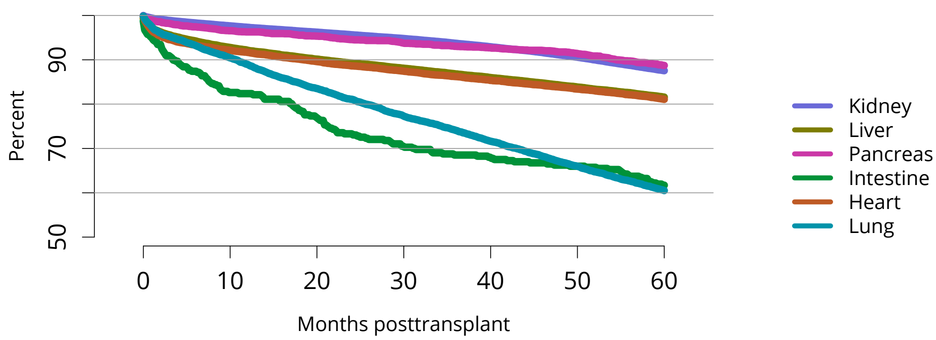
OPTN/SRTR 2022 Annual Data Report

Figure INT 6: Total counts of transplants for organs other than isolated kidney or liver. Pancreas: patients undergoing pancreas or simultaneous pancreas-kidney transplant. Heart: patients undergoing heart or heart-lung transplant. Lung: patients undergoing lung or heart-lung transplant. Retransplants and multiorgan transplants are included.



OPTN/SRTR 2022 Annual Data Report

Figure INT 7: Rates of organs recovered for transplant and not transplanted. Percentage of organs not transplanted out of all organs recovered for transplant. Kidneys and lungs recovered en bloc are counted once, and those recovered separately are counted twice.



OPTN/SRTR 2022 Annual Data Report

Figure INT 8: Patient survival among all transplant recipients, 2015-2017, by organ. Patient survival estimated using unadjusted Kaplan-Meier methods. Similar overall survival rates for kidney and pancreas recipients and liver and heart recipients may obscure an organ's line on the graph.

OPTN/SRTR 2022 Annual Data Report: Kidney

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Abstract

The year 2022 had continued successes and challenges for the field of kidney transplantation, as the community adapted to ongoing surges of the COVID-19 pandemic and broader geographic organ distribution. The total number of kidney transplants in the United States reached a record count of 26,309, driven by continued growth in deceased donor kidney transplants (DDKTs). The total number of candidates listed for DDKT rose slightly in 2022 but remained below 2019 listing levels, with 12.4% of candidates having been waiting 5 years or longer. Following the height of the COVID-19 pandemic, pretransplant mortality in 2022 declined across age, race and ethnicity, sex, and blood type groups. Pretransplant mortality continued to vary substantially by donation service area. The proportion of deceased donor kidneys recovered but not used for transplant (nonuse rate) rose to a high of 26.7% overall, with greater nonuse of biopsied kidneys (39.8%), kidneys from donors aged 55 years or older (54.7%), and kidneys with a kidney donor profile index (KDPI) of 85% or greater (71.3%). Nonuse of kidneys from donors who are hepatitis

C virus (HCV) antibody positive rose to 30.2% but only slightly exceeded that of HCV antibody–negative donors. Disparities in access to living donor kidney transplant (LDKT) persist, especially for non-White and publicly insured patients. Delayed graft function continues an upward trend and occurred in 26.3% of adult kidney transplants in 2022. Five-year graft survival after LDKT compared with DDKT was 90.0% versus 81.4% for recipients aged 18-34 years and 80.8% versus 67.8% for recipients aged 65 years or older, respectively. The total number of pediatric kidney transplants performed in 2022 decreased to 705, its lowest point in the past decade; 502 (71.2%) were DDKTs and 203 (28.8%) were LDKTs. Among pediatric recipients, LDKT remains low, with continued racial disparities. The rate of DDKT among pediatric candidates has decreased by almost 25% since 2011. Congenital anomalies of the kidney and urinary tract remain the leading primary kidney disease diagnosis among pediatric candidates with a reported diagnosis. Most pediatric deceased donor recipients received a kidney from a donor with a KDPI of less than 35%. The rate of delayed graft function was 5.8% in 2022 and has been stable over the past decade. Long-term graft survival continues to improve, with superior outcomes for living donor transplant recipients.

Keywords: Deceased donor transplant, kidney transplantation, living donor transplant, transplant access, transplant outcomes, waitlist outcomes

1 Introduction

While kidney transplant provides eligible patients with end-stage kidney disease the best opportunity for long-term, dialysis-free survival at the lowest cost to the health care system,[1] maximizing transplant access, reducing access disparities, and optimizing long-term allograft survival are ongoing challenges. National urgencies to increase access to kidney transplant are receiving unprecedented attention from the federal government, ranging from the Executive Order on Advancing American Kidney Health[2] to ongoing regulatory and legislative actions directed at increasing deceased donor organ procurement and organ use, removing barriers to living donation, and overall transplant system modernization to improve performance and efficiencies. Surges of the COVID-19 pandemic continued to affect transplant practice in 2022, as the community approached a transition from navigating the public health emergency to managing an endemic infection. While kidney transplant from deceased donors continues to rise, this success is challenged by an ongoing increase in kidney nonuse rates, along with continued increases in cold ischemia times and delayed graft function in the context of broader geographic organ sharing. Only a small proportion of kidney transplant candidates receive living donor allografts, at static rates characterized by sociodemographic disparities. The Annual Data Report provides an opportunity to assess the state of kidney transplantation and examine successes along with concerning trends that warrant further monitoring and evaluation. Data on US adult and pediatric kidney transplant waiting lists, deceased and living donation, transplants, and outcomes are provided.

2 Adult Kidney Transplant

2.1 Waiting List

The number of adult candidates added to the kidney waiting list during the year 2022 rose to a high of 44,187, reflecting ongoing recovery from the COVID-19 pandemic–related decline to 37,400 in 2020 and exceeding the 2019 prepandemic waitlist addition peak of 42,932 (Figure KI 1). The total number of adult candidates listed for kidney transplant (including multiple listings for those listed at more than one center) rose slightly to 140,165, compared with 139,011 in 2021, but remained below the 144,058 candidates listed in 2019 (Figure KI 2). There were 4,454 waitlist removals due to death in 2022, a notable decrease from 5,283 in 2021 during the COVID-19 pandemic; however, the 4,504 waitlist removals due to being too sick for transplant in 2022 reflect an increase from 4,058 in 2021, and waitlist removals for other reasons aside from transplant were also higher in 2022 (Table KI 5). The trend of a gradual increase in the age of candidates on the waiting list over the past decade persisted (Figure KI 3). Candidates aged 50-64 years at listing remained the largest age group (42.3% of listed candidates), while the proportion of candidates aged 65 years or older rose slightly to a high of 26.5% (Figure KI 3). The sex distribution of the waiting list was largely unchanged, with men making up 61.9% of kidney candidates (Figure KI 4). Since 2011, the proportions of Asian and Hispanic candidates on the kidney waiting list have gradually increased, accompanied by a decline in the proportion of White candidates, but the distribution in 2022 was stable compared with 2021 (Figure KI 5). The distribution of primary kidney failure diagnoses was stable in 2022, with diabetes (38.3%) and hypertension (20.4%) as the most common identified causes (Figure KI 6).

The proportion of candidates prevalent on the waiting list with waiting time less than 1 year rose to 36.1% in 2022, up from 34.2% in 2021 and 31.4% in 2020, while 12.4% on the waiting list at some point in 2022 have been waiting 5 years or longer, a proportion that has decreased in recent years (Figure KI 7). The proportion of waitlisted candidates with a high body mass index (BMI) also continued to increase slightly in 2022, with 18.9% having a BMI of 35 kg/m^2 or greater, while a stable 27.4% had a BMI of 30 to less than

35 kg/m^2 (Figure KI 8). Encouragingly, the proportion of candidates waitlisted before starting dialysis continued to increase, reaching 25.6% in 2022, although 15.9% of those waitlisted had been on dialysis for 6 or more years (Figure KI 9). The distribution of candidates across blood groups remained stable in 2022, with 52.6% of waitlisted kidney candidates having blood type O (Figure KI 10). The proportion of candidates with a previous transplant was 11.0% in 2022, reflecting a gradual decline from 15.0% in 2011 (Figure KI 11).

The proportion of candidates willing to accept a kidney with a high kidney donor profile index (KDPI) decreased slightly in all age groups in 2022 compared with 2021, continuing a decline after implementation of the revised kidney allocation system (KAS) in December 2014 (Figure KI 12). Only 49.0% of candidates aged 50-64 years and 63.9% of candidates aged 65 years or older were willing to accept these kidneys (Figure KI 12), even though patients aged 50 years and older have a lower rate of deceased donor kidney transplant (DDKT) under the current KAS compared with younger patients (Figure KI 15). Conversely, the proportion of candidates willing to accept a kidney from a donor who is hepatitis C virus (HCV) antibody positive continued to increase sharply, to 46.4% in 2022, correlating with availability of highly effective direct-acting antiviral agents and experience using these regimens to manage anticipated donor-derived infections (Figure KI 13).

Rates of DDKT among adult waitlisted candidates continued to increase in 2022, after a nadir in 2014 (Figure KI 14). Increased rates were noted across all age groups (Figure KI 15) and primary kidney disease diagnosis groups (Figure KI 17). Rates of DDKT rose across racial and ethnic groups, especially among Asian, Black, and Multiracial candidates, such that Black candidates had the highest DDKT rate among the groups in 2022 (22.3 per 100 patient-years) (Figure KI 16). Rates of DDKT among patients with calculated panel-reactive antibody (cPRA) levels of 80% and higher showed slight declines in 2022 compared with 2021, while DDKT rates among those with cPRA less than 1% rose from 19.8 to 21.4 per 100 patient-years (Figure KI 18). In 2022, DDKT rates were highest in those with cPRA levels of 80%-<98%, at 30.9 per 100 patient-years (Figure KI 18). Rates of DDKT rose across candidate blood groups in 2022, reaching a high of 39.0 per 100 patient-years in those with blood type AB (Figure KI 19). In 2022, DDKT rates increased across those with waiting times less than 5 years (Figure KI 20). Among those with 5 or more years of waiting time, the rate declined slightly to 19.2 per 100 patient-years, compared with 19.5 per 100 patient-years in 2021 (Figure KI 20). Rates of DDKT were similar between men and women in 2022, remaining slightly higher in women since 2016 (Figure KI 21).

For patients waitlisted in 2017-2019, 31.4% were still waiting 3 years after listing;

28.9% had undergone DDKT, 14.0% had undergone living donor kidney transplant (LDKT), 6.5% had died, and 19.2% were removed from the waiting list (Figure KI 22). The proportion of patients who underwent DDKT within 3 months rose to a high of 11.8% among those listed in 2021, while the percentage who underwent DDKT within 3 years also continued to increase (Figure KI 23).

Following the height of the COVID-19 pandemic, pretransplant mortality declined in 2022 to 5.4 deaths per 100 patient-years, compared with 6.2 per 100 patient-years in 2021 (Figure KI 24), with decreases across age (Figure KI 25), race and ethnicity (Figure KI 26), sex (Figure KI 27), and blood type groups (Figure KI 29). Considered by blood type, pretransplant mortality was lowest for those with type AB, the group with the highest DDKT rate (Figure KI 29). Pretransplant mortality declined in all diagnosis groups except glomerulonephritis (Figure KI 28), but those with glomerulonephritis or cystic kidney disease continued to have the lowest mortality rates (Figure KI 28). Pretransplant mortality continued to vary substantially by donation service area, from 1.8 to 7.5 deaths per 100 patient-years (Figure KI 30).

Death within 6 months of removal from the waiting list (for waitlist removal reasons other than transplant or death) declined in 2022 compared with 2021 (Figure KI 31), including among both women and men (Figure KI 35). Considered by diagnosis group, mortality after waitlist removal declined for those with diabetes, hypertension, and Other/unknown causes, but increased in those with cystic kidney disease or glomerulonephritis (Figure KI 32). By age, death within 6 months of waitlist removal rose slightly for candidates aged 65 years and older but declined in all other age groups (Figure KI 33). By race, death within 6 months of waitlist removal rose for Asian candidates, was stable for White candidates, and declined for Black, Hispanic, and especially Multiracial and Native American candidates (Figure KI 34).

2.2 Deceased Donation

The counts of deceased donors from whom at least one kidney was recovered for transplant continued to increase in 2022 (Figure KI 36), particularly among donors aged 30 years and older (Figure KI 37). The counts of HCV antibody–positive deceased donors from whom kidneys were recovered also rose in 2022 (Figure KI 38), although the proportion (10.5%) has been stable since 2019 (Figure KI 42). The racial and ethnic distribution of deceased kidney donors remained largely unchanged over the past decade (Figure KI 41), and the predominance of male deceased donors in 2022 (62.3%) was stable compared with 2021 (Figure KI 40). In 2022, the proportion of deceased kidney donors aged 29 years and younger declined compared with 2021, the proportion aged 30-54 years was stable, and the proportion aged 55 years and older increased (Figure KI 39). The proportion of deceased kidney donors who died of head trauma declined slightly in 2022, while the proportion with Other/unknown causes of death rose slightly in 2022 compared with 2021 (Figure KI 43).

Overall, the proportion of deceased donor kidneys recovered but not transplanted (nonuse rate) rose to a notable high of 26.7% in 2022 compared with 17.9% in 2011 (Figure KI 44), in the context of the broader geographic organ distribution and the continuing COVID-19 pandemic, but also varied substantially by donor characteristics. Nonuse rates were highest for kidneys recovered from donors aged 55 years or older, reaching 54.7% in 2022 (Figure KI 45). The nonuse rate was also higher in kidneys recovered from donors with diabetes, hypertension, or elevated BMI, compared to donors without each of these characteristics, respectively (Figure KI 46, Figure KI 49, and Figure KI 50). In 2022, the nonuse rate was slightly higher for kidneys recovered from Asian and Black donors (30.8% and 29.1%, respectively) compared with White donors (27.0%), while nonuse was lower for kidneys recovered from donors in the Hispanic and Other categories (Figure KI 48). Recovered kidneys from which biopsies were obtained continued to have rising nonuse rates, up to 39.8% in 2022 (Figure KI 52). The proportion of unused kidneys recovered from HCV antibody–positive donors declined sharply from 2013 to 2020, but increased to 30.2% in 2022 (Figure KI 54). A *lower* proportion of kidneys from donors with increased infection risk as defined by the US Public Health Service guidelines were not used compared with kidneys from donors with standard infection risk in 2022 (21.3% versus 27.9%) (Figure KI 55), perhaps because kidneys with increased infection risk are often from younger donors,[3] and otherwise of high quality with low KDPI. In 2022, the nonuse rate of kidneys with a KDPI of 85% or greater reached a high of 71.3% (Figure KI 57), while the nonuse rate of kidneys from donation after circulatory death donors rose to 33.9% (Figure KI 56).

2.3 Living Donation

Following a rise in the number of LDKTs from 5,809 in 2017 up to 6,855 in 2019, LDKTs decreased to 5,226 in 2020 during the COVID-19 pandemic, partially recovered to 5,955 in 2021, and then slightly declined to 5,798 in 2022 (Figure KI 58). In 2022, among LDKTs performed, spousal donations increased and related donations declined, while direct, distantly related (defined as a biological relative other than a parent, child, full or half sibling) and paired kidney donations were stable compared with 2021, with 19.1% of LDKTs performed through donor exchanges (Figure KI 58). Only a small proportion of the waiting list receives an LDKT each year, despite government initiatives to reduce financial barriers to living donation and to encourage early LDKT.[4]

In 2022, the proportion of living kidney donors aged 40 years or older rose slightly, while the proportion aged 39 years and younger declined, with young adult living donors aged 18-29 years reaching a low of 12.9% (Figure KI 59). Living donors aged 40-54 years continued to make up the most common donor age group (Figure KI 59). In 2022, the proportion of living kidney donors who were women remained stably high, at 63.8% (Figure KI 60). The racial and ethnic composition of living donors in 2022 was relatively stable compared with 2021, including 69.4% White, 16.3% Hispanic, and 7.6% Black (Figure KI 61). Notably, this reflects a general decline in the proportion of Black living donors, from 11.9% in 2011 (Figure KI 61). The proportion of living donors who were obese, based on BMI greater than 30 kg/m^2, was stable in 2022 compared with 2021, at 23.5% (Figure KI 63). Most donation surgeries began as laparoscopic hand assisted (59.9%) or pure laparoscopy (38.3%) (Figure KI 62).

2.4 Transplants

The upward trajectory in total kidney transplants (which includes adult and pediatric) was modestly slowed by the COVID-19 pandemic in 2020, then continued to rise through 2022, reaching a high of 26,309 (Figure KI 64). This trend was driven by growth in DDKTs, which rose to a high of 20,446 in 2022 (Figure KI 65), predominantly from donors with a KDPI of less than 85%. In 2022, the proportion of DDKTs from donors classified as KDPI less than 20% showed a slight but continued increase to 24.9%, while most DDKTs were from donors with KDPI of 35%-<85% (69.0%), and only 6.1% of DDKTs were from donors with KDPI of 85% or greater (Figure KI 70). Distributions of total kidney transplants in 2022 were similar to 2021 distributions across recipient sex, race and ethnicity, and cause of kidney disease groups (Figure KI 67, Figure KI 68, and Figure KI 69). Considered by recipient age, total transplant counts increased most in recipients aged 50-64 years, and especially in those aged 65 years and older (Figure KI 66). In 2022, 90.7% of adult DDKTs and 91.1% of adult LDKTs were performed in first-time recipients (Table KI 8).

Disparities in access to LDKT persist. While 31.7% of adult waitlisted candidates on December 31, 2022, were Black (Table KI 1), Black patients made up only 12.8% of LDKT recipients versus 34.1% of DDKT recipients that year (Table KI 6). White patients made up 35.5% of the waiting list (Table KI 1), while 61.4% of LDKT recipients and 35.3% of DDKT recipients were White (Table KI 6). Most adult LDKT recipients (54.5%) had private insurance at the time of transplant, compared with 26.9% of DDKT recipients (Table KI 6); 62.5% of DDKT recipients were Medicare beneficiaries compared with 37.6% of LDKT recipients (Table KI 6). LDKT recipients tended to have less dialysis time and lower cPRA levels than DDKT recipients (Table KI 7). In 2022, 33.3% of adult LDKT recipients underwent transplant without dialysis, compared with 12.1% of DDKT recipients (Table KI 7).

Induction immunosuppression was used in 92.1% of adult kidney transplants in 2022, a stable proportion compared with 2021 (Figure KI 71). Most patients received tacrolimus and mycophenolate mofetil (MMF)–based maintenance regimens at discharge, with use of triple therapy including steroids and use of tacrolimus-MMF (without reported steroid use) stable at 67.8% and 25.1%, respectively (Figure KI 72). As noted previously, the proportion of adult DDKT recipients with peak cPRA levels of 98%-100% increased sharply after the 2014 KAS revision and then gradually declined, from 12.5% in 2015 to 6.3% in 2020, and remained stable at 6.1% in 2022 (Figure KI 73). Following the March 2021 KAS250 revision, there was an increase in the proportion of DDKT recipients with cPRA levels of 80%-98%, from 7.0% in 2020 to 10.4% in 2021, followed by a slight decline to 9.2% in 2022 (Figure KI 73). By comparison, only 0.9% of LDKT recipients in 2022 had peak cPRA levels of 98%-100%, while most LDKT recipients (69.5%) had peak cPRA levels of less than 1% (Figure KI 74).

2.5 Outcomes

Delayed graft function, defined as dialysis within the first 7 days posttransplant, has trended up over the past decade, occurring in 26.3% of adult kidney recipients in 2022 (Figure KI 75). Estimated glomerular filtration rate (eGFR) at 12 months, calculated using the 2021 race-free Chronic Kidney Disease–Epidemiology Collaboration creatinine-based equation, an early surrogate of allograft outcome, was 45 mL/min/1.73 m^2 or higher for 62.4% of DDKT recipients in 2021, reflecting a downtrend from 67.8% in 2016 (Figure KI 88). Among LDKT recipients, 79.8% had 12-month eGFR of 45 mL/min/1.73 m^2 or higher in 2021, a slight decline from 82.6% in 2016 (Figure KI 89). For transplants performed in 2021, acute rejection by 1 year was highest in recipients aged 18-34 years at 8.8% and lowest in recipients aged 65 years or older at 5.4% (Figure KI 90). Acute rejection at 1 year occurred in 10.8% of those who received both interleukin 2 receptor antibody with T-cell–depleting induction (Figure KI 91), likely in part reflecting regimen changes in patients with early complications. Acute rejection at 1 year was reported in 7.0% who received only interleukin 2 receptor antibody, 6.0% who received only T-cell–depleting induction, and 4.7% of the small subgroup whose transplants were managed without induction (Figure KI 91). Posttransplant lymphoproliferative disorder was uncommon in 2011-2017 adult kidney transplant recipients, reported in 1.7% and 0.5% of Epstein Barr virus (EBV)–negative and EBV-positive recipients, respectively, at 5 years posttransplant (Figure KI 92).

Among 2015-2017 adult DDKT recipients, 5-year graft survival was lowest among older (versus younger) recipients, with 67.8% graft survival at 5 years among recipients aged 65 years and older compared with 81.4% graft survival at 5 years among recipients aged 18-34 years (Figure KI 76). Compared with graft survival among White recipients, 5-year DDKT graft survival was higher among Asian, Hispanic, and Multiracial recipients, but lower among Black and Native American recipients (Figure KI 77). Graft survival was lower among recipients with diabetes as the cause of kidney failure (versus other causes; Figure KI 79), and recipients with BMI of 30 kg/m^2 or higher (versus BMI of 18.5-<25 kg/m^2; Figure KI 83). Five-year DDKT graft survival was 64.0% for allografts with KDPI of 85% or greater, compared with 84.5%, 81.3%, and 75.4% for those with KDPI <20%, KDPI 20%-<35%, and KDPI 35%-<85%, respectively (Figure KI 80). Five-year graft survival did not differ for donation after circulatory death transplants compared with donation after brain death transplants (Figure KI 81). Graft survival was lower after transplant of kidneys that underwent a procurement biopsy compared to kidneys transplanted without biopsy (73.7% versus 81.2%, respectively; Figure KI 82), which likely reflects the donor characteristics of biopsied kidneys, including higher KDPI.[5] Of note, the Organ Procurement and Transplantation Network implemented minimum kidney biopsy criteria in September 2022; this policy change states that organ procurement organizations "must make a reasonable effort to ensure that a procurement kidney biopsy is performed" for all adult donors meeting the listed criteria, including KDPI greater than 85%.[6] Given the aforementioned high nonuse rate of biopsied kidneys, the utility of procurement biopsy in informing appropriate organ use is a topic of ongoing controversy.[7]

Among 2015-2017 adult LDKT recipients, 5-year graft survival was 80.8% in recipients aged 65 years or older, compared with 90.0% in recipients aged 18-34 years (Figure KI 84). Five-year LDKT graft survival was lower in recipients with diabetic kidney failure compared with those with other disease causes (Figure KI 87), and similar in women and men (Figure KI 86). Compared with graft survival among White recipients, 5-year LDKT survival was higher among Asian and Hispanic recipients and lower among Black, Multiracial, and Native American recipients (Figure KI 85).

Trends in adult posttransplant patient survival generally paralleled patterns of graft survival (Figure KI 93, Figure KI 94, Figure KI 95, Figure KI 96, Figure KI 97, Figure KI 98, Figure KI 99, Figure KI 100, and Figure KI 101). Five years posttransplant, 72.0% of DDKT recipients and 83.0% of LDKT recipients aged 65 years or older were alive, compared with 95.8% and 97.9% of those aged 18-34 years, respectively (Figure KI 93 and Figure KI 99). Patient survival after DDKT was higher in women than in men (Figure KI 95). Compared with patient survival among White recipients, 5-year patient survival after DDKT and LDKT was higher among Asian, Black, Hispanic, and Multiracial recipients, but lower among Native American recipients; however, across racial groups, patient survival was higher after LDKT compared with DDKT (Figure KI 94 and Figure KI 101). Five-year patient survival was lowest among recipients with diabetes as the cause of kidney disease, at 78.1% for DDKT recipients with diabetes and 85.9% for LDKT recipients with diabetes (Figure KI 96 and Figure KI 100). Patient survival was also lower among DDKT recipients who received kidneys with a KPDI of 85% or greater and grafts that had undergone a procurement biopsy (Figure KI 97 and Figure KI 98).

3 Pediatric Kidney Transplant

3.1 Waiting List

In 2022, there were 1,099 pediatric candidates added to the kidney transplant waiting list (Figure KI 102). The number of prevalent pediatric candidates (listed before age 18 years) has increased by 31.7%, from 2,124 in 2011 to 2,797 in 2022 (Figure KI 103). By age, candidates aged 12-17 years accounted for the largest proportion of those waiting, at 36.7%, compared with those aged 18 years or older (ie, turned 18 while waiting) at 31.1%, 6-11 years at 17.8%, 1-5 years at 14.3%, and younger than 1 year at 0.07% (Figure KI 104). In terms of race and ethnicity, White candidates accounted for the largest group (42.7%) on the kidney transplant waiting list followed by Hispanic (27.9%), Black (19.6%), Asian (6.1%), Multiracial (2.8%), and Native American candidates (0.9%) (Figure KI 105). Over the past decade, candidate age, candidate sex, and distance of candidates from their transplant center have remained largely unchanged (Table KI 11). The proportion of Black candidates decreased by 32.0% since 2012 (Table KI 11). The proportion of candidates with congenital anomalies of the kidney and urinary tract as primary cause of disease continued to increase, from 27.8% in 2012 to 35.4% in 2022, and the proportions with glomerulonephritis and focal segmental glomerulosclerosis decreased (Table KI 12). Most pediatric candidates (68.4%) waiting on December 31, 2022, had a cPRA level of less than 1%, and there was a decline in the proportion of sensitized candidates with cPRA of 80% or greater (Table KI 12). The proportion of pediatric candidates waiting for retransplant (listed for retransplant before age 18) decreased over the past decade, from 31.2% in 2012 to 16.8% in 2022 (Table KI 13).

The distribution of waiting time among pediatric candidates on the waiting list has remained similar over the past decade, with almost 50% of pediatric candidates waiting for less than 1 year (Figure KI 108). In 2022, of the 1,018 candidates removed from the waiting list, 591 (58.1%) received a deceased donor kidney, 230 (22.6%) received a living donor kidney, 24 (2.4%) died, 13 (1.3%) were considered too sick to undergo transplant, and 9 (0.9%) were removed from the list because their condition improved (Table KI 14 and Table KI 15). Among patients newly listed in 2017-2019, within 3 years, 51.6% underwent DDKT, 24.6% underwent LDKT, 16.2% were still waiting, 6.6% were removed from the list for other reasons, and 1.1% died (Figure KI 110). Concerningly, the rate of DDKT among pediatric waitlisted candidates has decreased by 23.7%, from 44.9 transplants per 100 patient-years in 2011 to 34.3 transplants per 100 patient-years in 2022 (Figure KI 111). In 2022, transplant rates were highest for candidates aged 12-17 years (47.2 transplants per 100 patient-years), followed by candidates aged 6-11 years, 1-5 years, younger than 1 year, and 18 years or older (41.5, 36.5, 17.9, and 12.4 transplants per 100 patient-years, respectively) (Figure KI 112). By race and ethnicity, the highest transplant rates were among Hispanic (37.8 transplants by 100 patient-years) and Black candidates (36.4 transplants by 100 patient-years) followed by White (32.5 transplants by 100 patient-years) and Asian candidates (28.2 transplants by 100 patient-years) (Figure KI 113). Transplant rates typically vary by cPRA; the highest rates in 2022 were among candidates with cPRA levels of 20%-<80% (39.9 transplants per 100 patient-years) and less than 1% (36.4 transplants by 100 patient-years). The priority for highly sensitized (cPRA levels of 98%-100%) candidates continued to result in higher transplant rates than pre-KAS, at 13.8 transplants per 100 patient-years in 2022, which has remained steady since 2015 (Figure KI 114). Pretransplant mortality was 1.5 deaths per 100 patient-years in 2022 among pediatric candidates, which is unchanged from 1.4 deaths per 100 patient-years in 2011 (Figure KI 115).

3.2 Transplant

The total number of pediatric kidney transplants performed in 2022 decreased to its lowest point in the past decade, at 705; of these, 502 (71.2%) were DDKTs and 203 (28.8%) were LDKTs (Figure KI 119). The 203 LDKTs represent a decrease of 33% since 2011, when 303 were performed. Children aged 12-17 years made up the largest group of pediatric LDKT recipients (44.8%) (Figure KI 121).

In 2022, 34 programs were performing only pediatric kidney transplants (here, meaning age 0-17 years and a small number up to age 21 years), compared with 137 performing only adult transplants (18 years or older), 56 performing mixed transplants (in both adults and children of any age), and 8 performing transplants in the functionally adult category (performing 80% or more transplants in adults and the remainder in adolescents aged 15-17 years); these values represent an increase of 13.3%, an increase of 16.1%, a decrease of 13.8%, and a decrease of 61.9% since 2011, respectively (Figure KI 122).

Looking at transplant center volume, 18.4% of transplants in candidates younger than 18 years were performed at programs with a volume of five or fewer pediatric transplants in 2022 (Figure KI 123). Most pediatric recipients who underwent transplant in 2022 were aged 12-17 years: 59.6% of pediatric DDKT recipients and 44.8% of pediatric LDKT recipients (Table KI 16). The racial and ethnic distribution was notably different for pediatric DDKT and LDKT recipients. For LDKT recipients, 63.5% were White, followed by 16.7%, Hispanic; 11.8%, Black; 4.9%, Asian; 2.5%, Multiracial; and 0.5%, Native American (Table KI 16). In contrast, 39.6% of DDKT recipients were White, followed by 30.9%, Hispanic; 21.3%, Black; 5.2%, Asian; 2.8%, Multiracial; and 0.2%, Native American (Table KI 16). Private insurance was more common among LDKT recipients (51.7%) and Medicare/Medicaid among DDKT recipients (62.9%) (Table KI 16). Most pediatric DDKT recipients (97.8%) underwent transplant with a kidney from a donor with a KDPI of less than 35% (Table KI 18). Most pediatric DDKT recipients (82.2%) had four or more HLA mismatches compared with only 30.6% of LDKT recipients (Figure KI 126). Multiorgan transplant remained uncommon; only 2.6% of pediatric candidates received multiorgan transplant in 2022, with the most common being kidney-liver transplant (Table KI 18).

The combination of a donor who was positive for cytomegalovirus and a pediatric recipient who was negative occurred in 36.9% of DDKTs (Table KI 19) and in 29.0% of LDKTs (Table KI 20). The combination of a donor who was positive for EBV and a pediatric recipient who was negative occurred in 37.3% of DDKTs (Table KI 19) and in 56.6% of LDKTs (Table KI 20).

3.3 Immunosuppressive Medication Use

Almost all (93.9%) pediatric kidney transplant recipients reported some induction use in 2022 (Figure KI 124). The most common maintenance immunosuppression regimen at hospital discharge was tacrolimus, MMF, and steroids in 54.3% of recipients, followed by tacrolimus and MMF in 36.7% (Figure KI 125).

3.4 Outcomes

The rate of delayed graft function in pediatric recipients was 5.8% in 2022 and has been stable over the past decade (Figure KI 127). Short-term renal function, measured by eGFR, has remained stable over the past decade. Proportions of pediatric LDKT and DDKT recipients from 2021 with eGFR of 60 mL/min/1.73 m^2 or higher at 12 months posttransplant were 69.8% and 69.2%, respectively (Figure KI 128 and Figure KI 129). Graft failure after DDKT in pediatric recipients was 2.2% at 6 months and 2.7% at 1 year for transplants in 2021, 7.1% at 3 years for transplants in 2019, 12.3% at 5 years for transplants in 2017, and 31.4% at 10 years for transplants in 2012 (Figure KI 130). Corresponding graft failure after LDKT was 1.3% at 6 months and 2.1% at 1 year for transplants in 2021, 5.0% at 3 years for transplants in 2019, 6.0% at 5 years for transplants in 2017, and 20.6% at 10 years for transplants in 2012 (Figure KI 131). For the cohort of recipients who underwent transplant in 2015-2017, the 1-, 3-, and 5-year graft survival were 97.5%, 93.0%, and 86.3% for DDKT recipients and 98.5%, 96.4%, and 93.7% for LDKT recipients, respectively (Figure KI 132). Looking at graft survival by recipient age, the 1-year graft survival ranged from 95.8% (age 1-5 years) to 97.5% (age 6-11 years), to 98.1% (age 12-17 years), to 100% (younger than 1 year) for DDKT recipients from 2015-2017 (Figure KI 133). The 5-year graft survival ranged from 83.7% (age 12-17 years) to 88.7% (age 1-5 years), to 90.7% (age 6-11 years), to 100% (younger than 1 year) for DDKT recipients from 2015-2017 (Figure KI 133). In the 2021 cohort, the overall incidence of acute rejection within the first year ranged from 7.6% among patients aged 1-5 years to 10.9% among patients aged 6-11 years and 13.0% among patients aged 12-17 years (Figure KI 134). Incidence of posttransplant lymphoproliferative disorder among EBV-negative recipients in 2011-2017 was 3.4% at 5 years posttransplant, compared with 0.9% among EBV-positive recipients (Figure KI 135). Overall, 5-year patient survival among pediatric DDKT recipients in 2015-2017 was very high, at 97.1% (Figure KI 137), with little variability by age: 95.8% (age 1-5 years), 97.2% (age 6-11 years), and 97.5% (age 12-17 years) (Figure KI 138).

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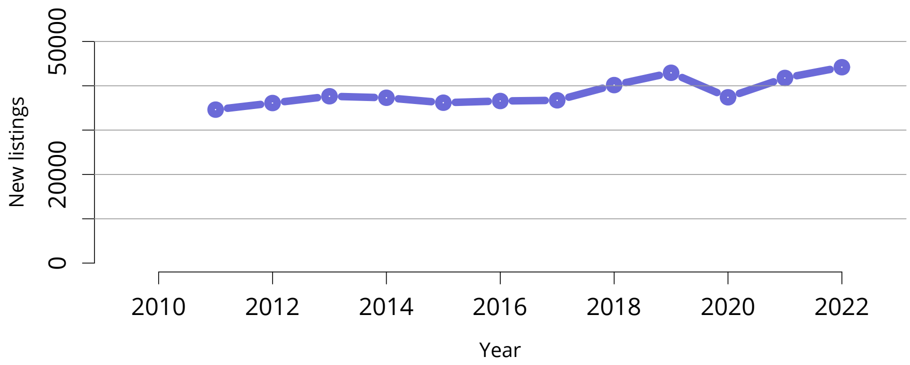

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Figure KI 1: New adult candidates added to the kidney transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing. Includes kidney and kidney-pancreas listings.

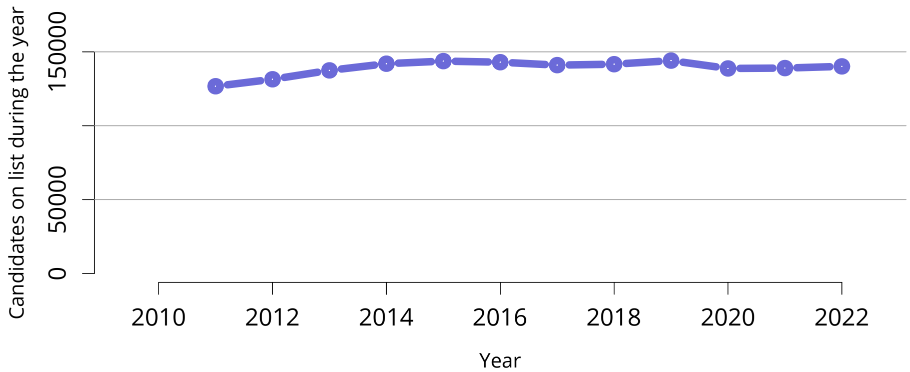

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Figure KI 2: All adult candidates on the kidney transplant waiting list. Adult candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing. Includes kidney and kidney-pancreas candidates.

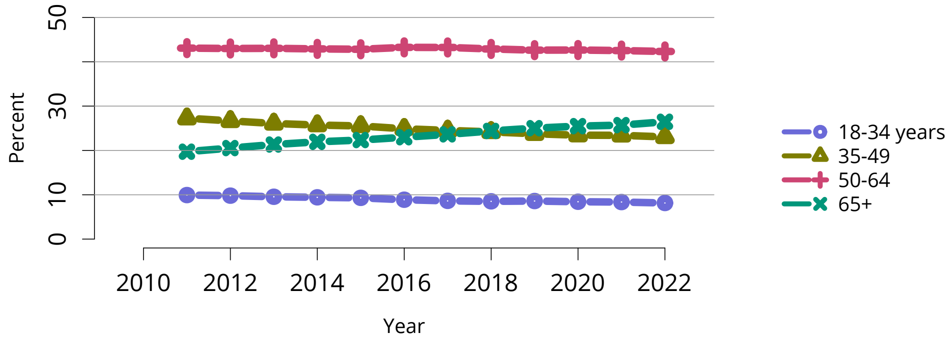

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Figure KI 3: Distribution of adults waiting for kidney transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.

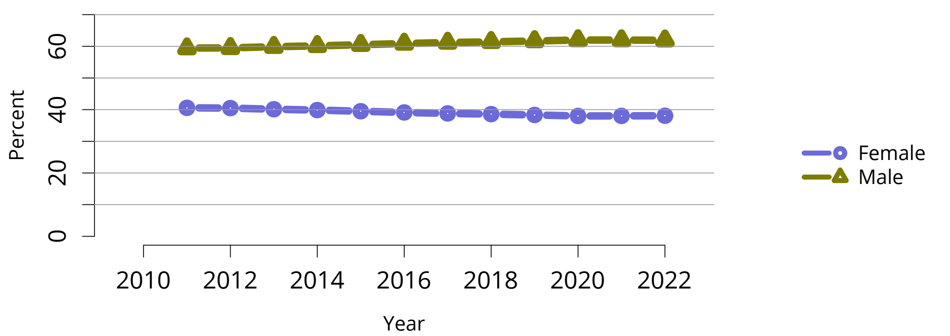

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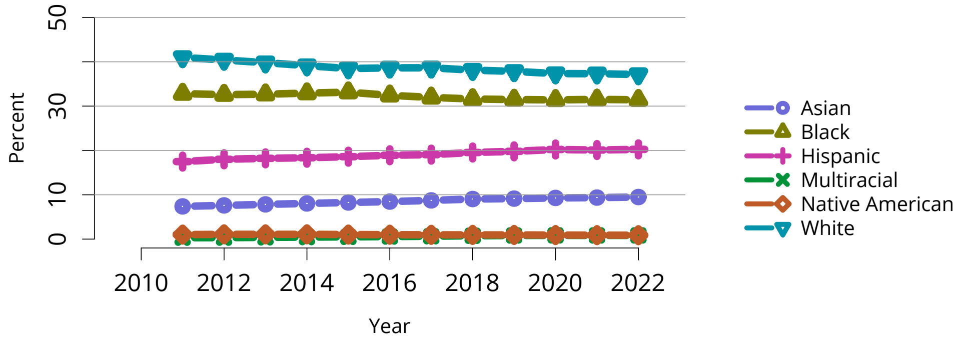
Figure KI 4: Distribution of adults waiting for kidney transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure KI 5: Distribution of adults waiting for kidney transplant by race and ethnicity. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

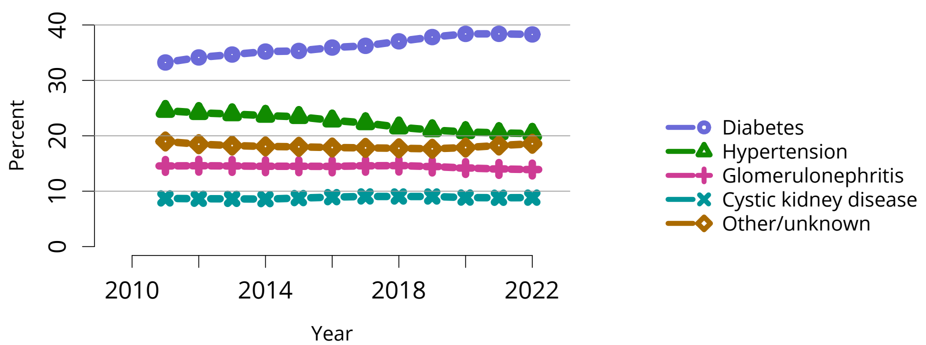


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Figure KI 6: Distribution of adults waiting for kidney transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

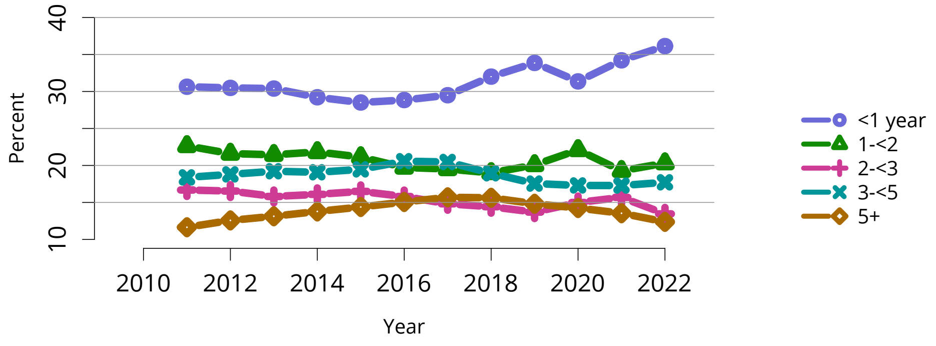

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Figure KI 7: Distribution of adults waiting for kidney transplant by waiting time (years). Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Candidates listed in the given year are considered to have been listed less than 1 year. Active and inactive candidates are included.

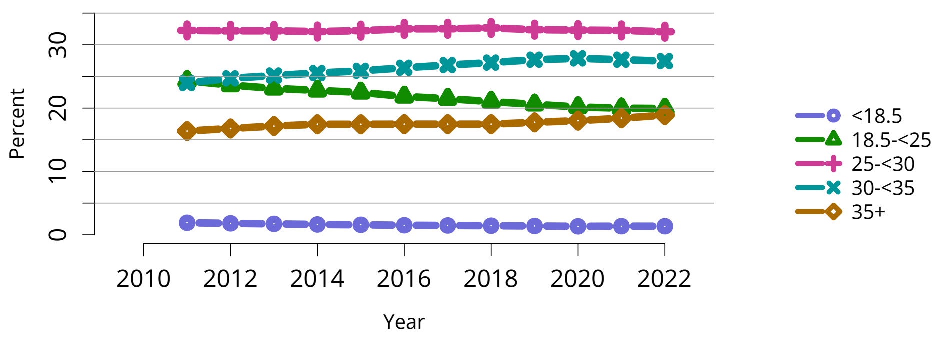

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Figure KI 8: Distribution of adults waiting for kidney transplant by BMI. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. BMI, body mass index.

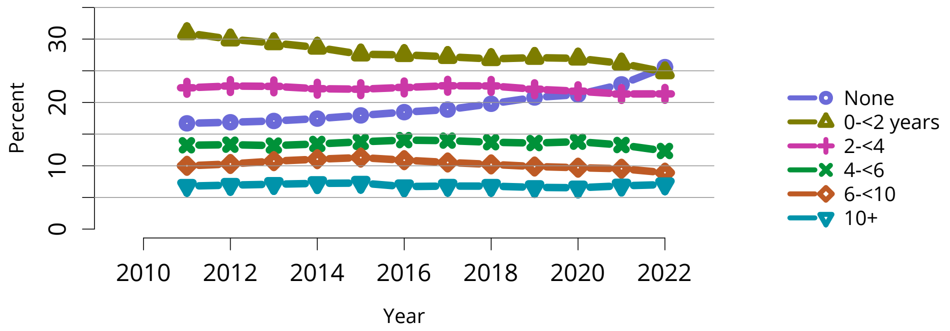

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Figure KI 9: Distribution of adults waiting for kidney transplant by years on dialysis. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Time on dialysis is computed as time from minimum of first end-stage renal disease service date or most recent graft failure to listing date or January 1 of the given year. Active and inactive candidates are included.

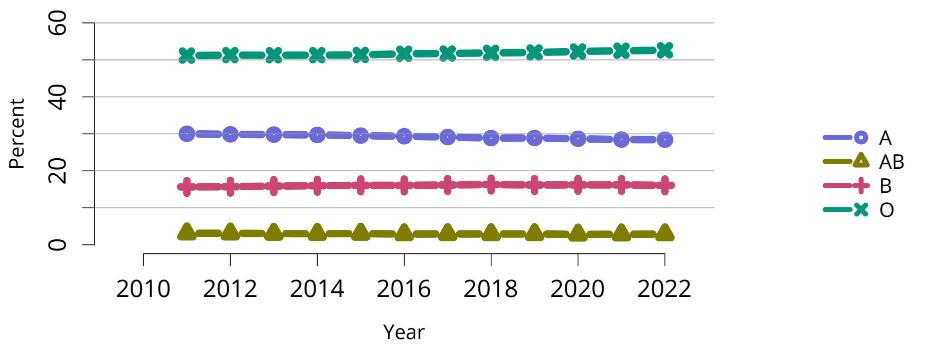

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Figure KI 10: Distribution of adults waiting for kidney transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

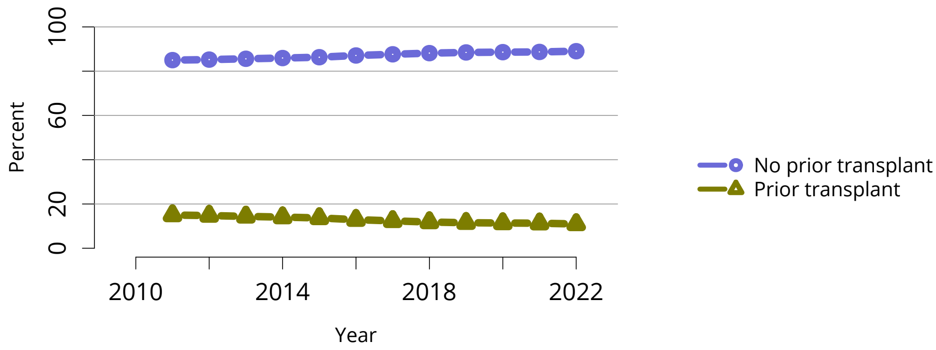

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Figure KI 11: Distribution of adults waiting for kidney transplant by prior transplant status. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

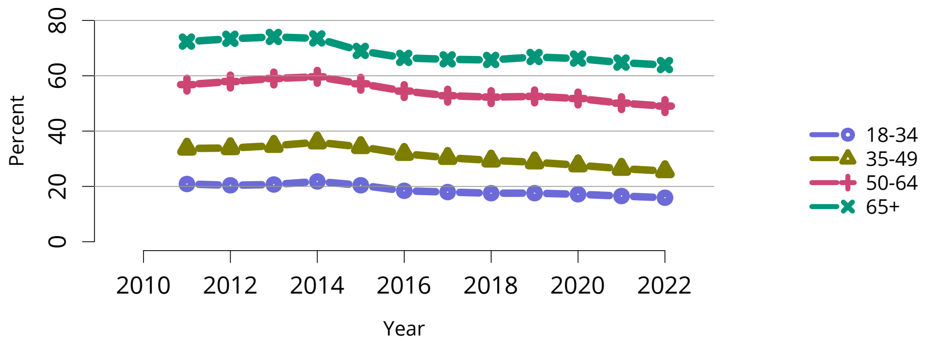

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Figure KI 12: Adults willing to accept a kidney designated ECD or KDPI >= 85% by age. Adults waiting for kidney transplant on December 31 of the given year. Candidates listed at more than one center are counted once per listing. Willingness to accept ECD kidney at time of listing or willingness to accept a local non-zero HLA mismatch KDPI >=85% kidney at the later of listing date or January 1 of the given year, beginning in 2014. ECD, expanded-criteria donor; KDPI, kidney donor profile index.

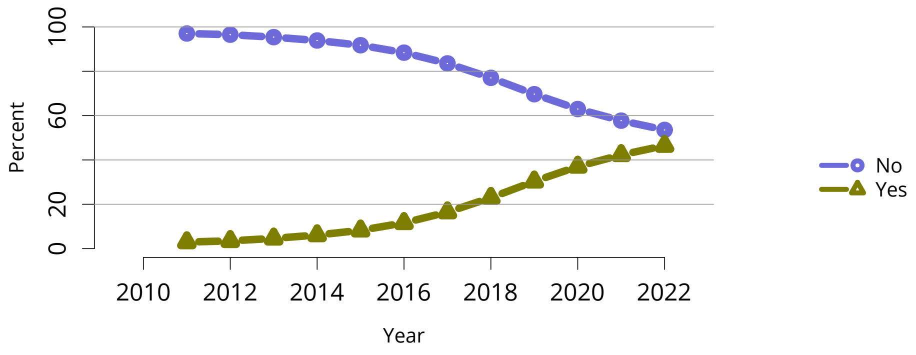

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Figure KI 13: Adults willing to accept kidney from HCV+ donor. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Willingness to accept HCV+ organ at time of listing. HCV, hepatitis C virus.

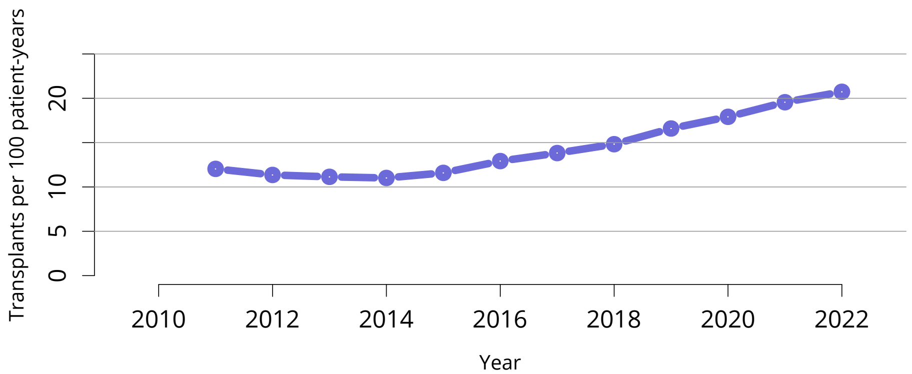

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Figure KI 14: Overall deceased donor kidney transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

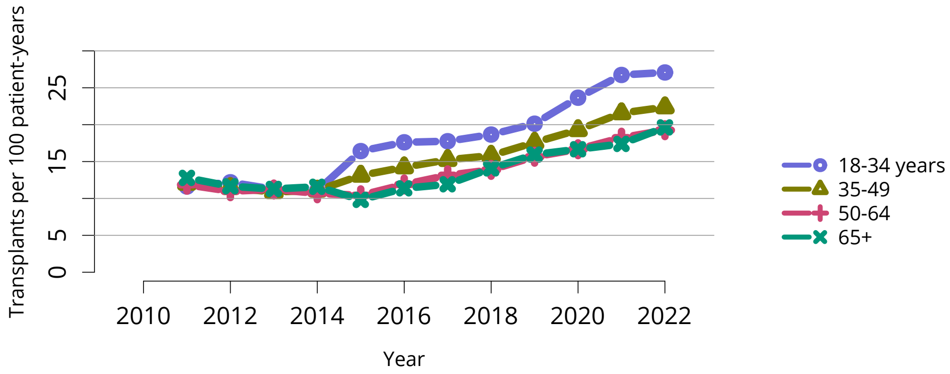

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Figure KI 15: Deceased donor kidney transplant rates among adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

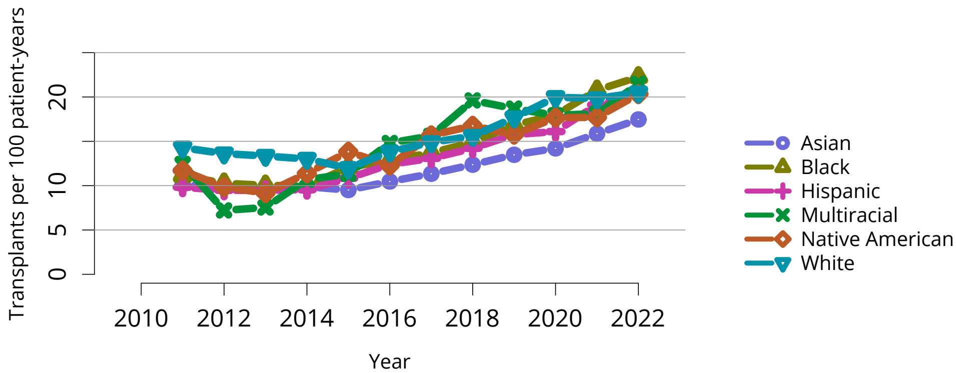

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Figure KI 16: Deceased donor kidney transplant rates among adult waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

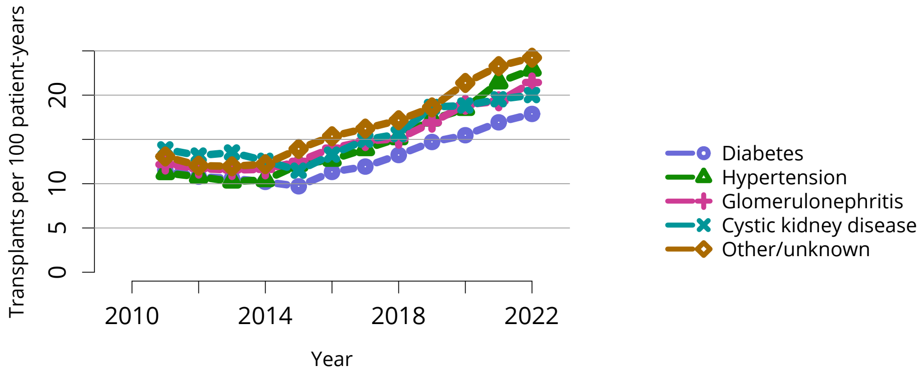

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Figure KI 17: Deceased donor kidney transplant rates among adult waitlist candidates by diagnosis. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

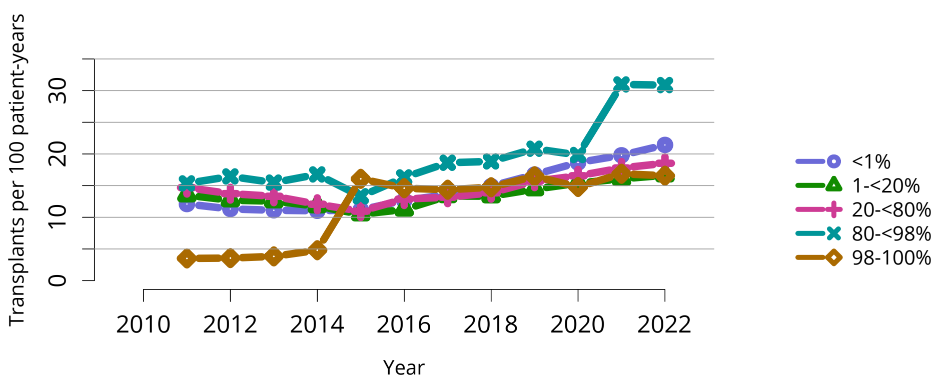

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Figure KI 18: Deceased donor kidney transplant rates among adult waitlist candidates by cPRA. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. cPRA is determined at the later of listing date or January 1 of the given year. cPRA, calculated panel-reactive antibody.

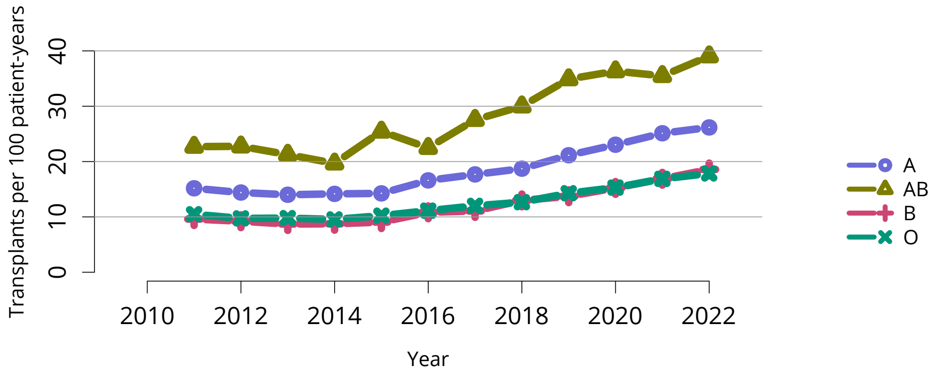

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Figure KI 19: Deceased donor kidney transplant rates among adult waitlist candidates by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

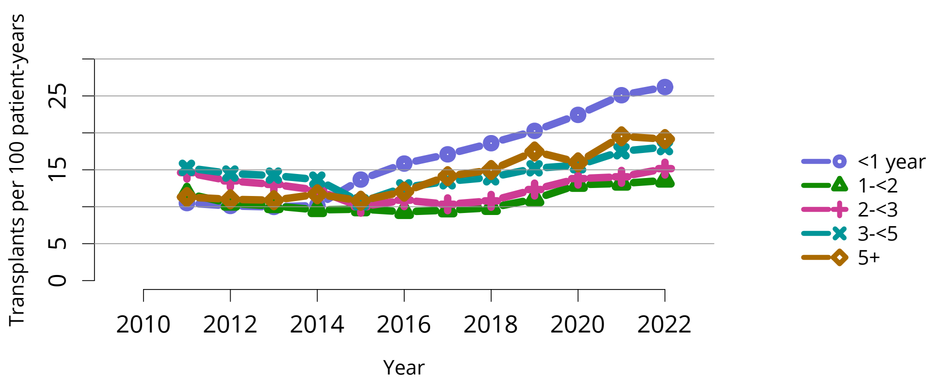

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Figure KI 20: Deceased donor kidney transplant rates among adult waitlist candidates by time on the waiting list. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

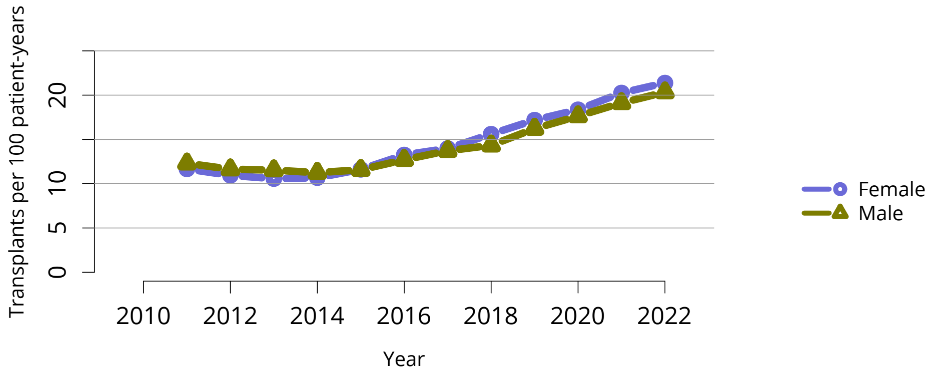

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Figure KI 21: Deceased donor kidney transplant rates among adult waitlist candidates by sex. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

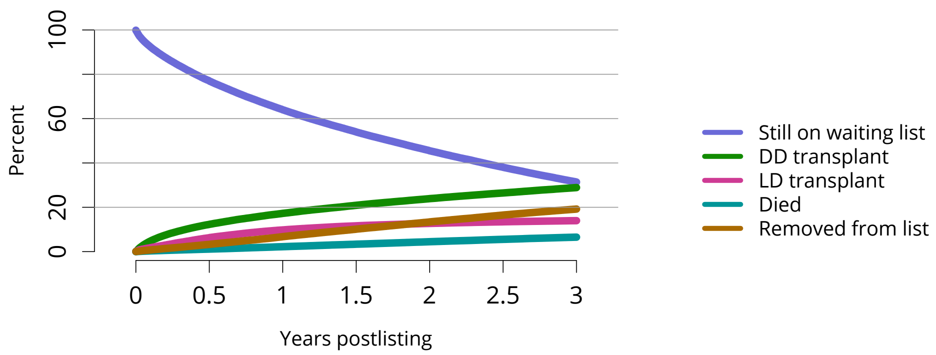

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Figure KI 22: Three-year outcomes for adults waiting for kidney transplant, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor; LD, living donor.

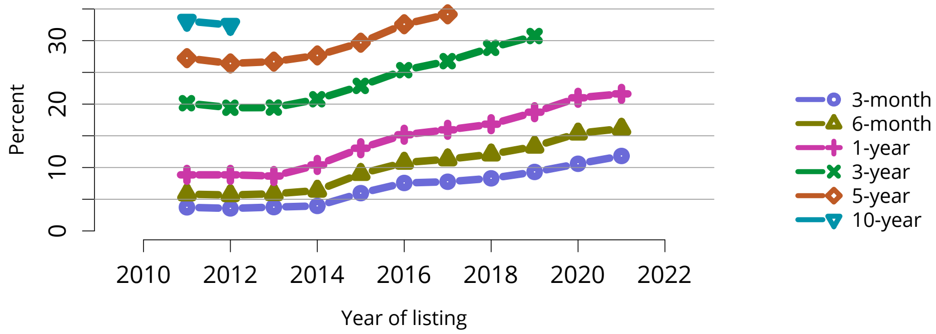

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Figure KI 23: Percentage of adults who underwent deceased donor kidney transplant within a given period of listing. Candidates listed at more than one center are counted once per listing.

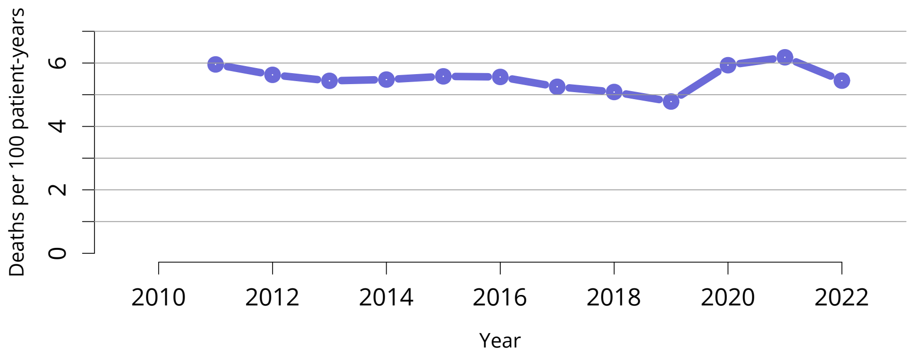

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Figure KI 24: Overall pretransplant mortality rates among adults waitlisted for kidney transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

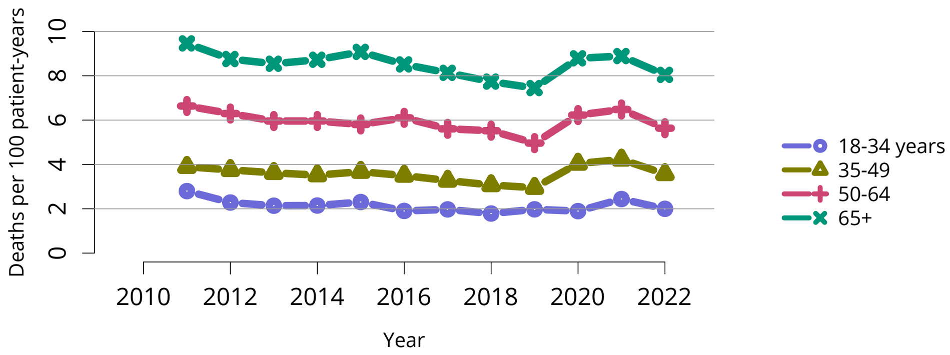

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Figure KI 25: Pretransplant mortality rates among adults waitlisted for kidney transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

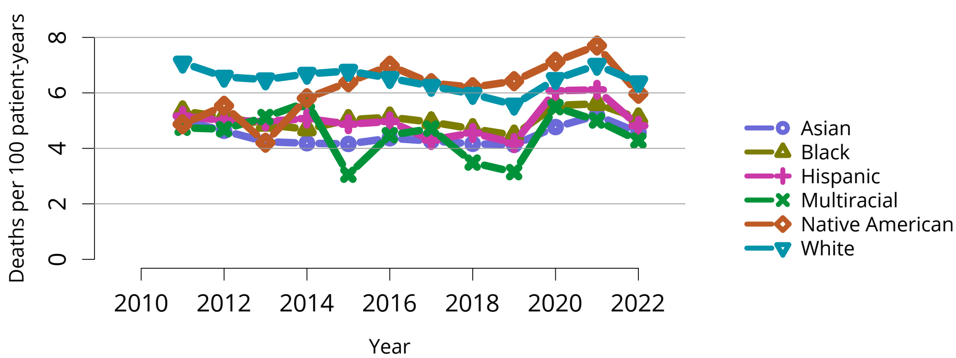

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Figure KI 26: Pretransplant mortality rates among adults waitlisted for kidney transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

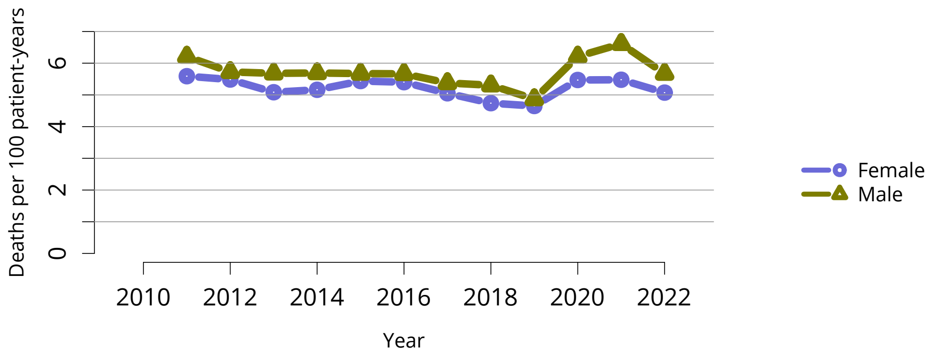

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Figure KI 27: Pretransplant mortality rates among adults waitlisted for kidney transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

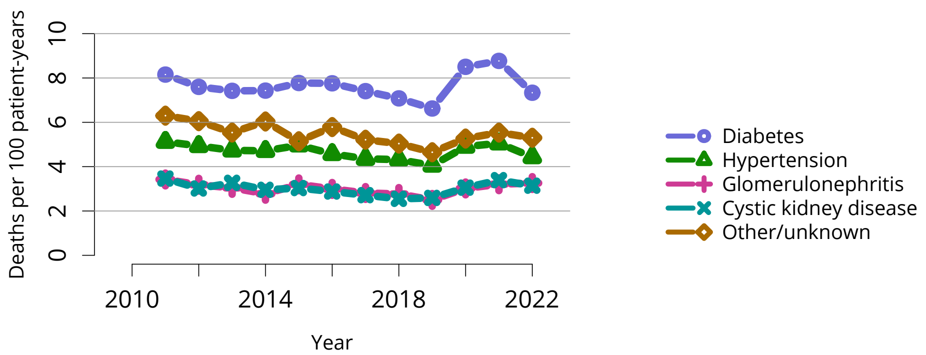

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Figure KI 28: Pretransplant mortality rates among adults waitlisted for kidney transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

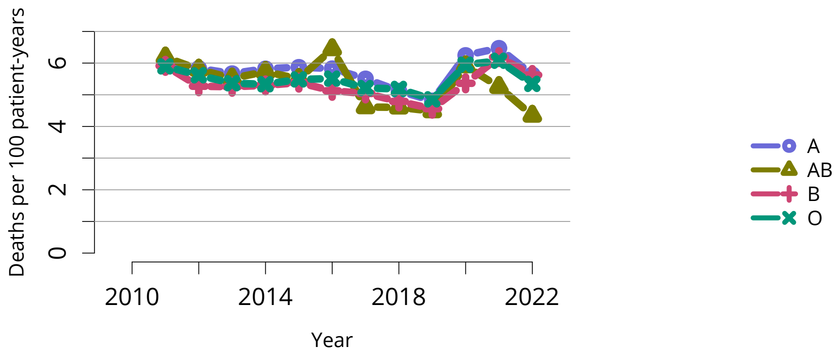

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Figure KI 29: Pretransplant mortality rates among adults waitlisted for kidney transplant by blood type. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

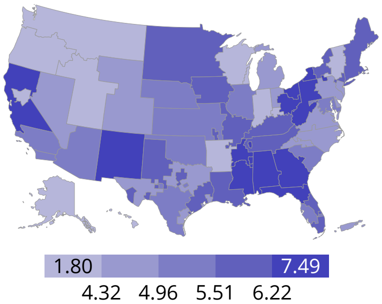

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Figure KI 30: Pretransplant mortality rates among adults waitlisted for kidney transplant in 2022 by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. DSA, donation service area.

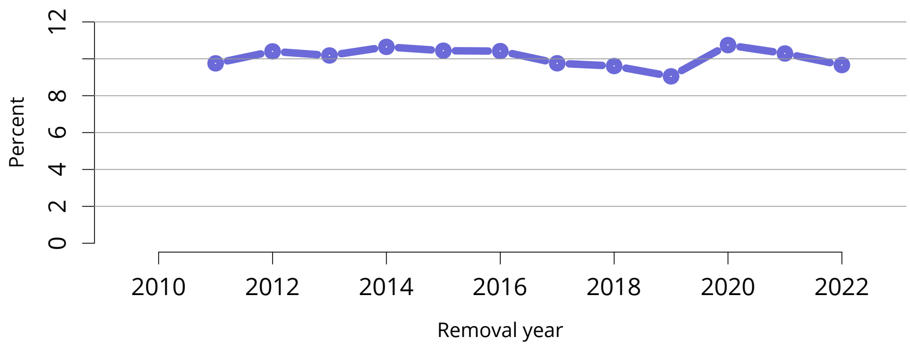

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Figure KI 31: Deaths within 6 months after removal among adult kidney waitlist candidates, overall. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

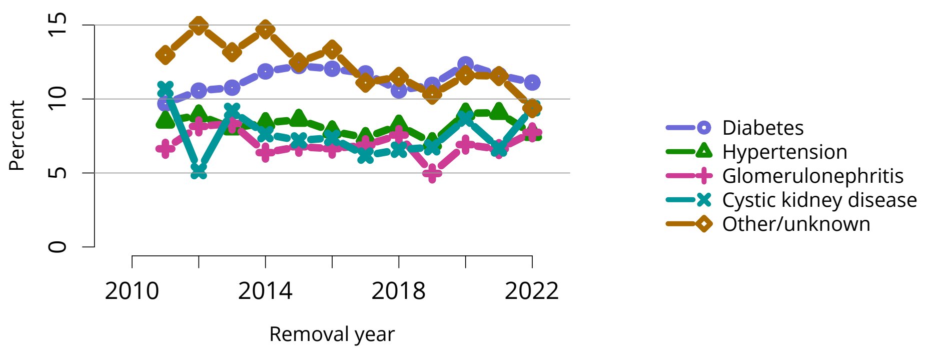

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Figure KI 32: Deaths within 6 months after removal among adult kidney waitlist candidates, by diagnosis group at removal. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

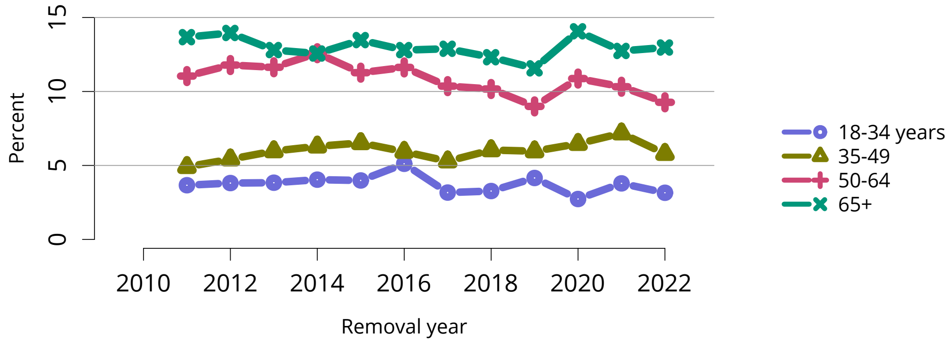

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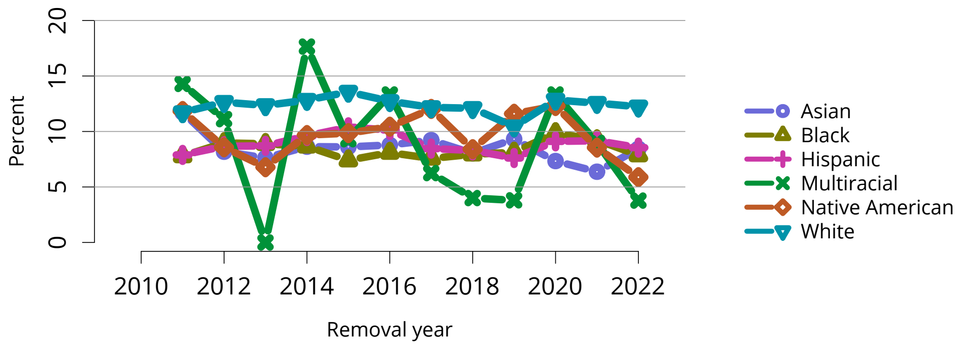
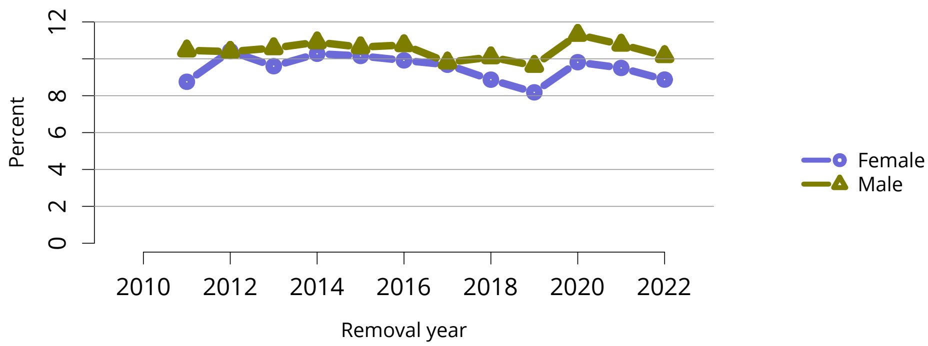
Figure KI 33: Deaths within 6 months after removal among adult kidney waitlist candidates, by age. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. Age is determined at removal.



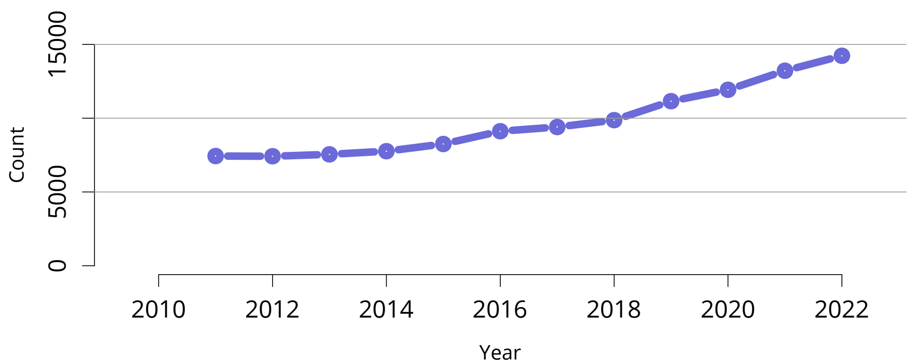
OPTN/SRTR 2022 Annual Data Report

Figure KI 34: Deaths within 6 months after removal among adult kidney waitlist candidates by race and ethnicity. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.



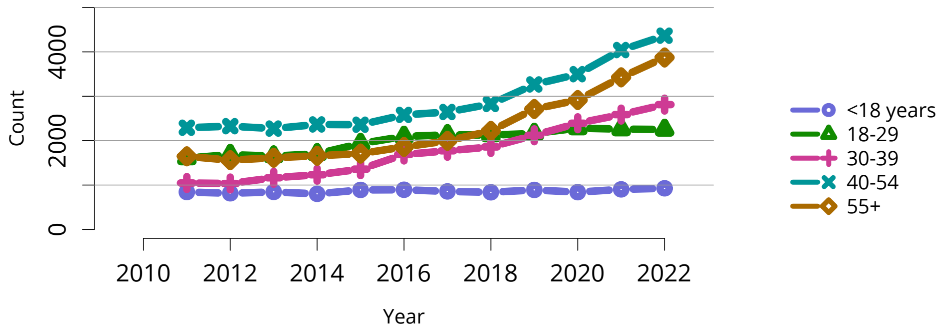
OPTN/SRTR 2022 Annual Data Report

Figure KI 35: Deaths within 6 months after removal among adult kidney waitlist candidates, by sex. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.



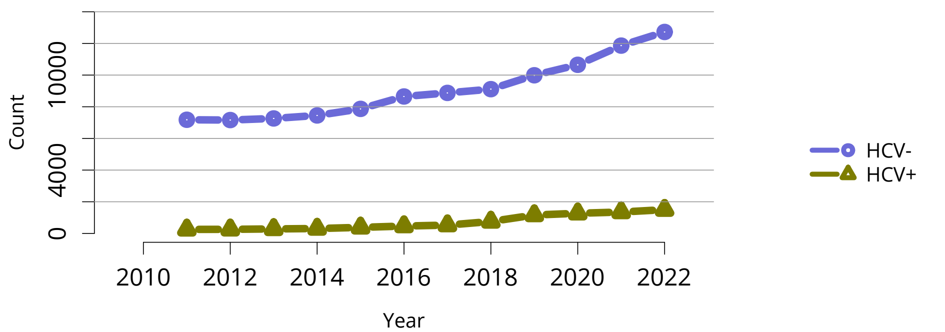
OPTN/SRTR 2022 Annual Data Report

Figure KI 36: Overall deceased kidney donor count. Count of deceased donors from whom at least one kidney was recovered for transplant.



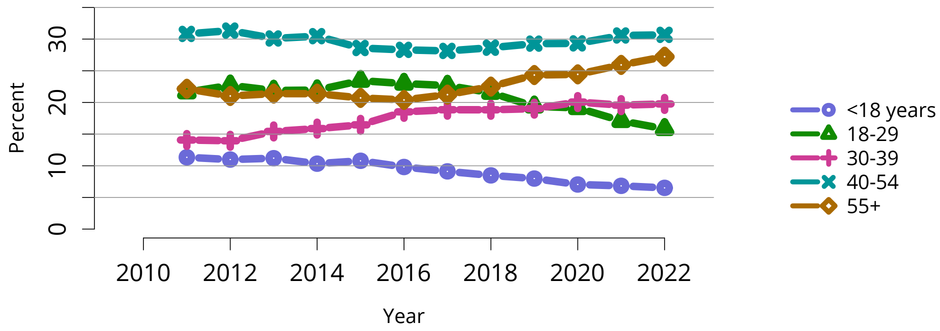
OPTN/SRTR 2022 Annual Data Report

Figure KI 37: Deceased kidney donor count by age. Count of deceased donors from whom at least one kidney was recovered for transplant.



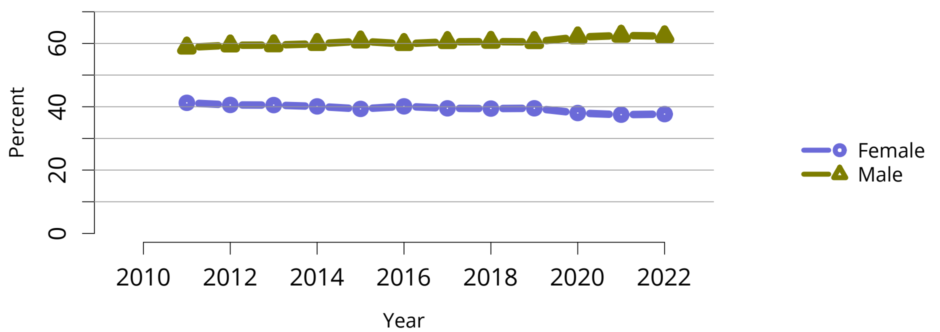
OPTN/SRTR 2022 Annual Data Report

Figure KI 38: Deceased kidney donor count by HCV status. Count of deceased donors from whom at least one kidney was recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



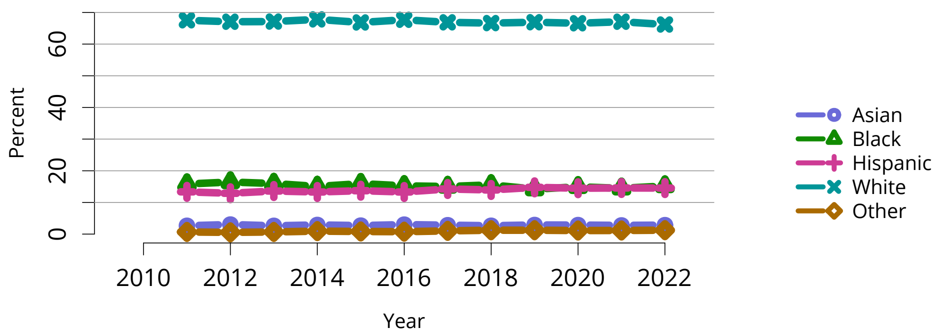
OPTN/SRTR 2022 Annual Data Report

Figure KI 39: Distribution of deceased kidney donors by age. Deceased donors from whom at least one kidney was recovered for transplant.



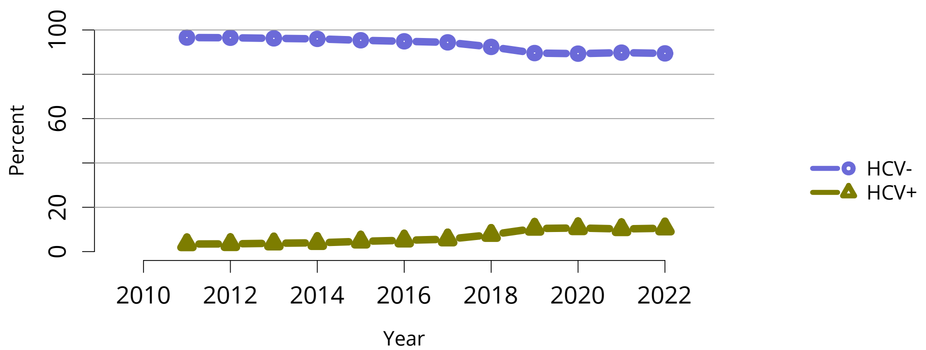
OPTN/SRTR 2022 Annual Data Report

Figure KI 40: Distribution of deceased kidney donors by sex. Deceased donors from whom at least one kidney was recovered for transplant.



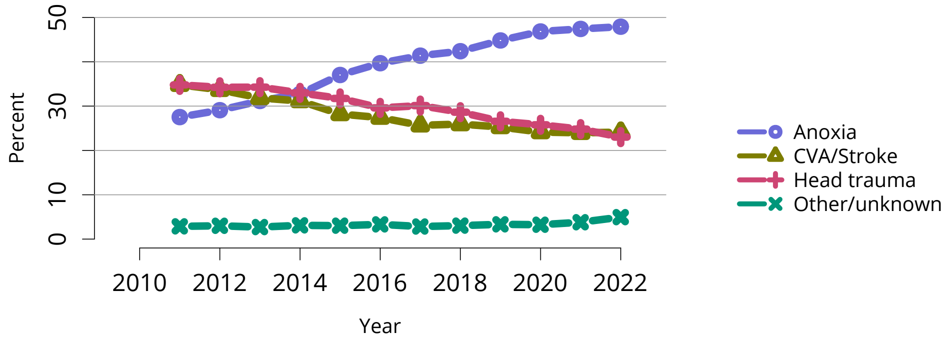
OPTN/SRTR 2022 Annual Data Report

Figure KI 41: Distribution of deceased kidney donors by race and ethnicity. Deceased donors from whom at least one kidney was recovered for transplant. The Other race category is composed of Native American and Multiracial categories.



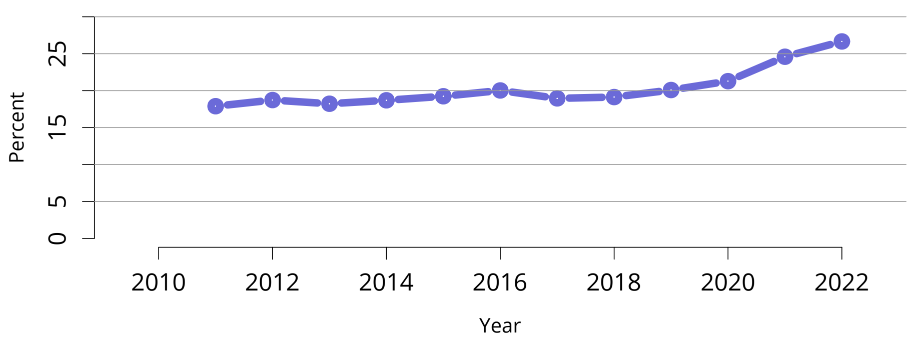
OPTN/SRTR 2022 Annual Data Report

Figure KI 42: Distribution of deceased kidney donors by donor HCV status. Deceased donors from whom at least one kidney was recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



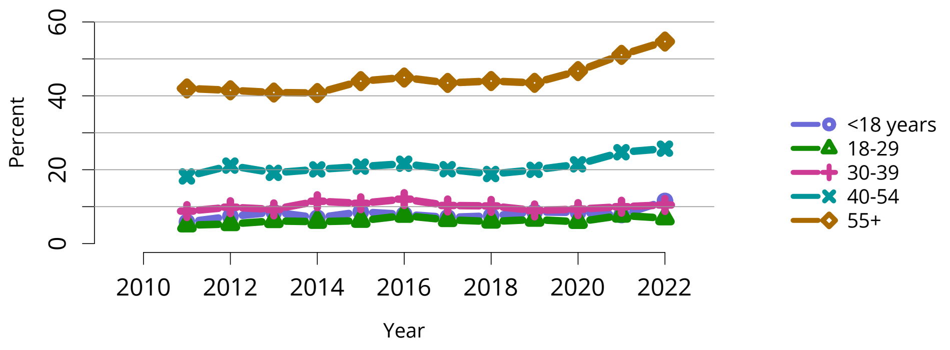
OPTN/SRTR 2022 Annual Data Report

Figure KI 43: Cause of death among deceased kidney donors. Deceased donors with at least one kidney recovered for transplant. Each donor is counted once. CVA, cerebrovascular accident.



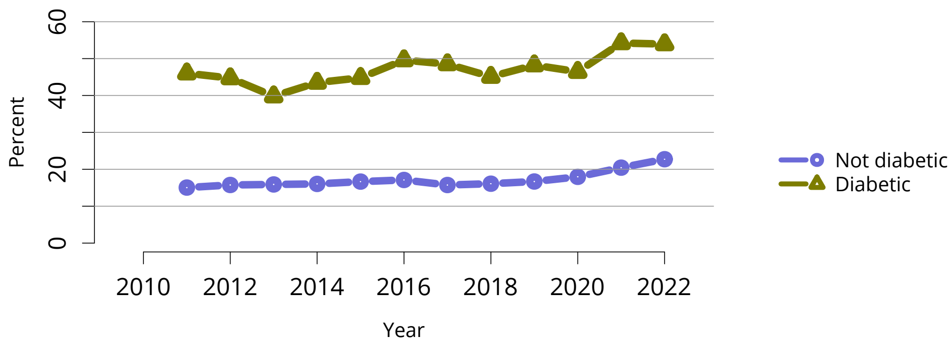
OPTN/SRTR 2022 Annual Data Report

Figure KI 44: Overall percent of kidneys recovered for transplant and not transplanted. Percentages of kidneys not transplanted out of all kidneys recovered for transplant.



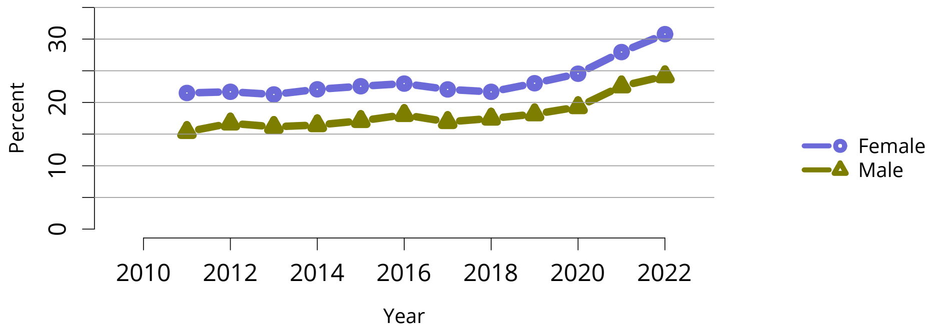
OPTN/SRTR 2022 Annual Data Report

Figure KI 45: Percent of kidneys recovered for transplant and not transplanted by donor age. Percentages of kidneys not transplanted out of all kidneys recovered for transplant.



OPTN/SRTR 2022 Annual Data Report

Figure KI 46: Percent of kidneys recovered for transplant and not transplanted by donor diabetes status. Percentages of kidneys not transplanted out of all kidneys recovered for transplant.



OPTN/SRTR 2022 Annual Data Report

Figure KI 47: Percent of kidneys recovered for transplant and not transplanted by donor sex. Percentages of kidneys not transplanted out of all kidneys recovered for transplant.

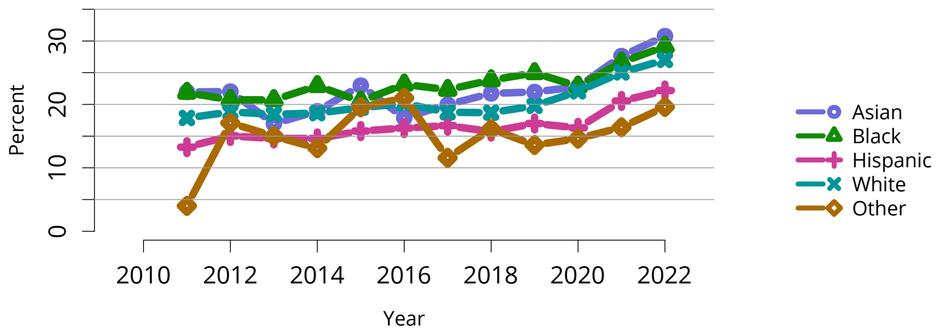


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Figure KI 48: Percent of kidneys recovered for transplant and not transplanted by donor race and ethnicity. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. The Other race category is composed of Native American and Multiracial categories.

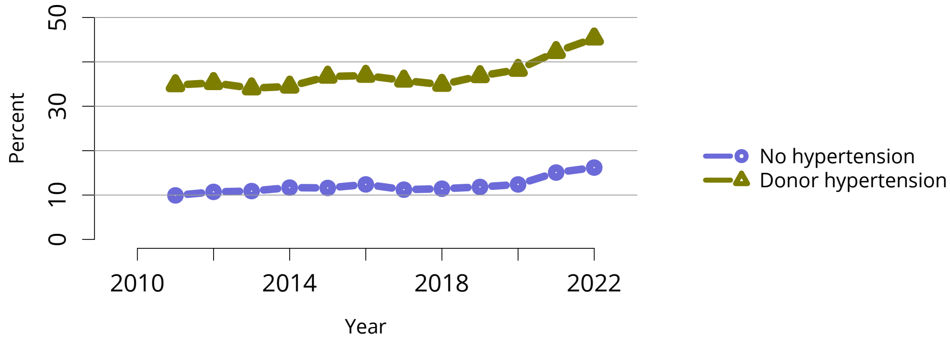

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Figure KI 49: Percent of kidneys recovered for transplant and not transplanted by donor hypertension status. Percentages of kidneys not transplanted out of all kidneys recovered for transplant.

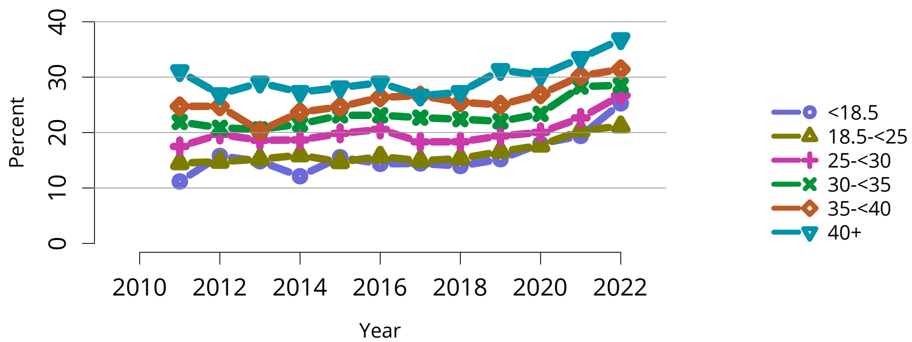

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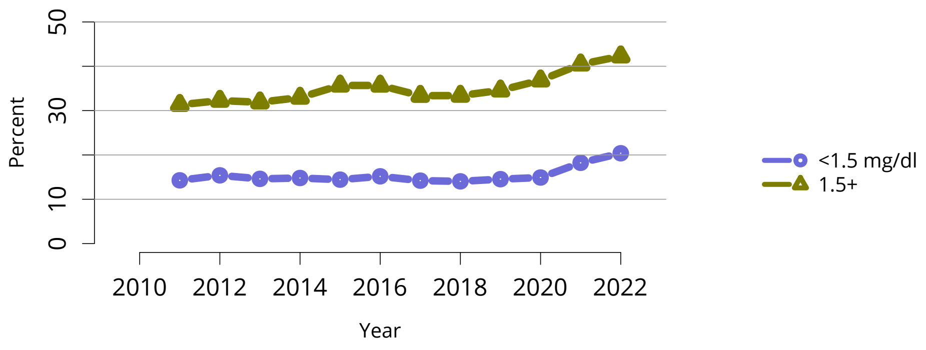
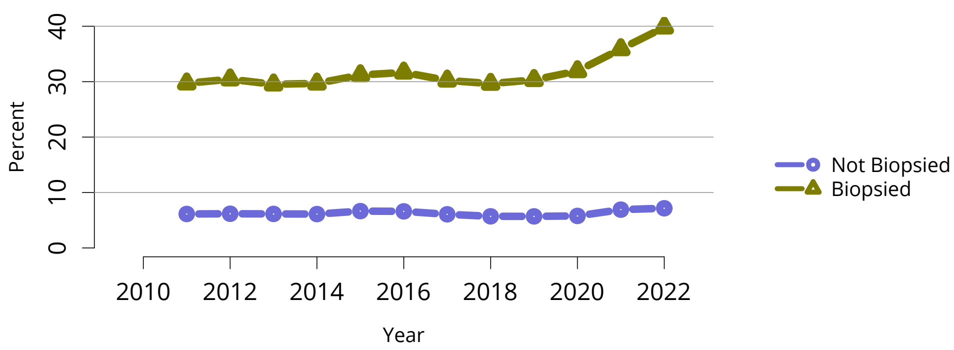
Figure KI 50: Percent of kidneys recovered for transplant and not transplanted by donor BMI. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. BMI, body mass index.



OPTN/SRTR 2022 Annual Data Report

Figure KI 51: Percent of kidneys recovered for transplant and not transplanted by donor terminal creatinine. Percentages of kidneys not transplanted out of all kidneys recovered for transplant.



OPTN/SRTR 2022 Annual Data Report

Figure KI 52: Percent of kidneys recovered for transplant and not transplanted by donor biopsy status. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. Kidneys are classified as biopsied if either of the donor's kidneys was biopsied.

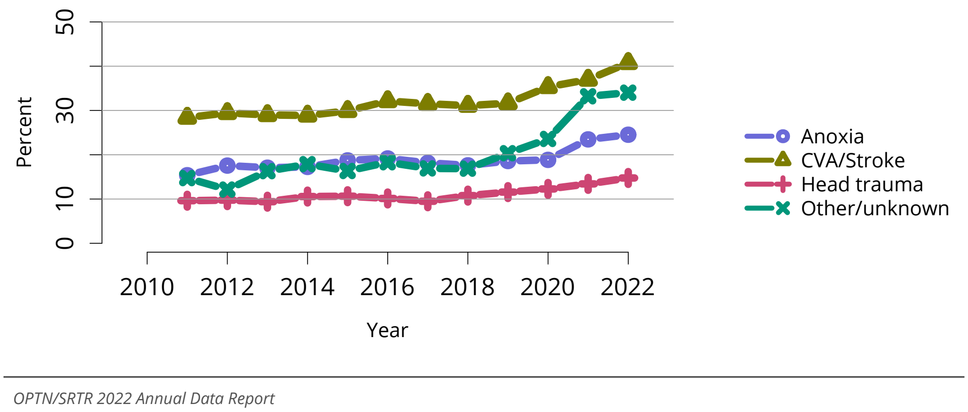


Figure KI 53: Percent of kidneys recovered for transplant and not transplanted by donor cause of death. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. CVA, cerebrovascular accident.

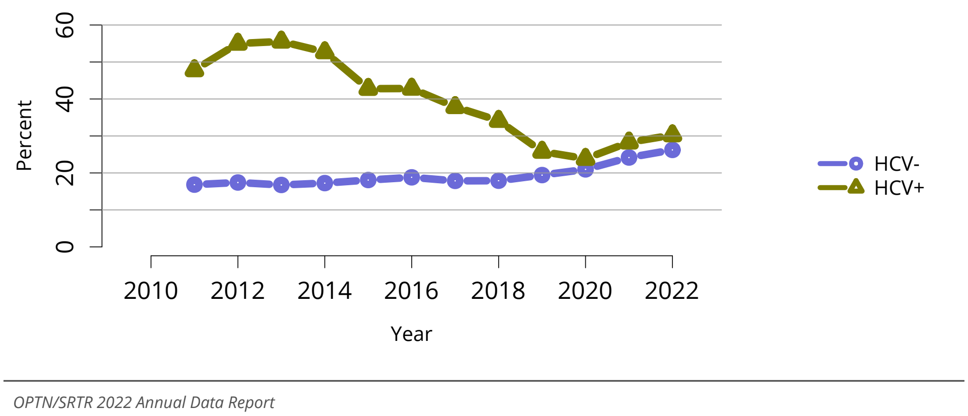
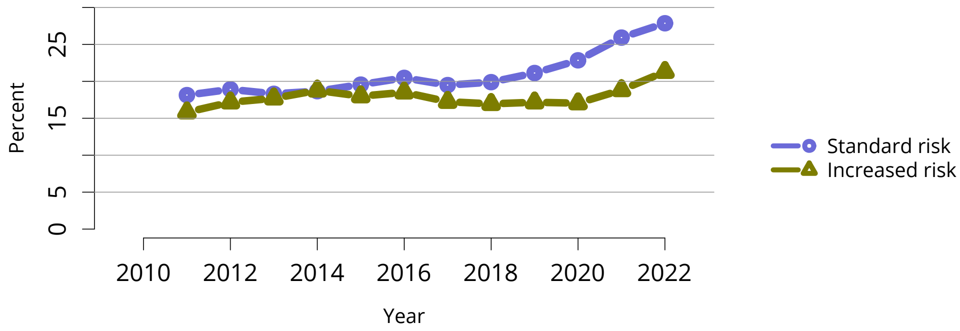
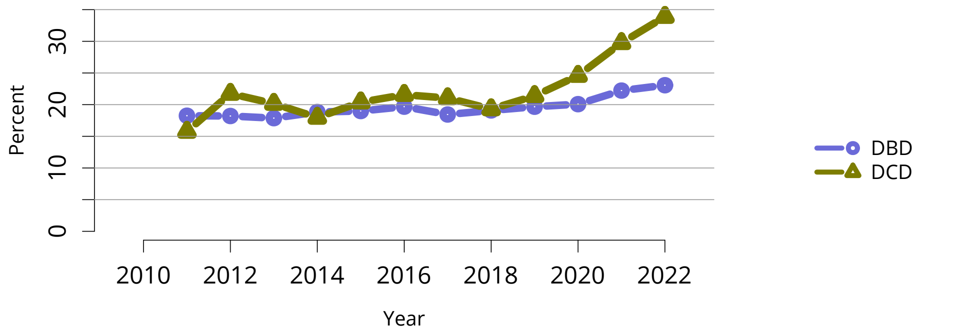


Figure KI 54: Percent of kidneys recovered for transplant and not transplanted by donor HCV status. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



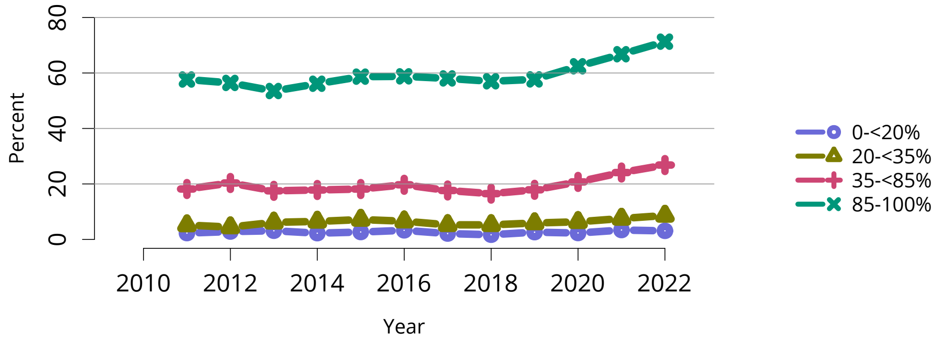
OPTN/SRTR 2022 Annual Data Report

Figure KI 55: Percent of kidneys recovered for transplant and not transplanted, by donor risk of disease transmission. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. "Increased risk" is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B, and hepatitis C transmission.



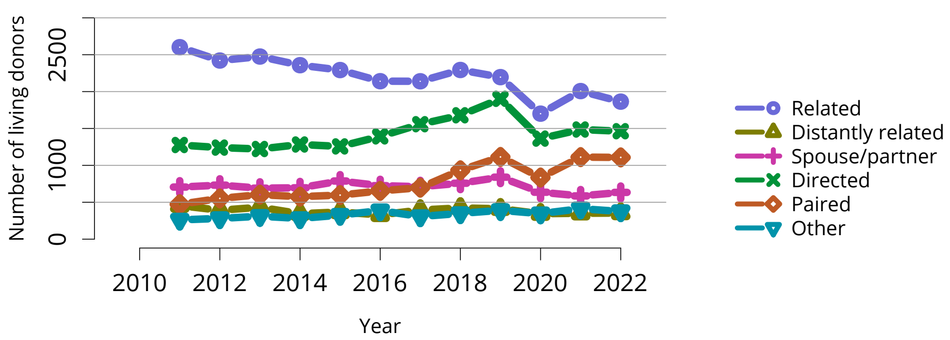
OPTN/SRTR 2022 Annual Data Report

Figure KI 56: Percent of kidneys recovered for transplant and not transplanted by DCD status. Percentages of kidneys not transplanted out of all kidneys recovered for transplant. DBD, donation after brain death; DCD, donation after circulatory death.



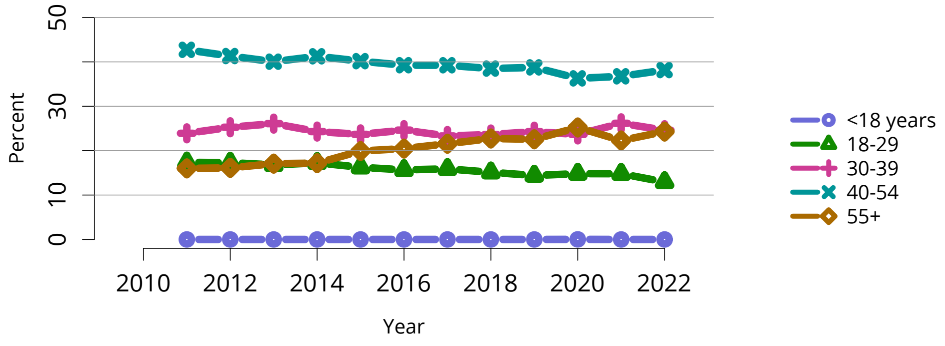
OPTN/SRTR 2022 Annual Data Report

Figure KI 57: Percent of kidneys recovered for transplant and not transplanted by KDPI. Percentages of kidneys not transplanted out of all kidneys recovered for transplant, by KDPI classification. Conversion of kidney donor risk index to KDPI is done using the OPTN KDPI Mapping Tables. For donors recovered January through May, the cohort 2 years prior was used to assign KDPI; for donors recovered June through December, the cohort 1 year prior was used to assign KDPI. KDPI, kidney donor profile index.



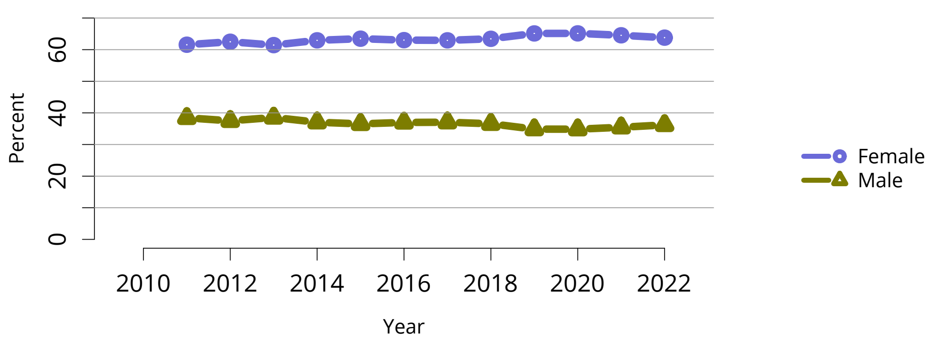
OPTN/SRTR 2022 Annual Data Report

Figure KI 58: Number of living kidney transplants by donor relation. As reported on the OPTN Living Donor Registration Form.



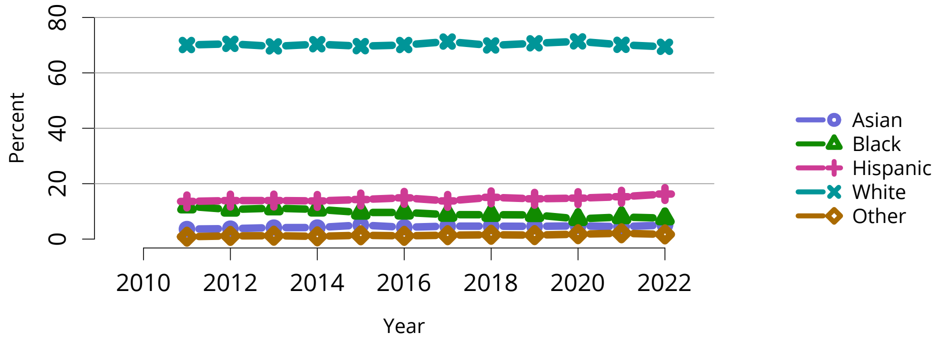
OPTN/SRTR 2022 Annual Data Report

Figure KI 59: Living kidney donors by age. As reported on the OPTN Living Donor Registration Form.



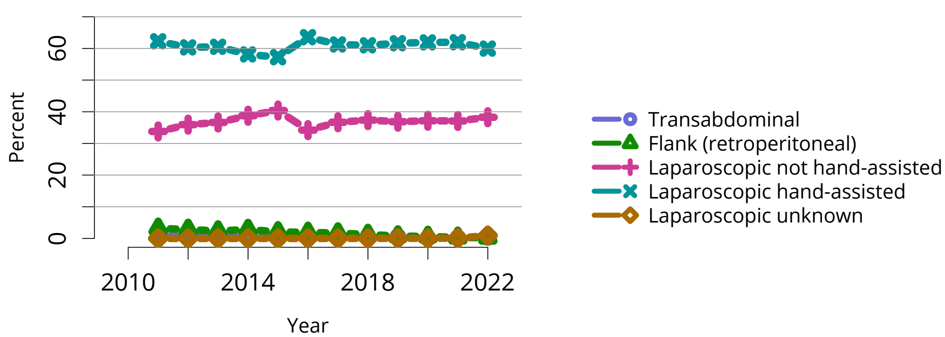
OPTN/SRTR 2022 Annual Data Report

Figure KI 60: Living kidney donors by sex. As reported on the OPTN Living Donor Registration Form.



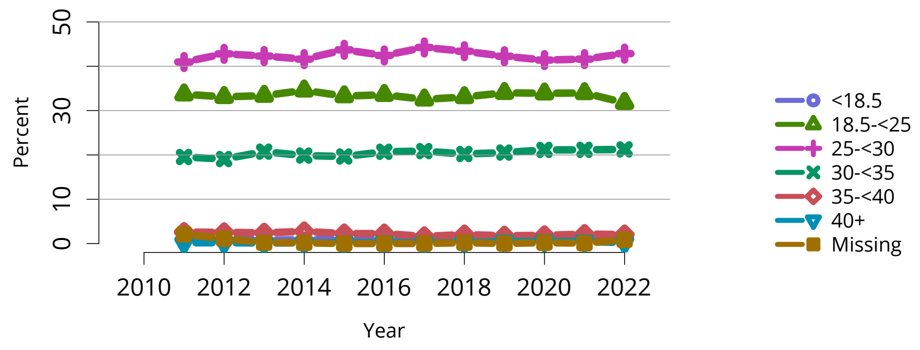
OPTN/SRTR 2022 Annual Data Report

Figure KI 61: Living kidney donors by race and ethnicity. As reported on the OPTN Living Donor Registration Form. The Other race category is composed of Native American and Multiracial categories.



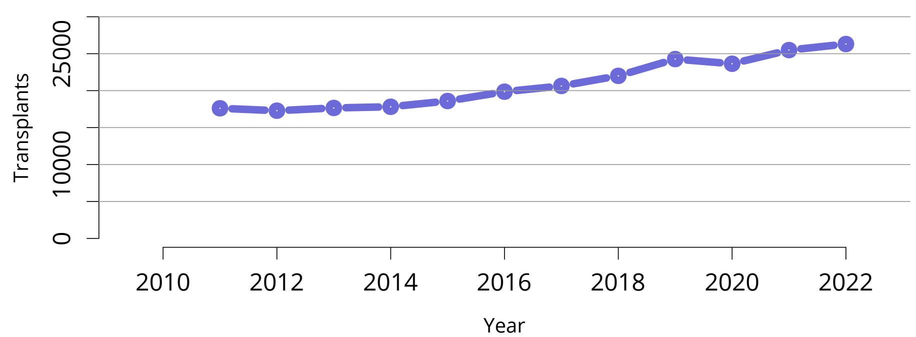
OPTN/SRTR 2022 Annual Data Report

Figure KI 62: Intended living kidney donor procedure type. As reported on the OPTN Living Donor Registration Form.



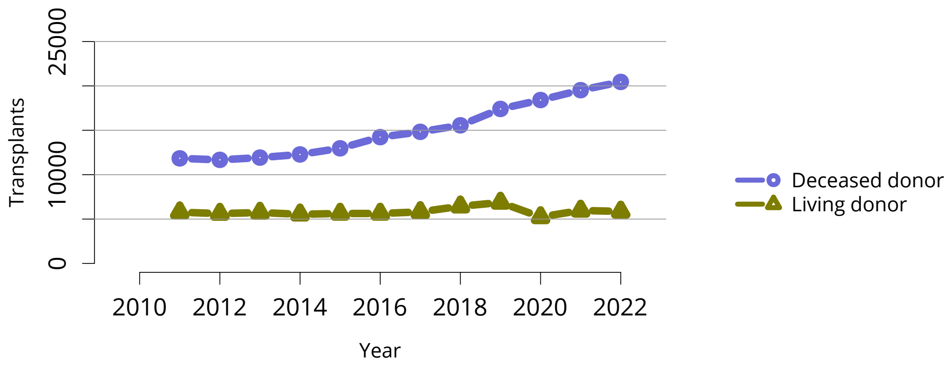
OPTN/SRTR 2022 Annual Data Report

Figure KI 63: BMI among living kidney donors. Donor height and weight reported on the OPTN Living Donor Registration Form. BMI, body mass index.



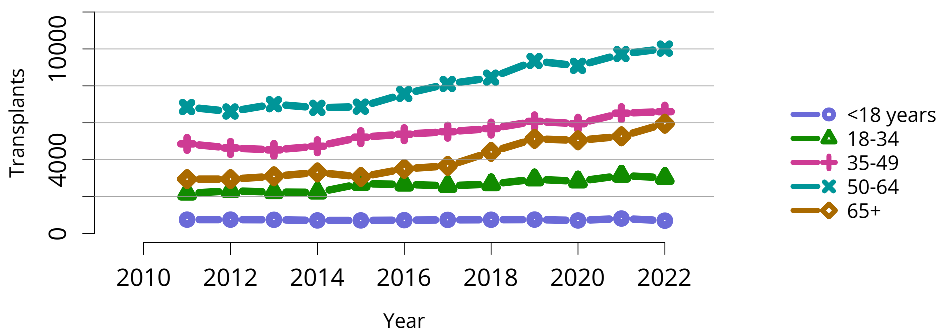
OPTN/SRTR 2022 Annual Data Report

Figure KI 64: Overall kidney transplants. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



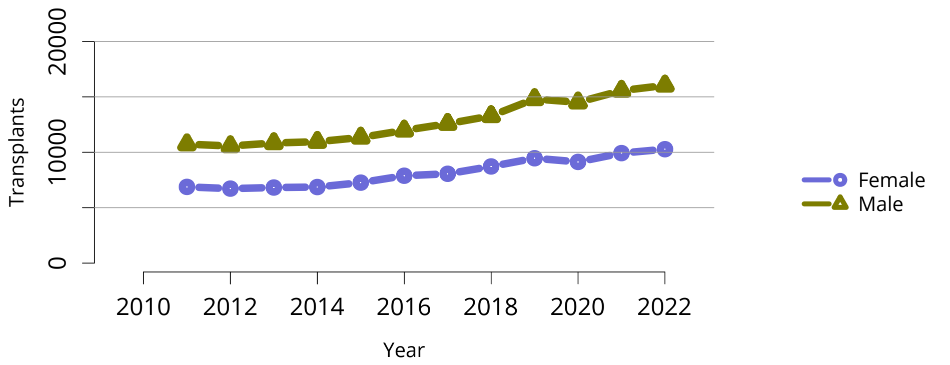
OPTN/SRTR 2022 Annual Data Report

Figure KI 65: Total kidney transplants by donor type. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



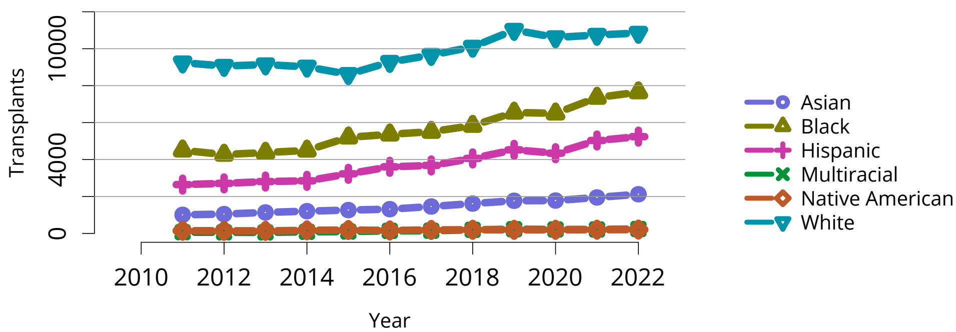
OPTN/SRTR 2022 Annual Data Report

Figure KI 66: Total kidney transplants by age. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure KI 67: Total kidney transplants by sex. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure KI 68: Total kidney transplants by race and ethnicity. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

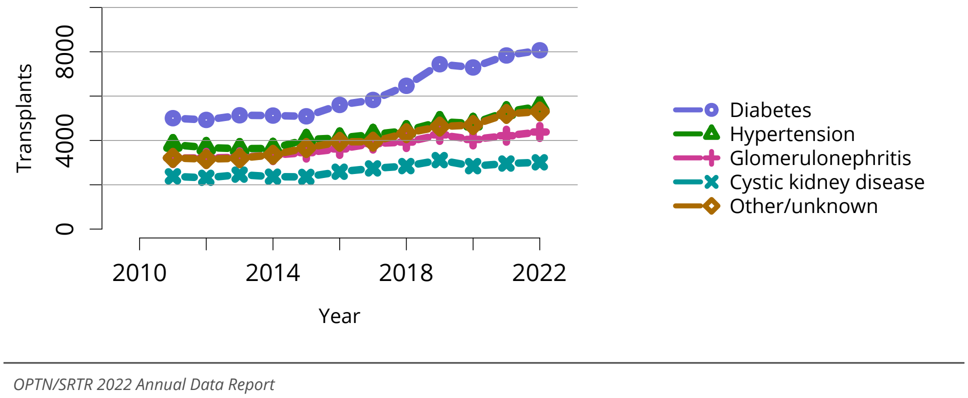


Figure KI 69: Total kidney transplants by diagnosis. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

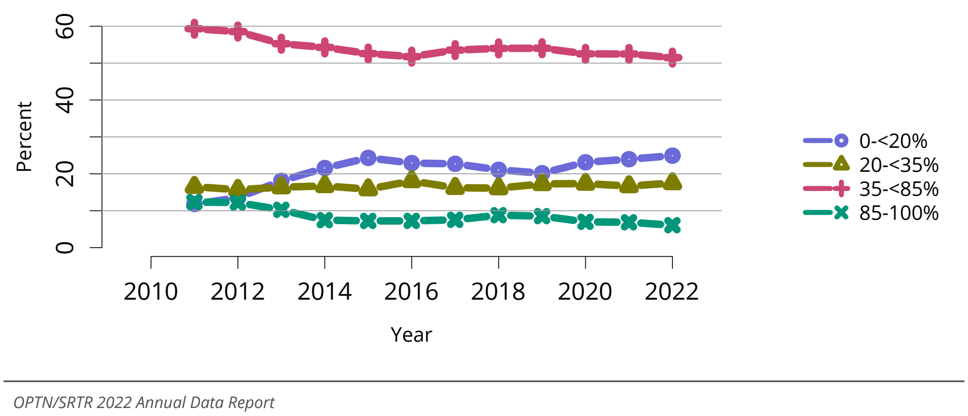
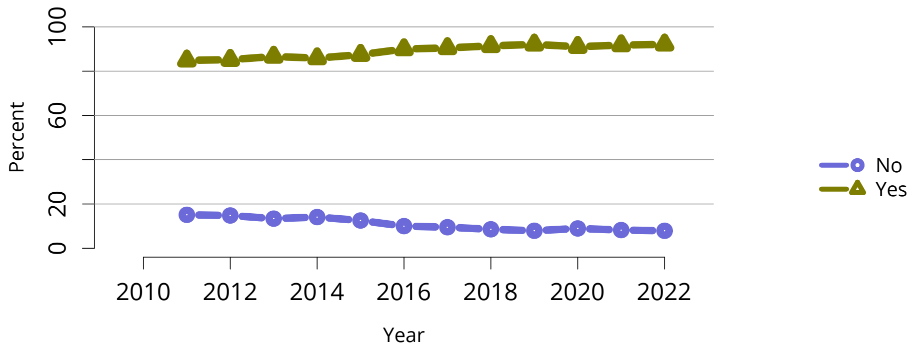
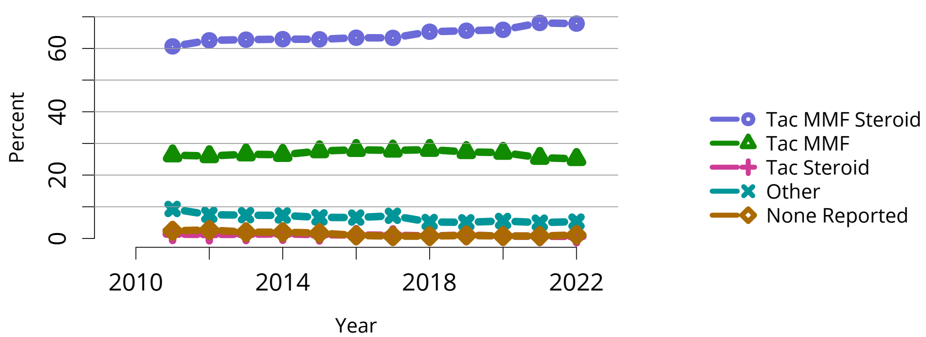


Figure KI 70: Kidney transplants by KDPI. All adult recipients of deceased donor kidneys, including multiorgan transplant recipients. Conversion of kidney donor risk index to KDPI is done using the OPTN KDPI Mapping Tables. For donors recovered January through May, the cohort 2 years prior was used to assign KDPI; for donors recovered June through December, the cohort 1 year prior was used to assign KDPI. Kidneys recovered en bloc are counted once. KDPI, kidney donor profile index.



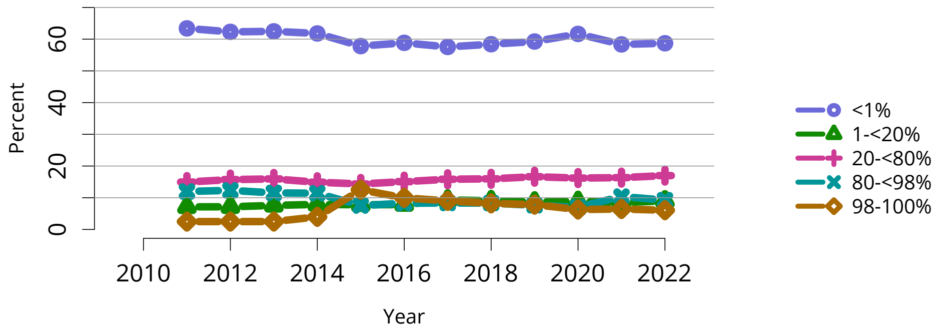
OPTN/SRTR 2022 Annual Data Report

Figure KI 71: Induction agent use in adult kidney transplant recipients. Immunosuppression at transplant reported to the OPTN.



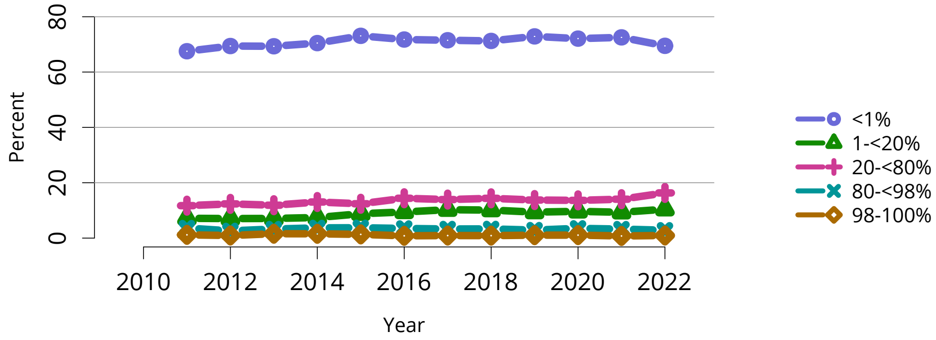
OPTN/SRTR 2022 Annual Data Report

Figure KI 72: Immunosuppression regimen use in adult kidney transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



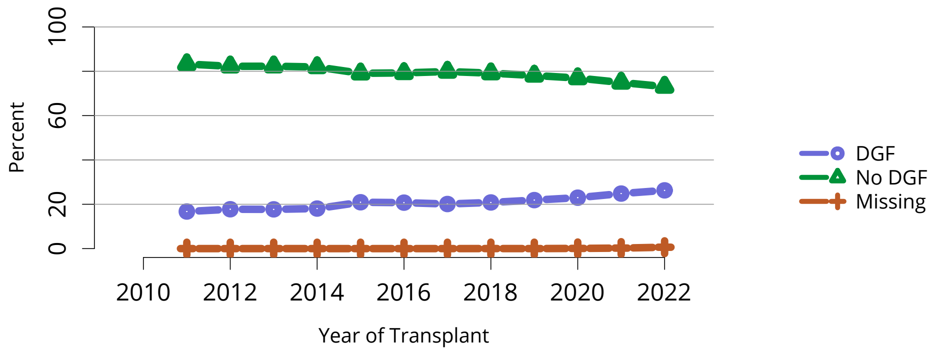
OPTN/SRTR 2022 Annual Data Report

Figure KI 73: Peak cPRA at time of kidney transplant in adult deceased donor recipients. Peak cPRA is used. cPRA, calculated panel-reactive antibody.



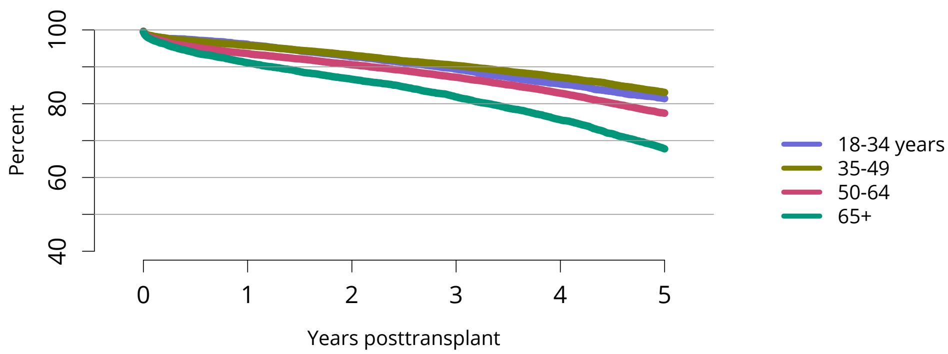
OPTN/SRTR 2022 Annual Data Report

Figure KI 74: Peak cPRA at time of kidney transplant in adult living donor recipients. Peak cPRA is used. cPRA, calculated panel-reactive antibody.



OPTN/SRTR 2022 Annual Data Report

Figure KI 75: Delayed graft function among adult kidney transplant recipients. All adult recipients of kidneys. Delayed graft function is defined as dialysis administered within the first 7 days posttransplant. DGF, delayed graft function.



OPTN/SRTR 2022 Annual Data Report

Figure KI 76: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by age. Graft survival estimated using unadjusted Kaplan-Meier methods.

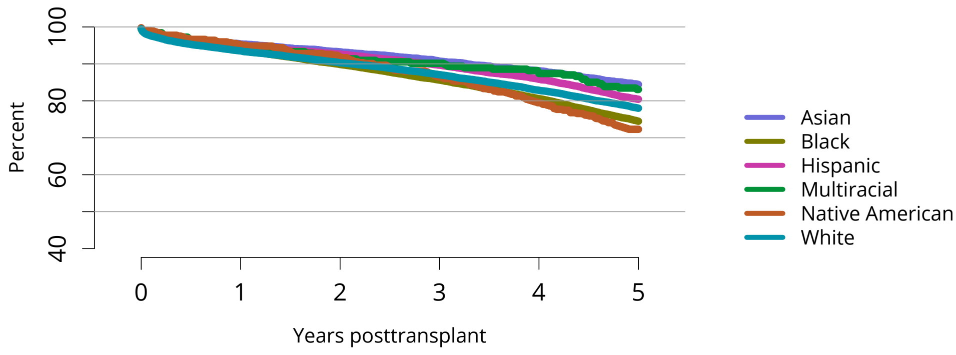


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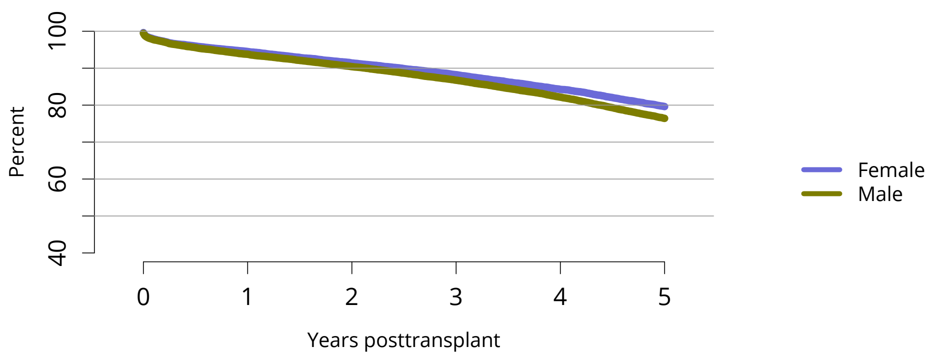
Figure KI 77: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by race and ethnicity. Graft survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure KI 78: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by sex. Graft survival estimated using unadjusted Kaplan-Meier methods.

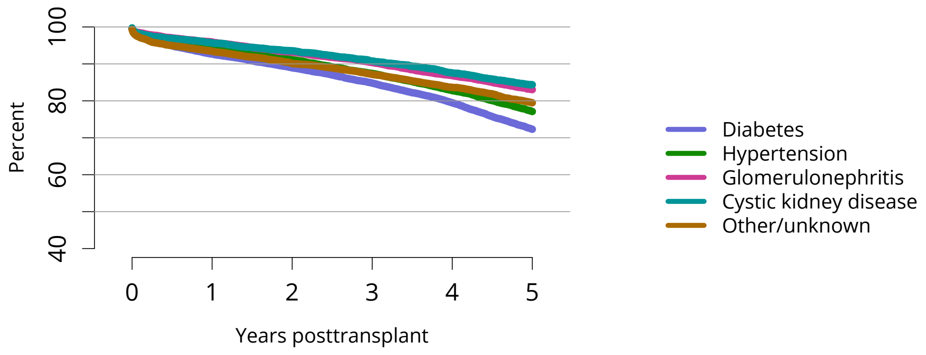


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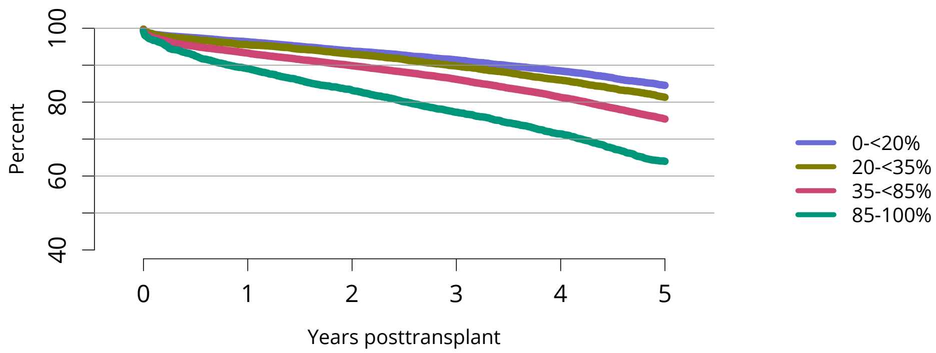
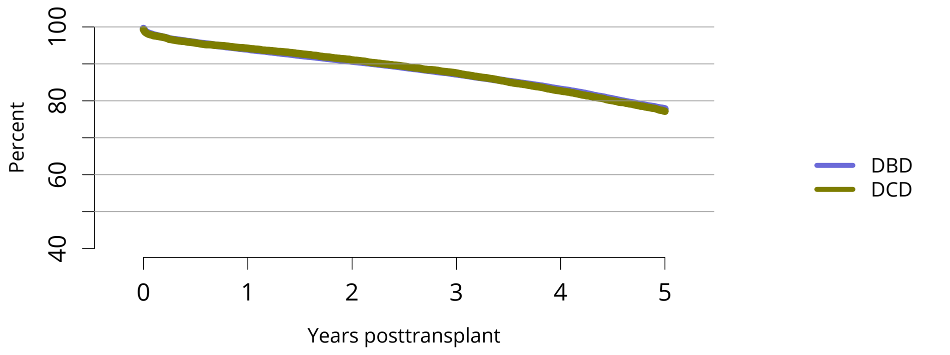
Figure KI 79: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods.



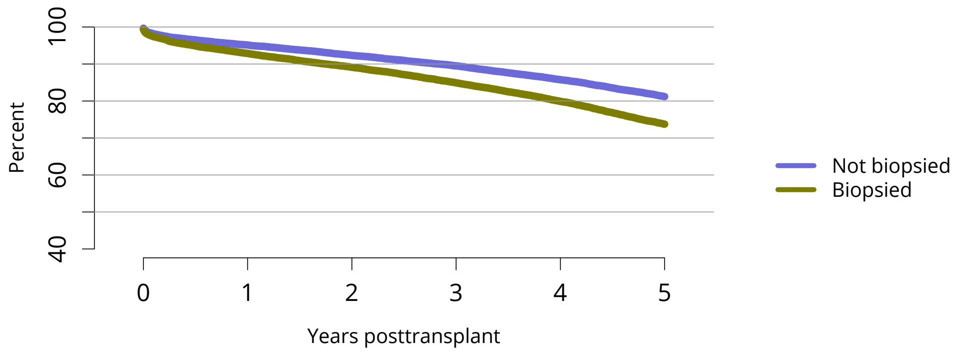
OPTN/SRTR 2022 Annual Data Report

Figure KI 80: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by KDPI. Graft survival estimated using unadjusted Kaplan-Meier methods. Conversion of kidney donor risk index to KDPI is done using the OPTN KDPI Mapping Tables. For donors recovered January through May, the cohort 2 years prior was used to assign KDPI; for donors recovered June through December, the cohort 1 year prior was used to assign KDPI. KDPI, kidney donor profile index.



OPTN/SRTR 2022 Annual Data Report

Figure KI 81: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by DCD status. Graft survival estimated using unadjusted Kaplan-Meier methods. DBD, donation after brain death; DCD, donation after circulatory death.



OPTN/SRTR 2022 Annual Data Report

Figure KI 82: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by biopsy status. Graft survival estimated using unadjusted Kaplan-Meier methods. Kidneys are classified as biopsied if either of the donor's kidneys was biopsied.

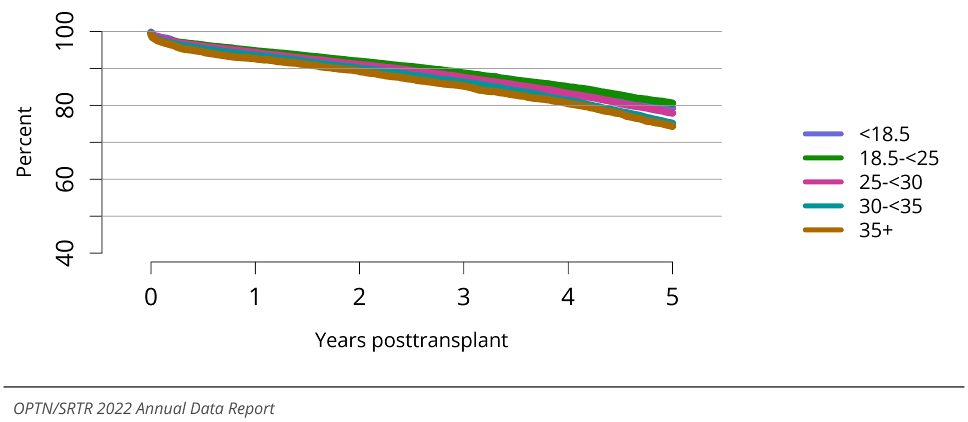


Figure KI 83: Graft survival among adult deceased donor kidney transplant recipients, 2015-2017, by BMI. Graft survival estimated using unadjusted Kaplan-Meier methods. BMI, body mass index.

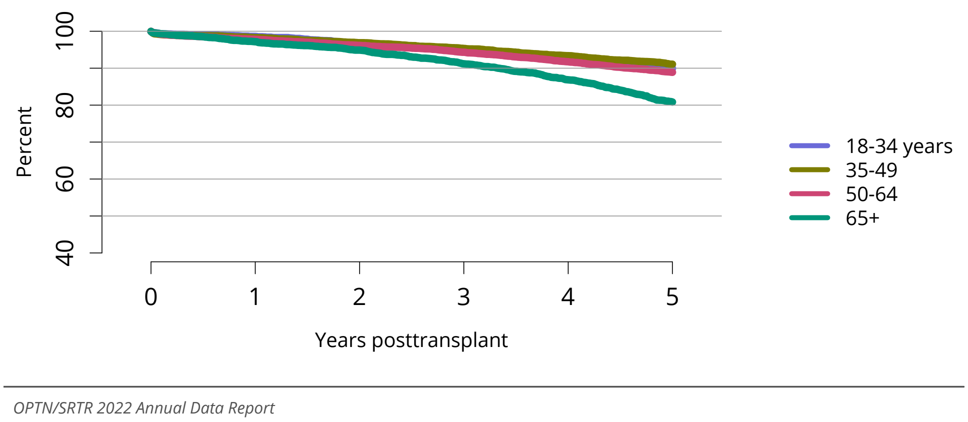
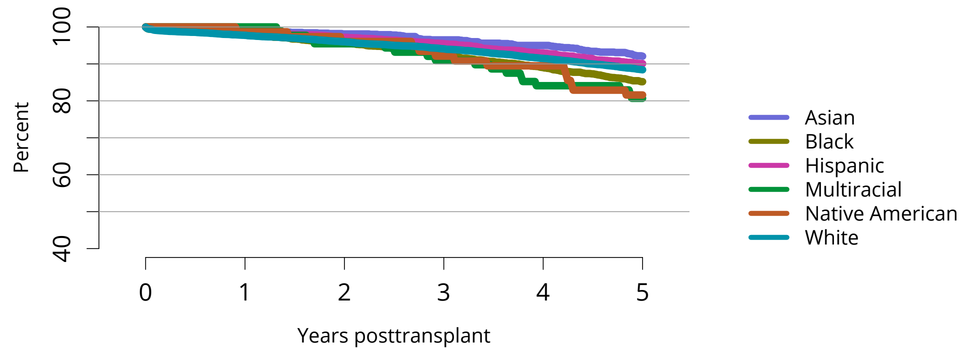
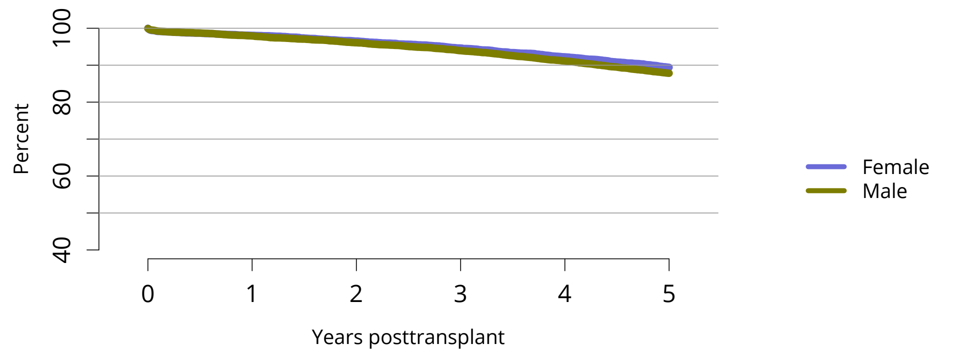


Figure KI 84: Graft survival among adult living donor kidney transplant recipients, 2015-2017, by age. Graft survival estimated using unadjusted Kaplan-Meier methods.



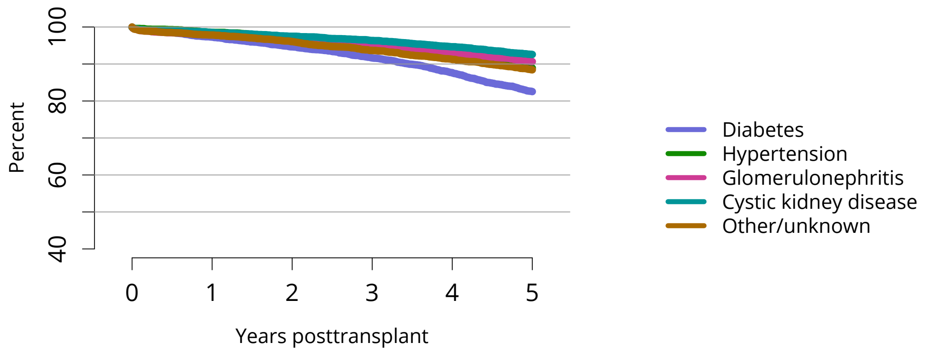
OPTN/SRTR 2022 Annual Data Report

Figure KI 85: Graft survival among adult living donor kidney transplant recipients, 2015-2017, by race and ethnicity. Graft survival estimated using unadjusted Kaplan-Meier methods.



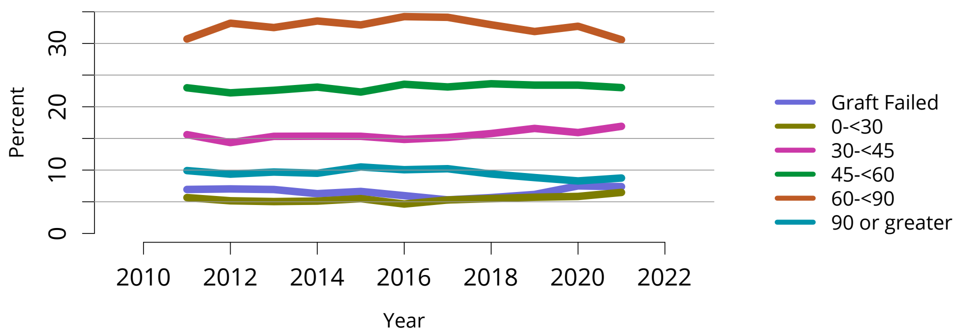
OPTN/SRTR 2022 Annual Data Report

Figure KI 86: Graft survival among adult living donor kidney transplant recipients, 2015-2017, by sex. Graft survival estimated using unadjusted Kaplan-Meier methods.



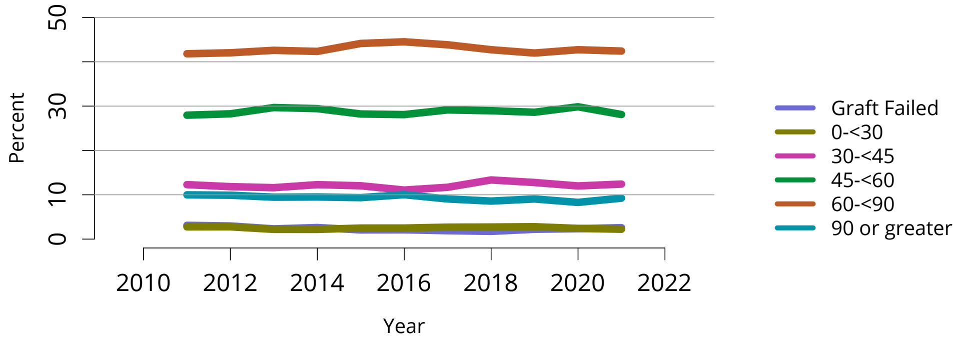
OPTN/SRTR 2022 Annual Data Report

Figure KI 87: Graft survival among adult living donor kidney transplant recipients, 2015-2017, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods.



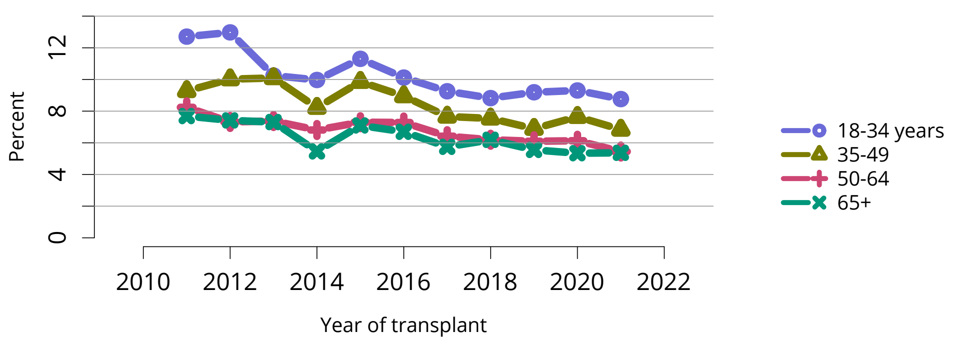
OPTN/SRTR 2022 Annual Data Report

Figure KI 88: Distribution of eGFR at 12 months posttransplant among adult deceased donor kidney transplant recipients. Glomerular filtration rate (mL/min/1.73 m^2) estimated using the race-free 2021 Chronic Kidney Disease Epidemiology Collaboration equation, and computed by SRTR for patients alive with graft function at 12 months posttransplant. eGFR, estimated glomerular filtration rate.



OPTN/SRTR 2022 Annual Data Report

Figure KI 89: Distribution of eGFR at 12 months posttransplant among adult living donor kidney transplant recipients. Glomerular filtration rate (mL/min/1.73 m^2) estimated using the race-free 2021 Chronic Kidney Disease Epidemiology Collaboration equation, and computed by SRTR for patients alive with graft function at 12 months posttransplant. eGFR, estimated glomerular filtration rate.



OPTN/SRTR 2022 Annual Data Report

Figure KI 90: Incidence of acute rejection by 1 year posttransplant among adult kidney transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.

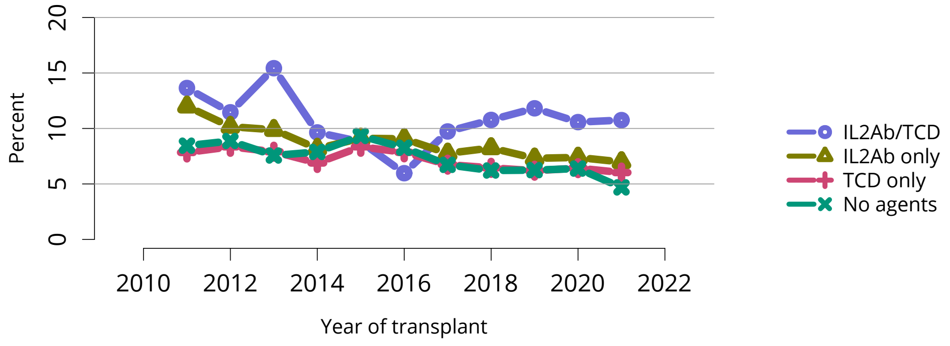


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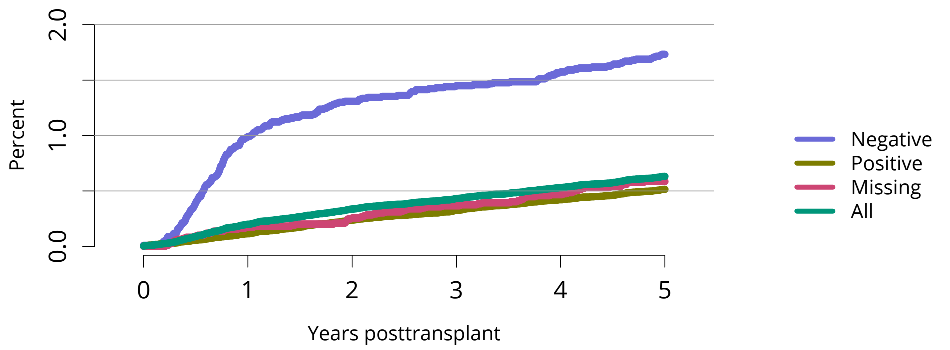
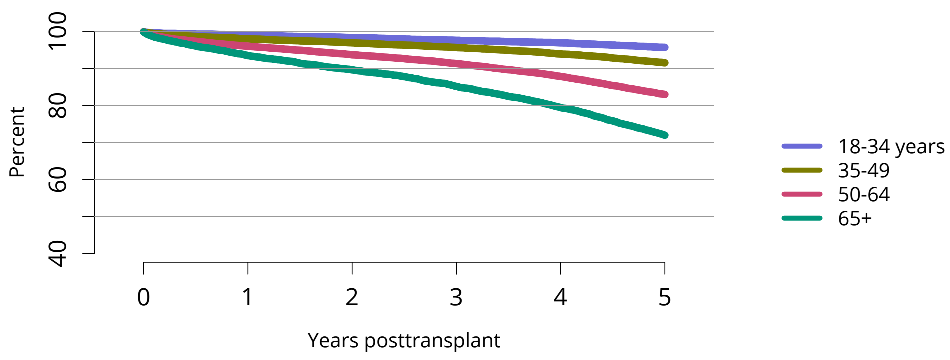
Figure KI 91: Incidence of acute rejection by 1 year posttransplant among adult kidney transplant recipients by induction agent. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method. IL2Ab, interleukin-2 receptor antibody; TCD, T-cell depleting.



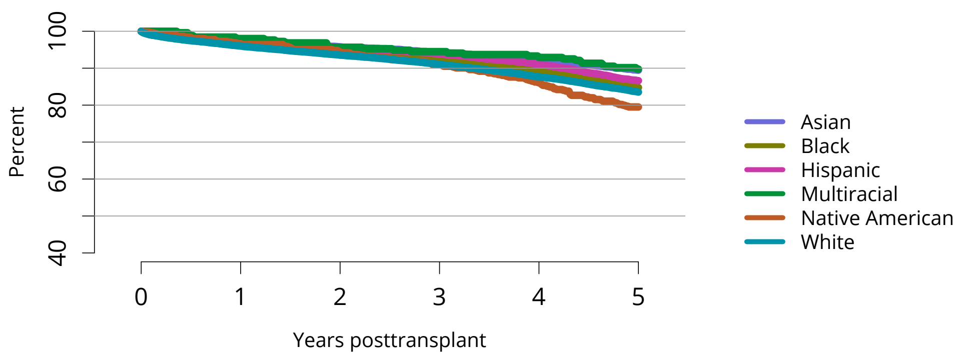
OPTN/SRTR 2022 Annual Data Report

Figure KI 92: Incidence of PTLD among adult kidney transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



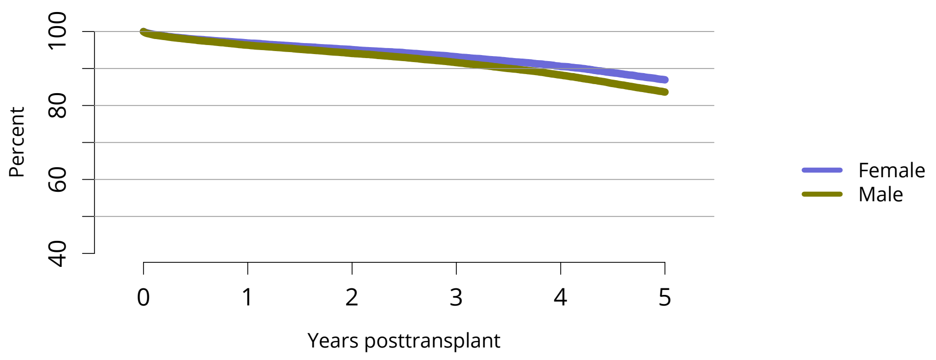
OPTN/SRTR 2022 Annual Data Report

Figure KI 93: Patient survival among adult deceased donor kidney transplant recipients, 2015-2017, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure KI 94: Patient survival among adult deceased donor kidney transplant recipients, 2015-2017, by race and ethnicity. Patient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure KI 95: Patient survival among adult deceased donor kidney transplant recipients, 2015-2017, by sex. Patient survival estimated using unadjusted Kaplan-Meier methods.

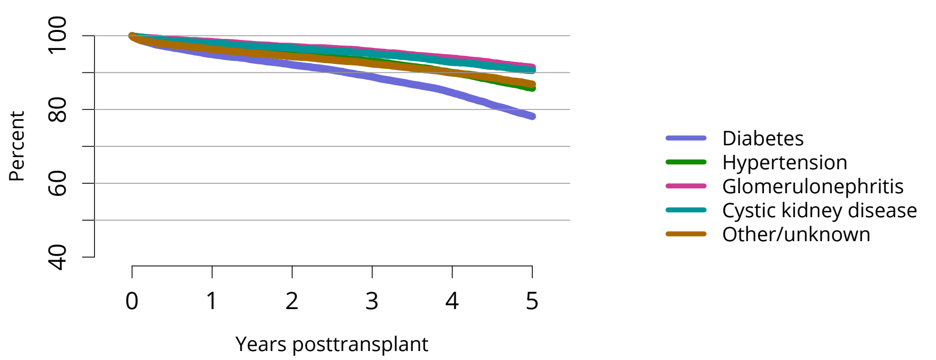


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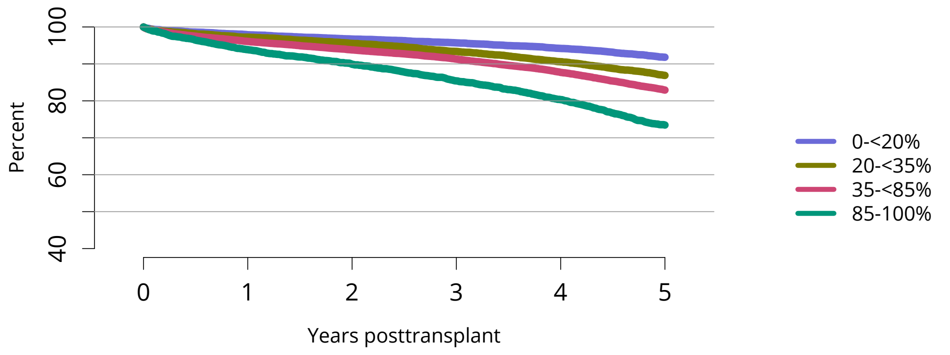
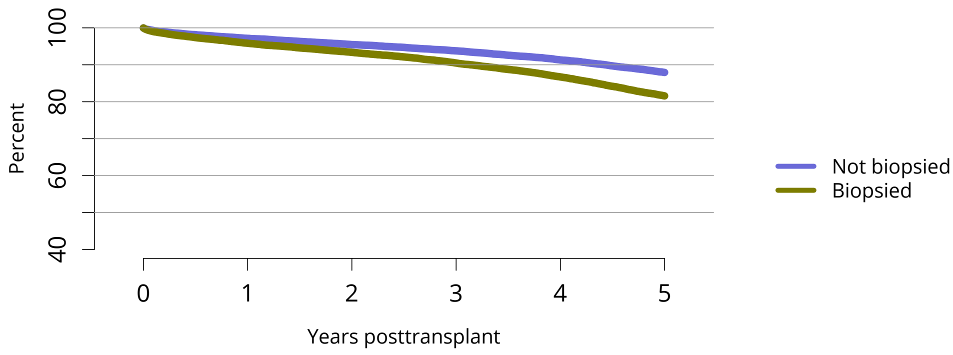
Figure KI 96: Patient survival among adult deceased donor kidney transplant recipients, 2015-2017, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods.



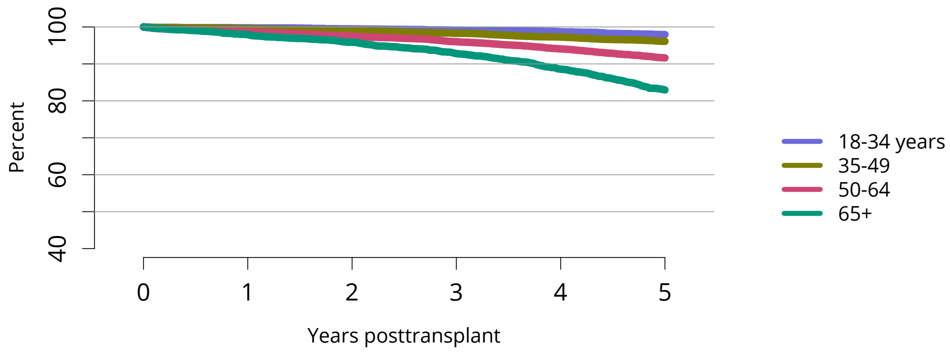
OPTN/SRTR 2022 Annual Data Report

Figure KI 97: Patient survival among adult deceased donor kidney transplant recipients, 2015-2017, by KDPI. Patient survival estimated using unadjusted Kaplan-Meier methods. Conversion of kidney donor risk index to KDPI is done using the OPTN KDPI Mapping Tables. For donors recovered January through May, the cohort 2 years prior was used to assign KDPI; for donors recovered June through December, the cohort 1 year prior was used to assign KDPI. KDPI, kidney donor profile index.



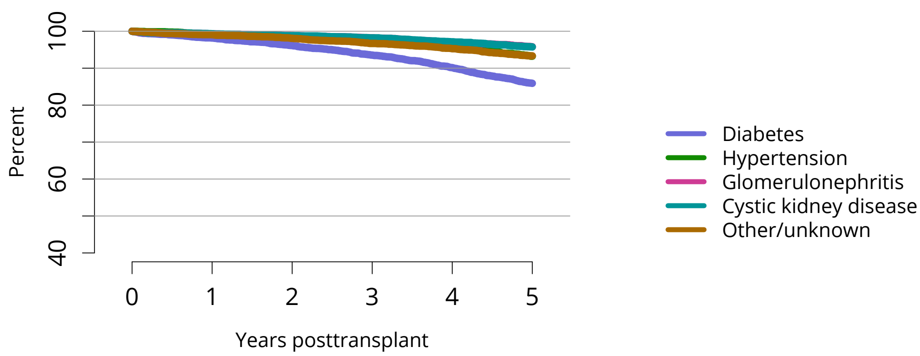
OPTN/SRTR 2022 Annual Data Report

Figure KI 98: Patient survival among adult deceased donor kidney transplant recipients, 2015-2017, by biopsy status. Patient survival estimated using unadjusted Kaplan-Meier methods. Kidneys are classified as biopsied if either of the donor's kidneys was biopsied.



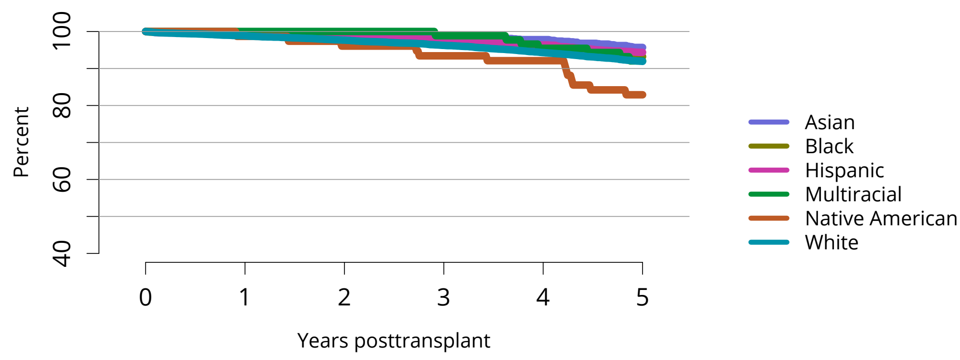
OPTN/SRTR 2022 Annual Data Report

Figure KI 99: Patient survival among adult living donor kidney transplant recipients, 2015-2017, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.



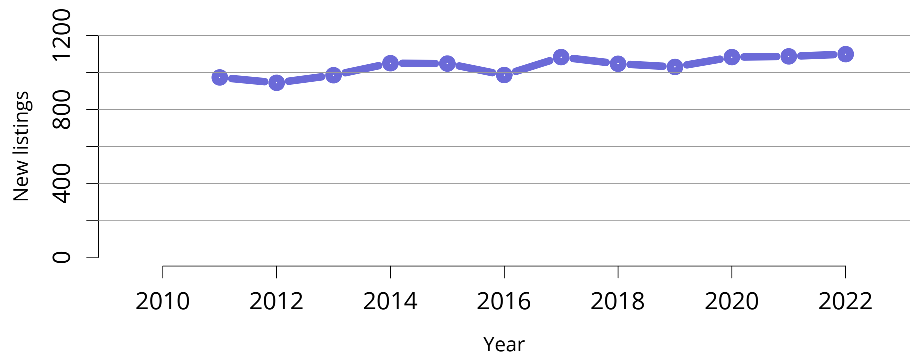
OPTN/SRTR 2022 Annual Data Report

Figure KI 100: Patient survival among adult living donor kidney transplant recipients, 2015-2017, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods.



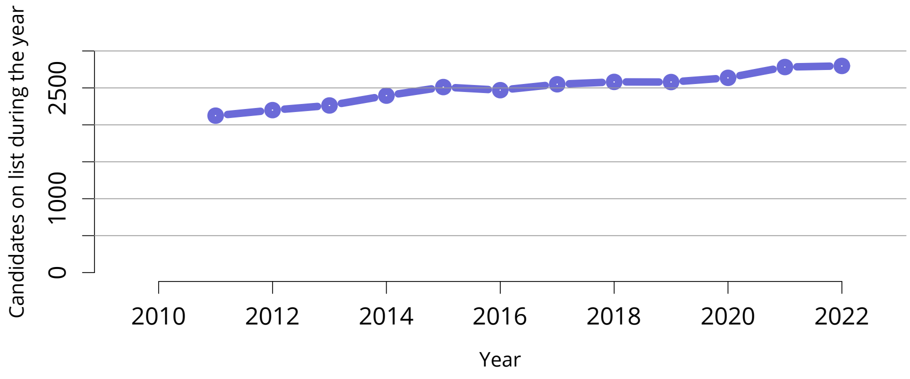
OPTN/SRTR 2022 Annual Data Report

Figure KI 101: Patient survival among adult living donor kidney transplant recipients, 2015-2017, by race and ethnicity. Patient survival estimated using unadjusted Kaplan-Meier methods.



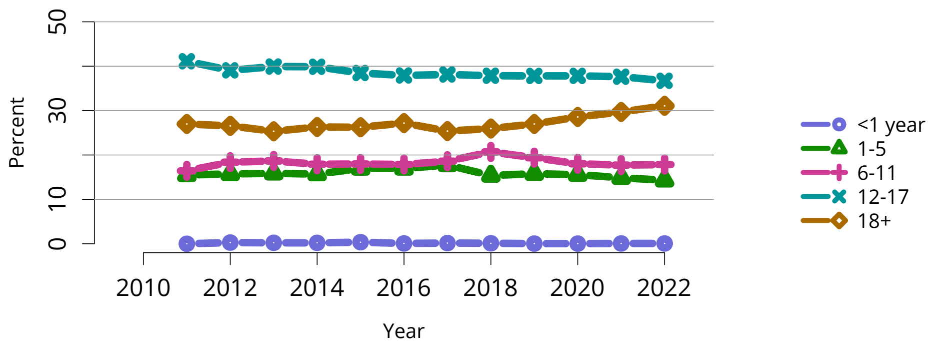
OPTN/SRTR 2022 Annual Data Report

Figure KI 102: New pediatric candidates added to the kidney transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



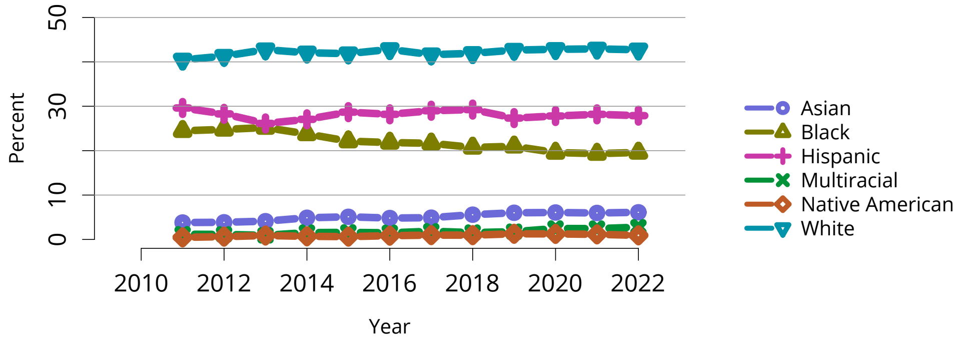
OPTN/SRTR 2022 Annual Data Report

Figure KI 103: All pediatric candidates on the kidney transplant waiting list. Candidates listed at more than one center are counted once per listing; age determined at first listing.



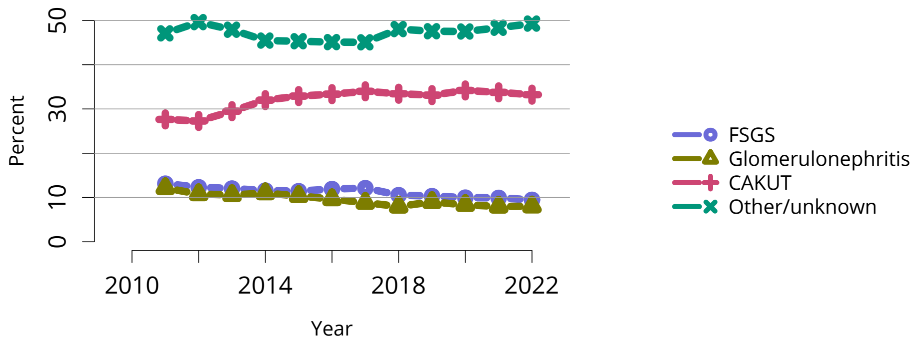
OPTN/SRTR 2022 Annual Data Report

Figure KI 104: Distribution of pediatric candidates waiting for kidney transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.



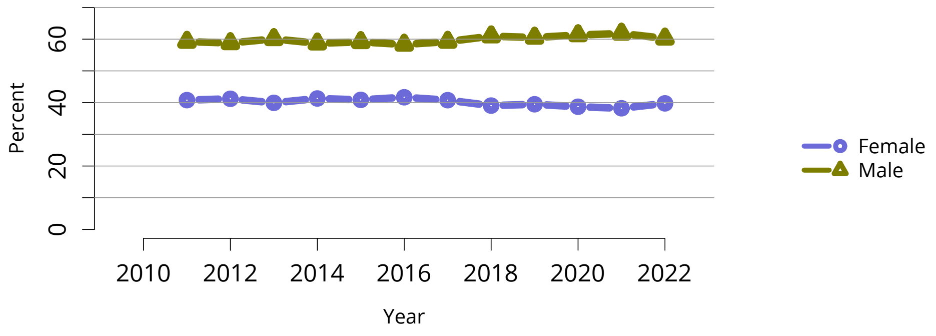
OPTN/SRTR 2022 Annual Data Report

Figure KI 105: Distribution of pediatric candidates waiting for kidney transplant by race and ethnicity. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included.



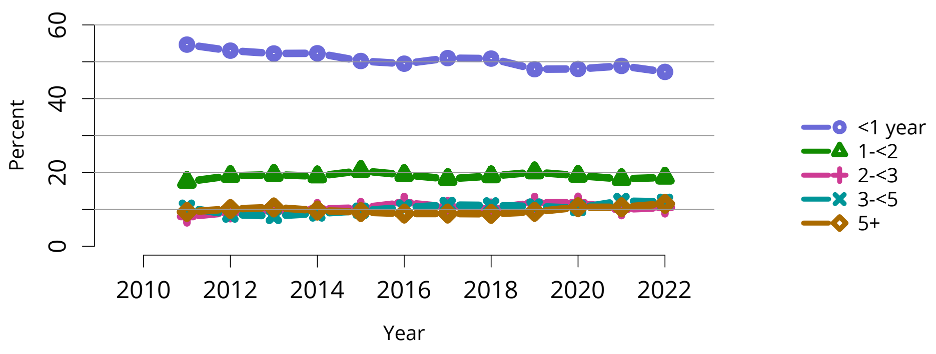
OPTN/SRTR 2022 Annual Data Report

Figure KI 106: Distribution of pediatric candidates waiting for kidney transplant by diagnosis. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Diagnosis categories follow North American Pediatric Renal Trials and Collaborative Studies recommendations. Active and inactive candidates are included. CAKUT, congenital anomalies of the kidney and urinary tract; FSGS, focal segmental glomerulosclerosis.



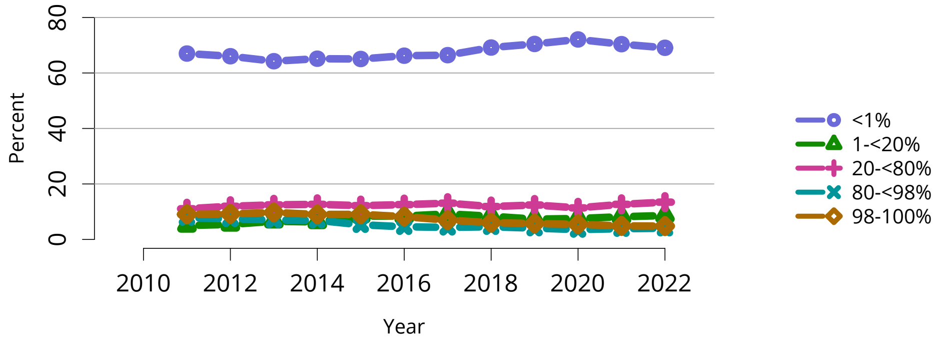
OPTN/SRTR 2022 Annual Data Report

Figure KI 107: Distribution of pediatric candidates waiting for kidney transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



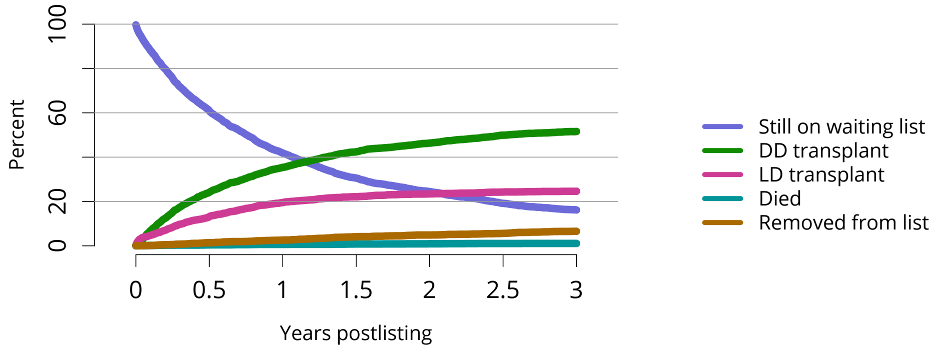
OPTN/SRTR 2022 Annual Data Report

Figure KI 108: Distribution of pediatric candidates waiting for kidney transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Candidates listed in the given year are considered to have been listed less than 1 year. Active and inactive candidates are included.



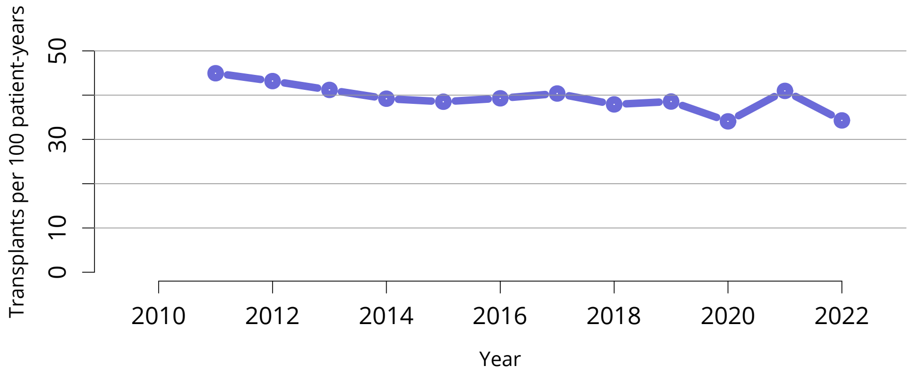
OPTN/SRTR 2022 Annual Data Report

Figure KI 109: Distribution of pediatric candidates waiting for kidney transplant by cPRA. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. cPRA is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included. cPRA, calculated panel-reactive antibody.



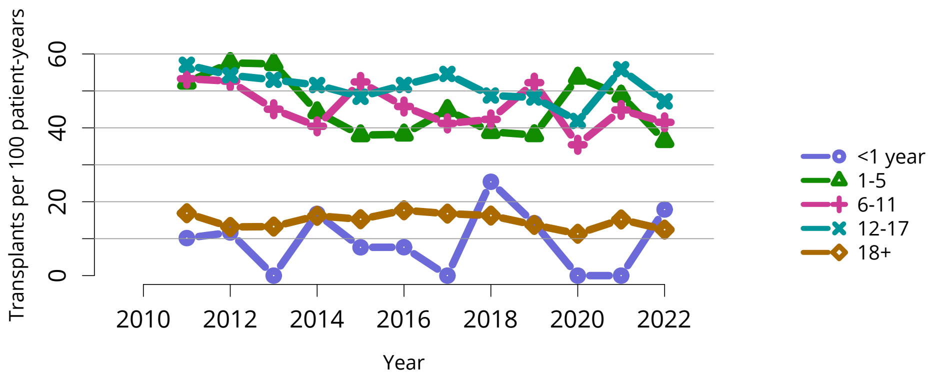
OPTN/SRTR 2022 Annual Data Report

Figure KI 110: Three-year outcomes for newly listed pediatric candidates waiting for kidney transplant, 2017-2019. Pediatric candidates who joined the waiting list in 2017-2019. Candidates listed at more than one center are counted once per listing. DD, deceased donor; LD, living donor.



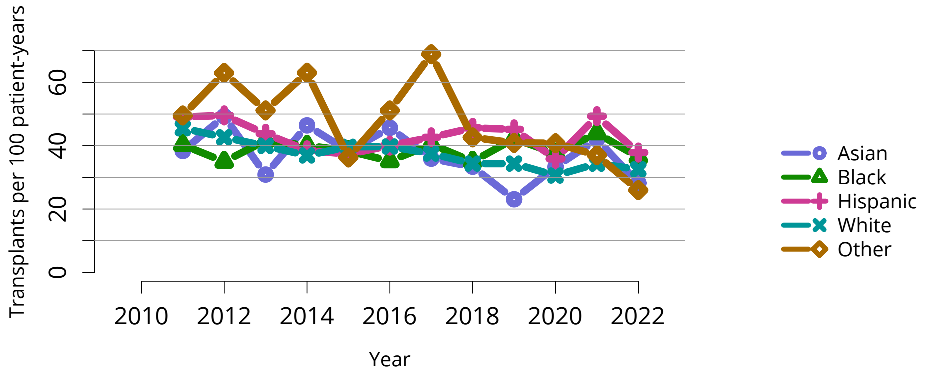
OPTN/SRTR 2022 Annual Data Report

Figure KI 111: Overall deceased donor kidney transplant rates among pediatric waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



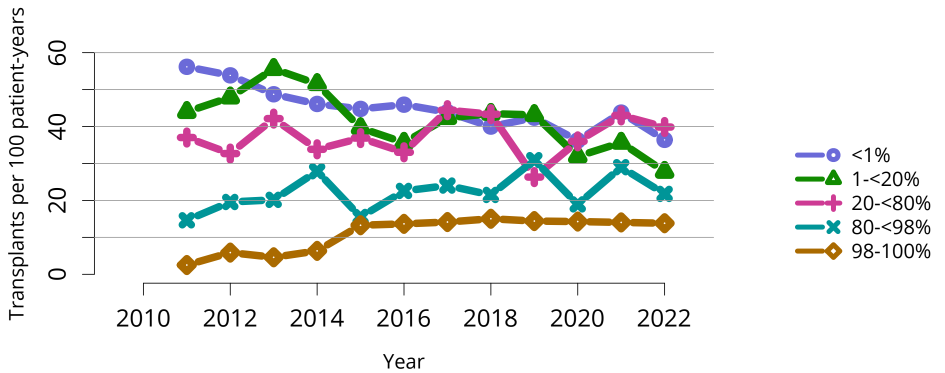
OPTN/SRTR 2022 Annual Data Report

Figure KI 112: Deceased donor kidney transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



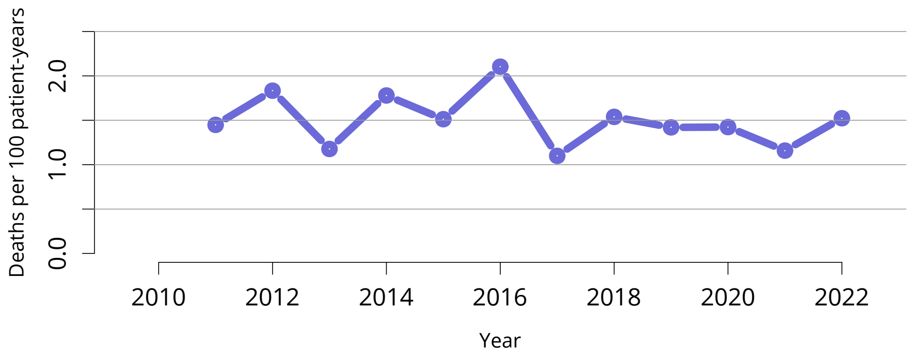
OPTN/SRTR 2022 Annual Data Report

Figure KI 113: Deceased donor kidney transplant rates among pediatric waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



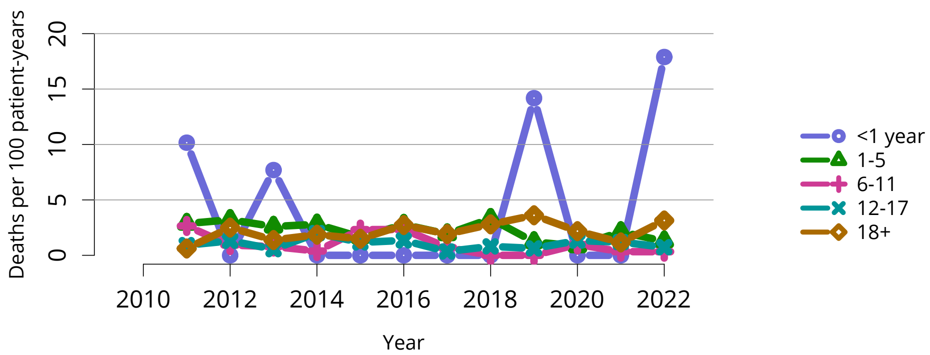
OPTN/SRTR 2022 Annual Data Report

Figure KI 114: Deceased donor kidney transplant rates among pediatric waitlist candidates by cPRA. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. cPRA is determined at the later of listing date or January 1 of the given year. cPRA, calculated panel-reactive antibody.



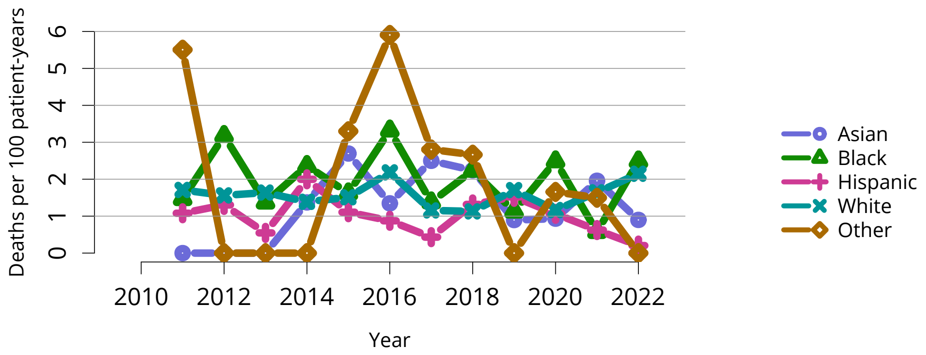
OPTN/SRTR 2022 Annual Data Report

Figure KI 115: Overall pretransplant mortality rates among pediatric candidates waitlisted for kidney. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



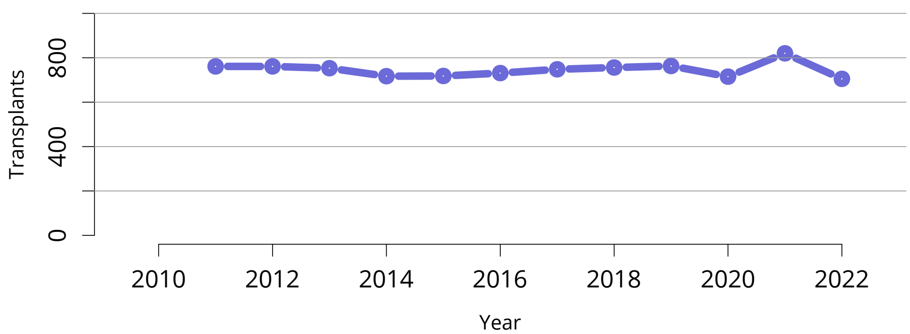
OPTN/SRTR 2022 Annual Data Report

Figure KI 116: Pretransplant mortality rates among pediatric candidates waitlisted for kidney transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



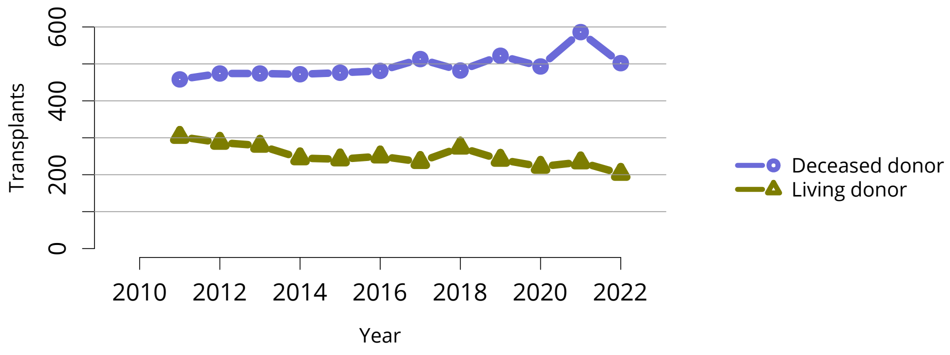
OPTN/SRTR 2022 Annual Data Report

Figure KI 117: Pretransplant mortality rates among pediatric candidates waitlisted for kidney transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



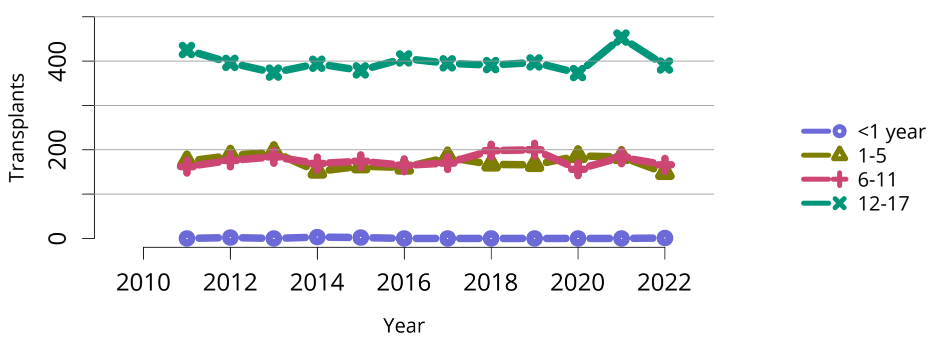
OPTN/SRTR 2022 Annual Data Report

Figure KI 118: Overall pediatric kidney transplants. All pediatric kidney transplant recipients, including retransplant and multiorgan recipients.



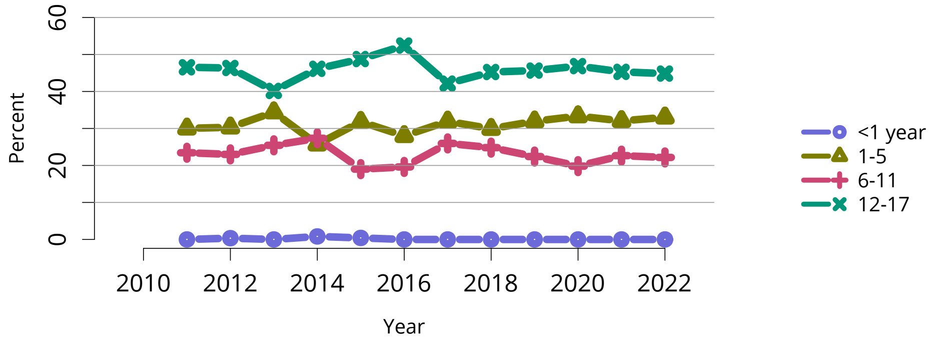
OPTN/SRTR 2022 Annual Data Report

Figure KI 119: Pediatric kidney transplants by donor type. All pediatric kidney transplant recipients, including retransplant and multiorgan recipients.



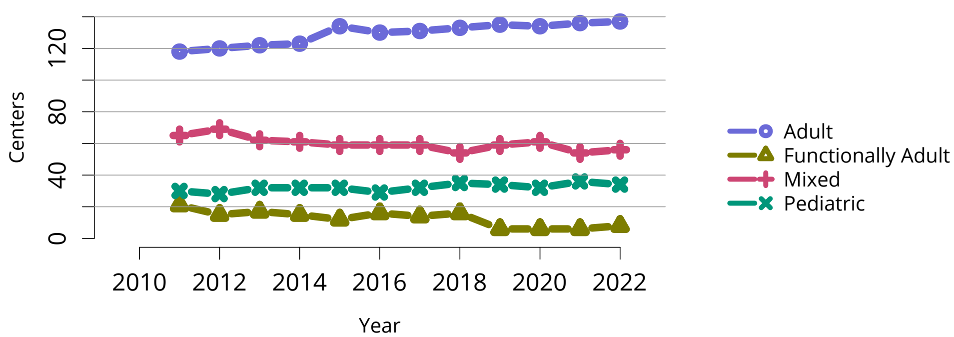
OPTN/SRTR 2022 Annual Data Report

Figure KI 120: Pediatric kidney transplants by recipient age. All pediatric kidney transplant recipients, including retransplant and multiorgan recipients.



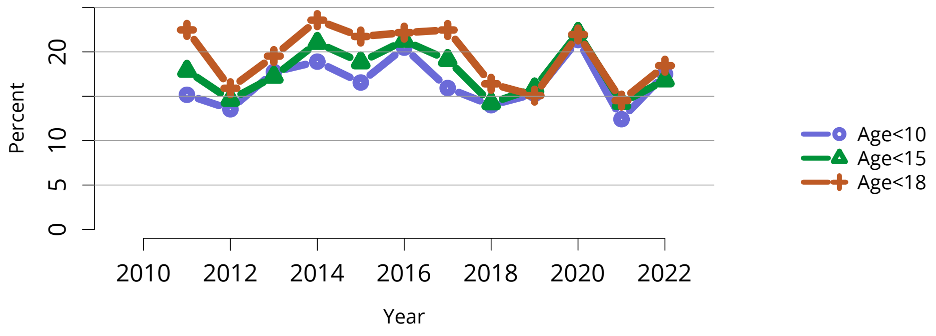
OPTN/SRTR 2022 Annual Data Report

Figure KI 121: Percent of pediatric kidney transplants from living donors by recipient age. All pediatric living kidney transplant recipients, including retransplant and multiorgan recipients.



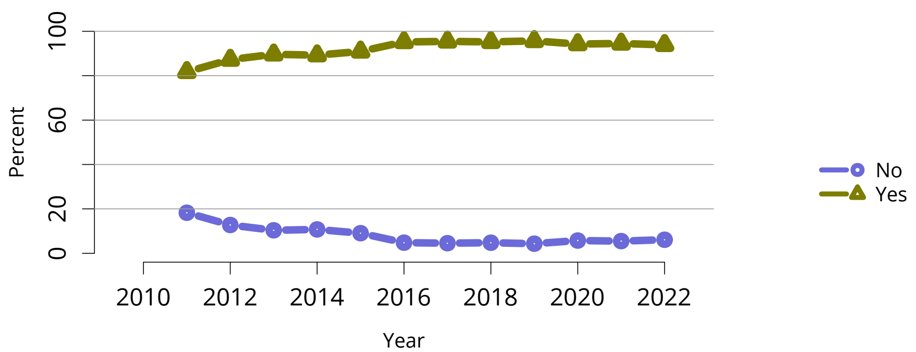
OPTN/SRTR 2022 Annual Data Report

Figure KI 122: Number of centers performing pediatric and adult kidney transplants by center age mix. Adult centers performed transplants only for recipients aged 18 years or older. Functionally adult centers performed transplants for 80% adults or more, and the remainder were children aged 15-17 years. Mixed included adults and children of any age groups. Pediatric centers performed transplants for recipients aged 0-17 years, and a small number of adults up to age 21 years.



OPTN/SRTR 2022 Annual Data Report

Figure KI 123: Pediatric kidney recipients at programs that perform five or fewer pediatric transplants annually. Age groups are cumulative.



OPTN/SRTR 2022 Annual Data Report

Figure KI 124: Induction agent use in pediatric kidney transplant recipients. Immunosuppression at transplant reported to the OPTN.

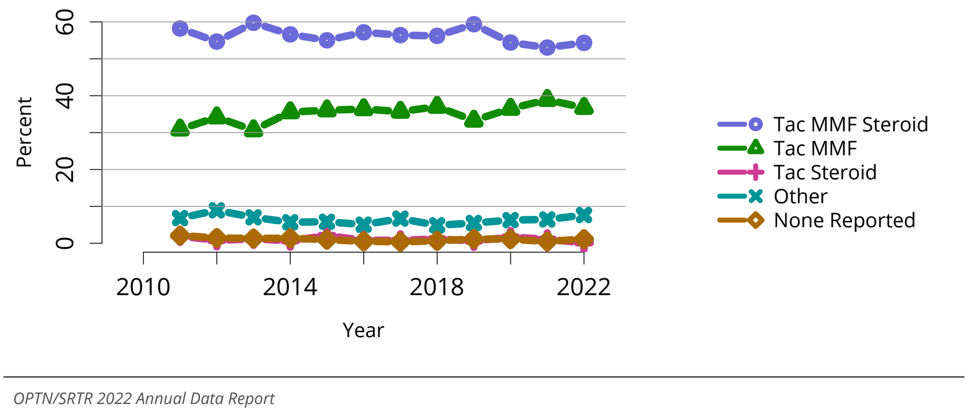


Figure KI 125: Immunosuppression regimen use in pediatric kidney transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.

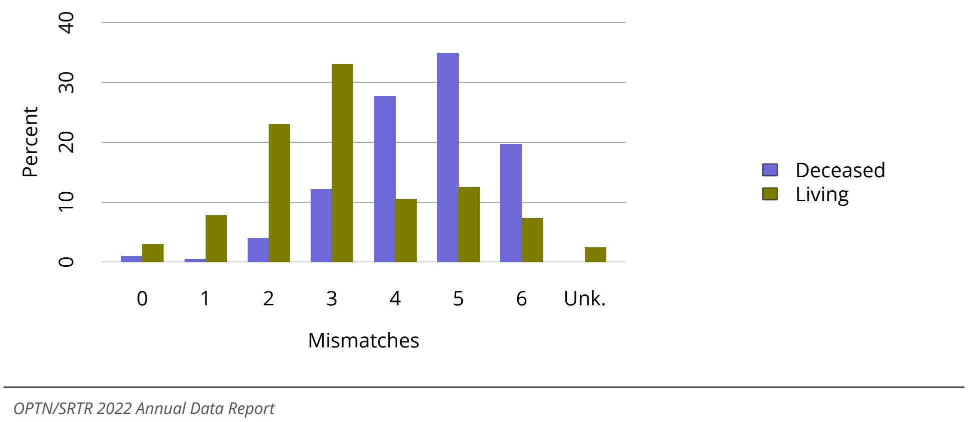
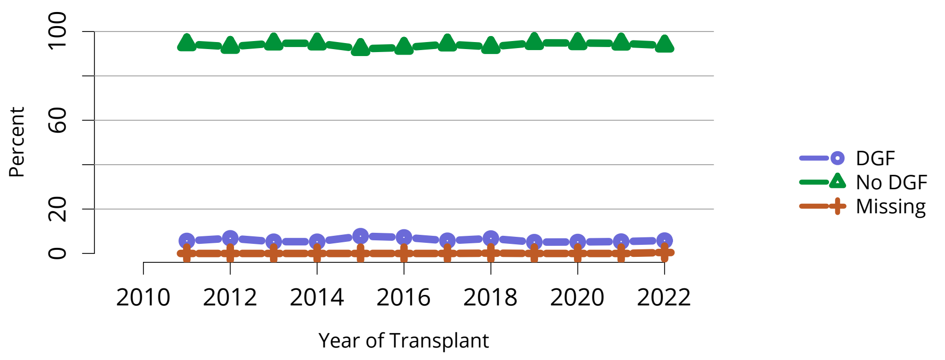
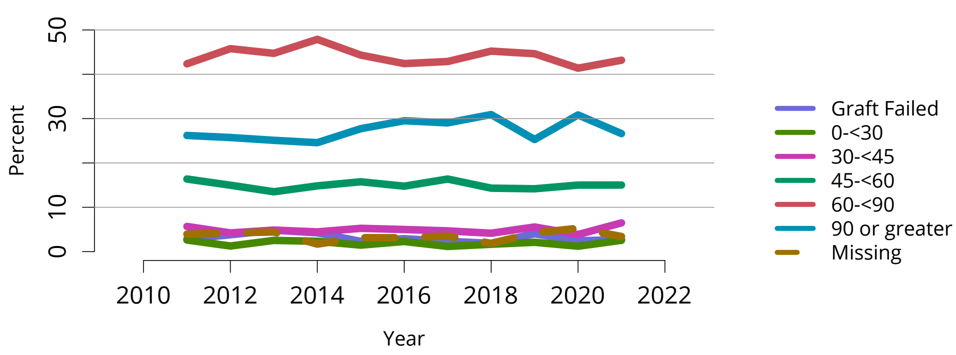


Figure KI 126: Total HLA A, B, and DR mismatches among pediatric kidney transplant recipients, 2018-2022. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2019. Unk, unknown.



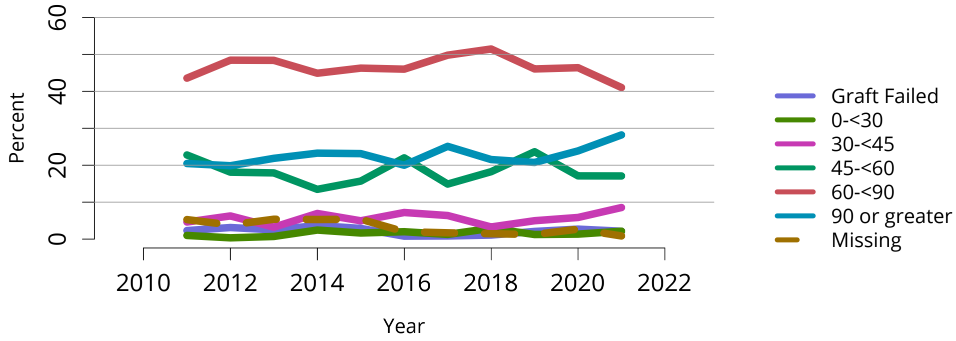
OPTN/SRTR 2022 Annual Data Report

Figure KI 127: Delayed graft function among pediatric kidney transplant recipients. All pediatric recipients of kidneys. Delayed graft function is defined as dialysis administered within the first 7 days posttransplant. DGF, delayed graft function.



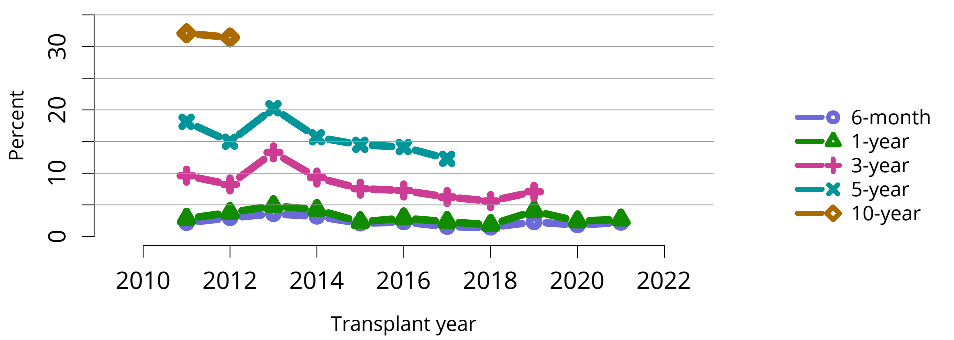
OPTN/SRTR 2022 Annual Data Report

Figure KI 128: Distribution of eGFR at 12 months posttransplant among pediatric deceased donor kidney transplant recipients. Glomerular filtration rate (mL/min/1.73 m^2) estimated using the bedside Schwartz equation, and computed by SRTR for patients alive with graft function at 12 months posttransplant. Equation: eGFR = 0.413*Height(cm)/Creatinine (mg/dL). eGFR, estimated glomerular filtration rate.



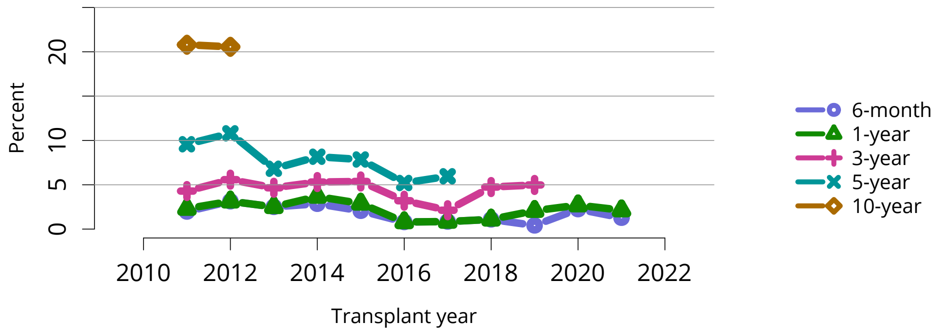
OPTN/SRTR 2022 Annual Data Report

Figure KI 129: Distribution of eGFR at 12 months posttransplant among pediatric living donor kidney transplant recipients. Glomerular filtration rate (mL/min/1.73 m^2) estimated using the bedside Schwartz equation, and computed by SRTR for patients alive with graft function at 12 months posttransplant. Equation: eGFR = 0.413*Height(cm)/Creatinine (mg/dL). eGFR, estimated glomerular filtration rate.



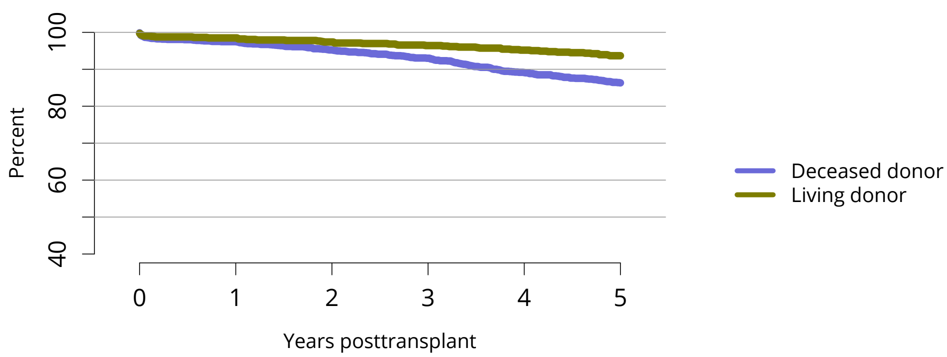
OPTN/SRTR 2022 Annual Data Report

Figure KI 130: Graft failure among pediatric deceased donor kidney transplant recipients. All pediatric recipients of deceased donor kidneys, including multiorgan transplant recipients. Estimates are unadjusted, computed using Kaplan-Meier methods. Recipients are followed to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 6 months, 1, 3, 5, or 10 years posttransplant. All-cause graft failure is defined as any of the prior outcomes prior to 6 months, 1, 3, 5, or 10 years, respectively.



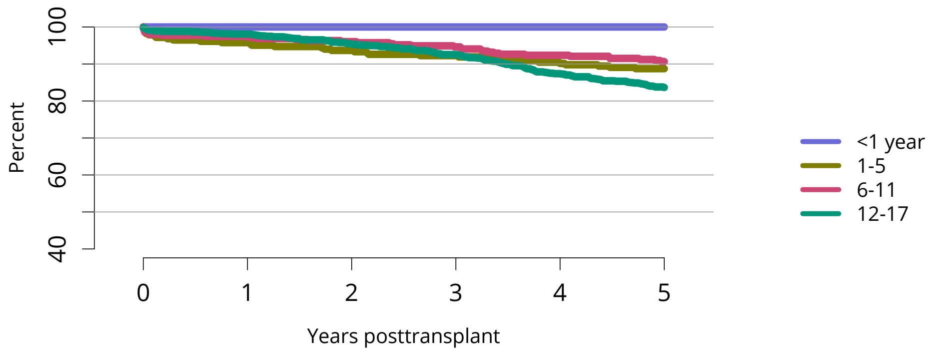
OPTN/SRTR 2022 Annual Data Report

Figure KI 131: Graft failure among pediatric living donor kidney transplant recipients. All pediatric recipients of living donor kidneys, including multiorgan transplant recipients. Estimates are unadjusted, computed using Kaplan-Meier methods. Recipients are followed to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 6 months, 1, 3, 5, or 10 years posttransplant. All-cause graft failure is defined as any of the prior outcomes prior to 6 months, 1, 3, 5, or 10 years, respectively.



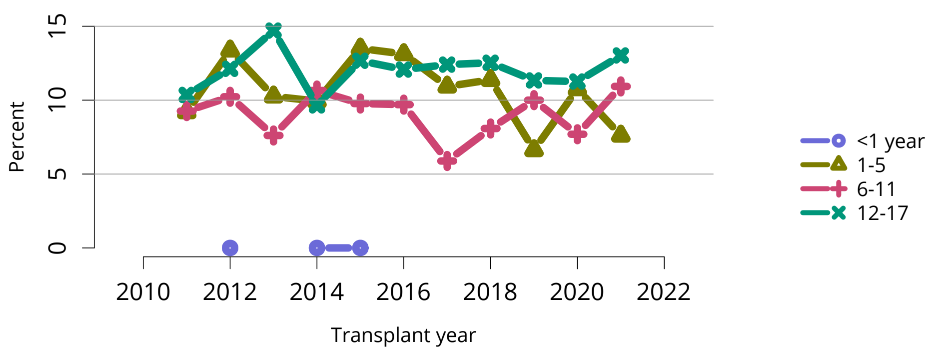
OPTN/SRTR 2022 Annual Data Report

Figure KI 132: Graft survival among pediatric kidney transplant recipients, 2015-2017, by donor type. Recipient survival estimated using unadjusted Kaplan-Meier methods.



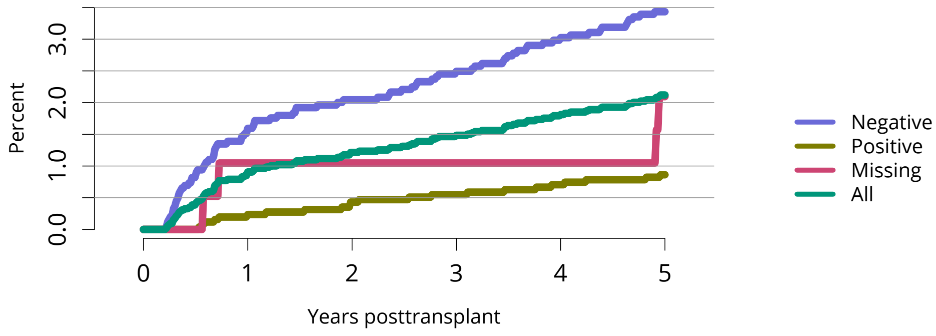
OPTN/SRTR 2022 Annual Data Report

Figure KI 133: Graft survival among pediatric deceased donor kidney transplant recipients, 2015-2017, by age. Recipient survival estimated using unadjusted Kaplan-Meier methods.



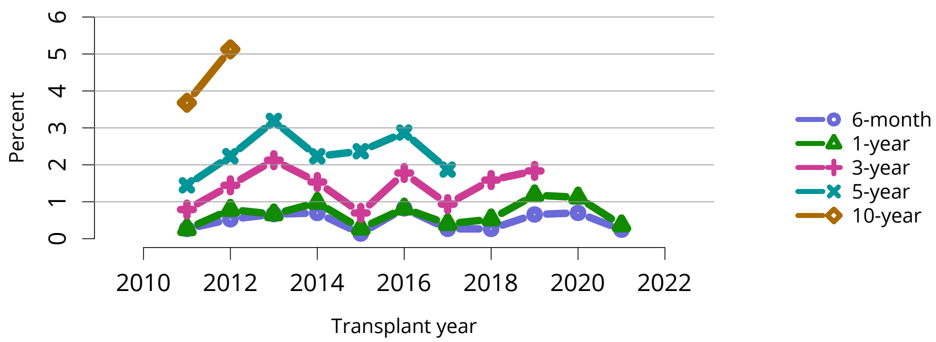
OPTN/SRTR 2022 Annual Data Report

Figure KI 134: Incidence of acute rejection by 1 year posttransplant among pediatric kidney transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



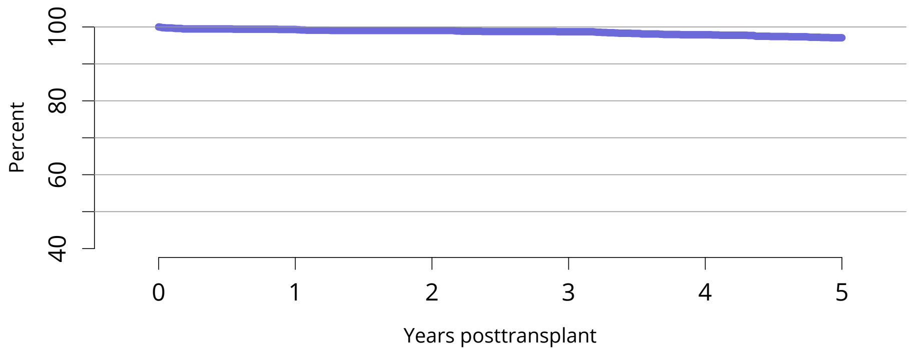
OPTN/SRTR 2022 Annual Data Report

Figure KI 135: Incidence of PTLD among pediatric kidney transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



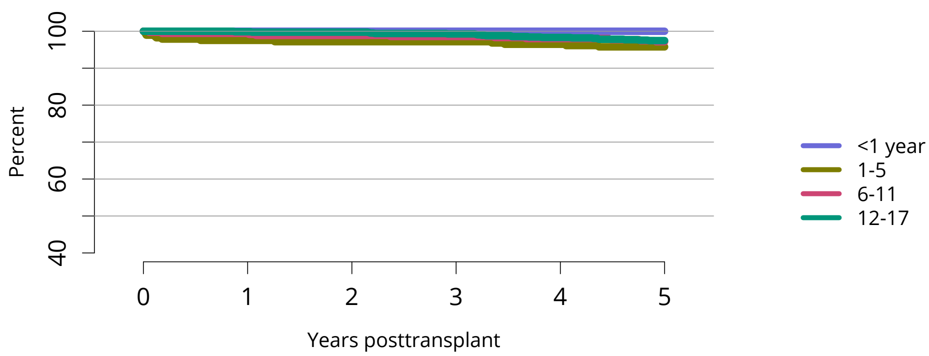
OPTN/SRTR 2022 Annual Data Report

Figure KI 136: Patient death among pediatric kidney transplant recipients. All pediatric recipients of deceased donor kidneys, including multiorgan transplant recipients. Estimates are unadjusted, computed using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure KI 137: Overall patient survival among pediatric deceased donor kidney transplant recipients, 2015-2017. Recipient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure KI 138: Patient survival among pediatric deceased donor kidney transplant recipients, 2015-2017, by recipient age. Recipient survival estimated using unadjusted Kaplan-Meier methods.

Table KI 1: Demographic characteristics of adults on the kidney transplant waiting list on December 31, 2012, December 31, 2017, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center. Age is determined on December 31 of the year.

	2012		2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Age (years)						
18-34 years	9617	9.6	8445	8.3	7313	7.7
35-49	27010	27	24962	24.6	22013	23.1
50-64	43381	43.4	44705	44	41449	43.5
65+	19847	19.9	23432	23.1	24616	25.8
Sex						
Female	40634	40.7	39413	38.8	36218	38
Male	59221	59.3	62131	61.2	59173	62
Race and ethnicity						
Asian	7929	7.9	9450	9.3	9598	10.1
Black	33941	34	33341	32.8	30209	31.7
Hispanic	18570	18.6	20080	19.8	20046	21
Multiracial	348	0.3	680	0.7	804	0.8
Native American	1109	1.1	987	1	845	0.9
White	37958	38	37006	36.4	33889	35.5
Miles between candidate and center						
<50 miles	66463	66.6	67170	66.1	62859	65.9
50-<100	14828	14.8	15591	15.4	15097	15.8
100-<150	7124	7.1	7018	6.9	6453	6.8
150-<250	6617	6.6	6721	6.6	5631	5.9
250+	4057	4.1	4564	4.5	4850	5.1
Missing	766	0.8	480	0.5	501	0.5
All candidates						
All candidates	99855	100	101544	100	95391	100

Table KI 2: Clinical characteristics of adults on the kidney transplant waiting list on December 31, 2012, December 31, 2017, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. Diabetes status based on diagnosis and comorbid conditions. cPRA, calculated panel-reactive antibody.

	2012		2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Diagnosis						
Diabetes	34138	34.2	37192	36.6	37165	39
Hypertension	24702	24.7	22907	22.6	19362	20.3
Glomerulonephritis	14547	14.6	14724	14.5	13205	13.8
Cystic kidney disease	8423	8.4	9054	8.9	8361	8.8
Other/unknown	18044	18.1	17666	17.4	17298	18.1
NA	1	0	1	0	0	0
Blood type						
A	28593	28.6	28051	27.6	25524	26.8
AB	2791	2.8	2618	2.6	2391	2.5
B	16155	16.2	17006	16.7	15572	16.3
O	52316	52.4	53869	53	51904	54.4
cPRA						
<1%	63493	63.6	62673	61.7	58570	61.4
1-<20%	6700	6.7	9496	9.4	9532	10
20-<80%	14032	14.1	16203	16	16816	17.6
80-<98%	6738	6.7	6032	5.9	4769	5
98-100%	8892	8.9	7140	7	5704	6
All candidates						
All candidates	99855	100	101544	100	95391	100

Table KI 3: Listing characteristics of adults on the kidney transplant waiting list on December 31, 2012, December 31, 2017, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date.

	2012		2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Waiting time (years)						
<1 year	30756	30.8	29028	28.6	33040	34.6
1-<2	22136	22.2	20978	20.7	20935	21.9
2-<3	16550	16.6	15611	15.4	13095	13.7
3-<5	18211	18.2	20724	20.4	17103	17.9
5+	12202	12.2	15203	15	11218	11.8
Previous transplant						
No prior transplant	84725	84.8	88945	87.6	84566	88.7
Prior transplant	15130	15.2	12599	12.4	10825	11.3
All candidates						
All candidates	99855	100	101544	100	95391	100

Table KI 4: Kidney transplant waitlist activity among adults. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	**2020**	**2021**	**2022**
Waiting list state			
Patients at start of year	101360	97246	95978
Patients added during year	37400	41765	44187
Patients removed during year	41491	43022	44774
Patients at end of year	97269	95989	95391

Table KI 5: Removal reason among adult kidney transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	17848	18829	19854
Living donor transplant	4986	5714	5633
Transplant outside US	47	39	57
Patient died	5163	5283	4454
Patient refused transplant	304	282	296
Improved, transplant not needed	180	217	269
Too sick for transplant	3909	4058	4504
Other	8825	8278	9321
Changed to kidney-pancreas list	198	242	219
Still on waiting list	31	80	167

Table KI 6: Demographic characteristics of adult kidney transplant recipients, 2022. Kidney transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	Deceased		Living		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Recipient age (years)						
18-34 years	2125	10.7	901	15.9	3026	11.8
35-49	5065	25.4	1540	27.2	6605	25.8
50-64	8011	40.2	2008	35.5	10019	39.1
65+	4743	23.8	1211	21.4	5954	23.3
Sex						
Female	7834	39.3	2142	37.8	9976	39
Male	12110	60.7	3518	62.2	15628	61
Race and ethnicity						
Asian	1684	8.4	402	7.1	2086	8.1
Black	6794	34.1	726	12.8	7520	29.4
Hispanic	4074	20.4	977	17.3	5051	19.7
Multiracial	176	0.9	44	0.8	220	0.9
Native American	171	0.9	34	0.6	205	0.8
White	7045	35.3	3477	61.4	10522	41.1
Insurance						
Private	5366	26.9	3082	54.5	8448	33
Medicare	12471	62.5	2130	37.6	14601	57
Medicaid	1532	7.7	292	5.2	1824	7.1
Other/unknown	575	2.9	156	2.8	731	2.9
Miles between recipient and center						
<50 miles	13005	65.2	3704	65.4	16709	65.3
50-<100	3244	16.3	886	15.7	4130	16.1
100-<150	1469	7.4	361	6.4	1830	7.1
150-<250	1032	5.2	312	5.5	1344	5.2
250+	981	4.9	318	5.6	1299	5.1
Missing	213	1.1	79	1.4	292	1.1
All recipients						
All recipients	19944	100	5660	100	25604	100

Table KI 7: Clinical characteristics of adult kidney transplant recipients, 2022. Kidney transplant recipients, including retransplant recipients. cPRA, calculated panel-reactive antibody.

	Deceased		Living		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Diagnosis						
Diabetes	6672	33.5	1392	24.6	8064	31.5
Hypertension	4597	23	939	16.6	5536	21.6
Glomerulonephritis	3006	15.1	1262	22.3	4268	16.7
Cystic kidney disease	1781	8.9	951	16.8	2732	10.7
Other/unknown	3888	19.5	1116	19.7	5004	19.5
Blood type						
A	6758	33.9	2144	37.9	8902	34.8
AB	940	4.7	264	4.7	1204	4.7
B	2934	14.7	778	13.7	3712	14.5
O	9312	46.7	2474	43.7	11786	46
Years of dialysis						
None	2406	12.1	1884	33.3	4290	16.8
<1 year	1770	8.9	1138	20.1	2908	11.4
1-<3	4287	21.5	1498	26.5	5785	22.6
3-<5	3940	19.8	460	8.1	4400	17.2
5+	7541	37.8	680	12	8221	32.1
cPRA						
<1%	11709	58.7	3933	69.5	15642	61.1
1-<20%	1797	9	590	10.4	2387	9.3
20-<80%	3385	17	924	16.3	4309	16.8
80-<98%	1842	9.2	160	2.8	2002	7.8
98-100%	1209	6.1	53	0.9	1262	4.9
Missing	2	0	0	0	2	0
All recipients						
All recipients	19944	100	5660	100	25604	100

Table KI 8: Transplant characteristics of adult kidney transplant recipients, 2022. Kidney transplant recipients, including retransplant recipients. DCD status and KDPI scores apply to deceased donor transplants only. DBD, donation after brain death; DCD, donation after circulatory death; KDPI, kidney donor profile index.

	Deceased		Living		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Waiting time (years)						
None	175	0.9	71	1.3	246	1
<1 year	9710	48.7	3473	61.4	13183	51.5
1-<3	4817	24.2	1672	29.5	6489	25.3
3-<5	2924	14.7	344	6.1	3268	12.8
5+	2318	11.6	100	1.8	2418	9.4
KDPI						
0-<20%	4970	24.9	0	0	4970	19.4
20-<35%	3491	17.5	0	0	3491	13.6
35-<85%	10271	51.5	0	0	10271	40.1
85-100%	1212	6.1	0	0	1212	4.7
Missing	0	0	5660	100	5660	22.1
Donation after circulatory death						
DBD	13832	69.4	0	0	13832	54
DCD	6112	30.6	0	0	6112	23.9
Living donor	0	0	5660	100	5660	22.1
Previous transplant for recipients						
No prior transplant	18080	90.7	5158	91.1	23238	90.8
Prior transplant	1864	9.3	502	8.9	2366	9.2
Organs transplanted						
Kidney only	17939	89.9	5659	100	23598	92.2
Kidney-pancreas	806	4	0	0	806	3.1
Kidney-liver	777	3.9	0	0	777	3
Heart-kidney	384	1.9	0	0	384	1.5
Kidney-lung	22	0.1	0	0	22	0.1
Intestine-pancreas-liver-kidney	2	0	0	0	2	0
Other	14	0.1	1	0	15	0.1
All recipients						
All recipients	19944	100	5660	100	25604	100

Table KI 9: Adult deceased donor kidney donor-recipient serology matching, 2019-2022. Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. Any evidence for a positive serology is treated as positive for that serology. Donor HCV NAT data are shown by recipient HCV antibody status. CMV, cytomegalovirus; EBV, Epstein-Barr virus; HBsAg, hepatitis B surface antigen; HCV, hepatitis C virus; NAT, nucleic acid test; unk, unknown.

Donor	Recipient	CMV	EBV	HBsAg	HCV antibody	HCV NAT
Donor						
D-	R-	12.99	0.52	96.39	84.01	87.94
D-	R+	24.74	7.24	1.2	3.04	3.25
D-	R unk	0.82	0.29	2.16	2.51	2.63
D+	R-	18.48	5	0.18	9.48	5.53
D+	R+	41.27	82.96	0.01	0.7	0.5
D+	R unk	1.24	3.75	0	0.25	0.13
D unk	R-	0.12	0.01	0.05	0.01	0.03
D unk	R+	0.35	0.22	0	0	0
D unk	R unk	0	0.01	0	0	0

Table KI 10: Adult living donor kidney donor-recipient serology matching, 2020-2022. Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. Any evidence for a positive serology is treated as positive for that serology. Donor HCV NAT data are shown by recipient HCV antibody status. CMV, cytomegalovirus; EBV, Epstein-Barr virus; HBsAg, hepatitis B surface antigen; HCV, hepatitis C virus; NAT, nucleic acid test; unk, unknown.

Donor	Recipient	CMV	EBV	HBsAg	HCV antibody	HCV NAT
Donor						
D-	R-	24.04	1.15	93.11	91.27	84.48
D-	R+	20.78	7.56	0.81	1.69	1.57
D-	R unk	0.74	0.22	3.29	3.84	3.37
D+	R-	16.92	5.96	0.41	0.81	0.08
D+	R+	31.8	79.8	0.01	0.02	0.01
D+	R unk	0.79	2.6	0	0.02	0
D unk	R-	2.01	0.17	1.94	1.88	9.4
D unk	R+	2.44	2.03	0.02	0.04	0.17
D unk	R unk	0.48	0.52	0.41	0.43	0.93

Table KI 11: Demographic characteristics of pediatric candidates on the kidney transplant waiting list on December 31, 2012, December 31, 2017, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date. Age is determined on December 31 of the year. Distance is computed from candidate's home zip code to the transplant center.

	2012		2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Age (years)						
<1 year	5	0.4	3	0.2	1	0.1
1-5	179	14	245	16	233	13.1
6-11	231	18.1	286	18.6	317	17.8
12-17	453	35.5	541	35.3	589	33.1
18+	409	32	459	29.9	639	35.9
Sex						
Female	515	40.3	604	39.4	695	39.1
Male	762	59.7	930	60.6	1084	60.9
Race and ethnicity						
Asian	46	3.6	84	5.5	115	6.5
Black	363	28.4	348	22.7	344	19.3
Hispanic	349	27.3	465	30.3	523	29.4
Multiracial	11	0.9	23	1.5	51	2.9
Native American	8	0.6	16	1	22	1.2
White	500	39.2	598	39	724	40.7
Miles between candidate and center						
<50 miles	794	62.2	980	63.9	1153	64.8
50-<100	217	17	239	15.6	279	15.7
100-<150	108	8.5	120	7.8	135	7.6
150-<250	90	7	113	7.4	120	6.7
250+	52	4.1	75	4.9	84	4.7
Missing	16	1.3	7	0.5	8	0.4
All candidates						
All candidates	1277	100	1534	100	1779	100

Table KI 12: Clinical characteristics of pediatric candidates on the kidney transplant waiting list on December 31, 2012, December 31, 2017, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date. CAKUT, congenital anomalies of the kidney and urinary tract; cPRA, calculated panel-reactive antibody; FSGS, focal segmental glomerulosclerosis; GN, glomerulonephritis.

	2012		2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Pediatric diagnosis						
FSGS	152	11.9	166	10.8	158	8.9
Glomerulonephritis	147	11.5	118	7.7	136	7.6
CAKUT	355	27.8	554	36.1	629	35.4
Other/unknown	623	48.8	696	45.4	855	48.1
NA	0	0	0	0	1	0.1
Blood type						
A	416	32.6	445	29	580	32.6
AB	35	2.7	34	2.2	60	3.4
B	202	15.8	251	16.4	265	14.9
O	624	48.9	804	52.4	874	49.1
cPRA						
<1%	777	60.8	1004	65.4	1216	68.4
1-<20%	69	5.4	138	9	164	9.2
20-<80%	150	11.7	183	11.9	220	12.4
80-<98%	116	9.1	81	5.3	78	4.4
98-100%	165	12.9	128	8.3	101	5.7
All candidates						
All candidates	1277	100	1534	100	1779	100

Table KI 13: Listing characteristics of pediatric candidates on the kidney transplant waiting list on December 31, 2012, December 31, 2017, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date.

	2012		2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Waiting time (years)						
<1 year	572	44.8	694	45.2	696	39.1
1-<2	249	19.5	292	19	362	20.3
2-<3	136	10.6	180	11.7	211	11.9
3-<5	148	11.6	202	13.2	256	14.4
5+	172	13.5	166	10.8	254	14.3
Previous transplant						
No prior transplant	878	68.8	1211	78.9	1480	83.2
Prior transplant	399	31.2	323	21.1	299	16.8
All candidates						
All candidates	1277	100	1534	100	1779	100

Table KI 14: Kidney transplant waitlist activity among pediatric candidates. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	1553	1695	1698
Patients added during year	1083	1087	1099
Patients removed during year	941	1084	1018
Patients at end of year	1695	1698	1779

Table KI 15: Removal reason among pediatric kidney transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	563	692	591
Living donor transplant	248	257	230
Transplant outside US	1	0	0
Patient died	21	20	24
Patient refused transplant	2	6	5
Improved, transplant not needed	5	4	9
Too sick for transplant	8	9	13
Other	92	96	146
Changed to kidney-pancreas list	1	0	0

Table KI 16: Demographic characteristics of pediatric kidney transplant recipients, 2022. Pediatric kidney transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	Deceased		Living		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Recipient age (years)						
<1 year	1	0.2	0	0	1	0.1
1-5	81	16.1	67	33	148	21
6-11	121	24.1	45	22.2	166	23.5
12-17	299	59.6	91	44.8	390	55.3
Sex						
Female	213	42.4	88	43.3	301	42.7
Male	289	57.6	115	56.7	404	57.3
Race and ethnicity						
Asian	26	5.2	10	4.9	36	5.1
Black	107	21.3	24	11.8	131	18.6
Hispanic	155	30.9	34	16.7	189	26.8
Multiracial	14	2.8	5	2.5	19	2.7
Native American	1	0.2	1	0.5	2	0.3
White	199	39.6	129	63.5	328	46.5
Insurance						
Private	132	26.3	105	51.7	237	33.6
Medicare	96	19.1	28	13.8	124	17.6
Medicaid	220	43.8	55	27.1	275	39
Other/unknown	54	10.8	15	7.4	69	9.8
Miles between recipient and center						
<50 miles	299	59.6	122	60.1	421	59.7
50-<100	93	18.5	37	18.2	130	18.4
100-<150	37	7.4	20	9.9	57	8.1
150-<250	47	9.4	14	6.9	61	8.7
250+	21	4.2	10	4.9	31	4.4
Missing	5	1	0	0	5	0.7
All recipients						
All recipients	502	100	203	100	705	100

Table KI 17: Clinical characteristics of pediatric kidney transplant recipients, 2022. Pediatric kidney transplant recipients, including retransplant recipients. Diagnosis categories follow North American Pediatric Renal Trials and Collaborative Studies recommendations. CAKUT, congenital anomalies of the kidney and urinary tract; cPRA, calculated panel-reactive antibody; FSGS, focal segmental glomerulosclerosis; GN, glomerulonephritis.

	Deceased		Living		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Diagnosis						
FSGS	56	11.2	17	8.4	73	10.4
Glomerulonephritis	44	8.8	15	7.4	59	8.4
CAKUT	156	31.1	72	35.5	228	32.3
Other/unknown	246	49	99	48.8	345	48.9
Blood type						
A	162	32.3	82	40.4	244	34.6
AB	16	3.2	14	6.9	30	4.3
B	61	12.2	39	19.2	100	14.2
O	263	52.4	68	33.5	331	47
Years of dialysis						
None	139	27.7	65	32	204	28.9
<1 year	134	26.7	59	29.1	193	27.4
1-<3	147	29.3	59	29.1	206	29.2
3-<5	36	7.2	9	4.4	45	6.4
5+	46	9.2	11	5.4	57	8.1
cPRA						
<1%	350	69.7	157	77.3	507	71.9
1-<20%	44	8.8	11	5.4	55	7.8
20-<80%	86	17.1	29	14.3	115	16.3
80-<98%	13	2.6	3	1.5	16	2.3
98-100%	9	1.8	2	1	11	1.6
Missing	0	0	1	0.5	1	0.1
All recipients						
All recipients	502	100	203	100	705	100

Table KI 18: Transplant characteristics of pediatric kidney transplant recipients, 2022. Pediatric kidney transplant recipients, including retransplant recipients. DCD status and KDPI scores apply to deceased donor transplants only. DBD, donation after brain death; DCD, donation after circulatory death; DGF, delayed graft function; KDPI, kidney donor profile index.

	Deceased		Living		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Waiting time (years)						
None	3	0.6	6	3	9	1.3
<1 year	368	73.3	151	74.4	519	73.6
1-<3	99	19.7	37	18.2	136	19.3
3-<5	21	4.2	7	3.4	28	4
5+	11	2.2	2	1	13	1.8
KDPI						
0-<20%	410	81.7	0	0	410	58.2
20-<35%	81	16.1	0	0	81	11.5
35-<85%	11	2.2	0	0	11	1.6
Missing	0	0	203	100	203	28.8
Donation after circulatory death						
DBD	484	96.4	0	0	484	68.7
DCD	18	3.6	0	0	18	2.6
Living donor	0	0	203	100	203	28.8
Previous transplant for recipients						
No prior transplant	467	93	193	95.1	660	93.6
Prior transplant	35	7	10	4.9	45	6.4
Organs transplanted						
Kidney only	484	96.4	203	100	687	97.4
Kidney-pancreas	1	0.2	0	0	1	0.1
Kidney-liver	12	2.4	0	0	12	1.7
Heart-kidney	4	0.8	0	0	4	0.6
Intestine-pancreas-liver-kidney	1	0.2	0	0	1	0.1
All recipients						
All recipients	502	100	203	100	705	100

Table KI 19: Pediatric deceased donor kidney donor-recipient serology matching, 2020-2022. Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. Any evidence for a positive serology is treated as positive for that serology. CMV, cytomegalovirus; EBV, Epstein-Barr virus; unk, unknown.

Donor	Recipient	CMV	EBV
Donor			
D-	R-	26.76	5.63
D-	R+	13.35	7.02
D-	R unk	1.01	0.25
D+	R-	36.88	37.32
D+	R+	20.75	47.88
D+	R unk	0.38	1.39
D unk	R-	0.51	0.32
D unk	R+	0.38	0.19
D unk	R unk	0	0

Table KI 20: Pediatric living donor kidney donor-recipient serology matching, 2020-2022. Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. Any evidence for a positive serology is treated as positive for that serology. CMV, cytomegalovirus; EBV, Epstein-Barr virus; unk, unknown.

Donor	Recipient	CMV	EBV
Donor			
D-	R-	39.15	6.98
D-	R+	10.62	2.73
D-	R unk	0.46	0.15
D+	R-	28.98	56.6
D+	R+	15.78	30.8
D+	R unk	0.3	1.82
D unk	R-	3.19	0.46
D unk	R+	1.21	0.46
D unk	R unk	0.3	0

OPTN/SRTR 2022 Annual Data Report: Pancreas

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Abstract

The postpandemic recovery did not occur in pancreas transplantation as in other organs. The number of pancreas transplants in the United States decreased to 918 in 2022 from 963 in 2021. The number of simultaneous pancreas-kidney transplants decreased to 810 in 2022 from 820 in 2021, but the largest decrease was in pancreas transplant alone: 62 in 2022 compared with 92 in 2021. Pancreas-after-kidney transplants decreased to 46 in 2022 from 51 in 2021. The trend of increasing proportions of pancreas transplants in patients with type 2 diabetes seen over the past few years ended in 2022; there were 22.4% of such transplants in 2022 compared with 25.8% in 2021. The proportion of recipients older than 45 years decreased in 2022 as well. However, the proportions of candidates with type 2 diabetes and older candidates on the waiting list did not decrease. The number of pancreas donors decreased and the pancreas nonuse rate increased in 2022. Outcomes after pancreas transplant continued to improve, with an impressive 8.1% pancreas and 4.3% kidney graft failure rate for simultaneous pancreas-kidney transplant at 1 year in 2022. The proportion of pancreas transplants performed by medium-volume centers (11-24 transplants/year) returned to 37.2% in 2022 from a high of 48.3% in 2021, whereas the proportion of those done

by large-volume centers (25 or more transplants/year) returned to 25.3% in 2022 from a low of 15.9% in 2021.
Keywords: Pancreas transplant, transplant outcomes, waitlist outcomes

1 Introduction

The postpandemic recovery seen in other organs has not occurred in pancreas transplantation due to a combination of factors. The proportion of patients with type 2 diabetes undergoing pancreas transplant decreased for the first time in the past few years, probably related to newer noninsulin therapies for diabetes, improvement in medical management of diabetes, decreased risk tolerance by centers and patients, broader sharing with an increase in cold ischemic time, and lack of widespread surgical expertise for pancreas procurement and transplant. Initiatives to identify and address some of these issues are underway by various bodies, including the Organ Procurement and Transplantation Network's (OPTN) Pancreas Transplantation Committee, the American Society of Transplantation's Kidney Pancreas Community of Practice, and the International Pancreas and Islet Transplant Association's pancreas working group.

Meanwhile, outcomes after pancreas transplant continued to improve and in 2022 were probably the best they have ever been. Technical failures, immunologic loss, and short- and long-term graft and patient survival have all shown a positive trend. The definition of pancreas graft failure adopted in 2018 has helped set uniform criteria for failure, but these criteria will need refinement in the future as acknowledged at their implementation. In addition, the lack of data on recipient body weight and insulin dose poses a major issue. In particular, graft failure due to insulin dependence cannot be independently calculated from OPTN/Scientific Registry of Transplant Recipients (SRTR) data, because recipient body weight is not collected on transplant follow-up forms and transplant centers are allowed to report follow-up insulin dosage as missing, unknown, or not done.

The SRTR rolled out the new organ allocation simulator (OASIM) in 2022. The OPTN's Kidney and Pancreas Transplantation Committees' data requests for continuous distribution were simulated in fall 2022. After the report, the committees refined the request in March 2023 and a second simulation was run in summer 2023. This second round of modeling was more detailed and granular in nature. The scenarios modeled sought to explore different ratios of proximity efficiency to qualifying time while maintaining appropriately high access for candidates with high calculated panel reactive antibody (cPRA), pediatric candidates, and prior living donor candidates. At the time of this writing, the report is being reviewed by both Committees to decide on further action. The Pancreas Committee is in discussion for including a medical urgency attribute to the pancreas continuous distribution framework. A review-based medical urgency attribute will create a pathway for medically urgent pancreas patients and allow the Pancreas Committee to collect data on medical urgency status in pancreas patients.

In September 2023, the OPTN Board of Directors, in the process of establishing a working group on organ nonuse, discussed the kidney and pancreas continuous distribution project, and decided that the kidney and pancreas continuous distribution proposal would not be submitted for public comment in January 2024. The OPTN Kidney and Pancreas Committees were directed to evaluate the potential impact of continuous distribution on the following goals:

- decreased nonuse/nonutilization of kidneys and pancreata;
- decreased out-of-sequence allocation of kidneys; and
- consideration of expedited placement pathways for kidneys at a high risk of nonuse.

The Committees will continue to update the community with each public comment cycle on the project's progress to date.

To summarize, the continuous distribution proposal for kidney and pancreas needs additional refinement before it is ready for implementation. Defining outcome criteria, establishing medical urgency criteria, and improving utilization while allowing for broader sharing without defined boundaries—and doing all of this without adversely affecting pancreas transplant volumes—continue to be challenges in the field of pancreas transplantation.

2 Waiting List

The number of adult candidates added to the waiting list in 2022 remained stable in comparison with the previous year for simultaneous pancreas-kidney (SPK) transplant (1,486 in 2022 compared with 1,487 in 2021) and for pancreas transplant alone (PTA) (180 in 2022 compared with 181 in 2021). However, the number of pancreas-after-kidney (PAK) transplant candidates added to the waiting list dropped notably (71 in 2022 compared with 106 in 2021) (Figure PA 1). The PAK category had a consistent decline in candidates year over year during the past decade. This decline in PAK listings corresponded with an increase in SPK listings during the same period, probably reflecting the shift in preference to performing deceased donor SPK transplants, where waiting times are shorter (Table PA 3 and Table PA 12), over doing a living donor kidney transplant followed by a deceased donor pancreas transplant, where waiting times are longer (Table PA 3 and Table PA 12).

Prevalent adult listings increased for SPK (3,340 in 2022 compared with 3,207 in 2021). Prevalent adult listings were stable for PTA (541 in 2022 compared with 543 in 2021) but decreased for PAK (356 in 2022 compared with 399 in 2021) (Figure PA 2).

The age distribution of adult candidates on the waiting list shows trends over the past decade that are unmistakable. The proportion of older candidates (55 years or older) increased steadily, to 14.8% in 2022 from 11.6% in 2011, possibly related to the increased proportion of candidates with type 2 diabetes being added to the list. There was a corresponding drop for the 45- to 54-year age group (30.2% in 2022 compared with 35.1% in 2011). The 35- to 64-year age group was stable (34.9% in 2022 compared with 35.4% in 2011), and the 18- to 34-year age group increased (20.2% in 2022 compared with 17.9% in 2011) (Figure PA 3).

The sex distribution of adult pancreas waitlist candidates remained stable over the past decade with a male preponderance of about 10% (54.1% male and 45.9% female in 2022) (Figure PA 4). The male preponderance is probably driven by the majority SPK candidate population, because the PTA candidate population has a higher proportion of women (Table PA 1).

In terms of race and ethnicity, the proportion of adult White candidates on the pancreas waiting list continued to drop over the past decade. For the first time, White candidates did not make up the majority of the list (48.1% in 2022 compared with 67.3% in 2011) (Figure PA 5). The proportions of Black and Hispanic candidates continued to increase (28.5% Black in 2022 compared with 18.0% in 2011; 16.9% Hispanic in 2022 compared with 11.5% in 2011). The proportion of Asian candidates also increased but made up a small portion of the list. The Multiracial and Native American populations remained stable.

Perhaps the most notable trend for the pancreas waiting list in the past few years is the increase in listings of adult candidates with type 2 diabetes, which reached its highest level (23.2% in 2022 compared with 7.8% in 2011), with a corresponding decrease in listings of candidates with type 1 diabetes (68.8% in 2022 compared with 83.3% in 2011) (Figure PA 6). This drove a number of other changes in characteristics on the waiting list, such as age, body mass index (BMI), and race and ethnicity. For example, the proportion of candidates with obesity (BMI > 30 kg/m^2) increased over the past decade (23.2% in 2022 compared with 18.3% in 2011), while the proportion of candidates with a BMI of less than 25 kg/m^2 decreased (36.0% in 2022 compared with 42.8% in 2011) (Figure PA 8).

The distribution of adult candidates by waiting time shifted toward a higher proportion waiting 1-<2 years compared with those waiting less than 1 year (Figure PA 7). This shift might be due to the increase in prevalent listings with a gradual move toward longer waiting times.

The distribution of candidates by blood type was largely unchanged year over year from 2021 to 2022; in 2022, 47.2% of candidates had blood type O, 33.0% had type A, 16.2% had type B, and 3.7% had type AB. The 16.2% value for candidates with blood type B, however, represents a gradual increase in prevalence over the past decade (from 12.8% in 2011) (Figure PA 9).

With regard to transplant type, the waiting list in 2022 comprised predominately SPK candidates (78.8%), followed by PTA (12.8%) and PAK candidates (8.4%). The upward trend of SPK candidates, the decline of PAK candidates, and the stable proportion of PTAs has been the pattern over the past few years (Figure PA 10).

The proportion of adult retransplant candidates continued to decrease, to 7.0% in 2022 compared with 15.3% in 2011 (Figure PA 11). Historically, PAK candidates have been the most likely to have had a prior pancreas or kidney-pancreas transplant (Table PA 3); therefore, the overall drop in PAKs (Figure PA 10) has impacted the overall retransplant candidate rate as well.

Overall pancreas transplant rates among adult candidates have seen a decreasing trend since 2019, after an increasing trend for several years prior. The transplant rate in 2022 was 36.7 transplants per 100 patient-years, down from 40.2 in 2021 and the peak of 44.8 in 2019 (Figure PA 12). Initially it was thought that the drop after 2019 was attributable to the COVID-19 pandemic; however, the continued decline implies that other factors, such as more stringent criteria for pancreas donation and acceptance, are involved. Of note, this decrease in the transplant rate was most pronounced in candidates with type 2 diabetes (38.5 transplants per 100 patient-years in 2022 compared with 52.2 in 2021) (Figure PA 13). This suggests that centers may be using a higher threshold for organ acceptance for the older, higher BMI candidates. This could also partly be a function of a larger number of candidates with type 2 diabetes being added to the list.

The decrease in transplant rate in adults does not affect any blood type disproportionately compared with the past few years (Figure PA 14). Of note, the drop in overall transplant rates is not as apparent in candidates intended for PAK transplant, where the rates have been stable over the past 4 years, albeit at smaller numbers (Figure PA 15).

Three-year outcomes for adult candidates added to the waiting list from 2017 through 2019 show that among candidates for SPK transplant, most underwent transplant (61.4% with a deceased donor pancreas and kidney, 4.5% with a living donor kidney and deceased donor pancreas), 11.3% were still waiting, 5.2% died while waiting, and 17.5% were removed from the list (Figure PA 18). Among candidates for PTA, 46.6% underwent transplant, 21.0% were still waiting, 3.0% died, and 29.5% were removed from the list (Figure PA 17). Among candidates for PAK transplant, 32.3% underwent transplant, 29.4% were still waiting, 1.7% died, and 36.6% were removed from the list (Figure PA 16); note that the proportion removed from the list exceeded the proportion who underwent transplant.

Mortality on the waiting list has steadily decreased among adults since the peak in 2020 (6.2 deaths per 100 patient-years), down to 4.7 in 2022 (Figure PA 19). This 2020 peak is partly attributable to the COVID-19 pandemic. An exception to the decrease in mortality rate was among candidates for PTA, where it increased to 3.4 deaths per 100 patient-years in 2022 from 2.7 in 2021 (Figure PA 23), although this may be insignificant given the small numbers of PTA candidates. Another exception to the trend of decreasing waitlist mortality was among older candidates (55 years or older), where the rate increased to 8.9 deaths per 100 patient-years in 2022 from 6.7 in 2021 (Figure PA 20).

There were no notable trends in waitlist mortality by race and ethnicity (Figure PA 21), although year over year there was a slight decrease in mortality in Black candidates (4.1 deaths per 100 patient-years in 2022 compared with 5.6 in 2021), a slight increase in Hispanic candidates (4.4 deaths per 100 patient-years in 2022 compared with 3.7 in 2021), and, although they make up a smaller number on the waiting list (Table PA 1), a notable increase in Asian candidates (6.2 deaths per 100 patient-years in 2022 compared with 2.8 in 2021). No notable differences were found in waitlist mortality rates between male and female candidates (Figure PA 22). There were wide geographic variances across donation service areas in waitlist mortality ranging from 0.0 to 31.6 deaths per 100 patient-years, but these should be interpreted with caution since some donation service areas may have small numbers (Figure PA 24).

Deaths within 6 months after removal from the waiting list among adults increased year over year to 8.5% in 2022 from 6.8% in 2021 (Figure PA 25). This is also a notable increase from 4.9% in 2011, although this number has oscillated over the past decade. Surprising findings in the increase in deaths after waitlist removal were that it was quite pronounced in the younger age groups (18-34 and 35-44 years) and less pronounced in the older age group (55 years or older) and that deaths after waitlist removal actually decreased notably among 45- to 54-year-olds in 2022 compared with 2021 (Figure PA 26). These data should be watched closely in the upcoming years to note if there is a new trend. As expected, the SPK candidates had the highest proportion of deaths within 6 months after waitlist removal (11.7% in 2022), which was a pronounced increase from the previous year. Death after waitlist removal in 2022 among PAK candidates (0.0%) and among PTA candidates (2.9%) decreased from the previous year (Figure PA 27).

Regarding distance, 80% or more of SPK and PAK candidates live within 100 miles of the transplant center, whereas PTA candidates may travel farther, with 36.9% living outside of a 100-mile radius of the transplant center (Table PA 1).

3 Donations

The number of deceased donors whose pancreata were recovered for pancreas transplant was 1,285 in 2022, down from 1,307 in 2021 and 1,500 in 2011 (Figure PA 28). Consequently, this correlated with fewer pancreas transplants in 2022 (Figure PA 40). The younger age groups of donors (younger than 18 and 18-29 years) showed a decreasing trend as a percent of total donors over the past 3 years, while older donors showed a corresponding increase (Figure PA 29). The male-to-female ratio of pancreas donors remained largely unchanged with a male preponderance in 2022: 68.9% male and 31.1% female (Figure PA 30). The racial and ethnic distribution of donors also remained steady over the past 3 years, with 59.5% White, 19.6% Black, 16.8% Hispanic, 2.7% Asian, and 1.4% Other (Multiracial and Native American) in 2022 (Figure PA 31). By BMI, the large majority of donors (85.5%) were in the BMI 18.5-<30 range, a proportion largely unchanged in the past few years (Figure PA 32). Within this range, however, there was a slight shift toward the BMI 25-<30 group (30.9%) from the BMI 18.5-<25 group (54.6%) compared with the past 2 years. Of note, extremes of BMI were still considered for pancreas donation (7.0% BMI <18.5 and 7.5% BMI >30 in 2022), although one could reasonably assume the nonuse rate is likely to be higher, at least in the higher BMI group.

Considering donor cause of death, the opioid epidemic appears to still contribute to a continued increase in anoxic brain injury, with a record 40.8% of donors in 2022 dying of anoxia. Head trauma as a cause of death had a corresponding proportional decrease to 47.1% of donors in 2022 (Figure PA 33). Other donor causes of death remained largely unchanged.

The nonuse rate of pancreata, defined as pancreata recovered for transplant but not transplanted, inched up in 2022 to 28.6%, its highest level since 2011 (Figure PA 34). Pancreas continued to have one of the highest nonuse rates among organs, likely due to a combination of factors. As expected, the nonuse rate was highest, at 100% in 2022, for donors older than 55 years and dropped almost linearly as donor age decreased (Figure PA 35). The proposed continuous distribution pancreas allocation policy currently under development would give increased priority to pancreas islet candidates, a very small proportion of the pancreas waiting list, for pancreata from donors aged 45 years and older; therefore, it will be of interest to look at the implications for pancreas utilization above this age for future analyses. The male-to-female distribution of pancreas nonuse did not change in 2022 and has remained largely unchanged in the past 5 years (Figure PA 36). The distribution of pancreata that were not used was fairly stable between the Black, White, and Hispanic racial and ethnic groups in 2022 compared with 2021 (Figure PA 37) but increased in the Asian and Other (Multiracial and Native American) donor groups;

however, this might not be significant due to the small numbers. As expected, high-BMI donors had the highest nonuse rates in 2022 (83.3% for BMI 35-<40 and 42.9% for BMI 30-<35), and from there it decreased with decreasing BMI, with the lowest nonuse rate in the BMI <18.5 group at 15.6% (Figure PA 38). The Public Health Service (PHS) risk criteria for acute transmission of HIV, hepatitis B virus (HBV), or hepatitis C virus (HCV) did not seem to affect acceptance of pancreas offers; donors with risk factors for acute transmission of HIV, HBV, or HCV actually had a lower nonuse rate (23.9%) versus donors who did not have risk factors for disease transmission (29.5%) in 2022 (Figure PA 39). More accurate and time-sensitive testing methods and community education have contributed to improving the use of donors with PHS risk factors for disease transmission in the past few years.

4 Transplants

The overall number of pancreas transplants (including adult and pediatric) continued to decrease, with the lowest reported number in the past decade at 918 in 2022 (Figure PA 40). Following stabilization of the overall number of pancreas transplants in 2021 nearing the end of the COVID-19 pandemic, the number of pancreas transplants continued to decrease in all transplant categories, with the most pronounced decrease in PTA: 62 in 2022 from 92 in 2021 (Figure PA 41).

The previous trend toward increases in the total number of pancreas transplants in recipients older than 45 years reversed in 2022, but there were increases in the number of pancreas transplants in recipients in the 18-34 and 35-44 year age groups (Figure PA 42). The male-to-female ratio of pancreas transplant recipients has been consistent over the past decade, with more male than female recipients (Figure PA 43). The number of pancreas transplants performed in White recipients continued to decrease in 2022 while the number of pancreas transplants performed in Black and Hispanic recipients increased (Figure PA 44). The relative increase in the number of pancreas transplants in Hispanic recipients over the past decade corresponds to an increase in the number of pancreas transplants performed for recipients with type 2 diabetes. The number of pancreas transplants in recipients with type 2 diabetes increased by 221.9% from 2011 to 2022 (from 64 to 206), whereas the number of transplants for recipients with type 1 diabetes decreased by 29.6% from 2011 to 2022 (from 900 to 634). Nonetheless, there was a small drop in the proportion of pancreas transplants in recipients with type 2 diabetes in the past year, where 22.4% of pancreas transplants in 2022 were in recipients with type 2 diabetes compared with 25.8% in 2021 (Figure PA 45).

The proportion of pancreas transplants in adults that used induction with T-cell depletion alone has increased to 86.3% in 2022 from 76.1% in 2011, while the proportion of pancreas transplants using induction with interleukin-2 receptor antibody alone has decreased to 3.7% in 2022 from 8.2% in 2011 (Figure PA 46). The maintenance immunosuppressive regimens following pancreas transplant have remained consistent, with most centers using tacrolimus and mycophenolate mofetil plus or minus steroids (Figure PA 47). There were further decreases in the use of steroid-free maintenance regimens, with 22.8% reporting a steroid-free tacrolimus and mycophenolate regimen in 2022, nearly the lowest frequency for the past decade (Figure PA 47). The cPRA levels in pancreas transplants recipients has been relatively consistent over the past decade, with unsensitized recipients and recipients with cPRA of less than 20% constituting most of the transplants (Figure PA 48, Figure PA 49, and Figure PA 50), corresponding to incidences of acute rejection of less than 12% (Figure PA 62 and Figure PA 63).

The increases in the proportion of pancreas transplants performed in adults at medium-volume centers (11-24 transplants per year) noted in 2021 (48.3%) were reversed in 2022 (37.2%), with a corresponding notable increase in the proportion of pancreas transplants performed at large-volume centers (25 or more transplants per year; 15.9% in 2021 and 25.3% in 2022) and a slight increase in the proportion of pancreas transplant centers that performed fewer than 10 transplants per year (Figure PA 51 and Figure PA 52).

5 Outcomes

The incidence of pancreas graft failure among adults within the first 90 days following SPK, likely reflecting early technical losses, remained low at 6.1% (Figure PA 53). Early graft loss proportions decreased in 2022 for PAK (to 5.3% in 2022 from 8.0% in 2021) and PTA (to 8.8% in 2022 from 16.3% in 2021). Of importance, the incidence of pancreas graft failure within the first year posttransplant was lower in SPK and PAK transplant, with an incidence of 8.1% following SPK in 2021 and 10.0% following PAK in 2021. The incidence of pancreas graft failure in the first year posttransplant was higher following PTA, increasing to 20.4% after PTA in 2021 from 15.6% after PTA in 2020 (Figure PA 54). These are important data, because the present 2022 Annual Data Report reflects the third year that the new definition of pancreas graft failure has been in effect. Prior to 2020, there were no strict criteria for defining pancreas graft failure, and, as a result, only patient survival was reported. However, starting in 2020, the criteria for pancreas graft loss were clearly defined, and included any of the following: 1) a recipient's transplanted pancreas is removed; 2) a recipient reregisters for a pancreas transplant; 3) a recipient registers for an islet transplant after undergoing a pancreas transplant; 4) a recipient dies; or 5) a recipient's total insulin use is greater than or equal to 0.5 units/kg/day for 90 consecutive days (OPTN Policy 1.2: definitions). Since the SRTR started reporting pancreas graft failure using these more granular definitions in 2020, the incidence of pancreas graft loss within the first year posttransplant remained very low for SPK and PAK recipients (Figure PA 53 and Figure PA 54).

The all-cause unadjusted kidney failure rates among adults at 1, 5, and 10 years posttransplant are 4.3%, 14.1%, and 35.0%, respectively, following SPK transplant for the most recent data available (Figure PA 55). This long-term kidney graft success in part reflects the low (excellent) kidney donor profile index of the kidneys typically used for SPK transplant, but it also can be attributed to the normalization of hemoglobin A_{1c} with pancreas transplant and the associated prevention of recurrent diabetic nephropathy. The merits of providing normalization of hemoglobin A_{1c} on long-term kidney function are highlighted by the low rate of 10-year death-censored kidney graft failure at 19.8% among adult SPK recipients for transplants in 2012, the most recent year of data available (Figure PA 56). The benefits of consistent normoglycemia on the longevity of the kidney allograft are further reinforced by the low 10-year death-censored rates of kidney graft failure following PAK of 16.5% and 14.7% with deceased and living donor kidneys, respectively, for transplants in 2012-2013, the most recent years of data available (Figure PA 58 and Figure PA 60).

The incidence of acute rejection during the first year following pancreas transplant in adults has been consistently low for the past decade, with rates of 11.4%, 9.0%, and 10.9% for recipients aged 18-34, 35-49, and 50-64 years, respectively (Figure PA 62). The consistency of the immunosuppressive regimens over the past 5 years (Figure PA 46 and Figure PA 47) reflects the success of immunosuppression in overcoming both the alloimmune and autoimmune responses following pancreas transplant. Historically, the incidence of acute rejection during the first year following pancreas transplant was lower when the reported induction agent was lymphodepleting, although this was not observed in the data from 2021. These data showed an incidence of acute rejection at 11.1% and 10.2% following induction with a nonlymphodepleting versus lymphodepleting agent, respectively (Figure PA 63). Despite the more aggressive immunosuppressive regimens used following pancreas transplant and the associated low incidence of rejection, note that the rate of posttransplant lymphoproliferative disorder (PTLD) has remained consistently low during the 5 years after SPK and is dependent on the Epstein-Barr virus (EBV) status of the donor and the recipient. For SPK recipients, there was a PTLD incidence of 1.6% in EBV-negative recipients compared with an incidence of

0.62% in EBV-positive recipients (Figure PA 66). The disparity between EBV-negative and EBV-positive recipients was most pronounced for the recipients who underwent PTA, with a 5-year incidence of 6% in EBV-negative recipients versus 0.7% in EBV-positive recipients (Figure PA 65). The relatively high incidence of PTLD in EBV-negative recipients following PTA is consistent with the more aggressive immunosuppression required following pancreas transplant in the nonuremic recipient.

The rates of recipient mortality at 1 year following pancreas transplant have been consistently low for the past decade, with the most recent data showing rates of 2.5%, 1.3%, and 3.7% for PAK, PTA, and SPK, respectively (Figure PA 67). The low 1-year mortality rates reflect the relative safety of this procedure, despite the technical and immunosuppressive challenges associated with pancreas transplant. Ten-year mortality rates of 22.1%, 17.6%, and 23.7% for PAK, PTA, and SPK, respectively, for transplants in 2012-2013, the most recent available data, are likely the result of the cardiovascular comorbidities that were present at the time of the pancreas transplant in this cohort of recipients with long-standing diabetes (Figure PA 69). Of interest, the 5-year patient survival percentages following pancreas transplant in recipients with type 1 (91.9%) versus type 2 (87.3%) diabetes are comparable (Figure PA 71). It will be important to determine the impact of diabetes type on long-term pancreas allograft outcome using the more granular definitions of allograft success. These data will be key for getting a better understanding of which recipients with type 2 diabetes will benefit from SPK versus kidney transplant alone.

Support, Copyright, and Citation Information

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This report is available at https://srtr.transplant.hrsa.gov. Individual chapters may be downloaded.

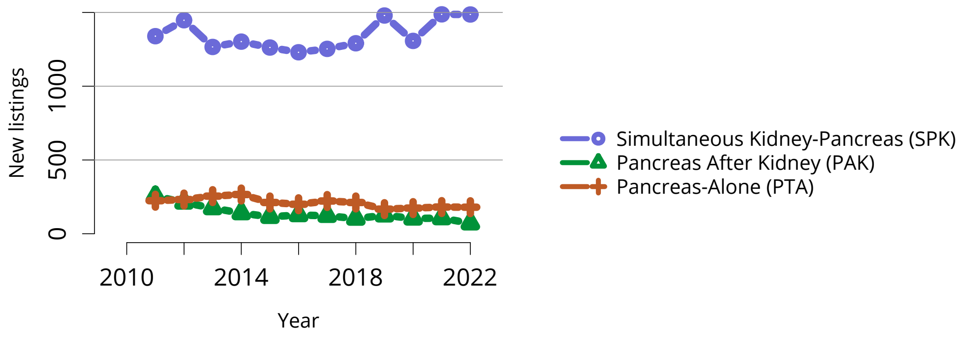

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Figure PA 1: New adult candidates added to the pancreas transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new.

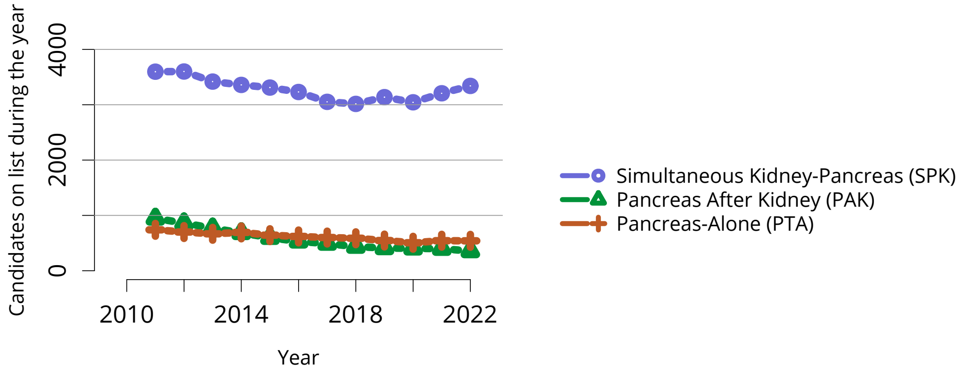

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Figure PA 2: All adult candidates on the pancreas transplant waiting list. Adult candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing.

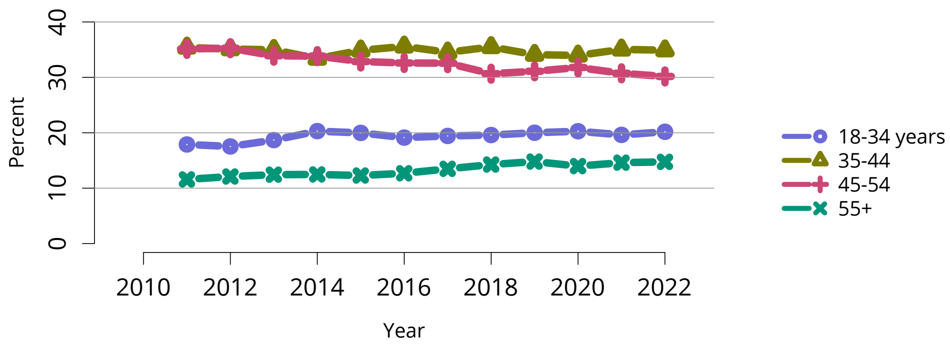

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Figure PA 3: Distribution of adults waiting for pancreas transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.

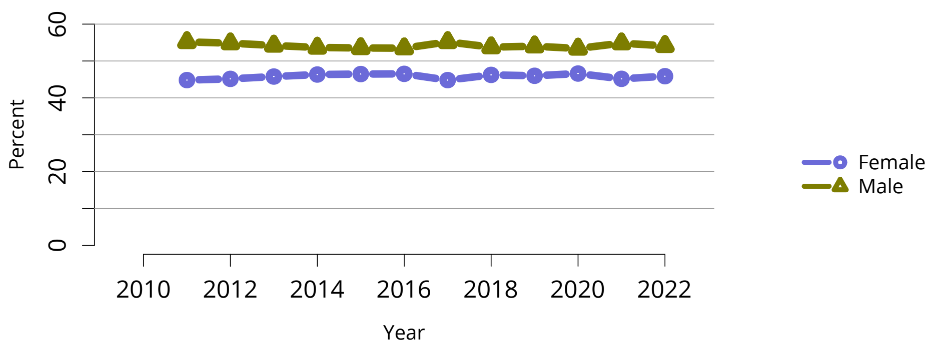

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Figure PA 4: Distribution of adults waiting for pancreas transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

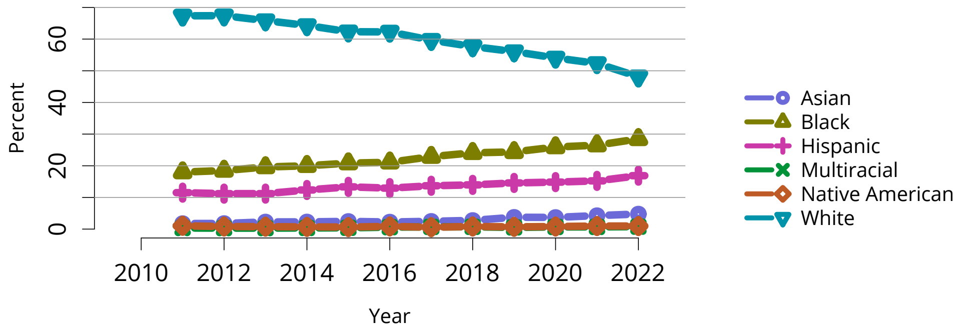

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Figure PA 5: Distribution of adults waiting for pancreas transplant by race and ethnicity. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

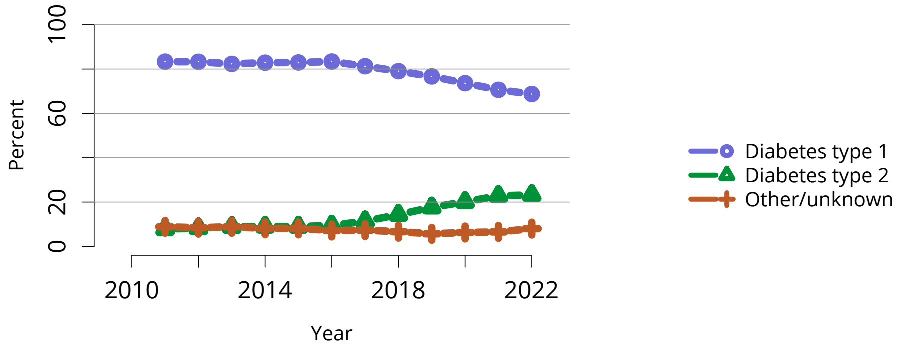

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Figure PA 6: Distribution of adults waiting for pancreas transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

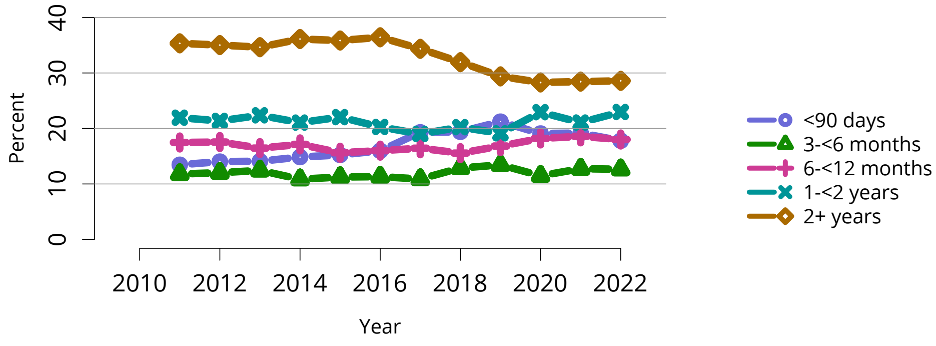

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Figure PA 7: Distribution of adults waiting for pancreas transplant by waiting time. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included.

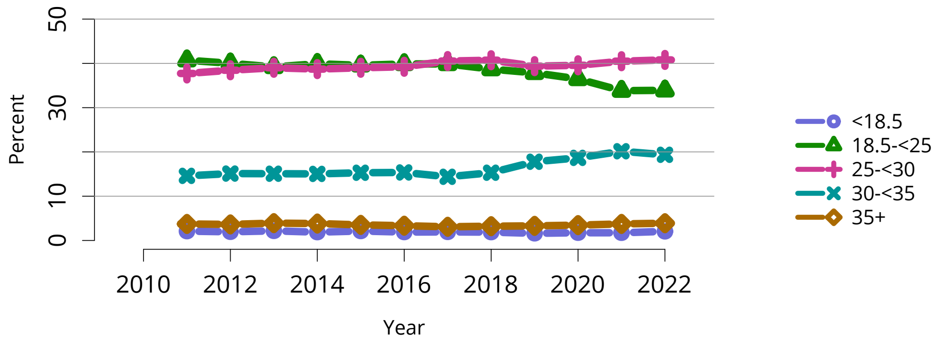

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Figure PA 8: Distribution of adults waiting for pancreas transplant by BMI. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. BMI, body mass index.

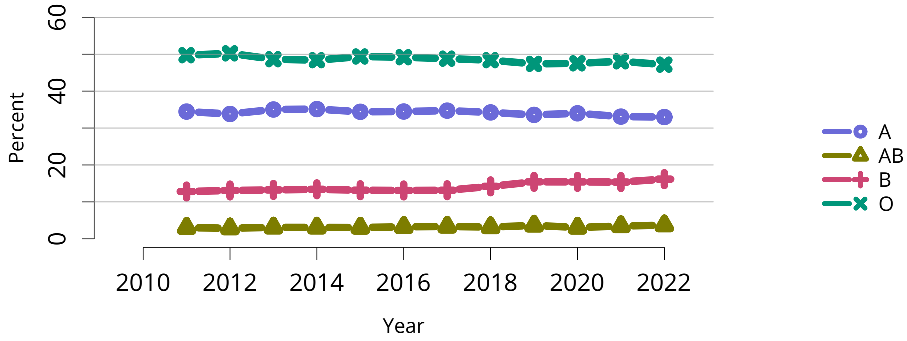

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Figure PA 9: Distribution of adults waiting for pancreas transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

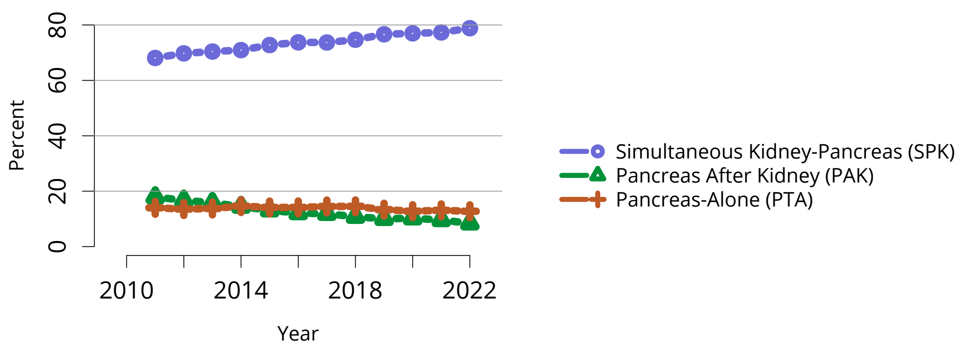

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Figure PA 10: Distribution of adults waiting for pancreas transplant by intended transplant type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

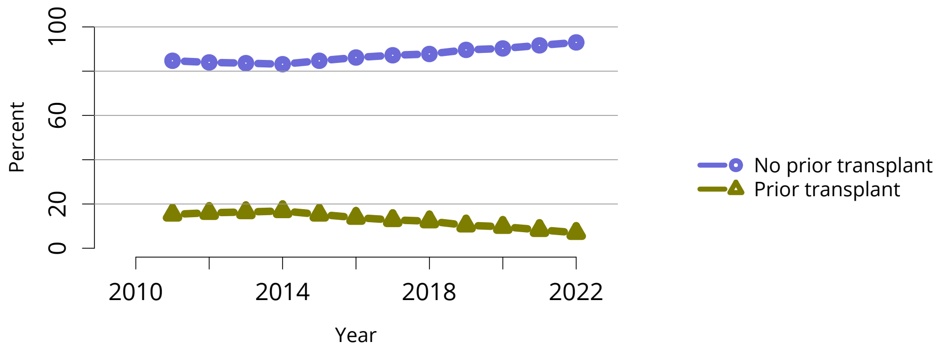

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Figure PA 11: Distribution of adults waiting for pancreas transplant by prior transplant status. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

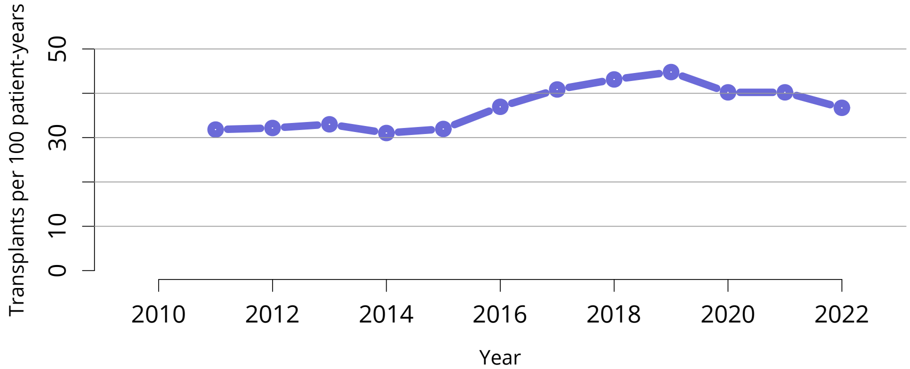

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Figure PA 12: Overall deceased donor pancreas transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

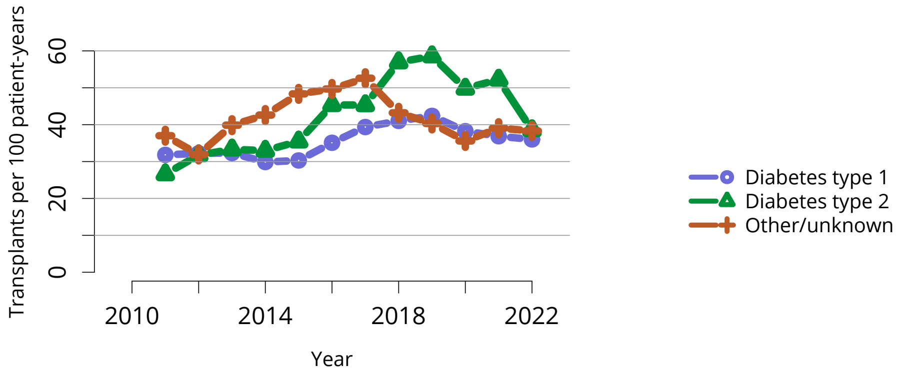

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Figure PA 13: Deceased donor pancreas transplant rates among adult waitlist candidates by diagnosis. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

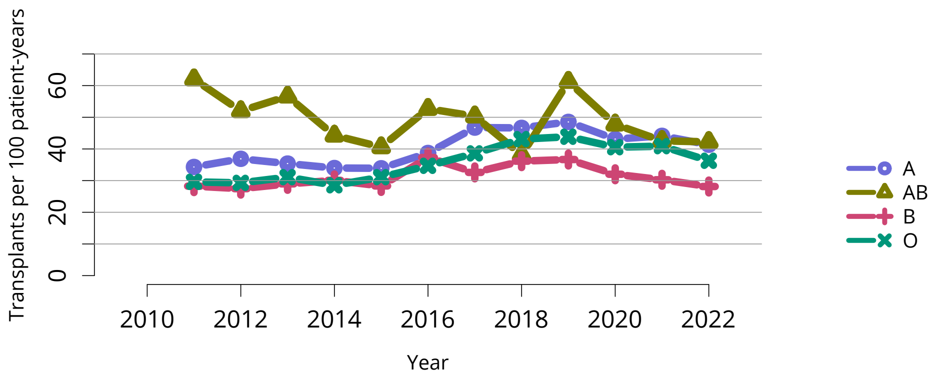

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Figure PA 14: Deceased donor pancreas transplant rates among adult waitlist candidates by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

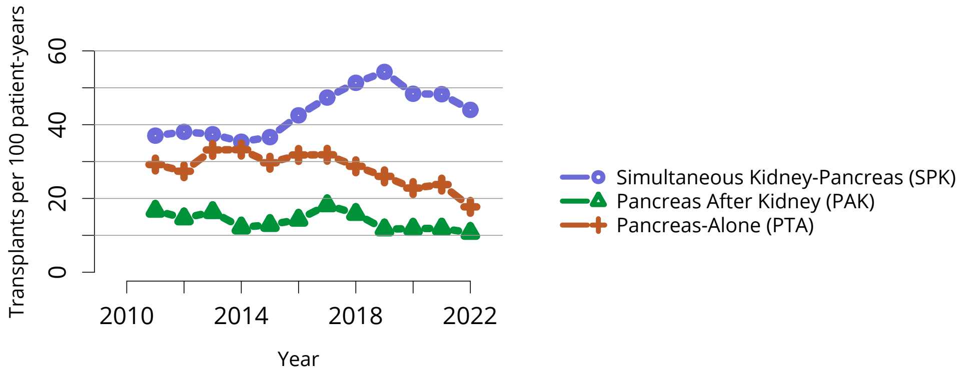

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Figure PA 15: Deceased donor pancreas transplant rates among adult waitlist candidates by intended transplant type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

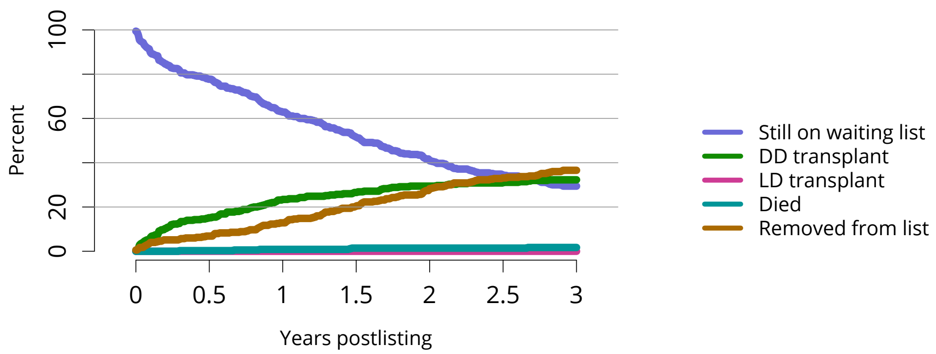

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Figure PA 16: Three-year outcomes for adults waiting for pancreas after kidney transplant, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor; LD, living donor.

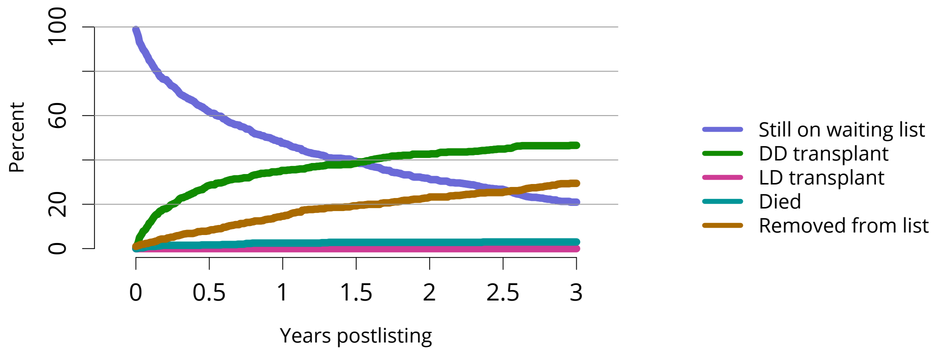

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Figure PA 17: Three-year outcomes for adults waiting for pancreas transplant alone, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor; LD, living donor.

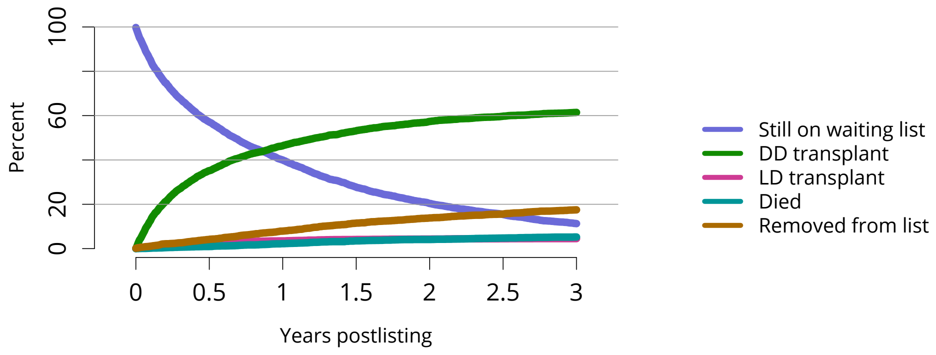

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Figure PA 18: Three-year outcomes for adults waiting for simultaneous pancreas-kidney transplant, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor; LD, living donor.

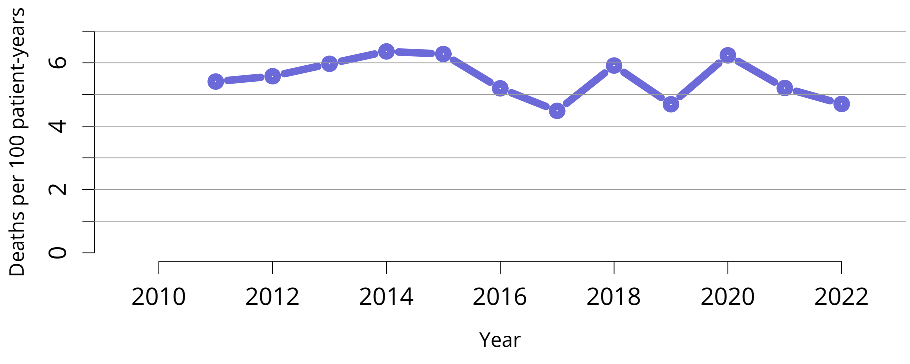

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Figure PA 19: Overall pretransplant mortality rates among adults waitlisted for pancreas transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

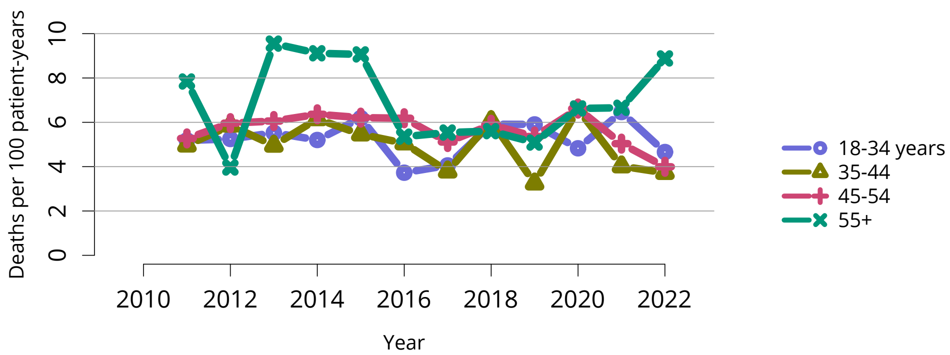

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Figure PA 20: Pretransplant mortality rates among adults waitlisted for pancreas transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

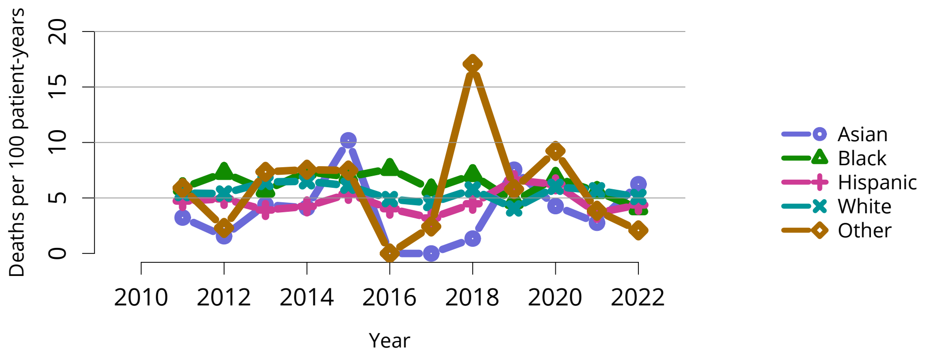

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Figure PA 21: Pretransplant mortality rates among adults waitlisted for pancreas transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.

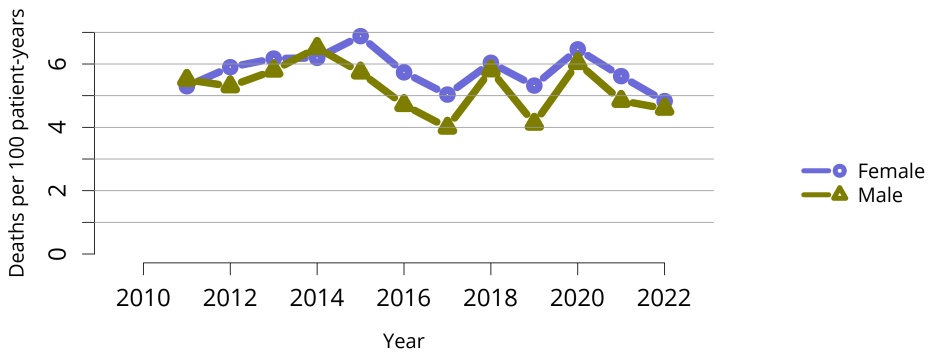

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Figure PA 22: Pretransplant mortality rates among adults waitlisted for pancreas transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

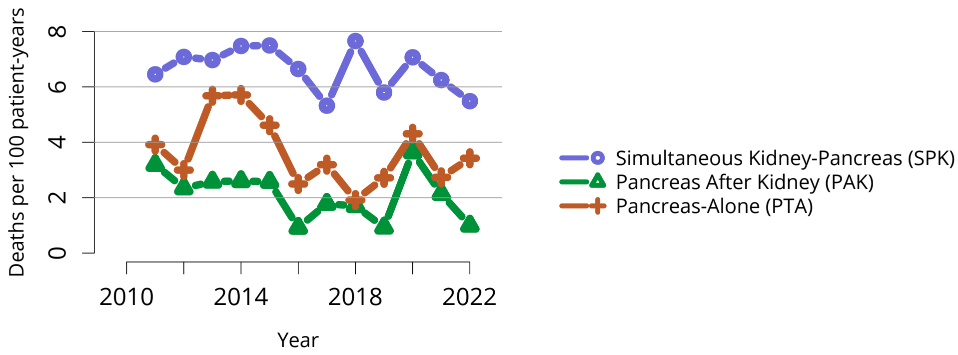

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Figure PA 23: Pretransplant mortality rates among adults waitlisted for pancreas transplant by intended transplant type. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

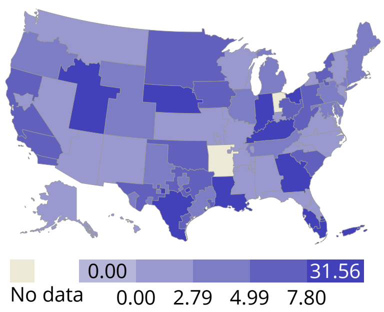

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Figure PA 24: Pretransplant mortality rates among adults waitlisted for pancreas transplant in 2022 by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. DSA, donation service area.

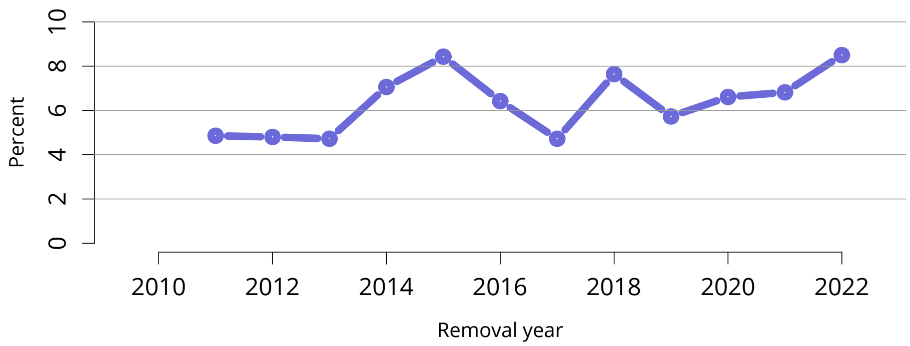

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Figure PA 25: Deaths within 6 months after removal among adult pancreas waitlist candidates, overall. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

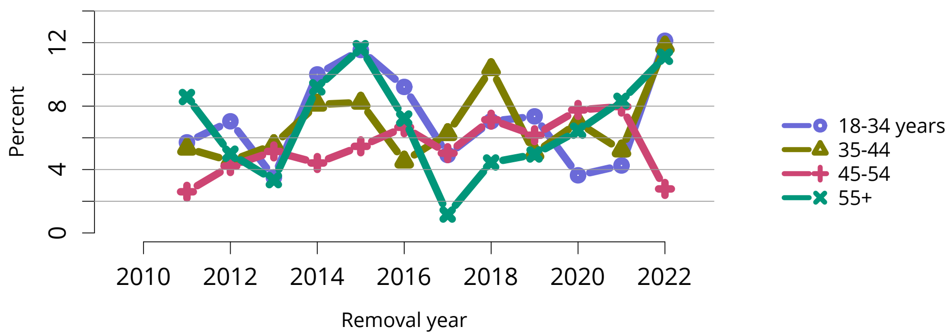

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Figure PA 26: Deaths within 6 months after removal among adult pancreas waitlist candidates, by age. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. Age is determined at removal.

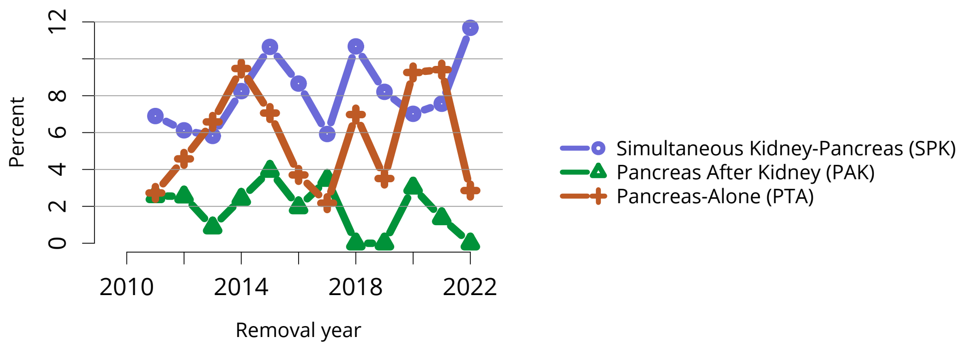

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Figure PA 27: Deaths within 6 months after removal among adult pancreas waitlist candidates, by intended transplant type. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

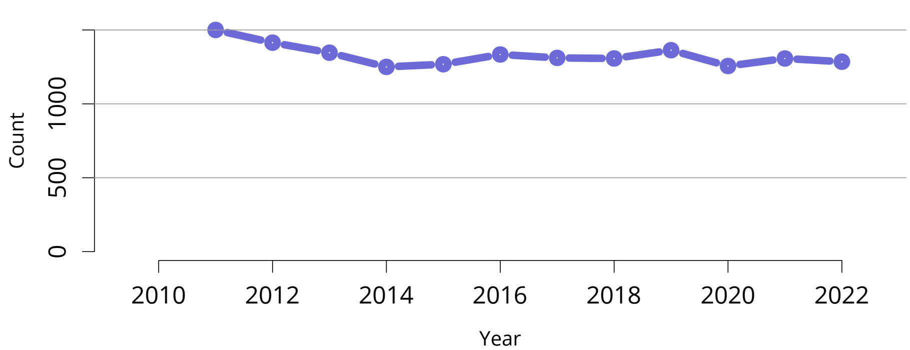

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Figure PA 28: Overall deceased pancreas donor count. Count of deceased donors whose pancreata were recovered for transplant. Pancreata recovered for islet transplant are excluded.

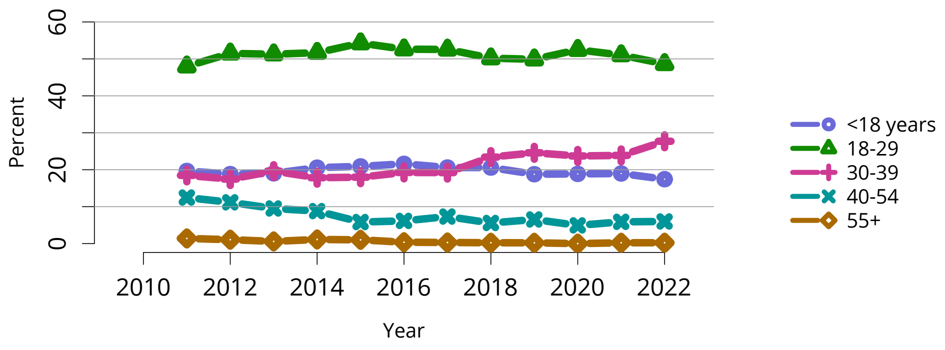

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Figure PA 29: Distribution of deceased pancreas donors by age. Deceased donors whose pancreata were recovered for transplant. Pancreata recovered for islet transplant are excluded.

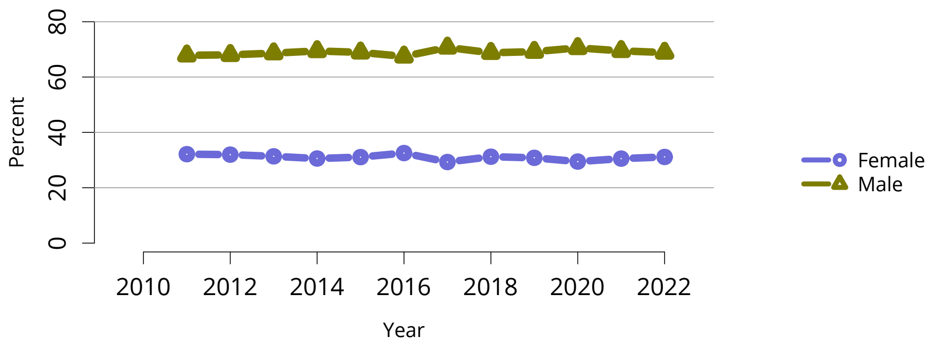

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Figure PA 30: Distribution of deceased pancreas donors by sex. Deceased donors whose pancreata were recovered for transplant. Pancreata recovered for islet transplant are excluded.

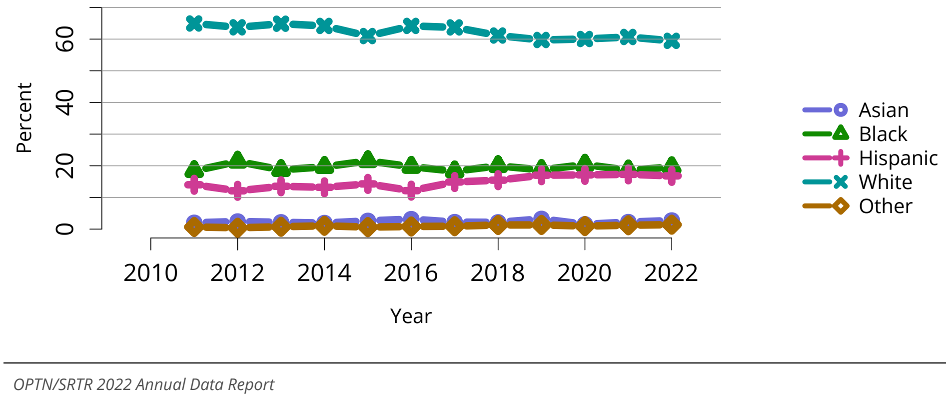

Figure PA 31: Distribution of deceased pancreas donors by race and ethnicity. Deceased donors whose pancreata were recovered for transplant. Pancreata recovered for islet transplant are excluded. The Other race category is composed of Native American and Multiracial categories.

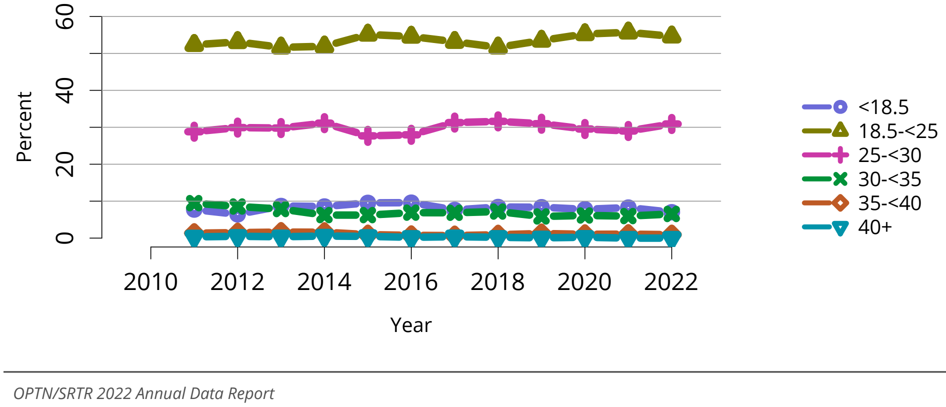

Figure PA 32: Distribution of deceased pancreas donors by donor BMI. Deceased donors whose pancreata were recovered for transplant. Pancreata recovered for islet transplant are excluded. BMI, body mass index.

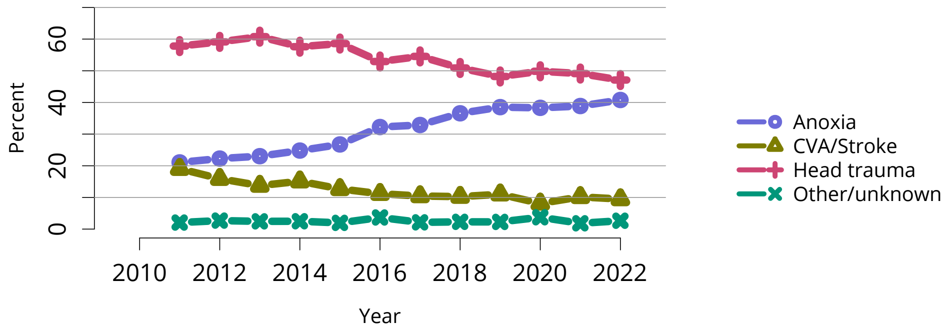

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Figure PA 33: Cause of death among deceased pancreas donors. Donors whose pancreata were transplanted. CVA, cerebrovascular accident.

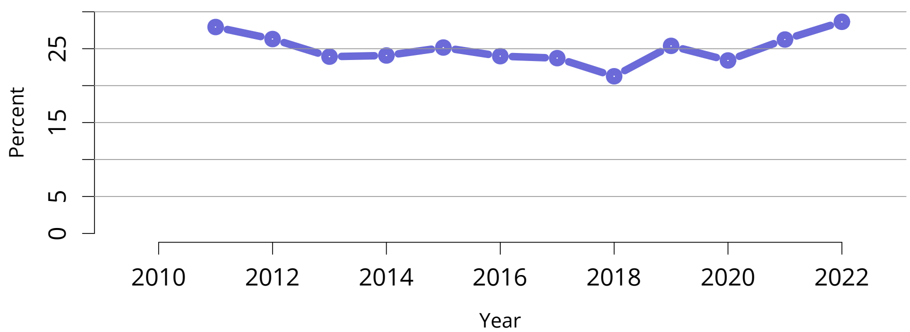

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Figure PA 34: Overall rates of pancreata recovered for transplant and not transplanted. Percentages of pancreata not transplanted out of all pancreata recovered for transplant. Pancreata recovered for islet transplant are excluded.

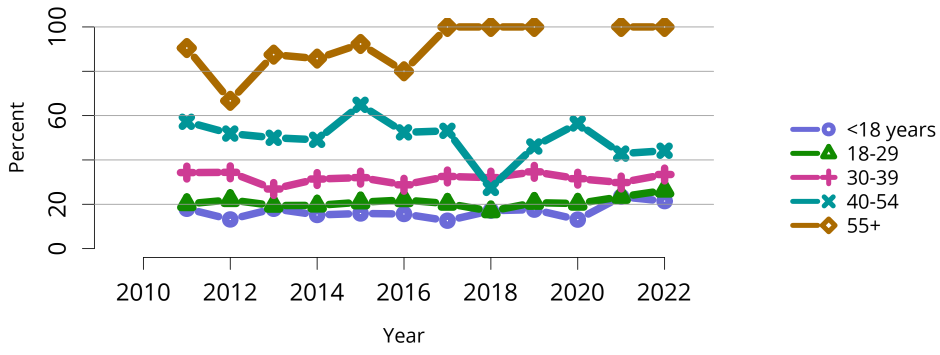

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Figure PA 35: Rates of pancreata recovered for transplant and not transplanted by donor age. Percentages of pancreata not transplanted out of all pancreata recovered for transplant. Pancreata recovered for islet transplant are excluded. Missing dots indicate no pancreata were recovered from donors in the age category in the year.

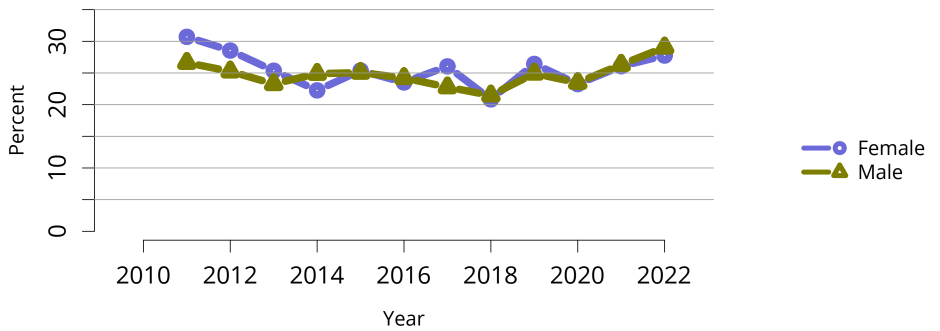

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Figure PA 36: Rates of pancreata recovered for transplant and not transplanted by donor sex. Percentages of pancreata not transplanted out of all pancreata recovered for transplant. Pancreata recovered for islet transplant are excluded.

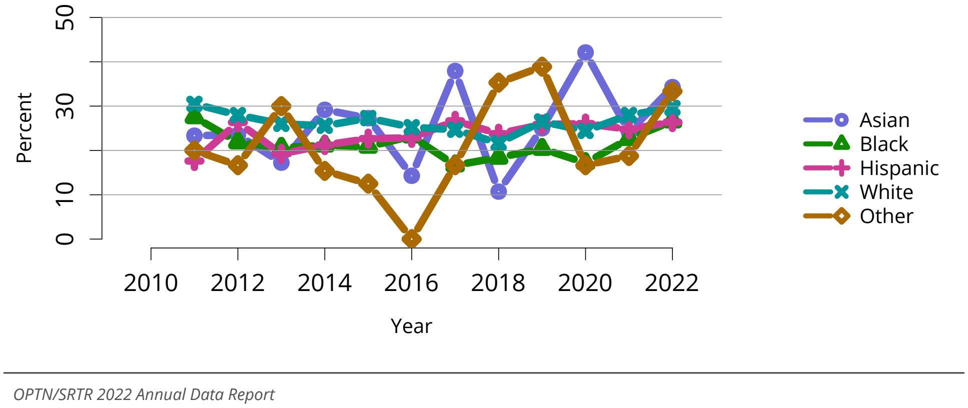

Figure PA 37: Rates of pancreata recovered for transplant and not transplanted by donor race and ethnicity. Percentages of pancreata not transplanted out of all pancreata recovered for transplant. Pancreata recovered for islet transplant are excluded. The Other race category is composed of Native American and Multiracial categories.

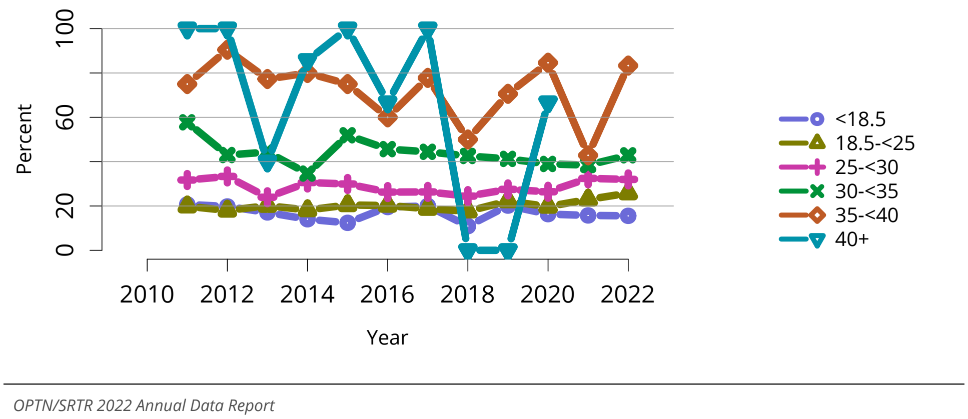

Figure PA 38: Rates of pancreata recovered for transplant and not transplanted by donor BMI. Percentages of pancreata not transplanted out of all pancreata recovered for transplant. Pancreata recovered for islet transplant are excluded. BMI, body mass index.

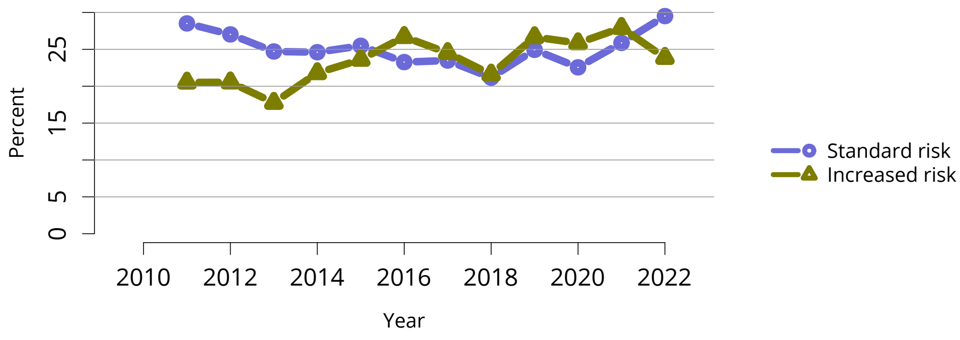

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Figure PA 39: Rates of pancreata recovered for transplant and not transplanted, by donor risk of disease transmission. Percentages of pancreata not transplanted out of all pancreata recovered for transplant. Pancreata recovered for islet transplant are excluded. Risk factors for blood-borne disease transmission are defined by US Public Health Service Guidelines risk criteria for HIV, hepatitis B virus, and hepatitis C virus transmission.

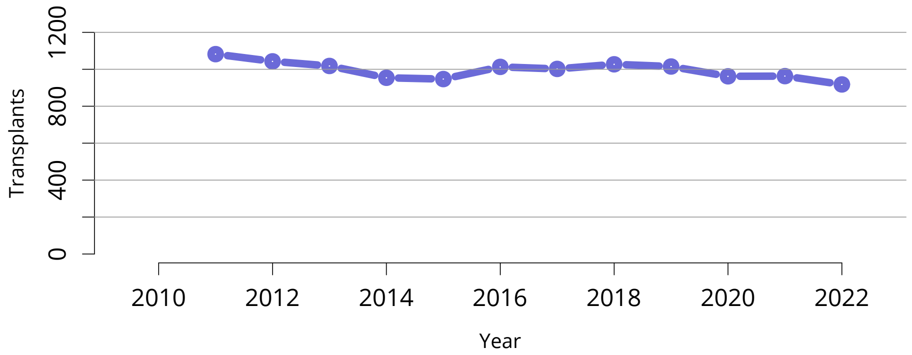

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Figure PA 40: Overall pancreas transplants. All pancreas transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

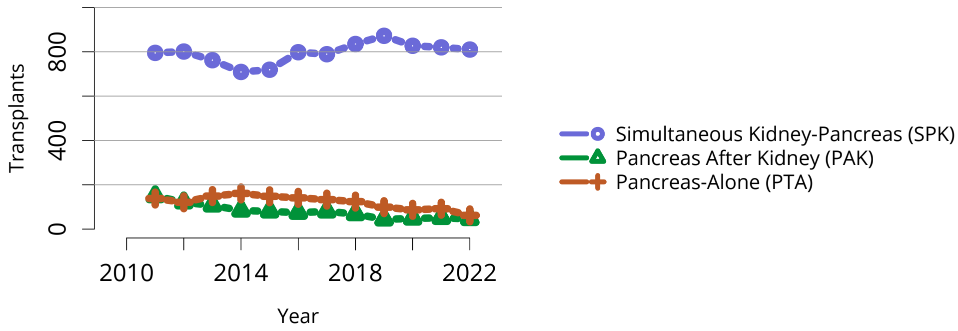

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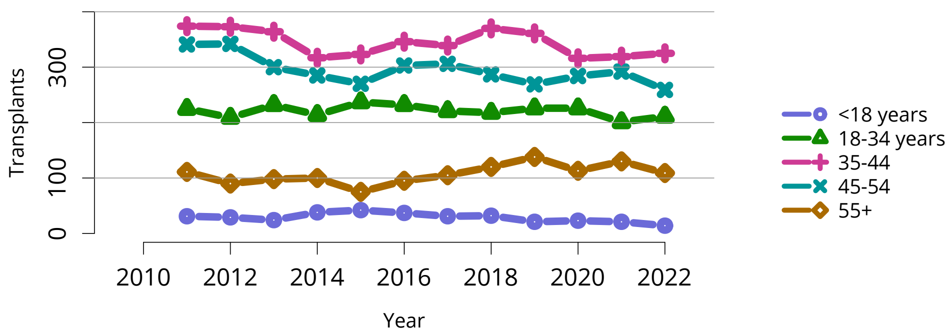
Figure PA 41: Total pancreas transplants by pancreas transplant type. All pancreas transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure PA 42: Total pancreas transplants by age. All pancreas transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

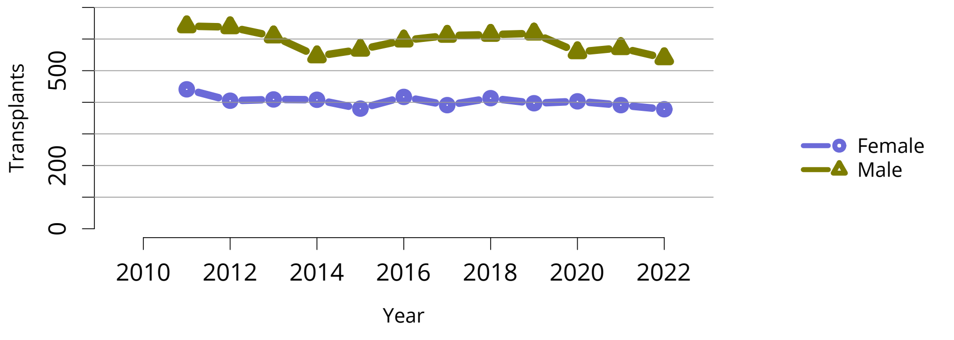


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Figure PA 43: Total pancreas transplants by sex. All pancreas transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

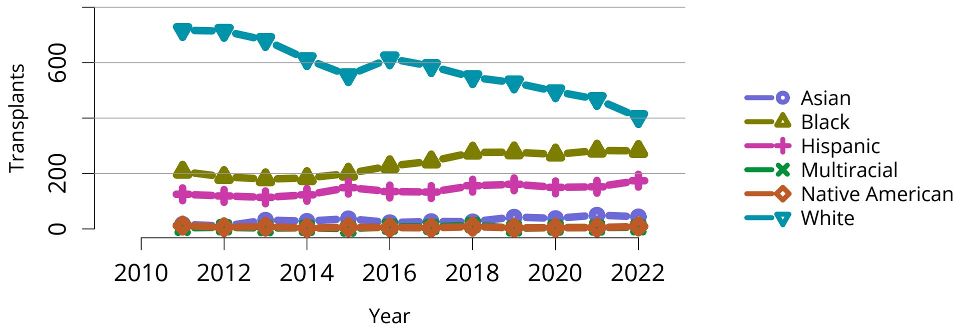

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Figure PA 44: Total pancreas transplants by race and ethnicity. All pancreas transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

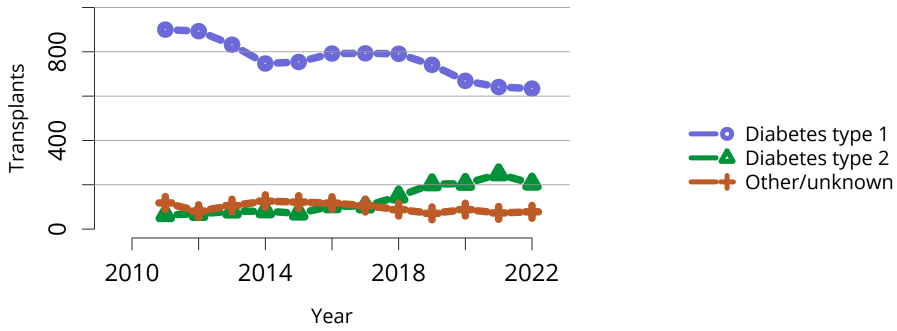

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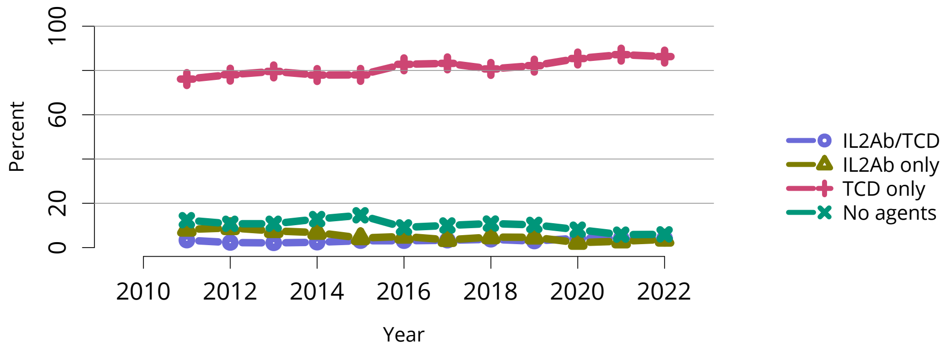
Figure PA 45: Total pancreas transplants by diagnosis. All pancreas transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure PA 46: Induction agent use in adult pancreas transplant recipients. Immunosuppression at transplant reported to the OPTN. IL2Ab, interleukin-2 receptor antibody; TCD, T-cell depleting.

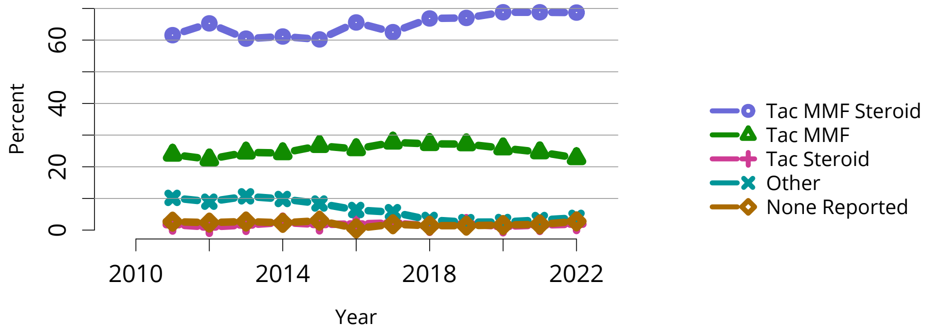


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Figure PA 47: Immunosuppression regimen use in adult pancreas transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.

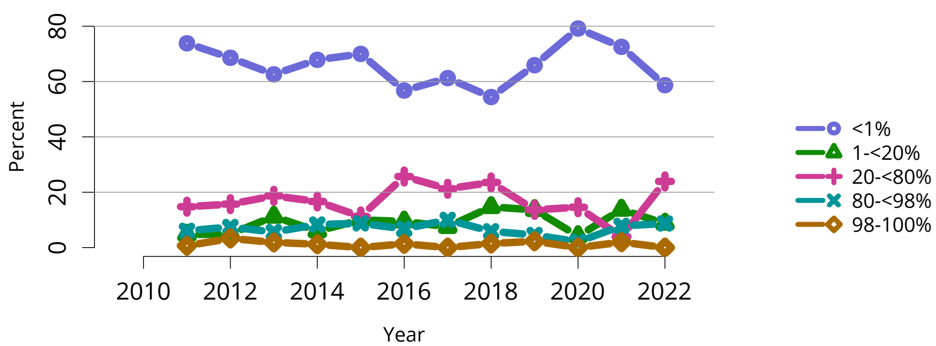

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Figure PA 48: CPRA in adult recipients of pancreas after kidney transplant. Peak cPRA is used. cPRA, calculated panel-reactive antibody.

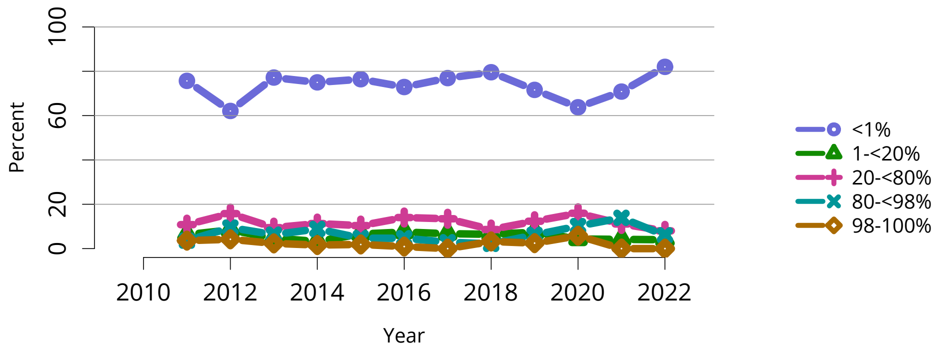

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Figure PA 49: CPRA in adult recipients of pancreas transplant alone. Peak cPRA is used. cPRA, calculated panel-reactive antibody.

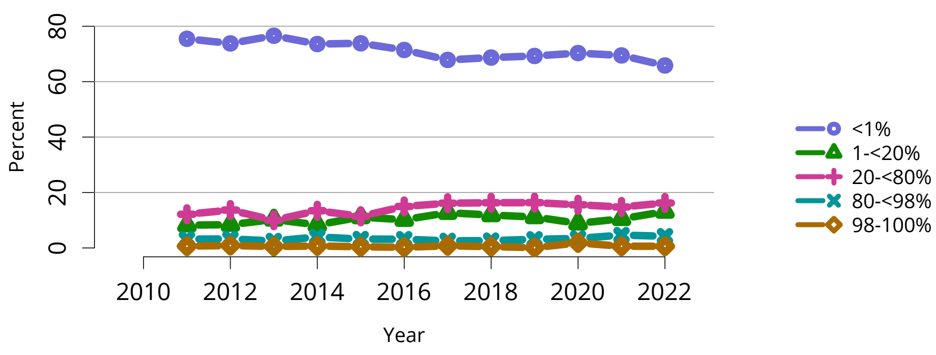

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Figure PA 50: CPRA in adult recipients of simultaneous pancreas-kidney transplant. Peak cPRA is used. cPRA, calculated panel-reactive antibody.

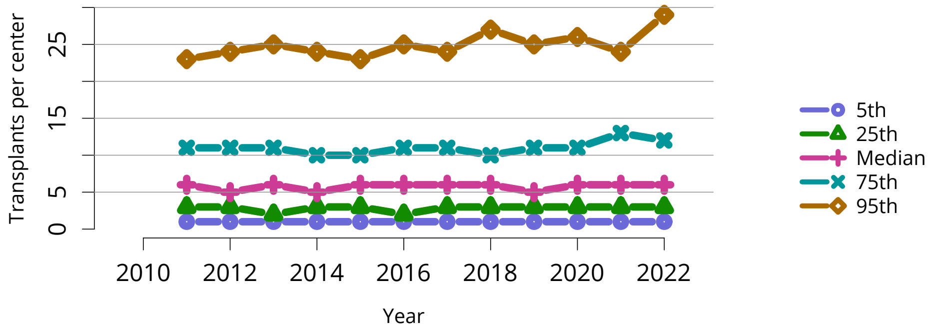

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Figure PA 51: Annual adult pancreas transplant center volumes by percentile. Annual volume data are limited to recipients aged 18 years or older.

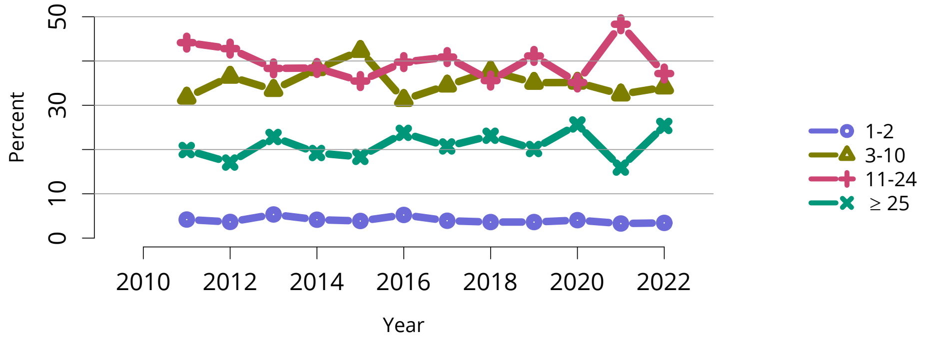

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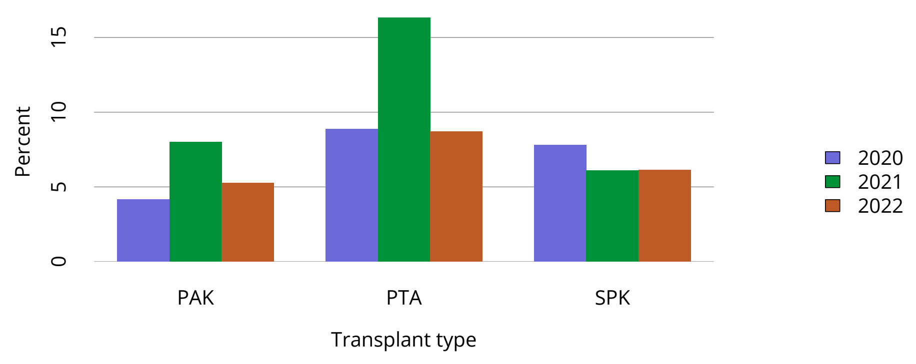
Figure PA 52: Distribution of adult pancreas transplants by annual center volume. Based on annual volume data among recipients aged 18 years or older.



OPTN/SRTR 2022 Annual Data Report

Figure PA 53: Pancreas graft failure within the first 90 days posttransplant among adult pancreas transplant recipients. All-cause graft failure is identified from multiple data sources, including the OPTN Transplant Recipient Registration Form, the OPTN Transplant Recipient Follow-up Form, and death dates from the Social Security Administration. Transplants after September 30, 2022, are excluded due to insufficient follow-up. Nonrenal multivisceral transplants are excluded. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

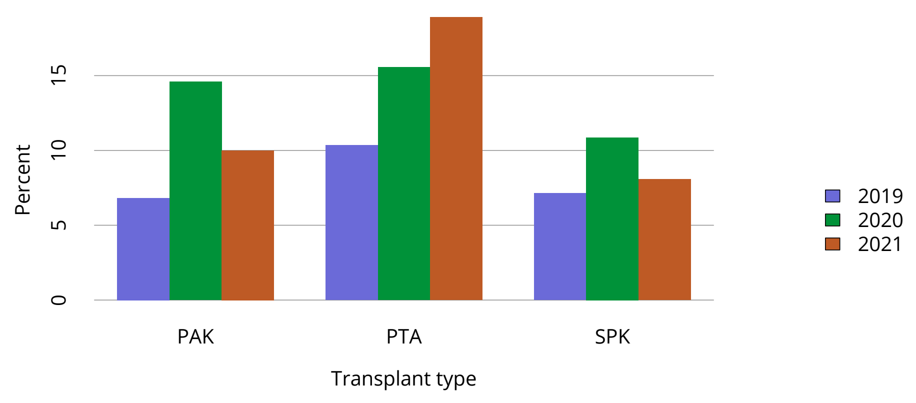


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Figure PA 54: Pancreas graft failure within the first year posttransplant among adult pancreas transplant recipients. All-cause graft failure is identified from multiple data sources, including the OPTN Transplant Recipient Registration Form, the OPTN Transplant Recipient Follow-up Form, and death dates from the Social Security Administration. Nonrenal multivisceral transplants are excluded. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

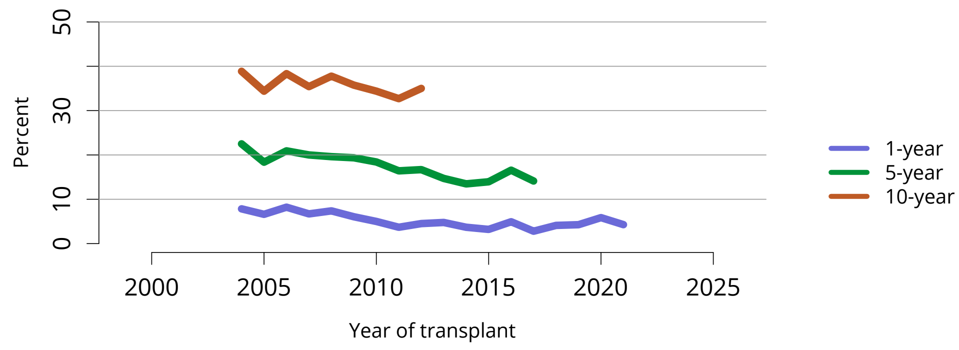

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Figure PA 55: Kidney graft failure among adult SPK transplant recipients. Estimates are unadjusted, computed using Kaplan-Meier methods. SPK transplant recipients are followed from date of transplant to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 1, 5, or 10 years posttransplant. All-cause graft failure is defined as any of the above outcomes prior to 1, 5, or 10 years, respectively. Nonrenal multivisceral transplants are excluded. SPK, simultaneous pancreas-kidney.

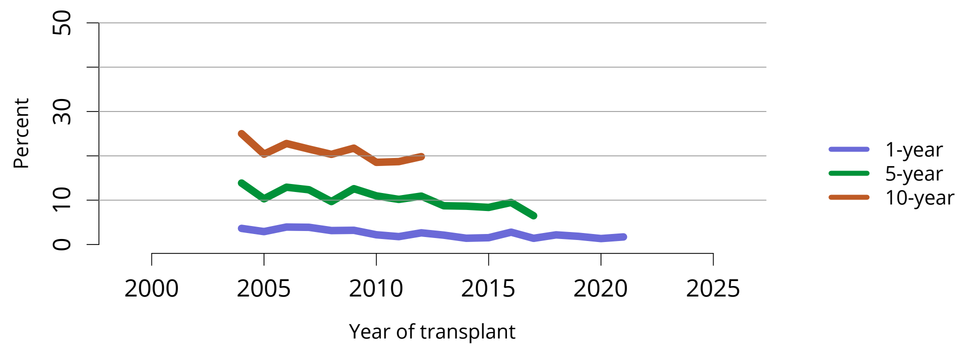

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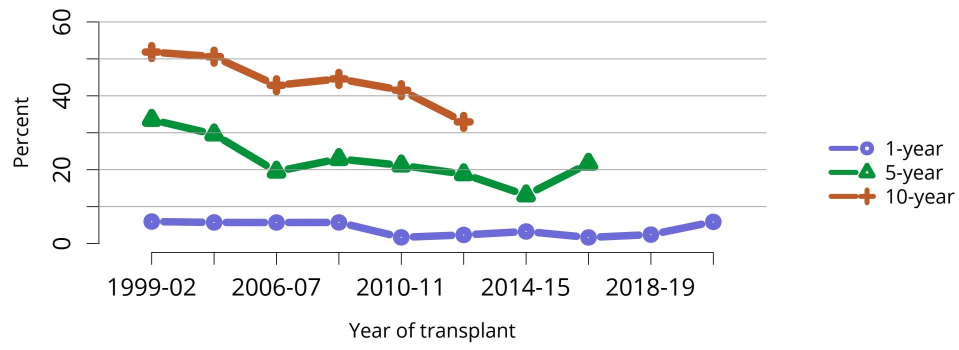
Figure PA 56: Death censored kidney graft failure among adult SPK transplant recipients. Estimates are unadjusted, computed using Kaplan-Meier competing risk methods. SPK transplant recipients are followed from date of transplant to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 1, 5, or 10 years posttransplant. Death-censored graft failure is defined as return to dialysis, reported graft failure, or kidney retransplant. Nonrenal multivisceral transplants are excluded. SPK, simultaneous pancreas-kidney.



OPTN/SRTR 2022 Annual Data Report

Figure PA 57: Kidney graft failure among adult PAK transplant recipients with a deceased donor kidney (from time of pancreas transplant). Estimates are unadjusted, computed using Kaplan-Meier methods. PAK transplant recipients who previously underwent deceased donor kidney transplant are followed from the date of pancreas transplant to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 1, 5, or 10 years posttransplant. Only PAK recipients with an OPTN record of previous kidney or kidney-pancreas transplant are included. Multivisceral transplants are excluded. All-cause graft failure is defined as any of the above outcomes prior to 1, 5, or 10 years, respectively. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney.

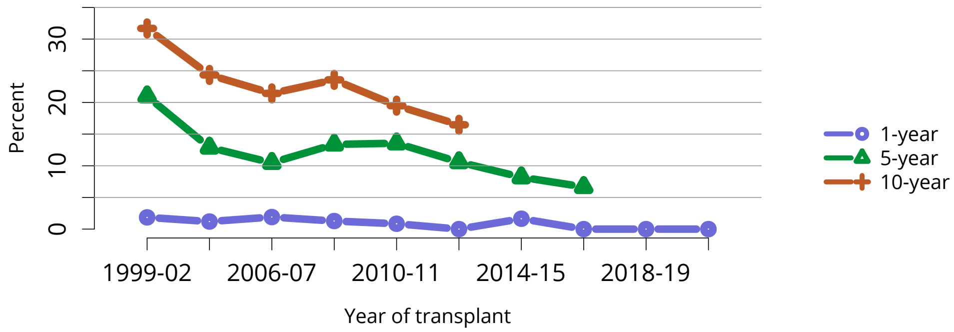


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Figure PA 58: Death-censored kidney graft failure among adult PAK transplant recipients with a deceased donor kidney (from time of pancreas transplant). Estimates are unadjusted, computed using Kaplan-Meier competing risk methods. PAK transplant recipients who previously underwent deceased donor kidney transplant are followed from the date of pancreas transplant to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 1, 5, or 10 years posttransplant. Only PAK recipients with an OPTN record of previous kidney or kidney-pancreas transplant are included. Multivisceral transplants are excluded. Death-censored graft failure is defined as return to dialysis, reported graft failure, or kidney retransplant. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney.

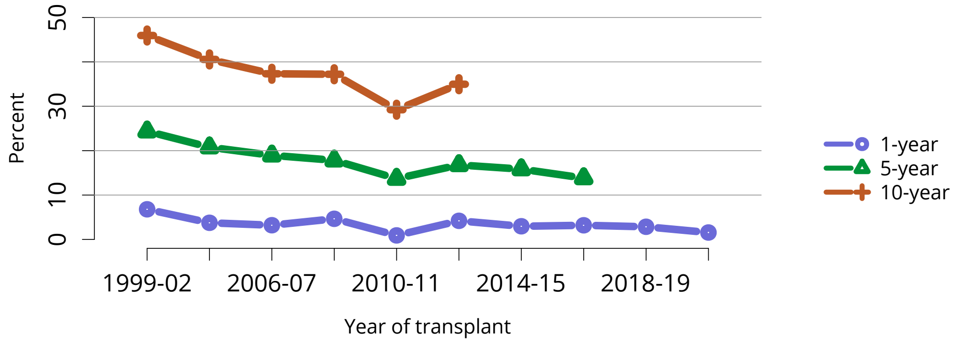

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Figure PA 59: Kidney graft failure among adult PAK transplant recipients with a living donor kidney (from time of pancreas transplant). Estimates are unadjusted, computed using Kaplan-Meier methods. PAK transplant recipients who previously underwent living donor kidney transplant are followed from date of pancreas transplant to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 1, 5, or 10 years posttransplant. Only PAK recipients with an OPTN record of a previous living kidney donor transplant are included. Multivisceral transplants are excluded. All-cause graft failure is defined as any of the above outcomes prior to 1, 5, or 10 years, respectively. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney.

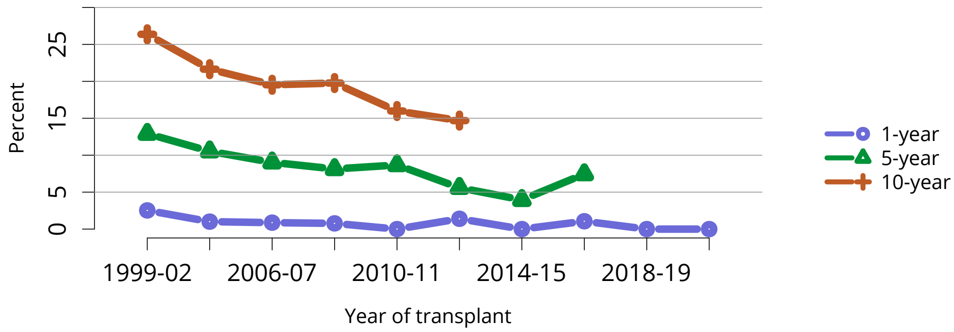

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Figure PA 60: Death-censored kidney graft failure among adult PAK transplant recipients with a living donor kidney (from time of pancreas transplant). Estimates are unadjusted, computed using Kaplan-Meier competing risk methods. PAK transplant recipients who previously underwent living donor kidney transplant are followed from date of pancreas transplant to the earliest of kidney graft failure; kidney retransplant; return to dialysis; death; or 1, 5, or 10 years posttransplant. Only PAK recipients with an OPTN record of a previous living kidney donor transplant are included. Multivisceral transplants are excluded. Death-censored graft failure is defined as return to dialysis, reported graft failure, or kidney retransplant. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney.

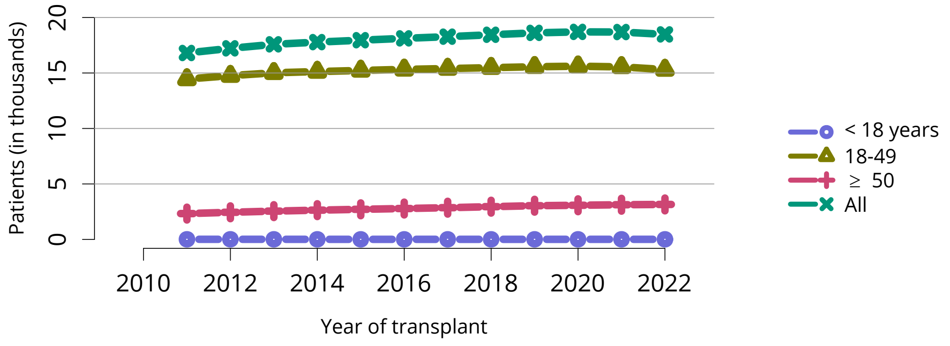

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Figure PA 61: Recipients alive after pancreas transplant on June 30 of the year, by age at transplant. Recipients are not censored at reported graft failure since the uniform definition of graft failure was not in effect until 2018. However, a recipient may experience a reported graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.

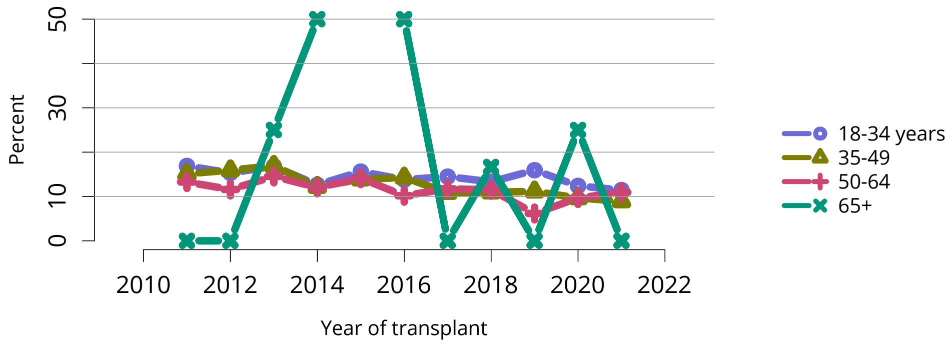

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Figure PA 62: Incidence of acute rejection by 1 year posttransplant among adult pancreas transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.

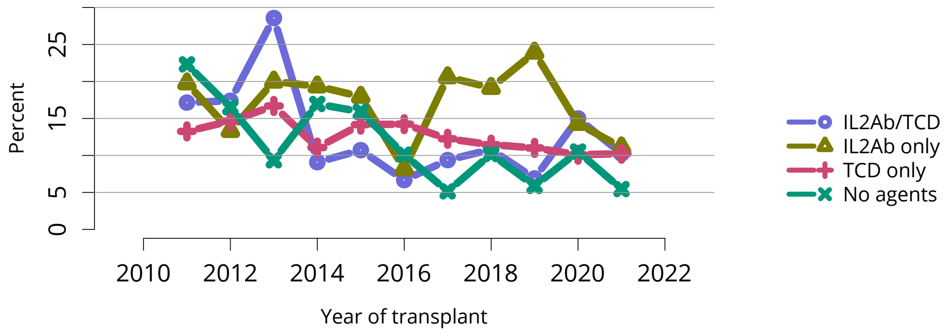

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Figure PA 63: Incidence of acute rejection by 1 year posttransplant among adult pancreas transplant recipients by induction agent. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method. IL2Ab, interleukin-2 receptor antibody; TCD, T-cell depleting.

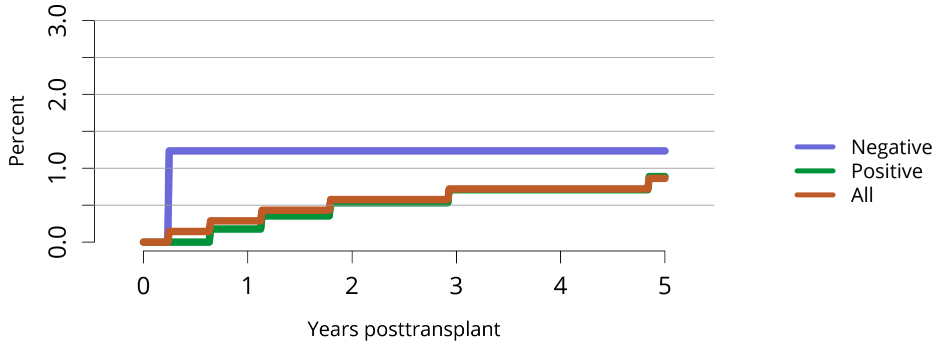

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Figure PA 64: Incidence of PTLD among adult recipients of pancreas after kidney transplant by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

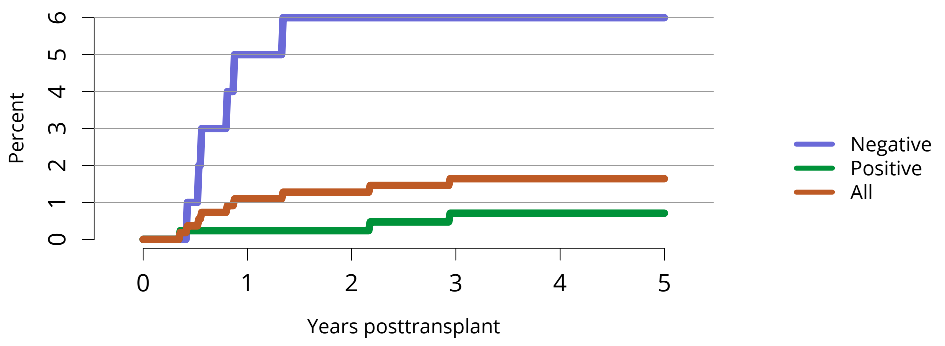

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Figure PA 65: Incidence of PTLD among adult recipients of pancreas transplant alone by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

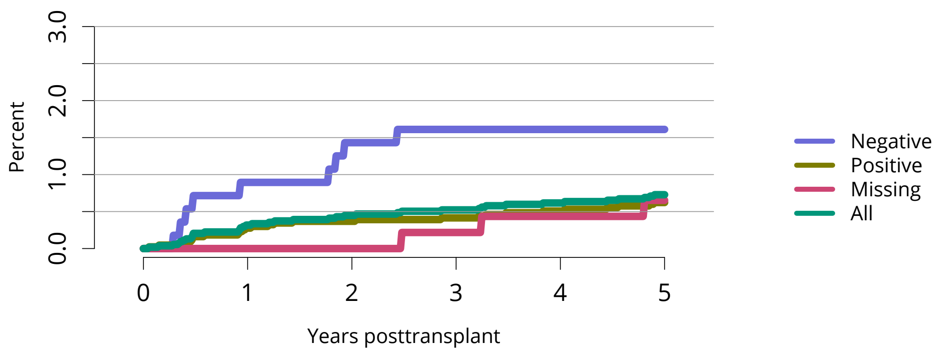

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Figure PA 66: Incidence of PTLD among adult recipients of simultaneous pancreas-kidney transplant by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

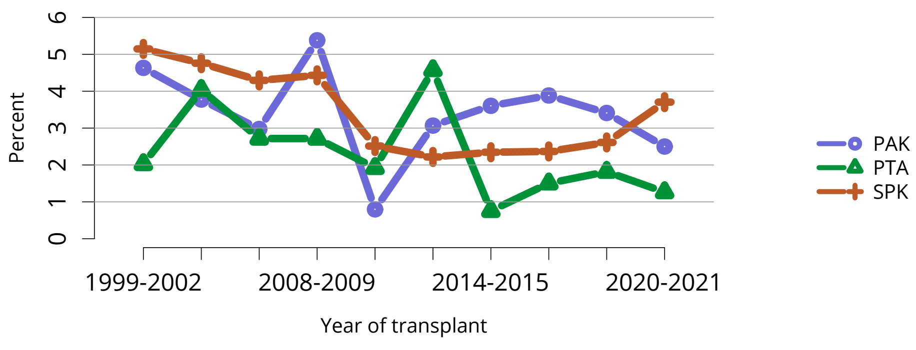

Figure PA 67: Patient death at 1 year among adult pancreas transplant recipients. Outcomes are computed using unadjusted Kaplan-Meier methods. Transplant recipients are followed from date of transplant to the earlier of death or 1 year posttransplant. Only first pancreas transplant is considered. PAK recipients without a record of previous kidney or kidney-pancreas transplant are reclassified as PTA. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

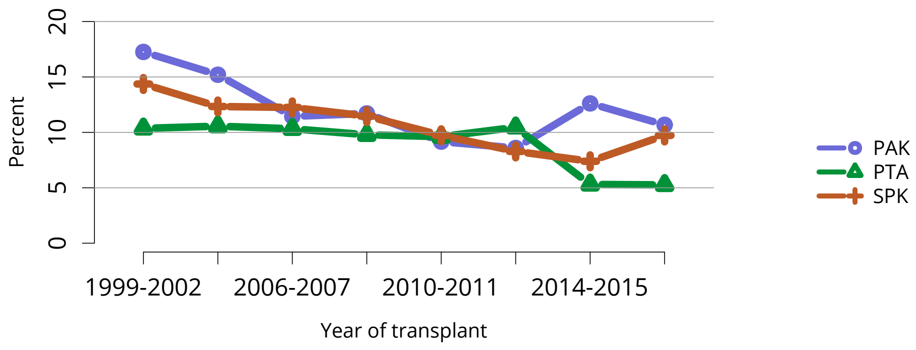

Figure PA 68: Patient death at 5 years among adult pancreas transplant recipients. Outcomes are computed using unadjusted Kaplan-Meier methods. Transplant recipients are followed from date of transplant to the earlier of death or 5 years posttransplant. Only first pancreas transplant is considered. PAK recipients without a record of previous kidney or kidney-pancreas transplant are reclassified as PTA. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

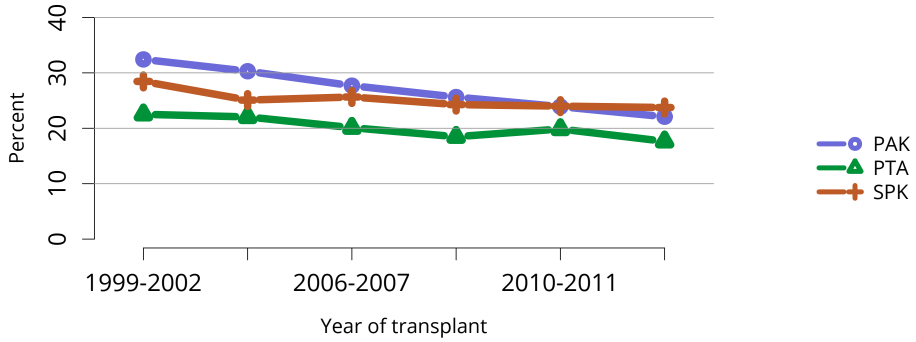

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Figure PA 69: Patient death at 10 years among adult pancreas transplant recipients. Outcomes are computed using unadjusted Kaplan-Meier methods. Transplant recipients are followed from date of transplant to the earlier of death or 10 years posttransplant. Only first pancreas transplant is considered. PAK recipients without a record of previous kidney or kidney-pancreas transplant are reclassified as PTA. Time point 1 is years 1999-2002; time point 2 is years 2003-2005; all other time points are 2-year periods. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

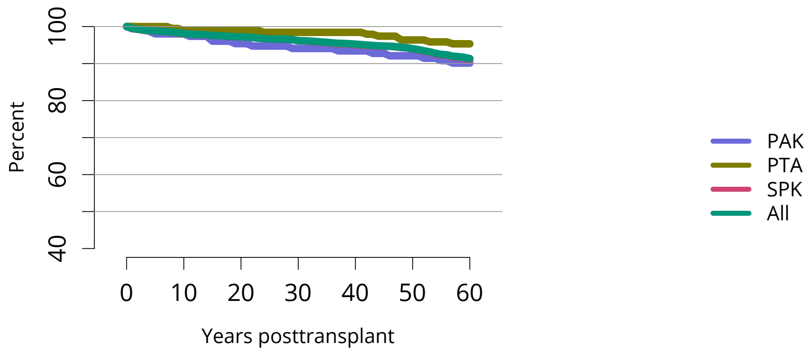

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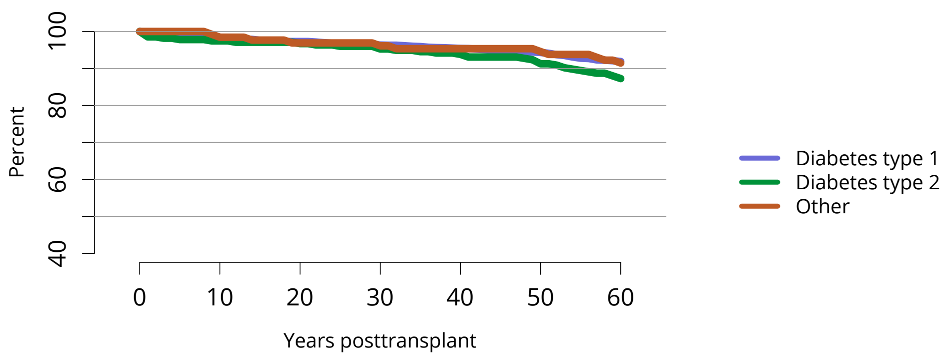
Figure PA 70: Patient survival among adult deceased donor pancreas transplant recipients, 2015-2017, by transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods. Multivisceral transplants are excluded. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.



OPTN/SRTR 2022 Annual Data Report

Figure PA 71: Patient survival among adult deceased donor pancreas transplant recipients, 2015-2017, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods. Multivisceral transplants are excluded.

Table PA 1: Demographic characteristics of adults on the pancreas transplant waiting list on December 31, 2022. Candidates waiting for transplant on December 31, 2022, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

	PAK		PTA		SPK		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Age (years)								
18-34 years	26	10	95	24.7	399	20.3	520	19.9
35-44	92	35.4	130	33.8	699	35.5	921	35.3
45-54	98	37.7	103	26.8	587	29.8	788	30.2
55+	44	16.9	57	14.8	282	14.3	383	14.7
Sex								
Female	116	44.6	209	54.3	906	46.1	1231	47.1
Male	144	55.4	176	45.7	1061	53.9	1381	52.9
Race and ethnicity								
Asian	10	3.8	8	2.1	105	5.3	123	4.7
Black	62	23.8	48	12.5	623	31.7	733	28.1
Hispanic	44	16.9	36	9.4	355	18	435	16.7
Multiracial	2	0.8	1	0.3	15	0.8	18	0.7
Native American	3	1.2	2	0.5	17	0.9	22	0.8
White	139	53.5	290	75.3	852	43.3	1281	49
Body mass index								
<18.5	5	1.9	20	5.2	34	1.7	59	2.3
18.5-<25	87	33.5	141	36.6	653	33.2	881	33.7
25-<30	96	36.9	141	36.6	814	41.4	1051	40.2
30-<35	57	21.9	66	17.1	380	19.3	503	19.3
35+	15	5.8	17	4.4	86	4.4	118	4.5
Miles between candidate and center								
<50 miles	163	62.7	186	48.3	1218	61.9	1567	60
50-<100	45	17.3	54	14	377	19.2	476	18.2
100-<150	25	9.6	30	7.8	156	7.9	211	8.1
150-<250	16	6.2	34	8.8	122	6.2	172	6.6
250+	11	4.2	78	20.3	79	4	168	6.4
Missing	0	0	3	0.8	15	0.8	18	0.7
All candidates								
All candidates	260	100	385	100	1967	100	2612	100

Table PA 2: Clinical characteristics of adults on the pancreas transplant waiting list on December 31, 2022. Candidates waiting for transplant on December 31, 2022, regardless of first listing date. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

	PAK		PTA		SPK		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Diagnosis								
Diabetes type 1	197	75.8	284	73.8	1309	66.5	1790	68.5
Diabetes type 2	52	20	23	6	527	26.8	602	23
Other/unknown	11	4.2	78	20.3	131	6.7	220	8.4
Blood type								
A	97	37.3	155	40.3	582	29.6	834	31.9
AB	16	6.2	17	4.4	65	3.3	98	3.8
B	35	13.5	51	13.2	368	18.7	454	17.4
O	112	43.1	162	42.1	952	48.4	1226	46.9
All candidates								
All candidates	260	100	385	100	1967	100	2612	100

Table PA 3: Listing characteristics of adults on the pancreas transplant waiting list on December 31, 2022. Candidates waiting for transplant on December 31, 2022, regardless of first listing date. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

	PAK		PTA		SPK		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Waiting time								
<90 days	14	5.4	36	9.4	320	16.3	370	14.2
3-<6 months	20	7.7	39	10.1	246	12.5	305	11.7
6-<12 months	23	8.8	61	15.8	400	20.3	484	18.5
1-<2 years	58	22.3	82	21.3	481	24.5	621	23.8
2+ years	145	55.8	167	43.4	520	26.4	832	31.9
Previous transplant								
No prior transplant	198	76.2	346	89.9	1878	95.5	2422	92.7
Prior transplant	62	23.8	39	10.1	89	4.5	190	7.3
All candidates								
All candidates	260	100	385	100	1967	100	2612	100

Table PA 4: Transplant waitlist activity among adults waiting for a pancreas after kidney transplant. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	301	293	285
Patients added during year	104	106	71
Patients removed during year	112	114	96
Patients at end of year	293	285	260

Table PA 5: Transplant waitlist activity among adults waiting for a pancreas transplant alone. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	332	362	361
Patients added during year	174	181	180
Patients removed during year	144	182	156
Patients at end of year	362	361	385

Table PA 6: Transplant waitlist activity among adults waiting for a simultaneous pancreas-kidney transplant. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	1737	1720	1854
Patients added during year	1307	1487	1486
Patients removed during year	1324	1352	1373
Patients at end of year	1720	1855	1967

Table PA 7: Removal reason among adults waiting for pancreas after kidney transplant. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	35	34	29
Patient died	8	6	3
Patient refused transplant	3	4	3
Improved, transplant not needed	0	2	1
Too sick for transplant	10	11	16
Other	54	54	44
Changed to kidney-pancreas list	1	3	0
Still on waiting list	1	0	0

Table PA 8: Removal reason among adults waiting for pancreas transplant alone. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	78	86	66
Patient died	11	7	10
Patient refused transplant	2	5	3
Improved, transplant not needed	2	7	2
Too sick for transplant	11	13	18
Other	32	56	49
Changed to kidney-pancreas list	8	8	8

Table PA 9: Removal reason among adults waiting for simultaneous pancreas-kidney transplant. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	858	858	852
Living donor transplant	49	75	53
Transplant outside US	0	2	1
Patient died	108	100	83
Patient refused transplant	3	6	6
Improved, transplant not needed	3	7	12
Too sick for transplant	71	73	80
Other	230	231	280
Still on waiting list	2	0	6

Table PA 10: Demographic characteristics of adult pancreas transplant recipients, 2022. Pancreas transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

	PAK		PTA		SPK		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Recipient age (years)								
18-34 years	13	28.3	13	26	185	22.9	211	23.3
35-49	26	56.5	19	38	410	50.7	455	50.3
50-64	7	15.2	18	36	211	26.1	236	26.1
65+	0	0	0	0	2	0.2	2	0.2
Sex								
Female	25	54.3	27	54	322	39.9	374	41.4
Male	21	45.7	23	46	486	60.1	530	58.6
Race and ethnicity								
Asian	0	0	1	2	42	5.2	43	4.8
Black	7	15.2	4	8	267	33	278	30.8
Hispanic	10	21.7	4	8	159	19.7	173	19.1
Multiracial	0	0	0	0	6	0.7	6	0.7
Native American	0	0	0	0	9	1.1	9	1
White	29	63	41	82	325	40.2	395	43.7
Body mass index								
<18.5	0	0	3	6	15	1.9	18	2
18.5-<25	13	28.3	21	42	330	40.8	364	40.3
25-<30	19	41.3	12	24	302	37.4	333	36.8
30-<35	11	23.9	10	20	130	16.1	151	16.7
35+	1	2.2	2	4	10	1.2	13	1.4
Missing	2	4.3	2	4	21	2.6	25	2.8
Insurance								
Private	21	45.7	27	54	327	40.5	375	41.5
Medicare	19	41.3	13	26	394	48.8	426	47.1
Medicaid	3	6.5	7	14	59	7.3	69	7.6
Other/unknown	3	6.5	3	6	28	3.5	34	3.8
Miles between recipient and center								
<50 miles	32	69.6	16	32	489	60.5	537	59.4
50-<100	10	21.7	7	14	144	17.8	161	17.8
100-<150	2	4.3	9	18	85	10.5	96	10.6
150-<250	1	2.2	7	14	34	4.2	42	4.6
250+	0	0	9	18	35	4.3	44	4.9
Missing	1	2.2	2	4	21	2.6	24	2.7
All recipients								
All recipients	46	100	50	100	808	100	904	100

Table PA 11: Clinical characteristics of adult pancreas transplant recipients, 2022. Pancreas transplant recipients, including retransplant recipients. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

	PAK		PTA		SPK		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Diagnosis								
Diabetes type 1	42	91.3	29	58	562	69.6	633	70
Diabetes type 2	3	6.5	2	4	201	24.9	206	22.8
Other/unknown	1	2.2	19	38	45	5.6	65	7.2
Blood type								
A	23	50	22	44	281	34.8	326	36.1
AB	0	0	3	6	33	4.1	36	4
B	4	8.7	5	10	103	12.7	112	12.4
O	19	41.3	20	40	391	48.4	430	47.6
All recipients								
All recipients	46	100	50	100	808	100	904	100

Table PA 12: Transplant characteristics of adult pancreas transplant recipients, 2022. Pancreas transplant recipients, including retransplant recipients. PAK, pancreas after kidney; PTA, pancreas transplant alone; SPK, simultaneous pancreas-kidney.

	PAK		PTA		SPK		All	
Characteristic	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
Waiting time								
None	0	0	0	0	5	0.6	5	0.6
<90 days	2	4.3	14	28	266	32.9	282	31.2
3-<6 months	4	8.7	12	24	133	16.5	149	16.5
6-<12 months	5	10.9	13	26	156	19.3	174	19.2
1-<2 years	23	50	5	10	155	19.2	183	20.2
2+ years	12	26.1	6	12	93	11.5	111	12.3
Previous transplant for recipients								
No prior transplant	40	87	44	88	799	98.9	883	97.7
Prior transplant	6	13	6	12	9	1.1	21	2.3
All recipients								
All recipients	46	100	50	100	808	100	904	100

OPTN/SRTR 2022 Annual Data Report: Liver

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Abstract

In 2022, liver transplant activity continued to increase in the United States, with an all-time high of 9,527 transplants performed, representing a 52% increase over the past decade (2012-2022). Of these transplants, 8,924 (93.7%) were from deceased donors and 603 (6.3%) were from living donors. Liver transplant recipients were 94.5% adult and 5.5% pediatric. The overall size of the liver transplant waiting list contracted, with more patients being removed than added, although 10,548 adult patients still remained on the waiting list at the end of 2022. Alcohol-associated liver disease continued to be the leading diagnosis among both candidates and recipients, followed by metabolic dysfunction–associated steatohepatitis. Simultaneous liver-kidney transplant was the most common multiorgan combination, with 800 liver-kidney transplants performed in 2022; in addition, there were 303 new listings for kidney transplant via the safety net mechanism. Among adults added

to the liver waiting list in 2021, 39.9% received a deceased donor liver transplant within 3 months; 45.7%, within 6 months; and 54.5%, within 1 year. Pretransplant mortality decreased to 12.3 deaths per 100 patient-years in 2022, although still 15.6% of removals from the waiting list were for death or being too sick for transplant. Graft and patient survival outcomes after deceased donor liver transplant improved, approximating pre–COVID-19 pandemic levels, with 5.1% mortality observed at 6 months; 6.8%, at 1 year; 12.7%, at 3 years; 19.8%, at 5 years; and 35.7%, at 10 years. Five-year graft and patient survival rates after living donor liver transplant exceeded those of deceased donor liver transplant. Candidates receiving model for end-stage liver disease exception points for hepatocellular carcinoma constituted 15.5% of transplants performed in 2022, with similar transplant rates and posttransplant outcomes compared to cases without hepatocellular carcinoma exception. In 2022, more pediatric liver transplant candidates were added to the waiting list and underwent transplant compared with either of the preceding 2 years, with an uptick in living donor liver transplant volume. Although pretransplant mortality has improved after the recent policy change prioritizing pediatric donors for pediatric recipients, still, in 2022, 50 children died or were removed from the waiting list for being too sick to undergo transplant. Posttransplant mortality among pediatric liver transplant recipients remained notable, with death occurring in 4.0% at 6 months, 6.0% at 1 year, 8.2% at 3 years, 9.8% at 5 years, and 13.9% at 10 years. Similar to adult living donor recipients, pediatric living donor recipients had better 5-year patient survival compared with deceased donor recipients.
Keywords: Allocation, distribution, liver transplant, waiting list

1 Adult Liver Transplantation in the United States

1.1 Waiting List

There were 24,186 adult candidates on the liver transplant waiting list at any point during 2022, a 10.7% decrease compared with 2012 (Figure LI 2). There were 11,324 waitlisted adults at the beginning of 2022; 12,862 were added and 13,638 were removed during the calendar year, leaving 10,548 on the waiting list at the end of 2022 (Figure LI 1, Table LI 4).

The proportion of candidates aged 50-64 years on the liver waiting list has steadily declined and was 47.4% in 2022, with a commensurate increase in the proportion of candidates aged 65 years or older (27.4%), 35-49 years (19.3%), and 18-34 years (6.0%)

(Figure LI 3). The composition of the waiting list in terms of sex and race and ethnicity remained relatively unchanged: 61.2% male, 38.8% female, 68.6% White, 18.7% Hispanic, 6.3% Black, 4.7% Asian, 1.1% Native American, and 0.6% Multiracial (Figure LI 4, Figure LI 5). Of the candidates remaining on the waiting list at the end of 2022, 84.2% reported living in a metropolitan area based on their permanent zip code; 56.7% were less than 50 miles from the transplant center, 18.8% were within 50-<100 miles, 9.3% were within 100-<150 miles, 8.0% were within 150-<250 miles, and 6.5% were 250 miles or farther (Table LI 1).

Obesity, defined as a body mass index (BMI) of 30 kg/m^2 or greater, was observed in 41.3% of adult candidates in 2022; 17.3% had a BMI of 35 kg/m^2 or greater (Figure LI 8). Of adults waiting for liver transplant, 3.0% had a history of prior liver transplant (Figure LI 10); 47.8% had blood type O, 38.2% had type A, 11.0% had type B, and 3.0% had type AB (Figure LI 9).

Alcohol-associated liver disease remained the most common primary diagnosis, at 37.5% of adult liver transplant candidates in 2022; this represents a 66.0% increase since 2012 (Figure LI 6). The prevalence of metabolic dysfunction–associated steatohepatitis (MASH), formerly known as nonalcoholic steatohepatitis, also increased, to 20.0% of candidates in 2022, with a commensurate decrease in the other/unknown category (15.8%). The prevalence of hepatitis C virus (HCV) (7.2%), cholestatic liver disease (7.3%), and acute liver failure (1.7%) on the waiting list continued to decrease. Hepatocellular carcinoma (HCC), which typically occurs in the context of chronic liver disease due to the aforementioned etiologies, was reported as the primary diagnosis for the remaining 10.5% of candidates.

The severity of liver disease, based on the last laboratory model for end-stage liver disease (MELD) score during the calendar year, increased in 2022, with a greater proportion of candidates with MELD scores of 25-34 (16.2%), 35-39 (5.0%), and 40 or greater (5.2%) compared with previous years (Figure LI 7).

1.2 Waitlist Outcomes

The overall deceased donor transplant rate among adult waitlist candidates continued to rise, and at 77.5 transplants per 100 patient-years in 2022, was more than double the rate from 2012 (Figure LI 11). This increase occurred across all age groups, sexes, racial and ethnic groups, and blood types (Figure LI 12, Figure LI 13, Figure LI 14, Figure LI 16). Still, male candidates had higher transplant rates compared with female candidates (80.1 versus 73.4 transplants per 100 patient-years), a disparity that may be addressed in part by the updated MELD scoring system (MELD 3.0) that was implemented in July

2023. Candidates with blood type AB had a much higher transplant rate compared with candidates of all other blood types (190.3 transplants per 100 patient-years compared with 108.7 for blood type B, 71.3 for blood type A, and 71.7 for blood type O). Transplant rates for patients with and without HCC exception points equalized in 2021, related to a series of policy changes over the preceding decade, and remained similar in 2022 (Figure LI 15).

Among adults listed for liver transplant in 2017-2019, only 7.7% remained on the waiting list after 3 years; 57.1% received a deceased liver transplant, 2.9% received a living donor liver transplant, 9.0% died, and 23.3% were removed from the list for other reasons (Figure LI 17). Among candidates who were added to the waiting list in 2021, 39.9%, 45.7%, and 54.5% received a deceased donor liver transplant within 3 months, within 6 months, and within 1 year, respectively—all increases compared with previous years (Figure LI 18). By comparison, only 39.6% of candidates listed in 2012 received a deceased donor liver transplant within 1 year; 49.8%, within 5 years; and 50.6%, within 10 years.

The pretransplant mortality rate decreased in 2022 to 12.3 deaths per 100 patient-years, from a peak of 17.9 deaths per 100 patient-years in 2014, despite the increased severity of liver disease in waitlist candidates (Figure LI 19). Like the overall deceased donor transplant rate, this decrease in pretransplant mortality occurred across all age groups (Figure LI 20), sexes (Figure LI 22), and etiologies of liver disease (Figure LI 23), yet female candidates still had an increased pretransplant mortality rate compared with male candidates (13.3 versus 11.7 deaths per 100 patient-years). Candidates with MASH and acute liver failure had higher pretransplant mortality rates (17.5 and 17.3 deaths per 100 patient-years, respectively) compared to candidates with other etiologies, with the lowest rates observed among those with cholestatic liver disease (9.45 deaths per 100 patient-years) and HCC (9.91 deaths per 100 patient-years). The pretransplant mortality rate remained highest among candidates with MELD scores of 40 or greater (based on the first active laboratory MELD score during the year) at 218.8 deaths per 100 patient-years in 2022, followed by those with MELD scores of 35-39 (179.2 deaths per 100 patient-years) (Figure LI 24). Pretransplant mortality was lower in candidates with an HCC exception compared to those without (10.1 versus 12.6 deaths per 100 patient-years), which has been sustained despite the policy change in 2019 that systematically lowered waitlist priority for patients with HCC (Figure LI 25). Overall, pretransplant mortality rates by donation service area still varied, ranging from 5.9 to 31.1 deaths per 100 patient-years (Figure LI 26).

Liver transplant was the most common reason for waitlist removal among adults in 2022, including 8,462 from a deceased donor and 515 from a living donor. The next most common reasons were "other" (1,434), being too sick for transplant (1,091), death (1,031), and condition improved with transplant no longer being needed (983) (Table LI 5). Removal for death or being too sick made up 15.6% of removals from the liver transplant waiting list. Deaths within 6 months after removal from the waiting list for reasons other than transplant or death decreased from 36.3% in 2012 to 13.3% in 2022 (Figure LI 27). This was similar across sexes and racial and ethnic groups (Figure LI 30, Figure LI 31). Candidates in the highest laboratory MELD score category (40 or greater at the time of removal) were actually less likely than those with MELD scores in the 35-39 and 25-34 categories to die within 6 months of removal (Figure LI 28).

1.3 Donation

The number of deceased liver donors (including adult and pediatric), defined as donors from whom the liver was recovered for transplant, continued to increase, reaching an all-time high of 9,812 in 2022, a nearly 50% increase since 2012 (Figure LI 32). In contrast to the increase in donation from older age groups, the absolute number of donors younger than 18 years has remained relatively stable during that period, representing 6.8% of donors in 2022 compared with 10.2% in 2012 (Figure LI 33, Figure LI 35). The sex and racial and ethnic composition of donors remained relatively unchanged in 2022: 62.4% male, 37.6% female, 61.8% White, 18.4% Black, 15.7% Hispanic, and 2.9% Asian (Figure LI 36, Figure LI 37). The proportion of livers with positive HCV antibody increased again in 2022, making up 9.6% of deceased donor livers recovered in 2022 (Figure LI 34, Figure LI 38). Anoxia remained the most common cause of death among deceased liver donors (47.5%), followed by head trauma (24.9%) and CVA/stroke (24.8%) (Figure LI 47).

Overall, 9.9% of livers (including adult and pediatric) were recovered and not transplanted, a value that has increased over the past 5 years from a low of 8.6% in 2018 (Figure LI 40). Livers from older donors were less likely to be transplanted, with 14.2% of livers recovered from donors aged 55 years or older and 11.4% of those from donors aged 40-54 years not transplanted (Figure LI 41). No major differences by sex, race and ethnicity, or donor cause of death were observed (Figure LI 42, Figure LI 43, Figure LI 44). Livers from donation after circulatory death (DCD) were much less likely to be transplanted than livers recovered from donation after brain death (26.8% versus 7.2%), although the rate of DCD livers recovered but not transplanted has decreased overall, from 32.2% in 2012 (Figure LI 47). Utilization of DCD livers may be anticipated to increase with wider availability of machine perfusion. Livers with positive HCV antibody were not more likely to be recovered for transplant and not transplanted than those without (9.4% versus 10.0%), nor were livers with positive HCV antibody considered to be at increased risk of disease transmission compared with those without (9.0% versus 10.2%) (Figure LI 45, Figure LI 46).

In 2022, there were 603 living donor liver transplants (including adult and pediatric) performed (Figure LI 55). Most donors were related (44.5%) or distantly related (11.1%; defined as a biological relative other than a parent, child, full or half sibling) to the recipient, whereas 21.5% were directed donations and 4.2% were from a spouse or partner (Figure LI 48). A small but growing number of living donor liver transplants (37 [6.4%]) were performed as a paired donation. Living donors were more likely to be female (58.5%) and White (78.4%) (Figure LI 50, Figure LI 51). Very few (4.5%) living donors were aged 55 years or older; 16.4% of living donors were obese (BMI of 30 kg/m^2 or greater) (Figure LI 49, Figure LI 53). In most cases, the right lobe of the liver was used for transplant (75.1%) (Figure LI 52).

1.4 Transplants

In 2022, a record 9,527 liver transplants (adult and pediatric) were performed in the United States, inclusive of adult, pediatric, retransplant, and multiorgan recipients, which is a 50% increase since 2012 (Figure LI 54). Of these, 8,924 (93.7%) were from deceased donors and 603 (6.3%) were from living donors (Figure LI 55). The number of pediatric recipients has remained relatively constant over the past decade, whereas the number and proportion of adult recipients have increased (Figure LI 56). In terms of sex and race and ethnicity, 61.9% were male; 38.1%, female; 68.8%, White; 18.1%, Hispanic; 6.9%, Black; 4.4%, Asian; 1.1%, Native American; and 0.7%, Multiracial (Figure LI 57, Figure LI 58). Alcohol-associated liver disease was again the most common indication for liver transplant overall, making up 38.6% of transplants, followed by MASH at 18.8% (Figure LI 59).

Among the 9,001 adult recipients in 2022, 94.3% received livers from deceased donors and 5.7% from living donors (Table LI 8). Of all 9,001 adult recipients, 62.4% were male; 37.6%, female; 70.1%, White; 17.7%, Hispanic; 6.3%, Black; and 4.2%, Asian (Table LI 6). Compared with a decade ago, there was a higher proportion of recipients aged 35-49 years (22.8% in 2022 versus 16.9% in 2012), aged 65 years or older (21.9% versus 14.6%), with BMI of 35 kg/m^2 or greater (15.5% versus 12.7%), and with Medicaid insurance (17.0% versus 12.8%). Most liver transplants (51.4%) were covered by private insurance, followed by Medicare (26.4%) and Medicaid (17.0%). In 2022, based on the rural-urban commuting area designation of their home zip code, 83.4% of recipients lived in metropolitan areas compared with 14.9% in nonmetropolitan areas; 56.9% lived less than 50 miles from the transplant center, 16.9% within 50-<100 miles, 9.8% within

100-<150 miles, 7.3% within 150-<250 miles, and 7.9% 250 miles or farther.

Alcohol-associated liver disease was the primary diagnosis for 40.8% of adult liver transplants in 2022, up from 17.0% in 2012 (Table LI 7). This was followed by MASH (19.9%) and other/unknown (14.5%). In 10.9% of recipients, HCC was the primary diagnosis, down from 19.7% in 2012. Cholestatic liver disease (7.1%), HCV (4.4%), and acute liver failure (2.3%) were less frequently the primary diagnosis. The proportion of recipients who underwent transplant with HCC MELD exception points was 15.5% in 2022, down from 27.0% in 2012. In 2022, recipients most commonly had blood type O (45.5%), followed by type A (36.4%), type B (13.4%), and type AB (4.7%). Regarding MELD score or urgency status at transplant, 14.2% of recipients had an allocation MELD score of 14 or lower, 26.2% had a MELD of 15-24, 36.4% had a MELD of 25-34, 11.0% had a MELD of 35-39, 9.8% had a MELD of 40 or greater, and 2.3% were status 1A.

Most adult liver transplant recipients (61.0%) waited less than 90 days, with only 13.0% waiting longer than 1 year (Table LI 8). Overall, waiting times in 2022 were shorter compared with 2012. The proportion of adults who received DCD livers increased to 11.3% in 2022 from 4.6% in 2012, while the proportion of those who received split livers remained low at 0.9%. The proportion of recipients with a history of previous transplant decreased to 3.5% in 2022 from 5.1% in 2012.

There were 800 simultaneous liver-kidney transplants in 2022, representing a stable proportion (8.4%) of liver transplant recipients over the past several years since the introduction of standardized medical eligibility criteria for simultaneous liver-kidney transplant in 2017 (Figure LI 60). Most recipients (89.3%) qualified for kidney listing because of chronic kidney disease, and 8.8% qualified because of sustained acute kidney injury (Figure LI 61).

1.5 Outcomes

Among liver transplants performed in 2021, the most recent year for which at least 1 full year of follow-up was available, graft failure occurred in 6.4% of adult deceased donor liver transplant recipients at 6 months and in 8.4% at 1 year, which are improvements from the previous year and closer to prepandemic levels (Figure LI 67). Longer term graft outcomes for recipients of deceased donor liver transplant were similar to those in previous years, with a graft failure frequency of 14.6% at 3 years for transplants in 2019, 21.6% at 5 years for transplants in 2017, and 38.1% at 10 years for transplants in 2012. Overall survival for adult deceased donor liver transplant recipients followed a similar pattern, with 5.1% mortality at 6 months, 6.8% at 1 year, 12.7% at 3 years, 19.8% at 5 years, and 35.7% at 10 years (Figure LI 69).

For adult recipients of deceased donor liver transplant in 2015-2017, the 5-year survival outcomes were lower among older recipients (65 years or older) compared with those in the younger age groups (Figure LI 70, Figure LI 86); among Black and Native American recipients compared with those in other race and ethnicity categories (Figure LI 71, Figure LI 87); and among men compared with women (Figure LI 72, Figure LI 88). Graft survival rates were highest for cholestatic (81.0%) and alcohol (80.3%) etiologies and lowest for acute liver failure (76.8%) and HCC (77.0%) (Figure LI 73). Patient survival rates by etiology followed a similar pattern (Figure LI 89). Recipients in the highest laboratory MELD category (40 or greater) had somewhat inferior graft and patient survival outcomes compared with those in lower MELD categories, but still had 75.3% graft and 76.9% patient survival at 5 years (Figure LI 74, Figure LI 90). Graft outcomes were equivalent between recipients with and without HCC exception points, as well as across BMI categories (Figure LI 76, Figure LI 77). The 5-year graft survival rate among recipients of DCD livers was 75.3%, compared with 79.2% for recipients of livers donated after brain death (Figure LI 75).

Outcomes for adult living donor liver transplant recipients have improved and were superior to those of deceased donor recipients, with graft failure occurring in 5.1% at 6 months, 6.5% at 1 year, 12.4% at 3 years, 15.9% at 5 years, and 32.5% at 10 years (Figure LI 68). Recipients with MASH and cholestatic liver disease had the highest 5-year graft survival: 86.6% and 86.3%, respectively. Five-year graft survival was notably worse among those with a diagnosis of acute liver failure (57.1%), although the absolute number of patients in this category was small (Figure LI 81). Similarly, worse outcomes were observed in the higher MELD score categories (MELD 25-34: 69.4%, MELD 35-39: 66.7%), whereas outcomes were similar between MELD of 14 or lower (83.7%) and MELD 15-24 (82.9%) (Figure LI 82). Five-year patient survival outcomes among living donor liver transplant recipients also exceeded those of deceased donor liver transplant recipients. Patterns similar to those seen with deceased donor transplants were observed, with lower survival rates among recipients aged 65 years or older, those with acute liver failure or HCC, and those with MELD of 25 or greater (Figure LI 91, Figure LI 92, Figure LI 94). No differences by sex or race and ethnicity were observed (Figure LI 79, Figure LI 80, Figure LI 93).

Induction therapy was used in 30.4% of adult liver transplants in 2022, and 69.9% of adult liver transplant recipients received steroid-containing immunosuppressive regimens (Figure LI 65, Figure LI 66). Acute rejection within the first year after liver transplant occurred more frequently with decreasing age, at a rate of 19.1% in recipients aged 18-34 years compared with 8.44% in those aged 65 years or older (Figure LI 83). No notable differences were seen in the incidence of acute rejection based on induction agent status or type (interleukin-2 receptor antibody versus T-cell depleting agent versus none) (Figure LI 84). The overall incidence of posttransplant lymphoproliferative disorder at 5 years posttransplant was 1.0%, and among Epstein-Barr virus (EBV)–negative patients was 2.0% (Figure LI 85).

In 2022, there were 725 new listings for kidney transplant with a previous history of liver transplant. The number of listings within 60-<365 days after liver transplant notably increased after the implementation of the safety net provision in 2017, with 303 new listings in 2022 (Figure LI 62). The most common diagnosis among new kidney transplant listings was hepatorenal syndrome (28.8%), followed by calcineurin inhibitor nephrotoxicity (18.9%) and diabetes (17.7%) (Figure LI 63).

2 Pediatric Liver Transplantation in the United States

2.1 Summary

In 2022, pediatric liver transplant activity increased, with more candidates added to the waiting list and more who underwent transplant compared with the preceding 2 years. In total, 526 pediatric liver transplants were performed: 439 (83.5%) deceased donor and 87 (16.5%) living donor (Figure LI 107, Figure LI 108). Overall, living donor transplant has increased in the past decade, and living donor recipients continue to have better long-term graft and patient survival compared with deceased donor recipients. Since February 2020, coinciding with the implementation of acuity circles, donations from pediatric donors have been prioritized for children nationally before being offered to adults within a 500–nautical mile radius, and pediatric pretransplant mortality has overall decreased compared with the years preceding this policy change. Although improved, candidates younger than 1 year still had the highest pretransplant mortality rates among pediatric age groups, and 50 children died on the waiting list or were removed for being too sick to undergo transplant (Table LI 13). Recipient mortality remains notable, with death observed in 6.0% of pediatric liver transplant recipients at 1 year, 9.8% at 5 years, and 13.9% at 10 years (Figure LI 121).

2.2 Waiting List

In 2022, there were 741 new registrants added to the pediatric liver transplant waiting list, and 704 were removed, leaving 438 candidates on the list at the end of the calendar year (Figure LI 95, Table LI 12). Of the 1,142 candidates on the waiting list during the year (Figure LI 96), those aged 1-5 years (32.3%) and 12-17 years (23.7%) made up the largest age groups, followed by younger than 1 year (19.4%), 6-11 years (16.8%), and 18 years or older (7.7%) (Figure LI 97). In terms of race and ethnicity, White registrants continued to make up the largest group on the waiting list (46.1%), followed by Hispanic (25.6%), Black (17.6%), Asian (7.2%), Multiracial (3.1%), and Native American (0.5%) registrants (Figure LI 98).

The overall deceased donor liver transplant rate for pediatric waitlist candidates in 2022 was higher than that for adults, at 103.5 transplants per 100 patient-years (Figure LI 101). The transplant rate was highest for candidates younger than 1 year (188.6 transplants per 100 patient-years), but this rate was lower compared with those of previous years (Figure LI 102). Pretransplant mortality remained steady at a rate of 6.0 deaths per 100 patient-years, with the highest mortality rate still among candidates younger than 1 year at 9.4 deaths per 100 patient-years (although a significant decrease compared with previous years) (Figure LI 104, Figure LI 105). In 2022, 50 children died on the waiting list or were removed for being too sick for transplant (Table LI 13).

In 2022, the most common reason for removal was deceased donor liver transplant (63.9%), then living donor liver transplant (12.5%), followed by condition improved and transplant no longer needed (11.2%), too sick for transplant (4.3%), and death (2.8%), among others (Table LI 13). After 3 years of follow-up, 67.1% of pediatric candidates listed in 2017-2019 had received a deceased donor liver transplant, 10.0% received a living donor liver transplant, 3.3% died, 15.2% were removed from the waiting list for other reasons, and 4.4% were still waiting for a liver transplant (Figure LI 100).

2.3 Transplants

In 2022, there were 526 pediatric liver transplants performed in the United States, closer to prepandemic volumes; 439 (83.5%) were deceased donor and 87 (16.5%) were living donor (Figure LI 107, Figure LI 108). Over the past decade, the proportion of living donor transplants has increased, to 16.5% in 2022 from 9.9% in 2012.

The number and proportion of adolescent (age 12-17 years) liver transplant recipients have increased, at 128 (24.3%) of pediatric liver transplants in 2022, although most transplants were still in children aged 5 years or younger (age <1 year, 27.6%; age 1-5 years, 32.3%) (Figure LI 109). Recipient demographic information, including age at the time of transplant, race and ethnicity, insurance type, and place of residence, has remained similar over the past decade. In 2022, 81.4% reported living in a metropolitan area based on their permanent zip code. Regarding distance from transplant center, 45.8% of recipients were less than 50 miles; 15.2%, within 50-<100 miles; 9.9%, within 100-<150 miles; 12.4%, within 150-<250 miles; and 14.4%, 250 miles or farther (Table LI

14). Recipients with a history of prior transplant made up 5.7% (Table LI 16).

Biliary atresia remained the leading indication for pediatric liver transplant in 2022 (37.3%), followed by other/unknown diagnosis (23.4%), metabolic (15.0%), acute liver failure (9.5%), hepatoblastoma (7.6%), and other cholestatic condition (7.2%) (Table LI 15). At the time of transplant, 13.1% of recipients were status 1A and 22.1% were status 1B, while 4.6%, 17.9%, 15.0%, and 27.4% had allocation MELD/pediatric end-stage liver disease (PELD) scores of 40 or greater, 25-39, 15-24, and 14 or lower, respectively. The use of technical variant grafts in pediatric liver transplant over the past decade has been relatively unchanged—in 2022, 59.7% were whole liver; 23.2%, partial liver; and 17.1%, split liver (Figure LI 110). In 2022, only one pediatric patient (0.2%) received a DCD liver graft, and 4.2% of grafts were ABO incompatible (Table LI 16).

In 2022, most pediatric liver transplant recipients received no induction therapy (61.2%) and steroid-containing initial immunosuppression regimens (78.1%) (Figure LI 111, Figure LI 112).

2.4 Outcomes

Within 1 year of transplant, 22.1%-29.0% of pediatric liver transplant recipients (transplants done in 2021) had at least one episode of rejection (Figure LI 119). Among pediatric recipients who underwent transplant in 2011-2017, posttransplant lymphoproliferative disorder was reported in 2.0% after 1 year, 3.5% after 3 years, and 4.1% after 5 years, with approximately twofold incidence among recipients negative for EBV compared with those positive for EBV (Figure LI 120).

Among pediatric deceased donor liver recipients for transplants in 2011-2021, graft failure occurred in 5.9% at 6 months, 8.0% at 1 year, 13.1% at 3 years, 13.7% at 5 years, and 20.3% at 10 years from transplant (Figure LI 113). Fewer living donor recipients developed graft failure, occurring in 5.2% at 6 months, 6.5% at 1 year, 7.6% at 3 years, 8.3% at 5 years, and 11.5% at 10 years from transplant (Figure LI 114). For transplants in 2015-2017, the 5-year graft survival was highest for deceased donor recipients who were aged 6-11 years at the time of transplant (90.1%), followed by younger than 1 year (86.7%), 12-17 years (84.3%), and 1-5 years (83.5%) (Figure LI 115). By diagnosis, 5-year graft survival was highest for deceased donor recipients with metabolic conditions (95.5%), followed by biliary atresia (90.3%), acute liver failure (82.8%), other cholestatic conditions (79.2%), hepatoblastoma (78.8%), and other/unknown (77.8%) (Figure LI 116). Deceased donor recipients who underwent transplant at a MELD/PELD score of 35-39 had the lowest 5-year graft survival at 75.4%, whereas survival exceeded 84.8% for all other MELD categories including 40 or greater (Figure LI 117). At all time points, living donor recipients had better graft survival compared with deceased donor recipients, with a 5-year graft survival of 91.5% compared with 85.5%, respectively (Figure LI 118).

Recipient mortality remains notable in pediatric liver transplant; death occurred in 4.0% of deceased and living donor recipients at 6 months, 6.0% at 1 year, 8.2% at 3 years, 9.8% at 5 years, and 13.9% at 10 years from transplant (Figure LI 121). Similar to adult living donor recipients, pediatric living donor recipients had better 5-year patient survival compared with deceased donor recipients (94.8% versus 89.5%) (Figure LI 125).

Support, Copyright, and Citation Information

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This report is available at https://srtr.transplant.hrsa.gov. Individual chapters may be downloaded.

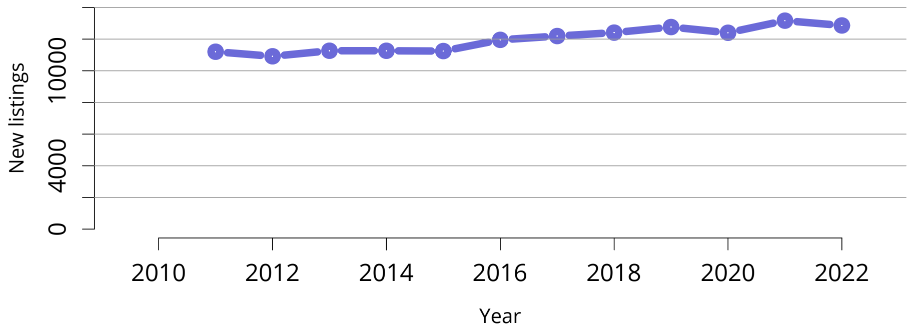

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Figure LI 1: New adult candidates added to the liver transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included.

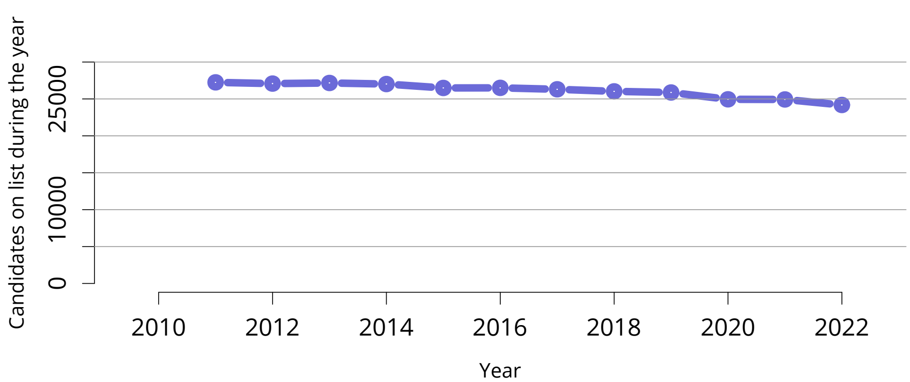

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Figure LI 2: All adult candidates on the liver transplant waiting list. Adult candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing.

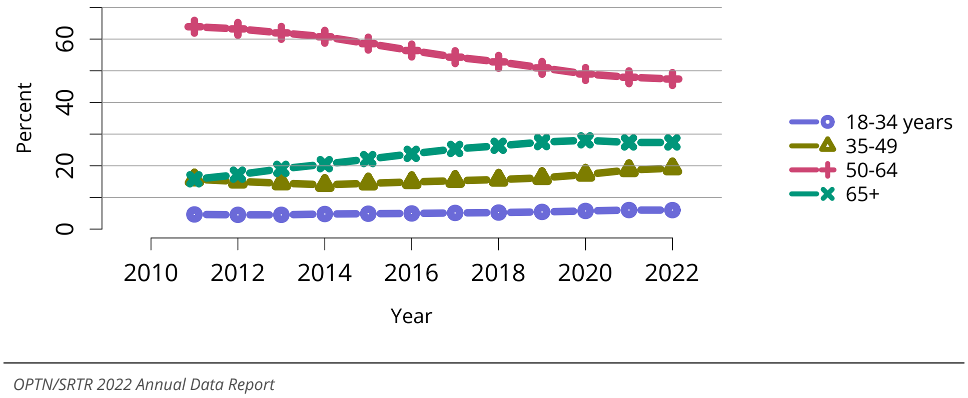

Figure LI 3: Distribution of adults waiting for liver transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.

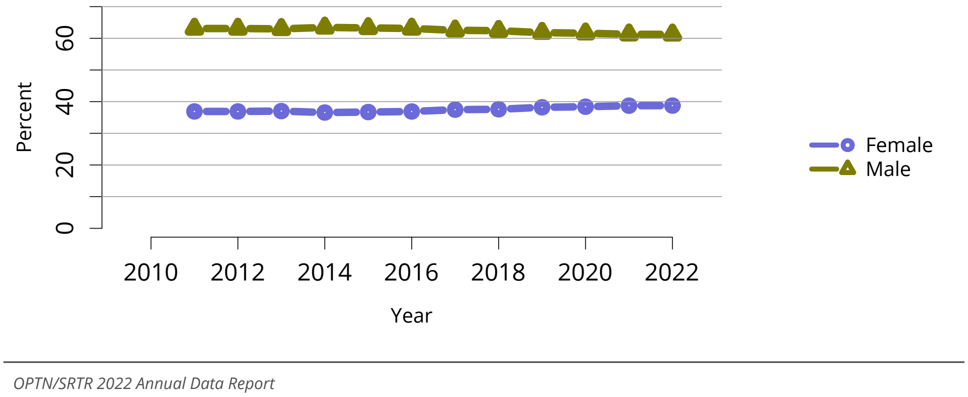

Figure LI 4: Distribution of adults waiting for liver transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

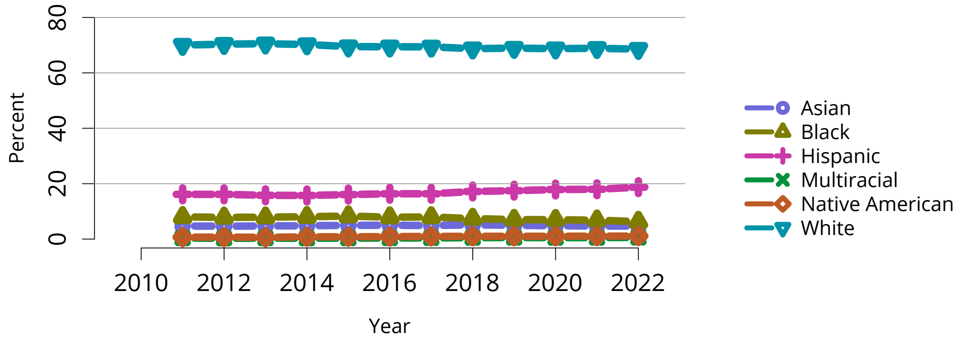

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Figure LI 5: Distribution of adults waiting for liver transplant by race and ethnicity. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

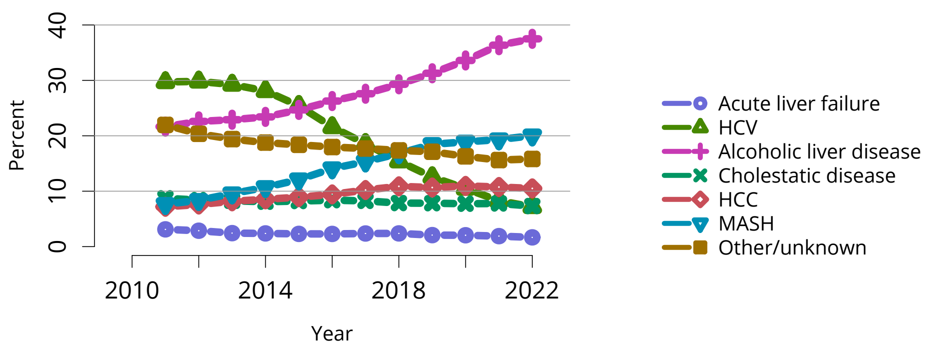

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Figure LI 6: Distribution of adults waiting for liver transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.

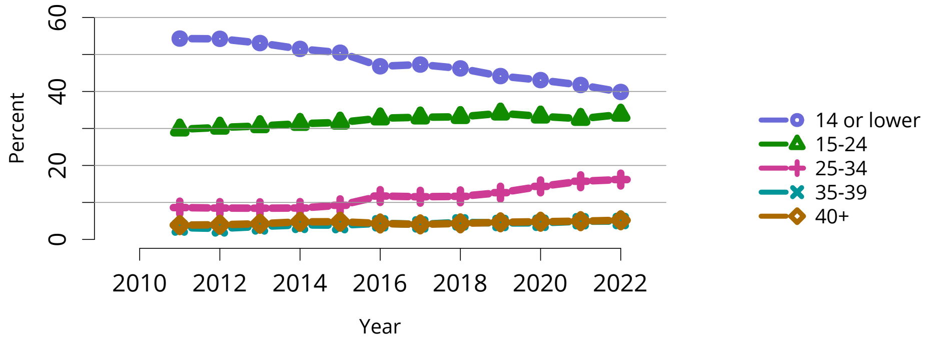

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Figure LI 7: Distribution of adults waiting for liver transplant by last laboratory MELD score in the year. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. MELD, model for end-stage liver disease.

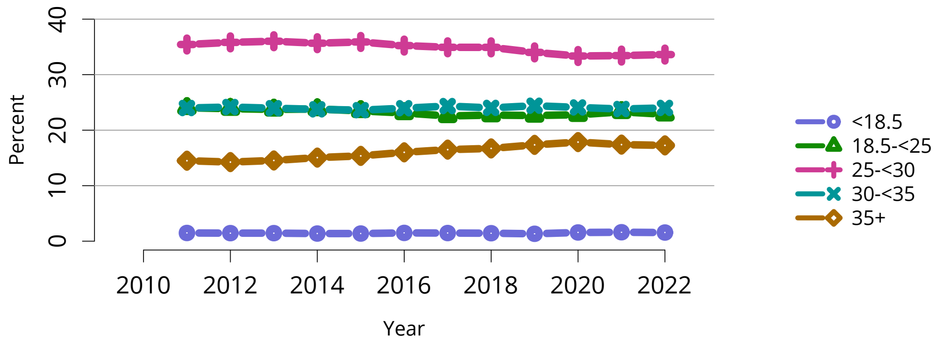

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Figure LI 8: Distribution of adults waiting for liver transplant by BMI. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. BMI, body mass index.

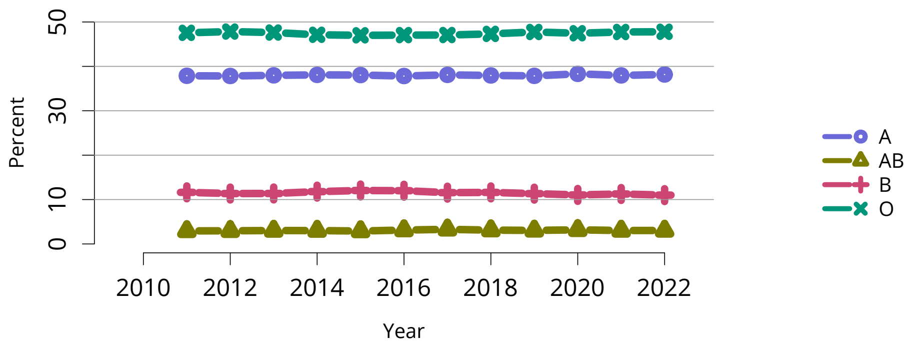

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Figure LI 9: Distribution of adults waiting for liver transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

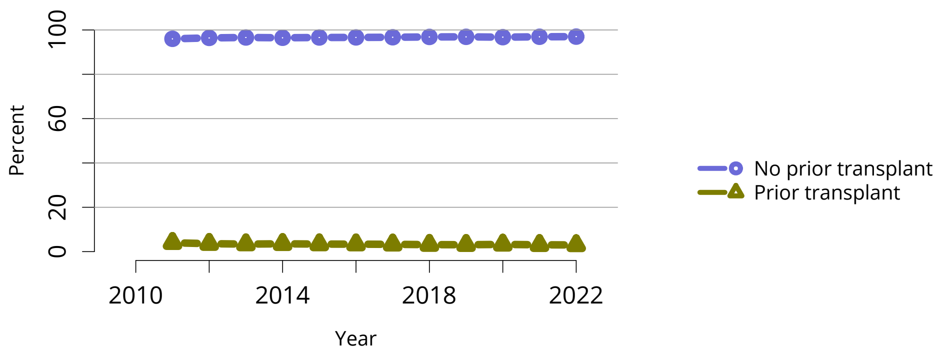

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Figure LI 10: Distribution of adults waiting for liver transplant by prior transplant status. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

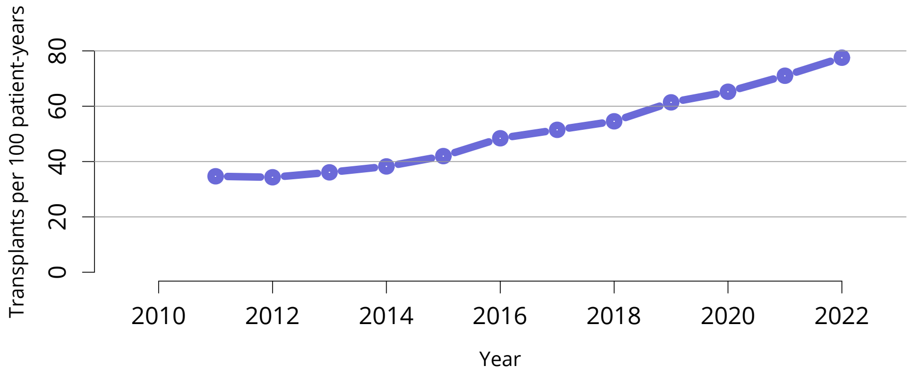

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Figure LI 11: Overall deceased donor liver transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

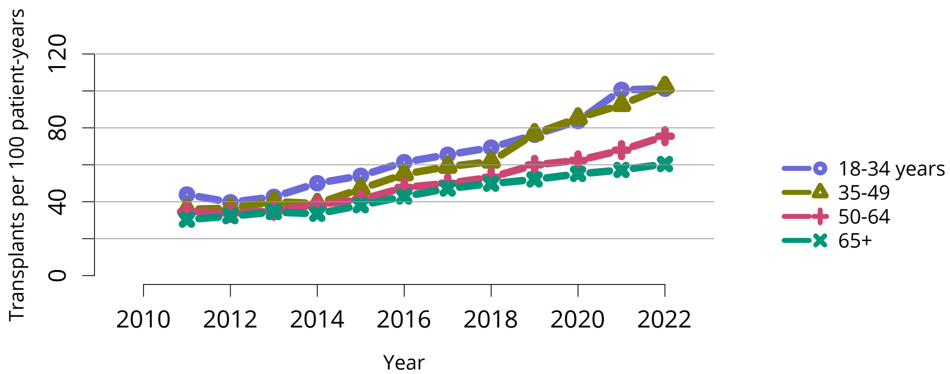

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Figure LI 12: Deceased donor liver transplant rates among adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

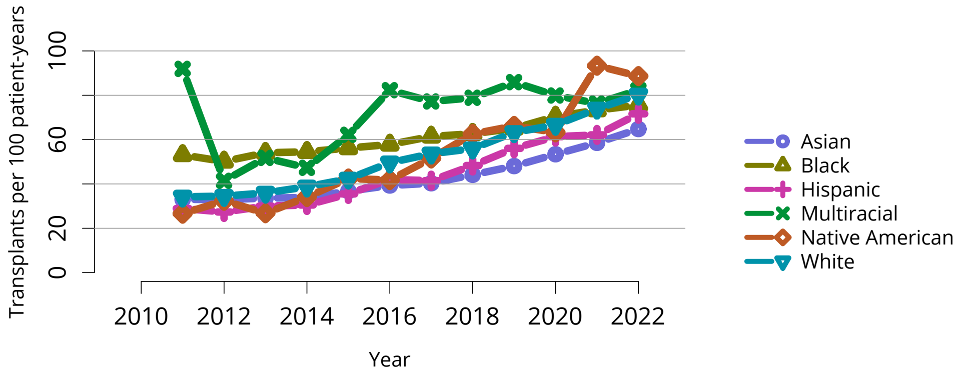

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Figure LI 13: Deceased donor liver transplant rates among adult waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

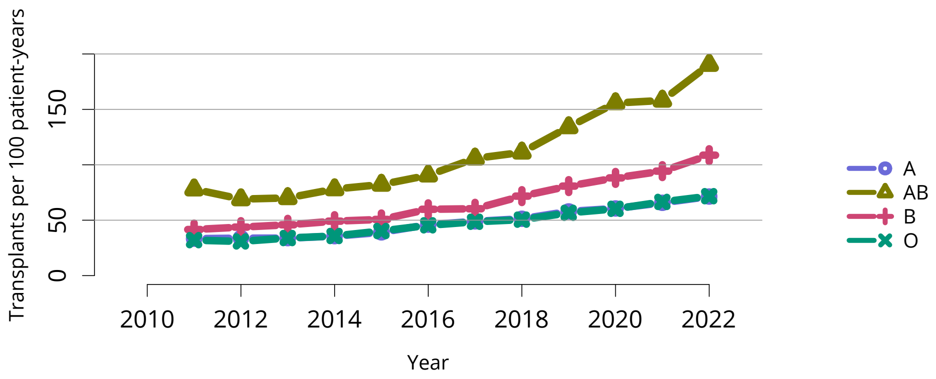

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Figure LI 14: Deceased donor liver transplant rates among adult waitlist candidates by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

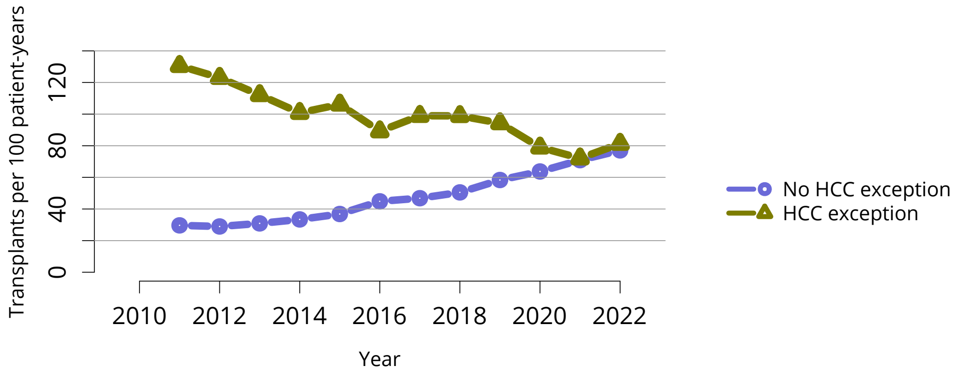

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Figure LI 15: Deceased donor liver transplant rates among adult waitlist candidates by HCC exception status. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. HCC is determined at the later of listing date or January 1 of the year. HCC, hepatocellular carcinoma.

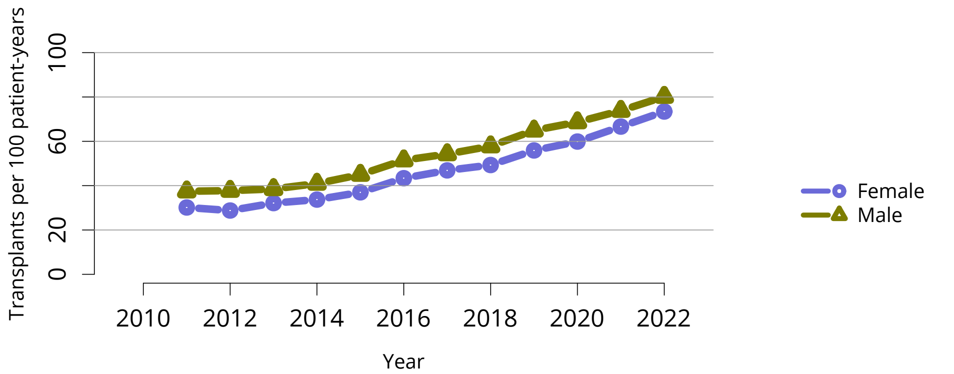

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Figure LI 16: Deceased donor liver transplant rates among adult waitlist candidates by sex. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

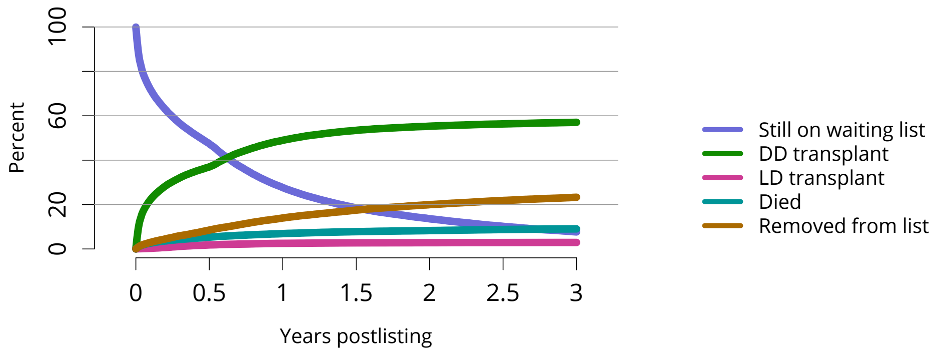

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Figure LI 17: Three-year outcomes for adults waiting for liver transplant, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor; LD, living donor.

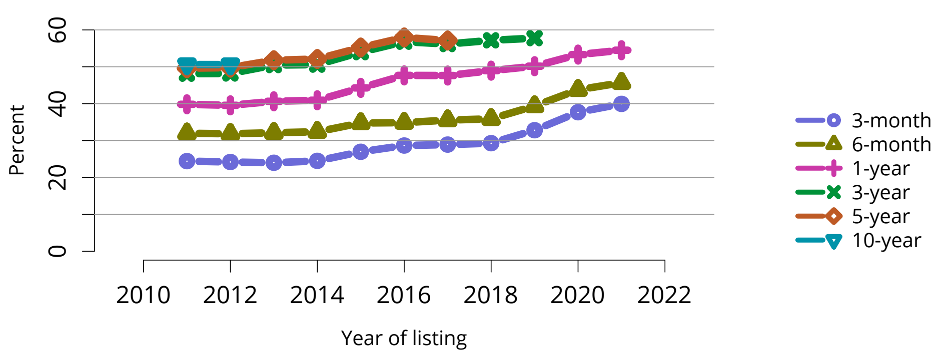

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Figure LI 18: Percentage of adults who underwent deceased donor liver transplant within a given period of listing. Candidates listed at more than one center are counted once per listing.

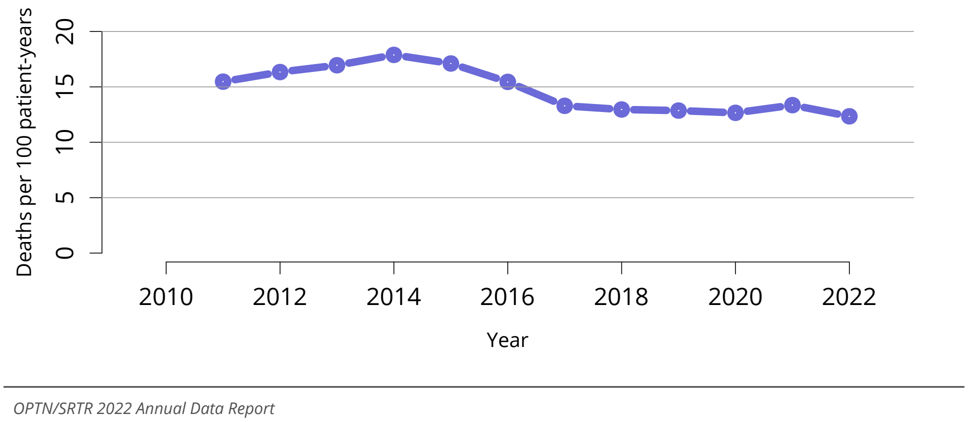

Figure LI 19: Overall pretransplant mortality rates among adults waitlisted for liver transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

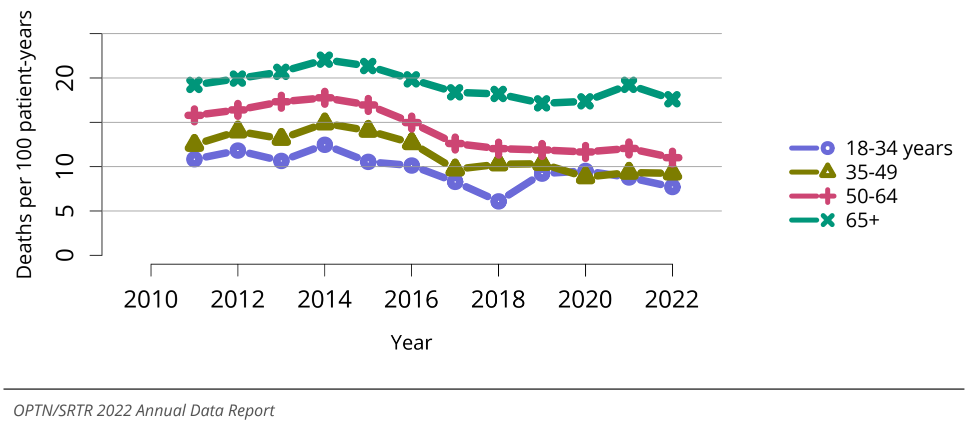

Figure LI 20: Pretransplant mortality rates among adults waitlisted for liver transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

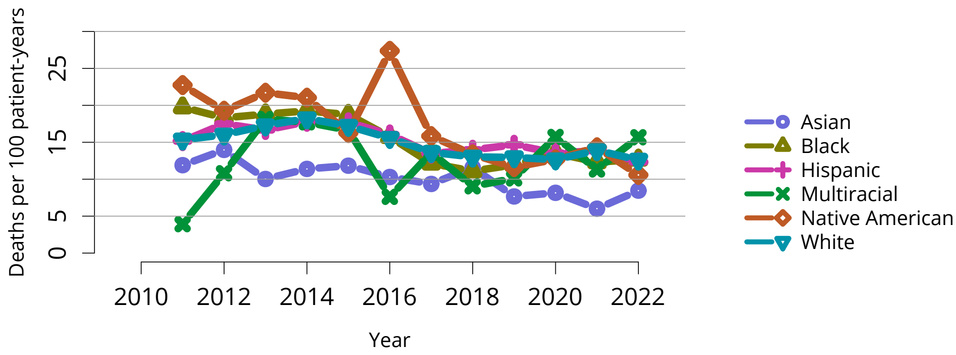

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Figure LI 21: Pretransplant mortality rates among adults waitlisted for liver transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

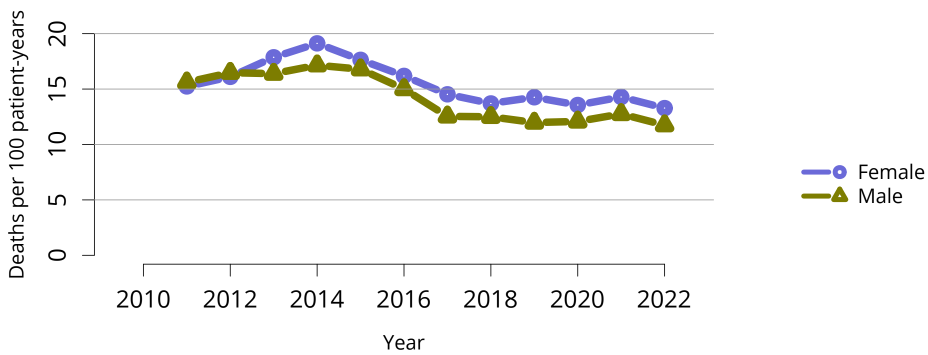

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Figure LI 22: Pretransplant mortality rates among adults waitlisted for liver transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

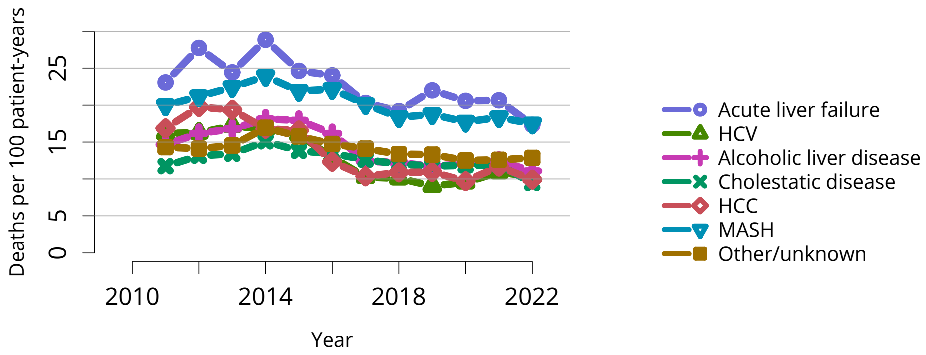

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Figure LI 23: Pretransplant mortality rates among adults waitlisted for liver transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.

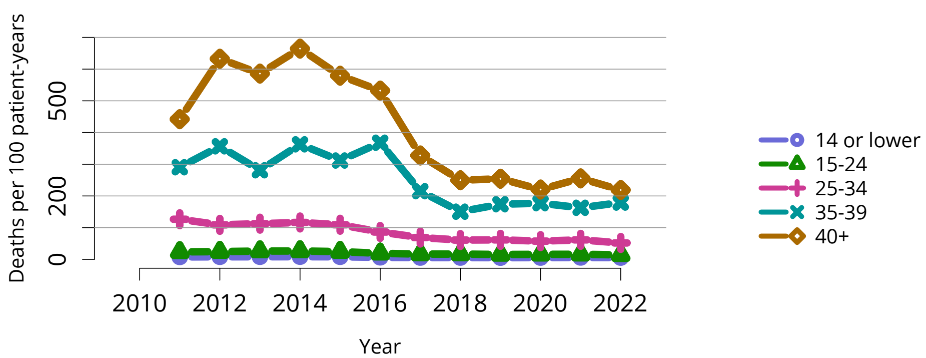

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Figure LI 24: Pretransplant mortality rates among adults waitlisted for liver transplant by first laboratory MELD score in the year. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Medical urgency is determined at the later of listing date or January 1 of the year. MELD, model for end-stage liver disease.

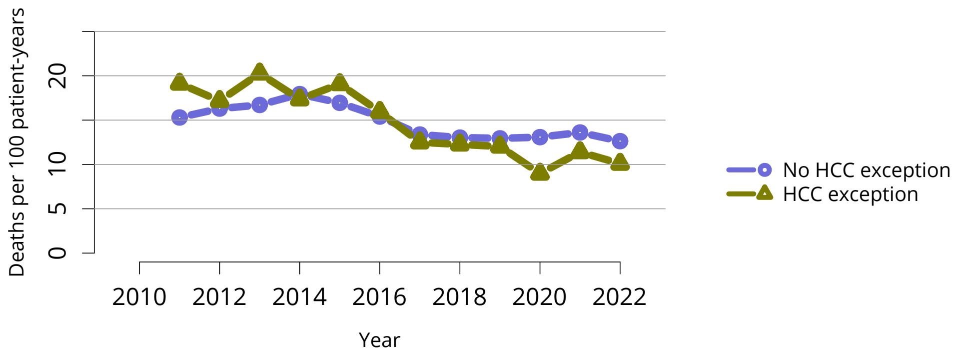

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Figure LI 25: Pretransplant mortality rates among adults waitlisted for liver by HCC exception status. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. HCC is determined at the later of listing date or January 1 of the year. HCC, hepatocellular carcinoma.

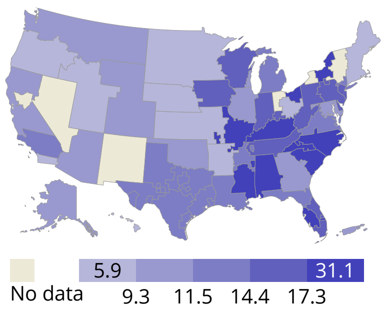

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Figure LI 26: Pretransplant mortality rates among adults waitlisted for liver transplant in 2022 by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. DSA, donation service area.

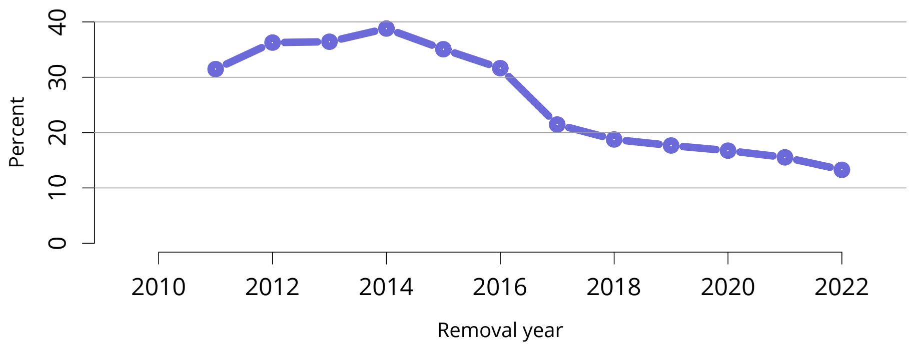

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Figure LI 27: Deaths within 6 months after removal among adult liver waitlist candidates, overall. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

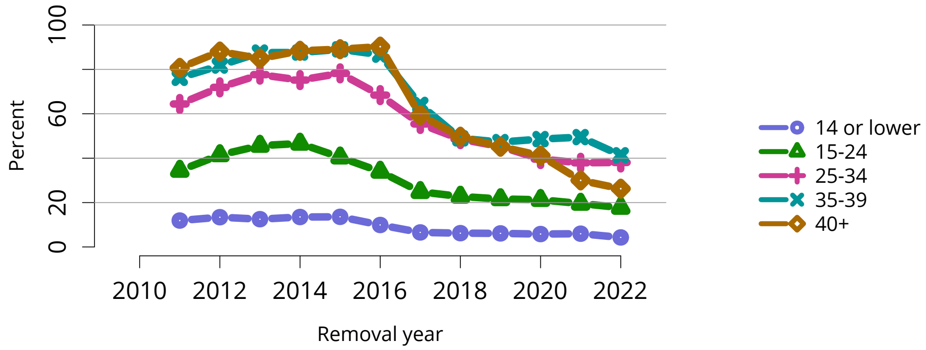

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Figure LI 28: Deaths within 6 months after removal among adult liver waitlist candidates, by laboratory MELD score at removal. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. MELD, model for end-stage liver disease.

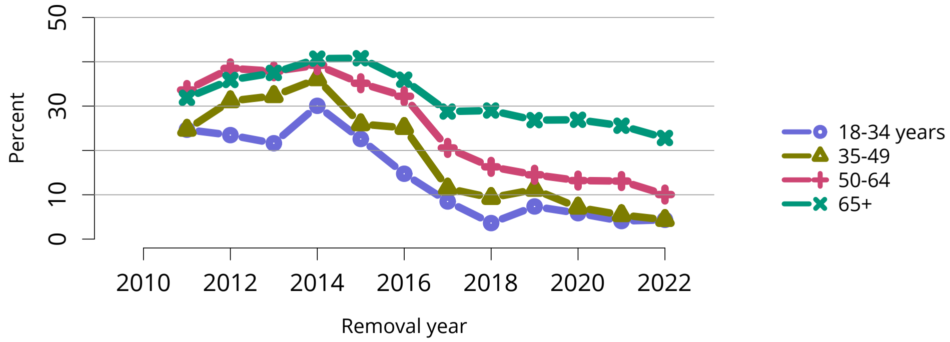

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Figure LI 29: Deaths within 6 months after removal among adult liver waitlist candidates, by age. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. Age is determined at removal.

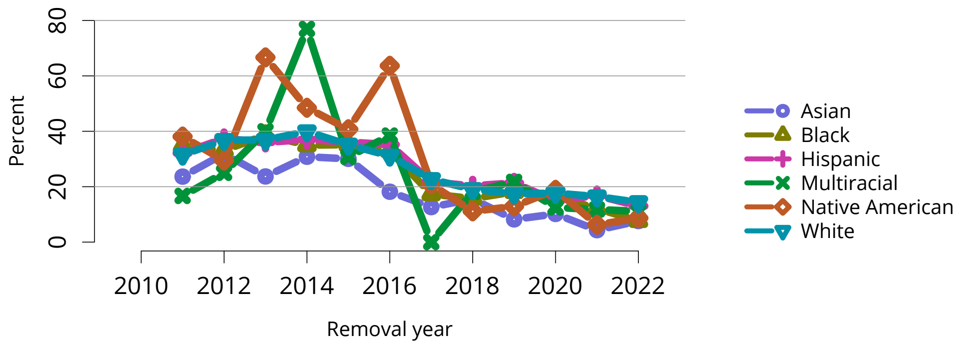

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Figure LI 30: Deaths within 6 months after removal among adult liver waitlist candidates by race and ethnicity. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

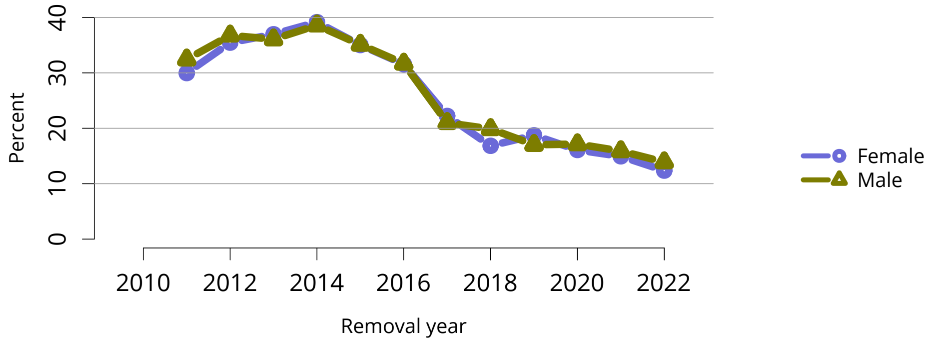

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Figure LI 31: Deaths within 6 months after removal among adult liver waitlist candidates, by sex. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

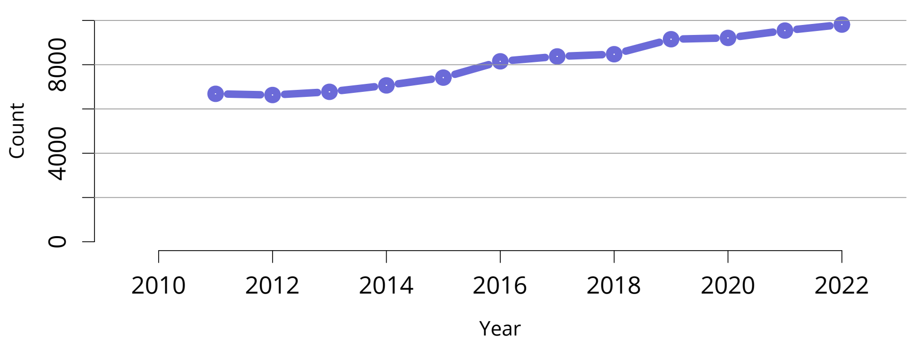

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Figure LI 32: Overall deceased liver donor count. Count of deceased donors whose livers were recovered for transplant.

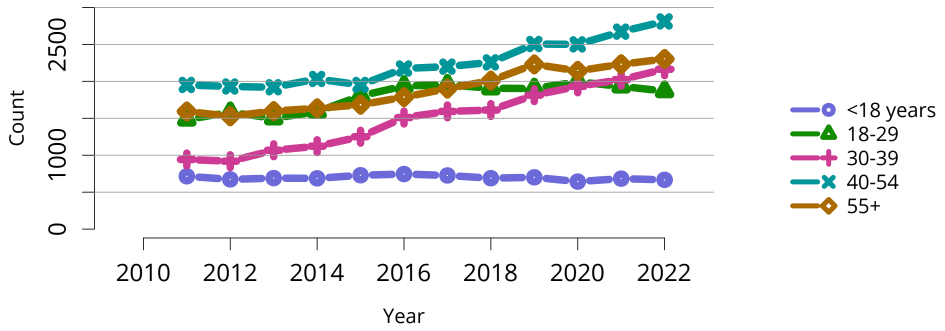

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Figure LI 33: Deceased liver donor count by age. Count of deceased donors whose livers were recovered for transplant.

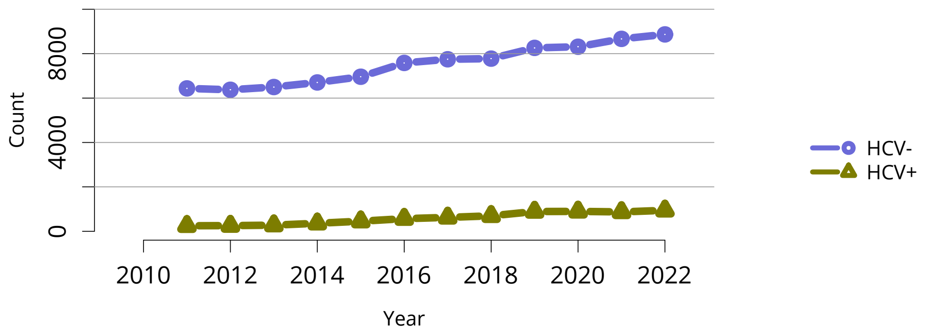

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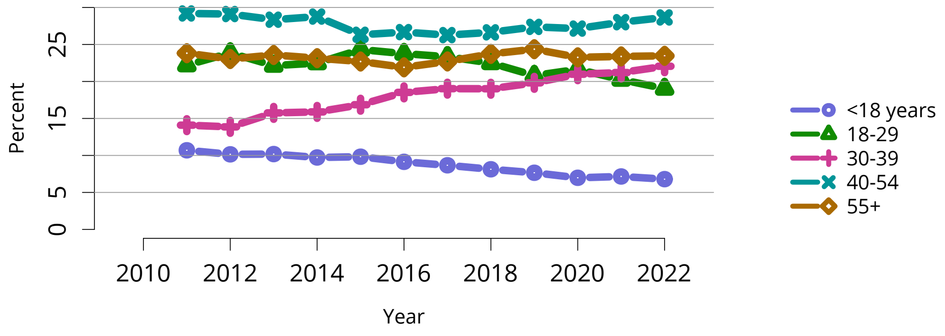
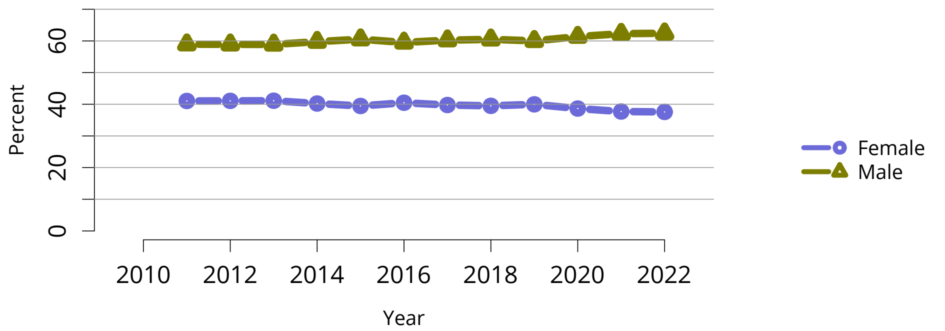
Figure LI 34: Deceased liver donor count by HCV status. Count of deceased donors whose livers were recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



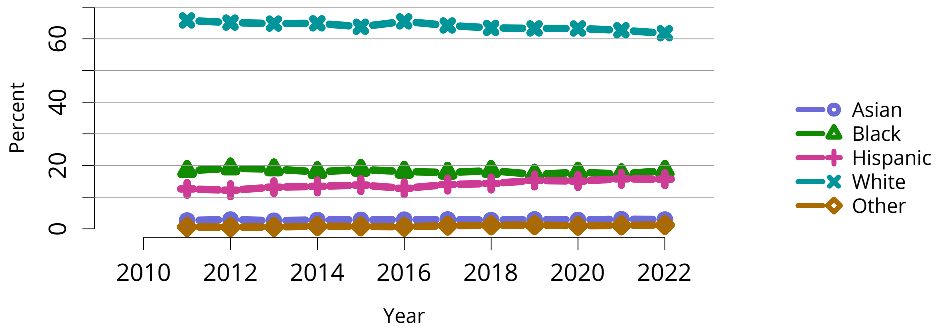
OPTN/SRTR 2022 Annual Data Report

Figure LI 35: Distribution of deceased liver donors by age. Deceased donors whose livers were recovered for transplant.



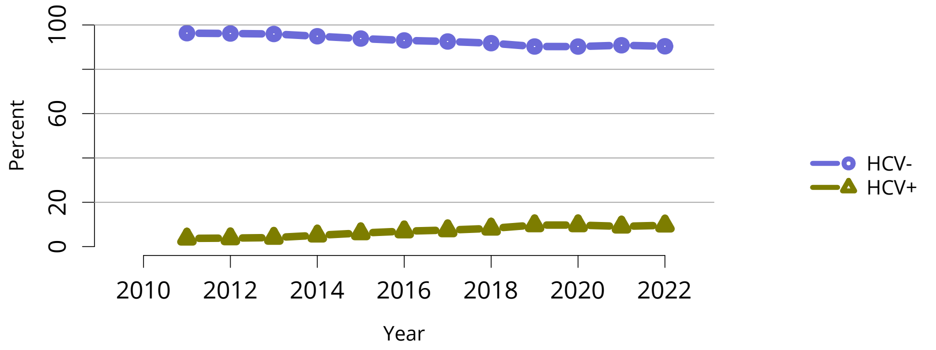
OPTN/SRTR 2022 Annual Data Report

Figure LI 36: Distribution of deceased liver donors by sex. Deceased donors whose livers were recovered for transplant.



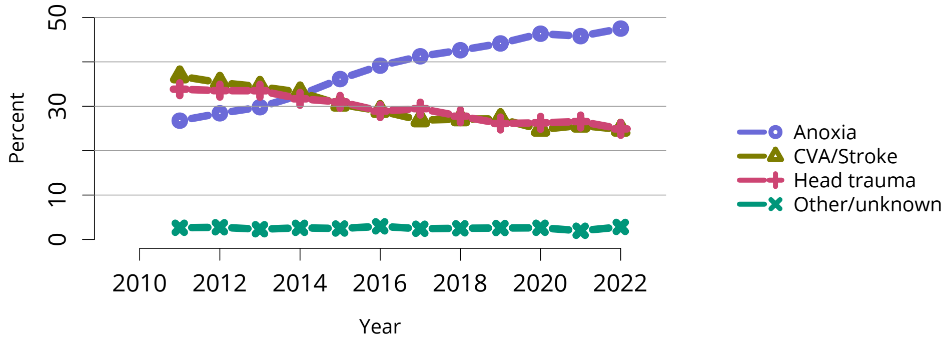
OPTN/SRTR 2022 Annual Data Report

Figure LI 37: Distribution of deceased liver donors by race and ethnicity. Deceased donors whose livers were recovered for transplant. The Other race category is composed of Native American and Multiracial categories.



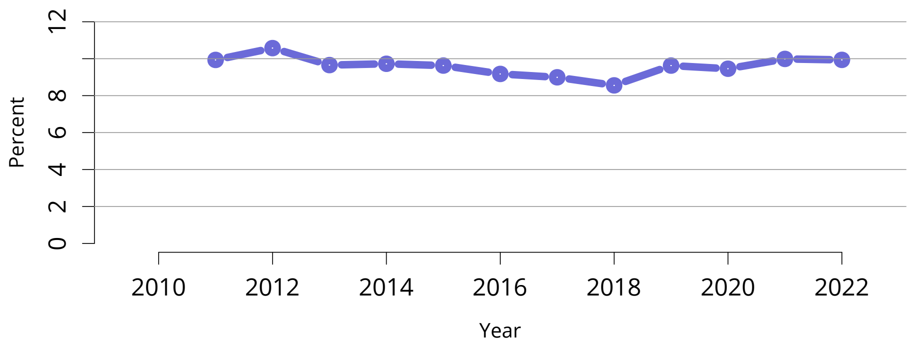
OPTN/SRTR 2022 Annual Data Report

Figure LI 38: Distribution of deceased liver donors by donor HCV status. Deceased donors whose livers were recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



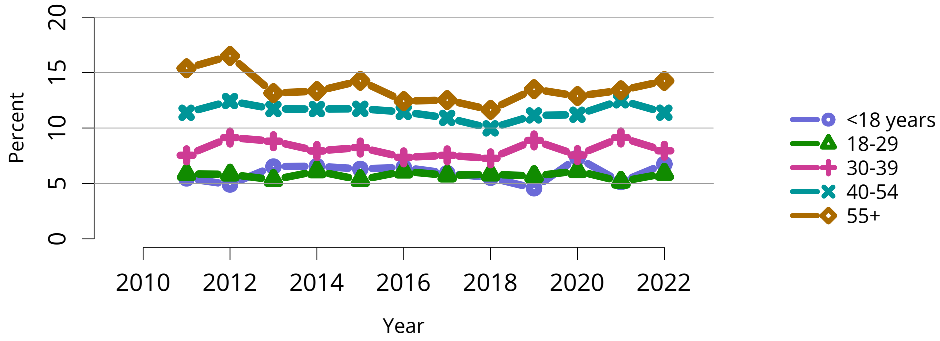
OPTN/SRTR 2022 Annual Data Report

Figure LI 39: Cause of death among deceased liver donors. Deceased donors with a liver recovered for the purposes of transplant. CVA, cerebrovascular accident.



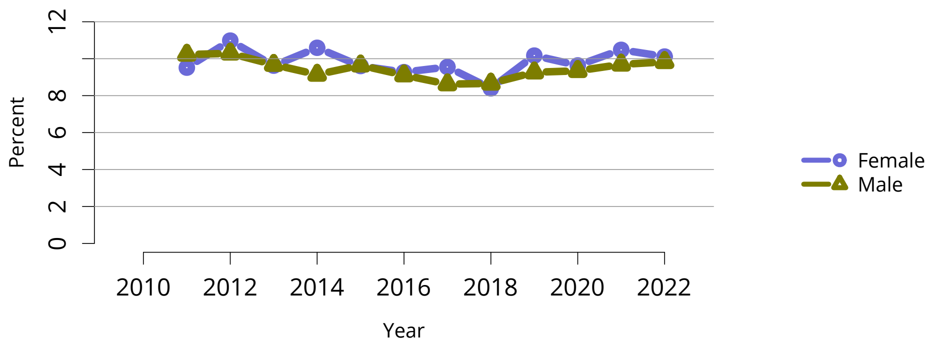
OPTN/SRTR 2022 Annual Data Report

Figure LI 40: Overall percent of livers recovered for transplant and not transplanted. Percentages of livers not transplanted out of all livers recovered for transplant.



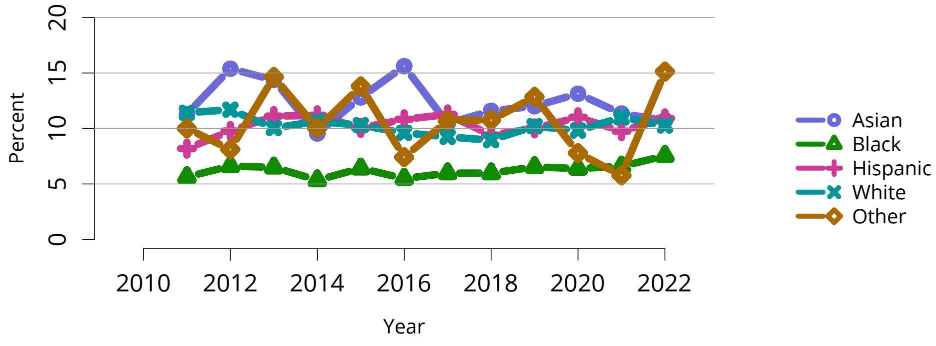
OPTN/SRTR 2022 Annual Data Report

Figure LI 41: Percent of livers recovered for transplant and not transplanted by donor age. Percentages of livers not transplanted out of all livers recovered for transplant.



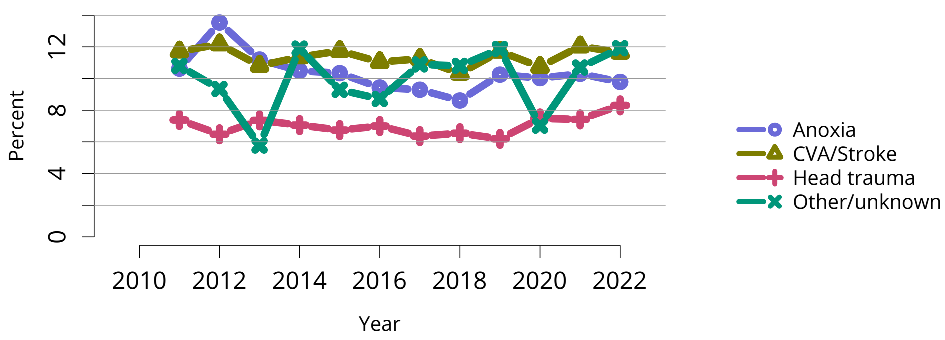
OPTN/SRTR 2022 Annual Data Report

Figure LI 42: Percent of livers recovered for transplant and not transplanted by donor sex. Percentages of livers not transplanted out of all livers recovered for transplant.



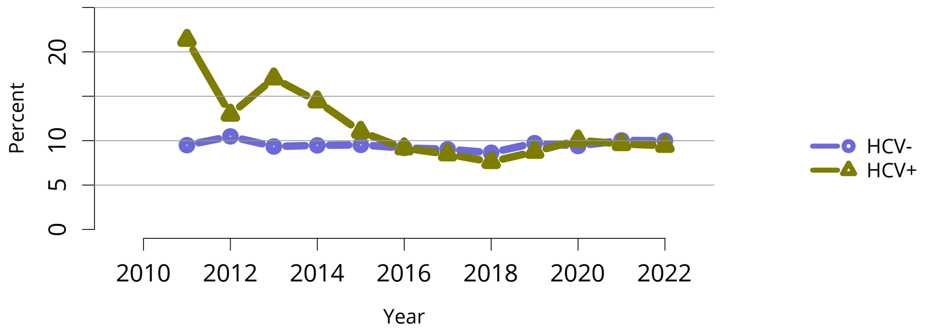
OPTN/SRTR 2022 Annual Data Report

Figure LI 43: Percent of livers recovered for transplant and not transplanted by donor race and ethnicity. Percentages of livers not transplanted out of all livers recovered for transplant. The Other race category is composed of Native American and Multiracial categories.



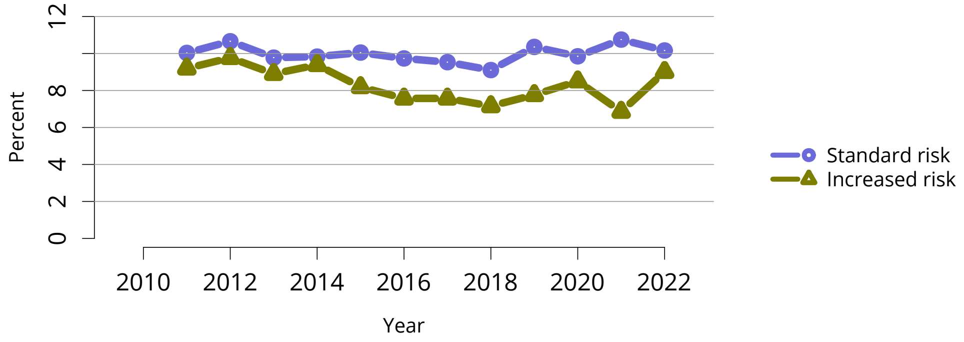
OPTN/SRTR 2022 Annual Data Report

Figure LI 44: Percent of livers recovered for transplant and not transplanted by donor cause of death. Percentages of livers not transplanted out of all livers recovered for transplant. CVA, cerebrovascular accident.



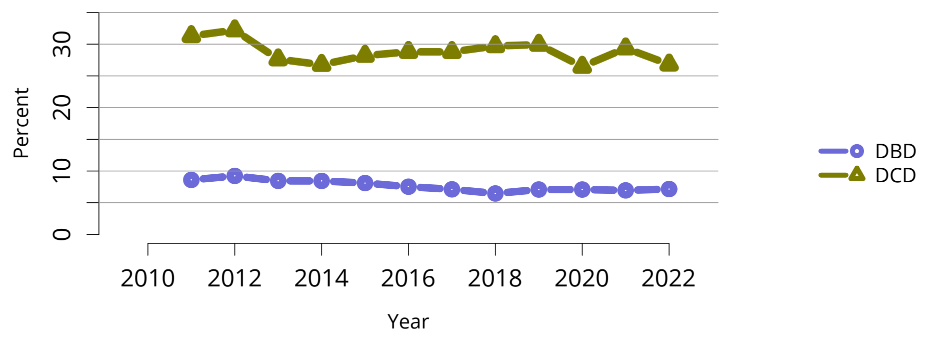
OPTN/SRTR 2022 Annual Data Report

Figure LI 45: Percent of livers recovered for transplant and not transplanted by donor HCV status. Percentages of livers not transplanted out of all livers recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



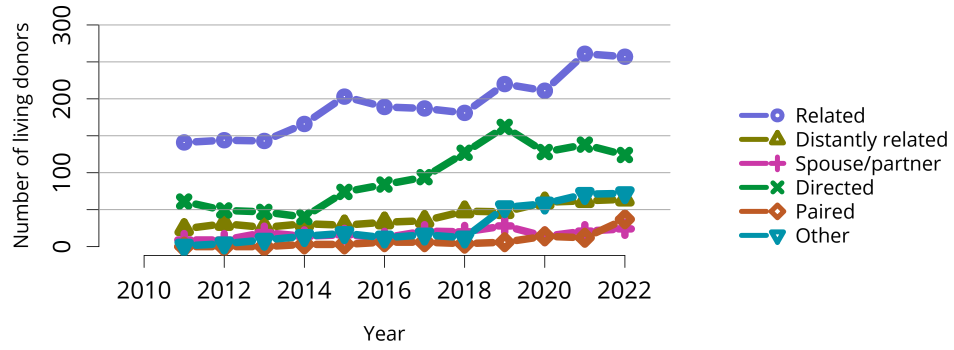
OPTN/SRTR 2022 Annual Data Report

Figure LI 46: Percent of livers recovered for transplant and not transplanted, by donor risk of disease transmission. Percentages of livers not transplanted out of all livers recovered for transplant. "Increased risk" is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B, and hepatitis C transmission.



OPTN/SRTR 2022 Annual Data Report

Figure LI 47: Percent of livers recovered for transplant and not transplanted by DCD status. Percentages of livers not transplanted out of all livers recovered for transplant. DBD, donation after brain death; DCD, donation after circulatory death.



OPTN/SRTR 2022 Annual Data Report

Figure LI 48: Number of living liver transplants by donor relation. Numbers of living donor donations, excluding domino livers, as reported on the OPTN Living Donor Registration Form.

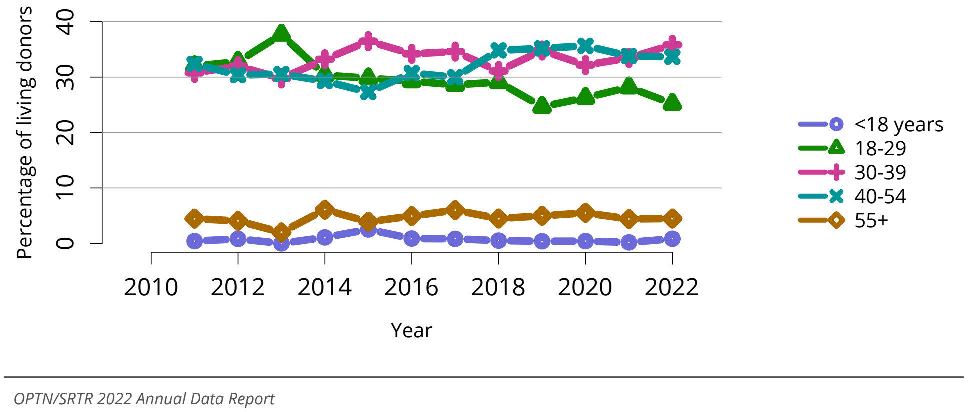


Figure LI 49: Living liver donors by age. As reported on the OPTN Living Donor Registration Form. Domino liver donors excluded.

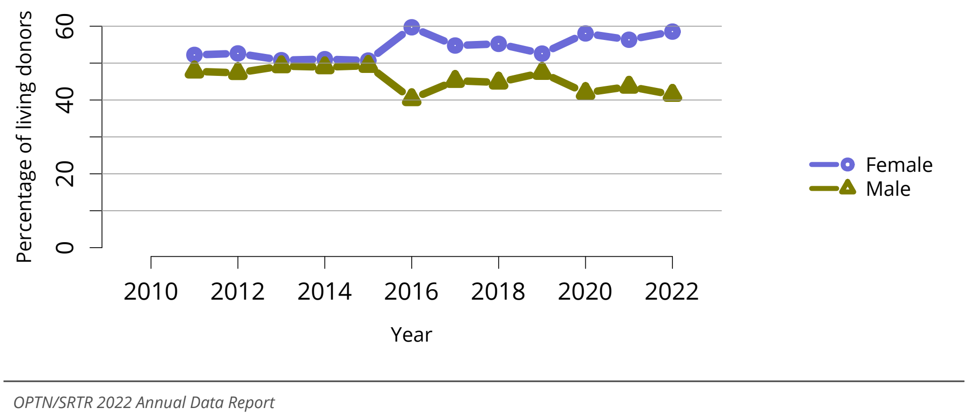
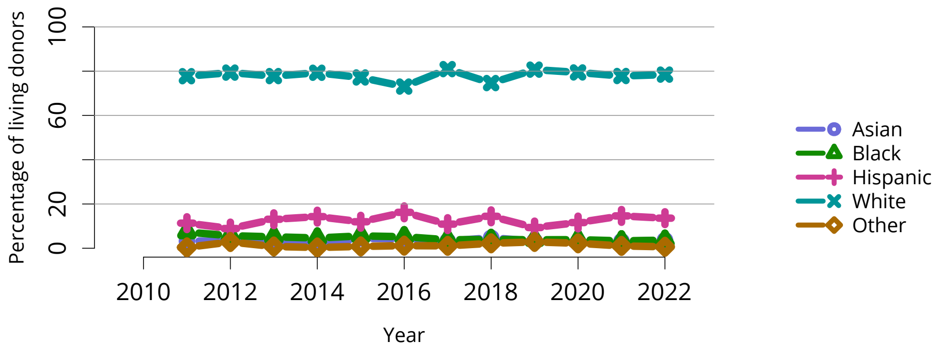
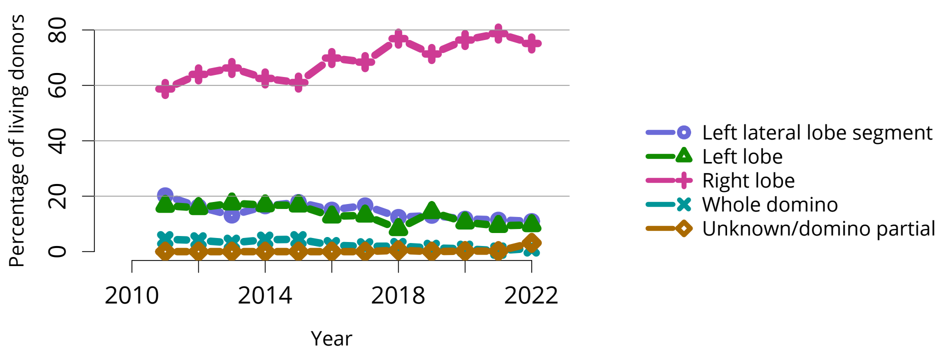


Figure LI 50: Living liver donors by sex. As reported on the OPTN Living Donor Registration Form. Domino liver donors excluded.



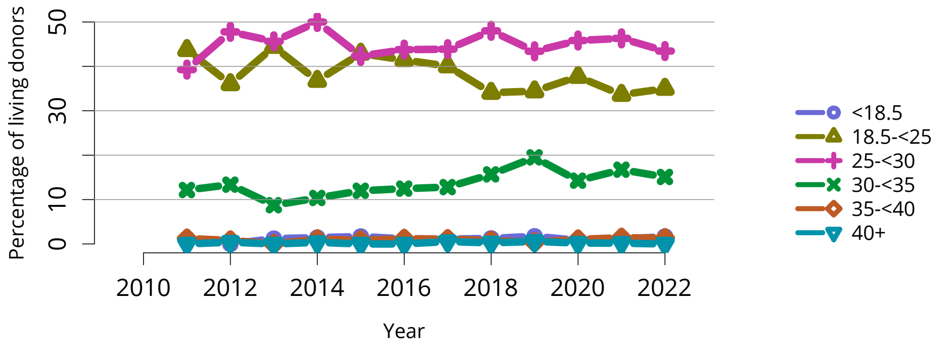
OPTN/SRTR 2022 Annual Data Report

Figure LI 51: Living liver donors by race and ethnicity. As reported on the OPTN Living Donor Registration Form. The Other race category is composed of Native American and Multiracial categories. Domino liver donors excluded.



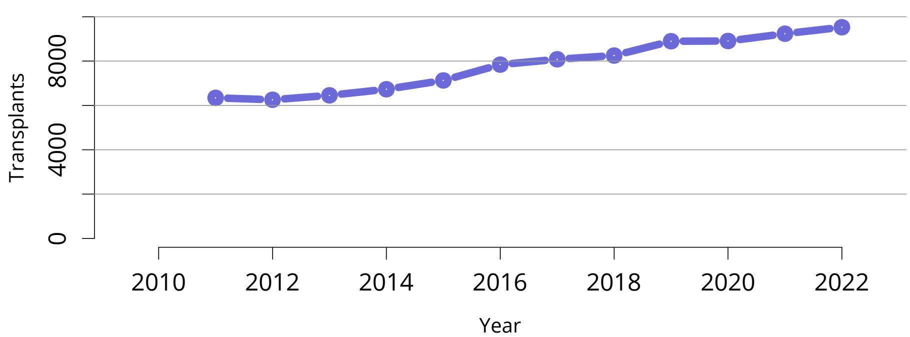
OPTN/SRTR 2022 Annual Data Report

Figure LI 52: Living donor liver transplant graft type. As reported on the OPTN Living Donor Registration Form.



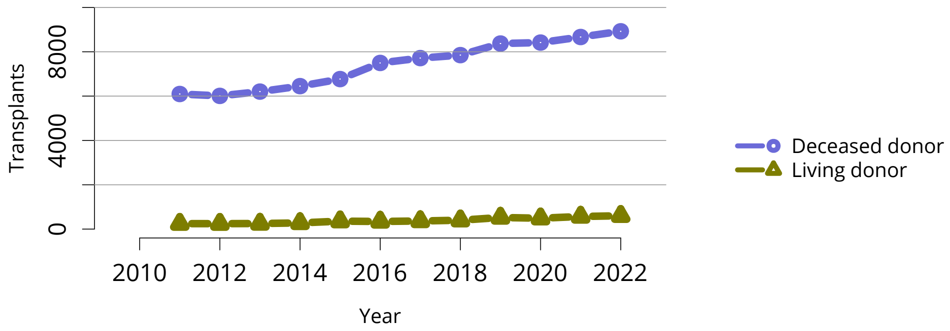
OPTN/SRTR 2022 Annual Data Report

Figure LI 53: BMI among living liver donors. Donor height and weight reported on the OPTN Living Donor Registration Form. Domino liver donors excluded. BMI, body mass index.



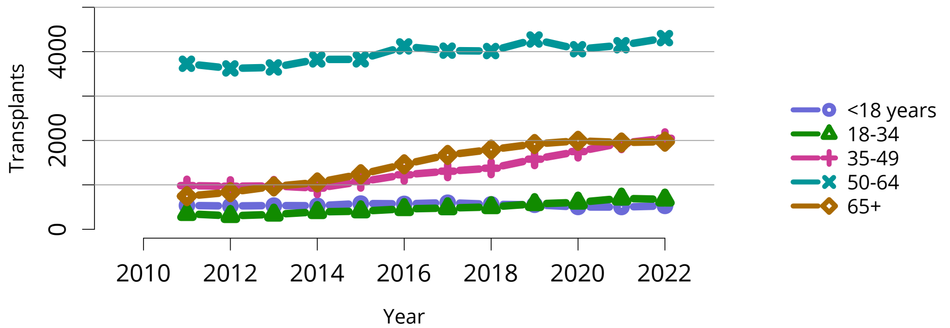
OPTN/SRTR 2022 Annual Data Report

Figure LI 54: Overall liver transplants. All liver transplant recipients, including adult and pediatric, re-transplant, and multiorgan recipients.



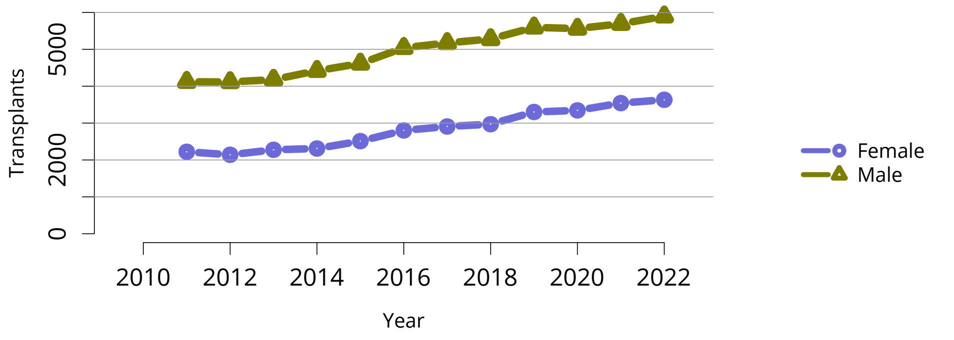
OPTN/SRTR 2022 Annual Data Report

Figure LI 55: Total liver transplants by donor type. All liver transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



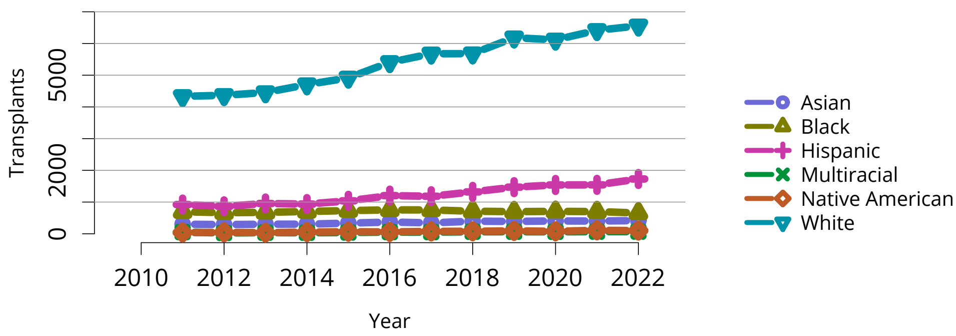
OPTN/SRTR 2022 Annual Data Report

Figure LI 56: Total liver transplants by age. All liver transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



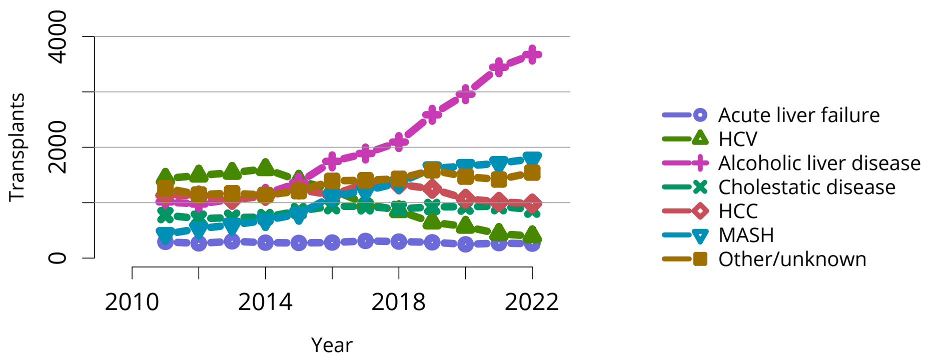
OPTN/SRTR 2022 Annual Data Report

Figure LI 57: Total liver transplants by sex. All liver transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



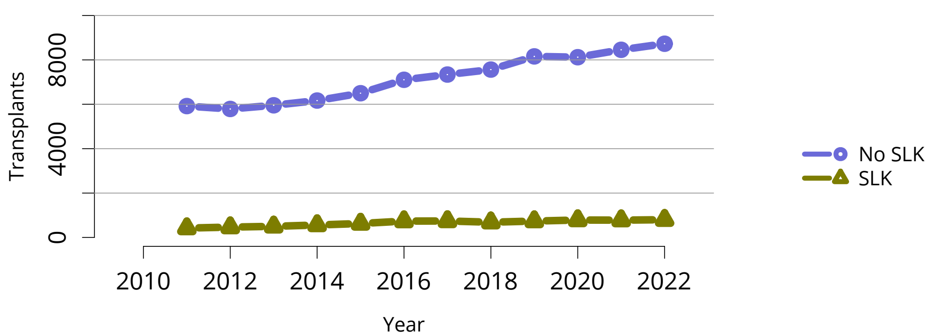
OPTN/SRTR 2022 Annual Data Report

Figure LI 58: Total liver transplants by race and ethnicity. All liver transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LI 59: Total liver transplants by diagnosis. All liver transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.



OPTN/SRTR 2022 Annual Data Report

Figure LI 60: Total liver transplants by SLK. All liver transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. SLK transplants are in recipients with a liver and kidney transplant from the same donor. SLK, simultaneous liver-kidney.

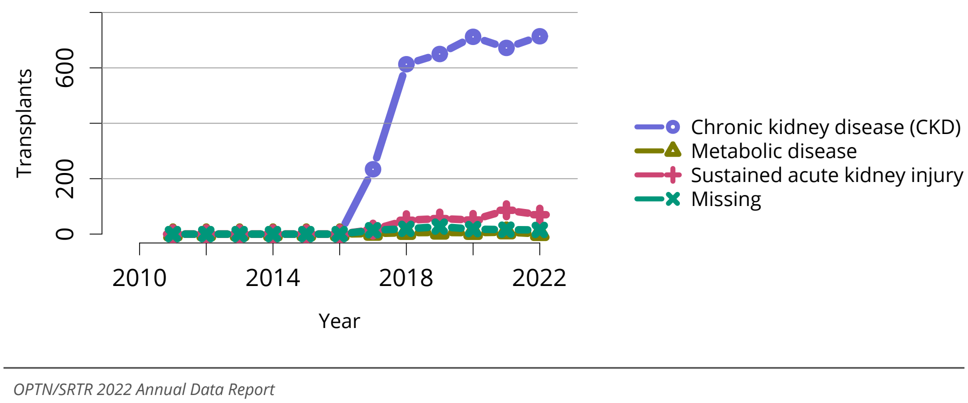


Figure LI 61: Total SLK transplants by SLK diagnosis. All SLK transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. SLK transplants are in recipients with a liver and kidney transplant from the same donor. SLK, simultaneous liver-kidney.

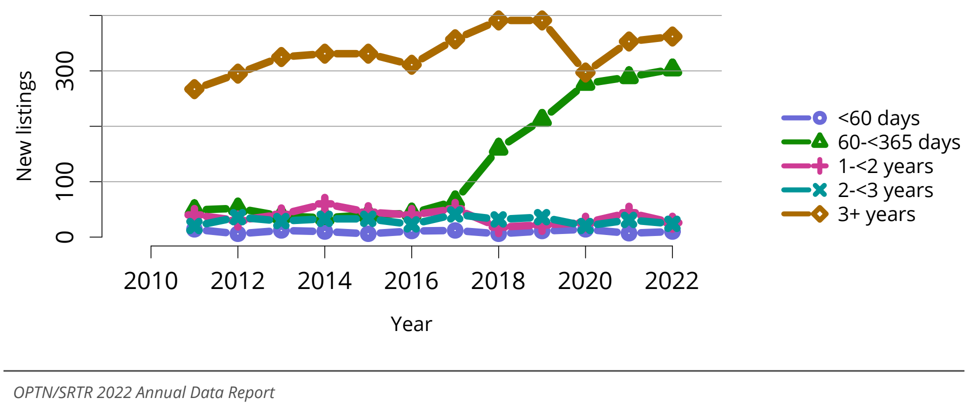
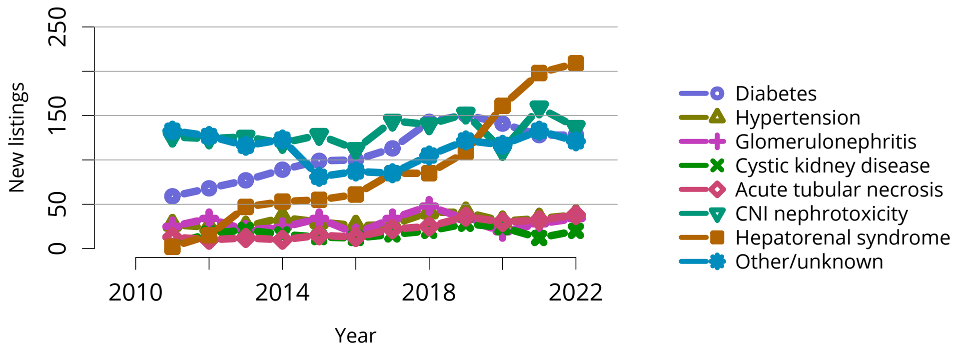
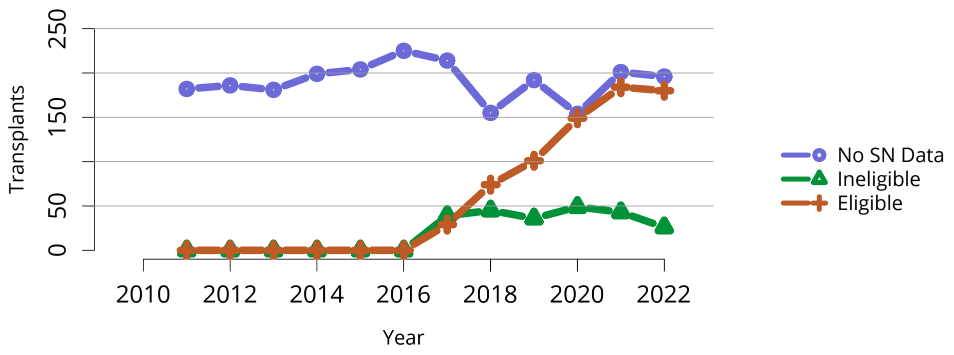


Figure LI 62: New candidates added to the kidney transplant waiting list after liver transplant by time to kidney listing from liver transplant. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure LI 63: New candidates added to the kidney transplant waiting list after liver transplant by diagnosis. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included. CNI, calcineurin inhibitor.



OPTN/SRTR 2022 Annual Data Report

Figure LI 64: Total kidney transplants by SLK safety net eligibility. All kidney transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. SLK transplants are in recipients with a liver and kidney transplant from the same donor. SLK, simultaneous liver-kidney; SN, safety net.

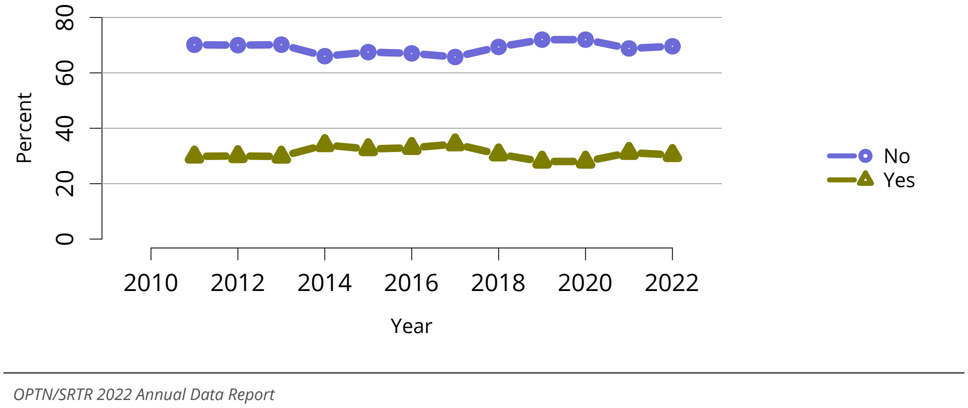


Figure LI 65: Induction agent use in adult liver transplant recipients. Immunosuppression at transplant reported to the OPTN.

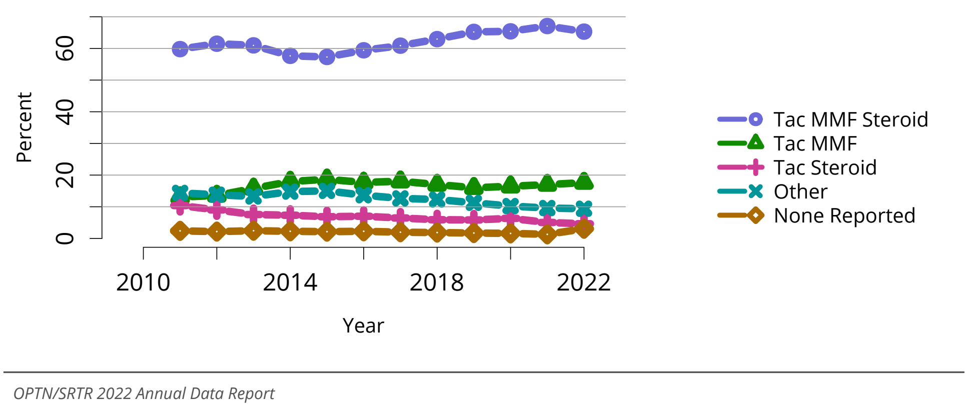
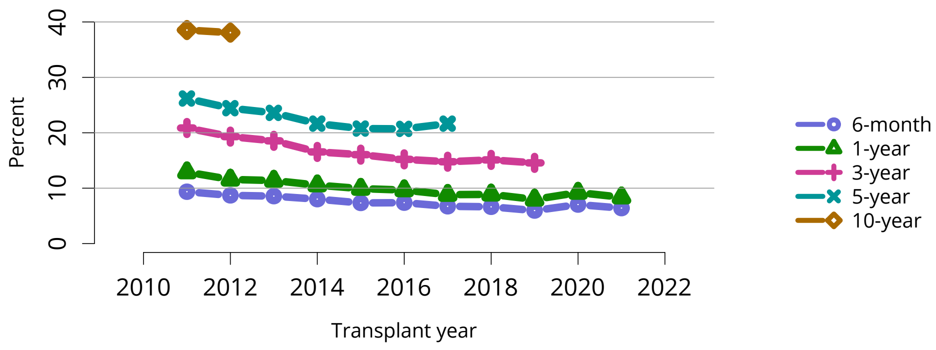
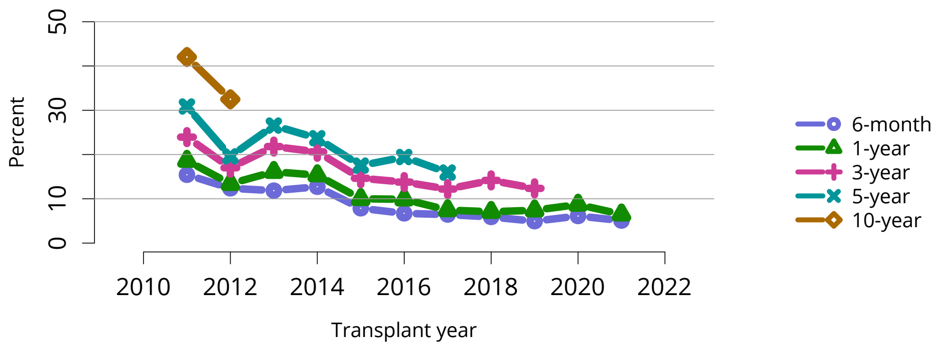


Figure LI 66: Immunosuppression regimen use in adult liver transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



OPTN/SRTR 2022 Annual Data Report

Figure LI 67: Graft failure among adult deceased donor liver transplant recipients. All adult recipients of deceased donor livers, including multiorgan transplant recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LI 68: Graft failure among adult living donor liver transplant recipients. All adult recipients of living donor livers, including multiorgan transplant recipients.

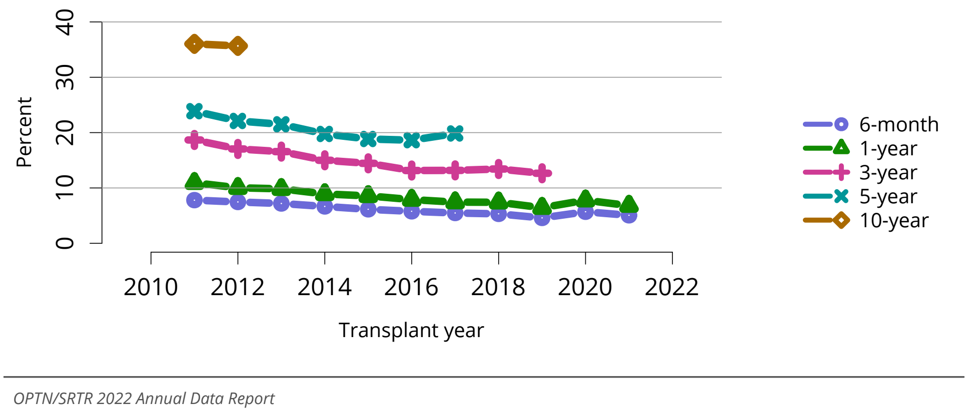


Figure LI 69: Patient death among adult liver transplant recipients. All adult recipients of deceased donor livers, including multiorgan transplant recipients.

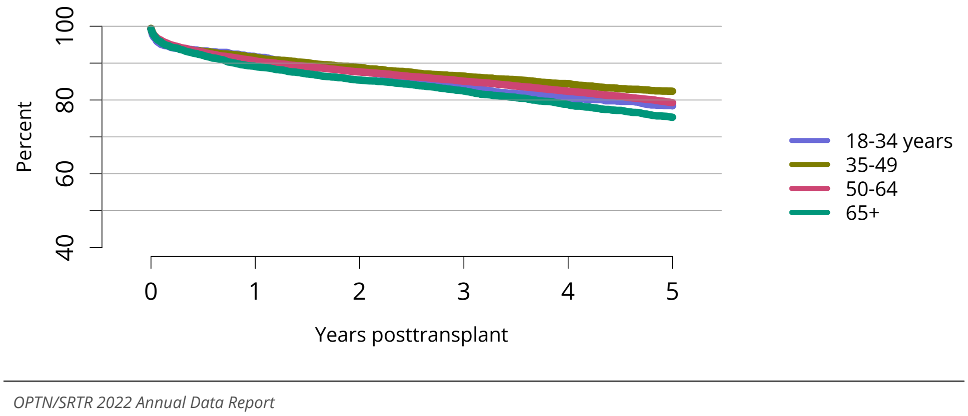
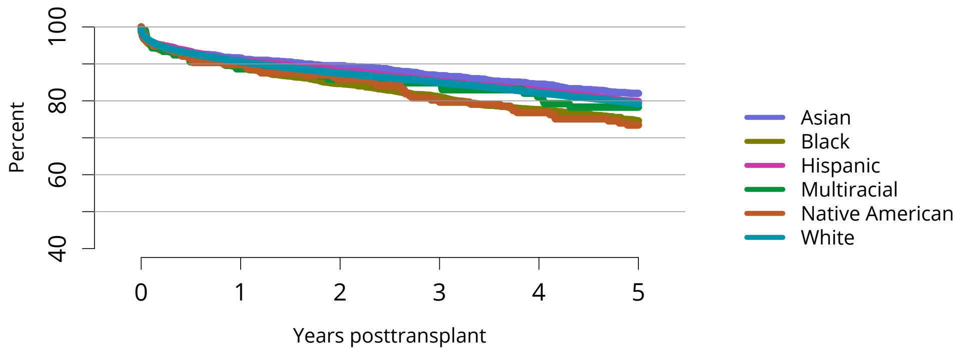
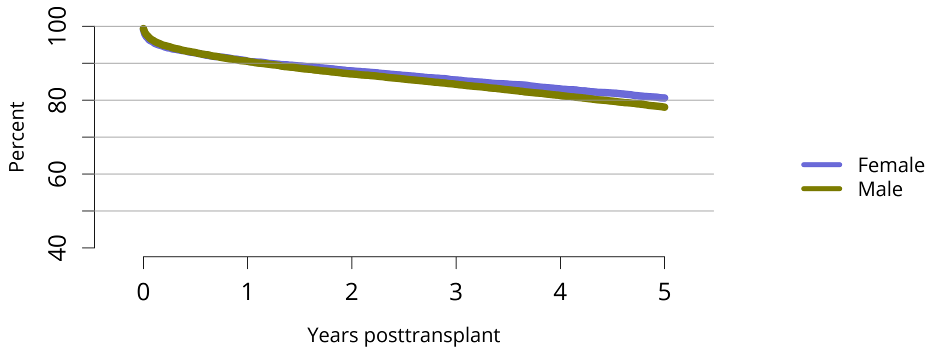


Figure LI 70: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by age. Graft survival estimated using unadjusted Kaplan-Meier methods.



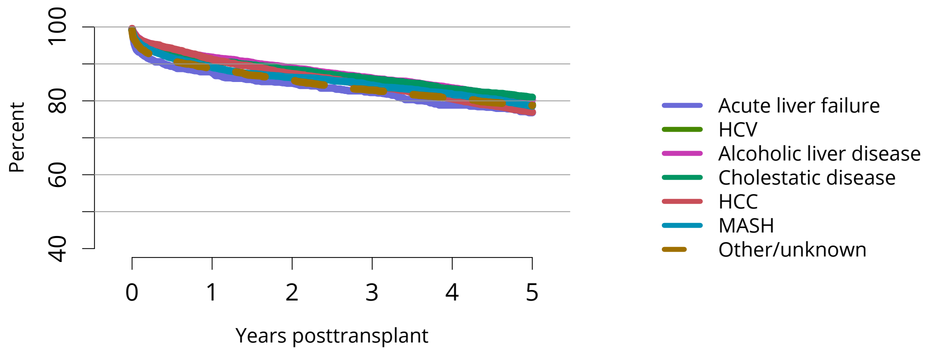
OPTN/SRTR 2022 Annual Data Report

Figure LI 71: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by race and ethnicity. Graft survival estimated using unadjusted Kaplan-Meier methods.



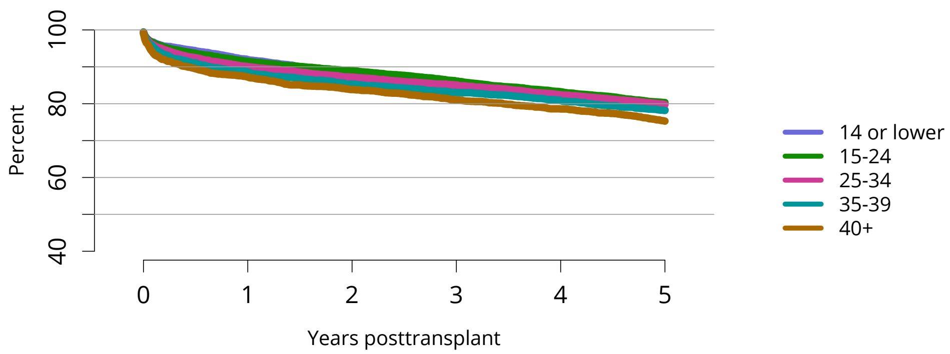
OPTN/SRTR 2022 Annual Data Report

Figure LI 72: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by sex. Graft survival estimated using unadjusted Kaplan-Meier methods.



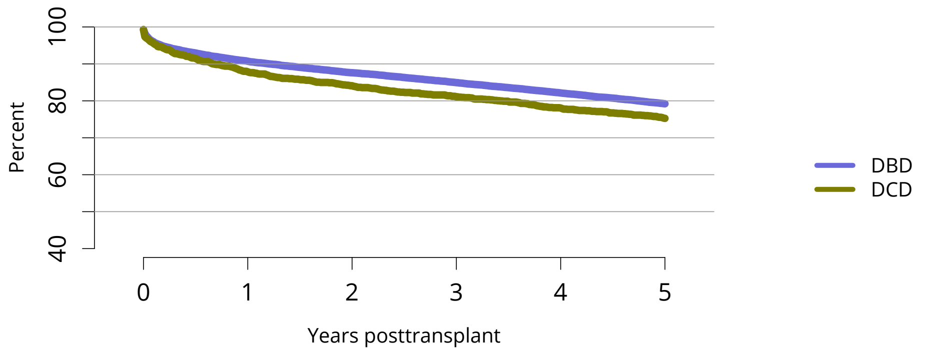
OPTN/SRTR 2022 Annual Data Report

Figure LI 73: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.



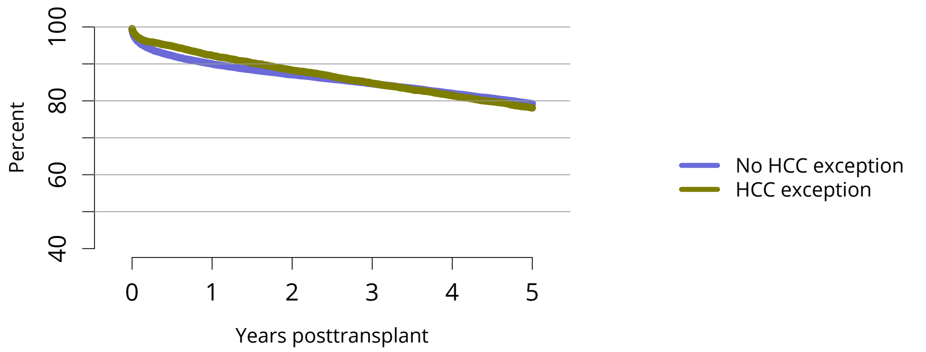
OPTN/SRTR 2022 Annual Data Report

Figure LI 74: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by laboratory MELD score. Graft survival estimated using unadjusted Kaplan-Meier methods. MELD, model for end-stage liver disease.



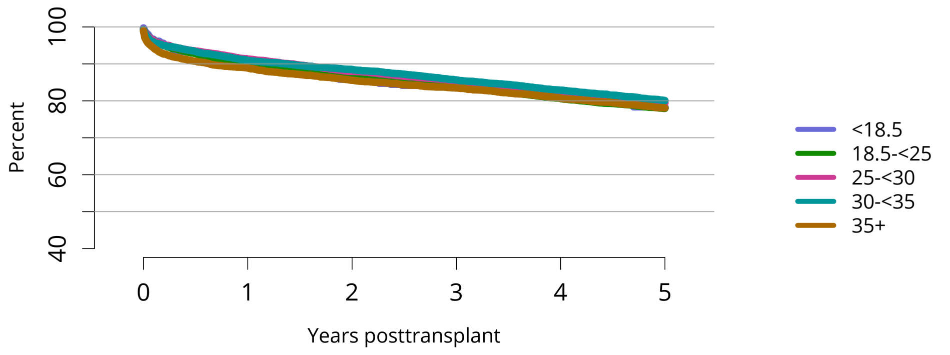
OPTN/SRTR 2022 Annual Data Report

Figure LI 75: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by DCD status. Graft survival estimated using unadjusted Kaplan-Meier methods. DBD, donation after brain death; DCD, donation after circulatory death.



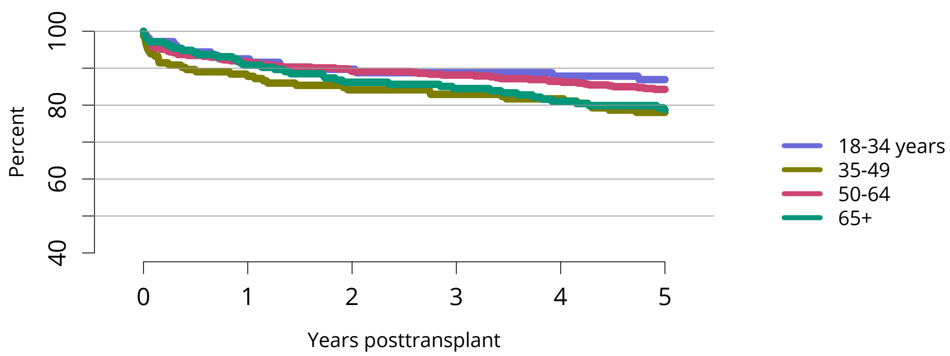
OPTN/SRTR 2022 Annual Data Report

Figure LI 76: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by HCC status. Graft survival estimated using unadjusted Kaplan-Meier methods. HCC, hepatocellular carcinoma.



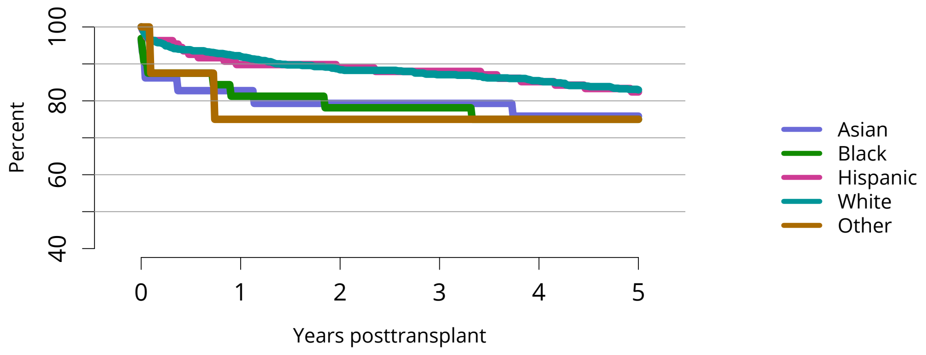
OPTN/SRTR 2022 Annual Data Report

Figure LI 77: Graft survival among adult deceased donor liver transplant recipients, 2015-2017, by BMI. Graft survival estimated using unadjusted Kaplan-Meier methods. BMI, body mass index.



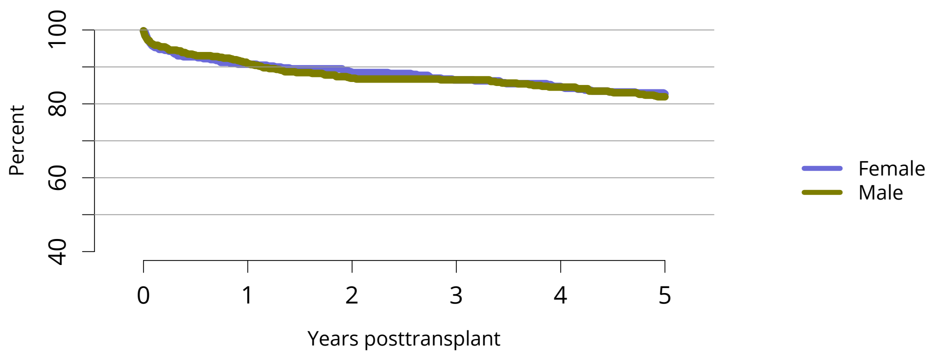
OPTN/SRTR 2022 Annual Data Report

Figure LI 78: Graft survival among adult living donor liver transplant recipients, 2015-2017, by age. Graft survival estimated using unadjusted Kaplan-Meier methods.



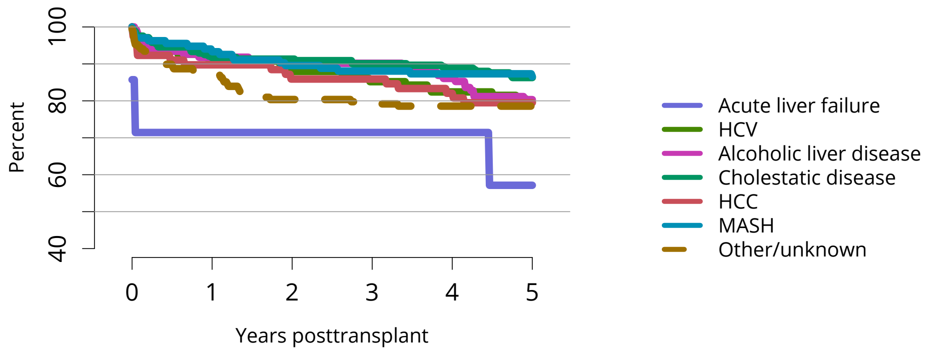
OPTN/SRTR 2022 Annual Data Report

Figure LI 79: Graft survival among adult living donor liver transplant recipients, 2015-2017, by race and ethnicity. Graft survival estimated using unadjusted Kaplan-Meier methods. The Other race category is composed of Native American and Multiracial categories.



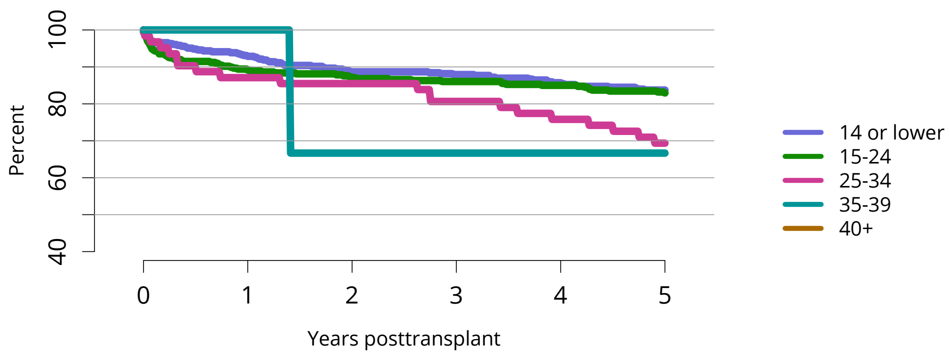
OPTN/SRTR 2022 Annual Data Report

Figure LI 80: Graft survival among adult living donor liver transplant recipients, 2015-2017, by sex. Graft survival estimated using unadjusted Kaplan-Meier methods.



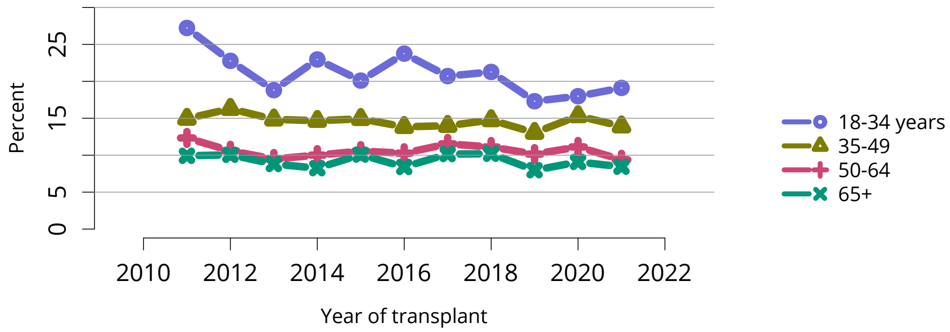
OPTN/SRTR 2022 Annual Data Report

Figure LI 81: Graft survival among adult living donor liver transplant recipients, 2015-2017, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.



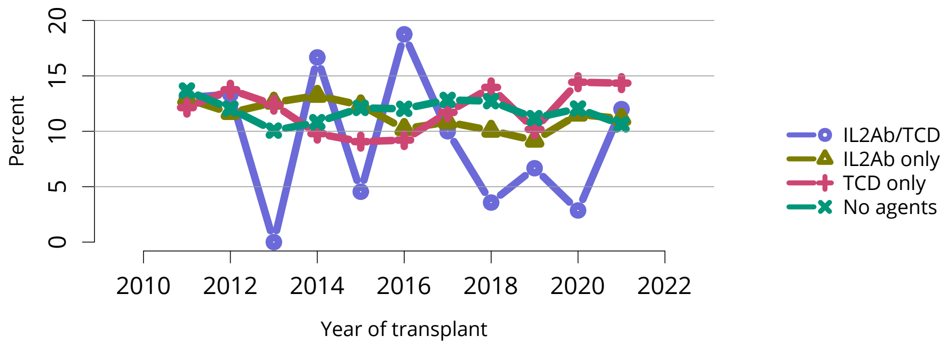
OPTN/SRTR 2022 Annual Data Report

Figure LI 82: Graft survival among adult living donor liver transplant recipients, 2015-2017, by laboratory MELD score. Graft survival estimated using unadjusted Kaplan-Meier methods. MELD, model for end-stage liver disease.



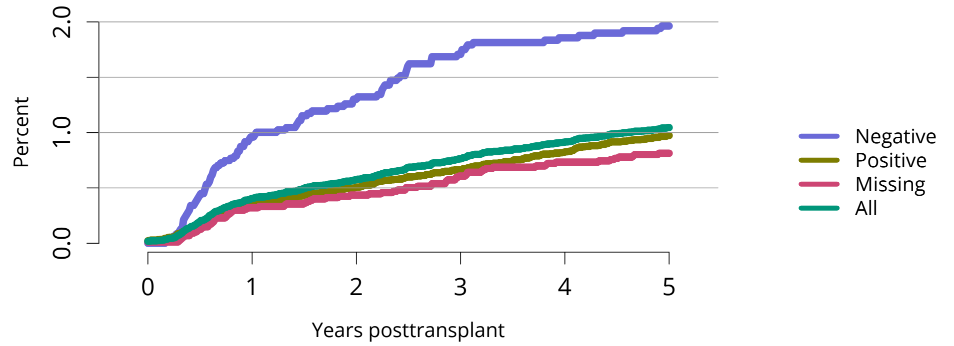
OPTN/SRTR 2022 Annual Data Report

Figure LI 83: Incidence of acute rejection by 1 year posttransplant among adult liver transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



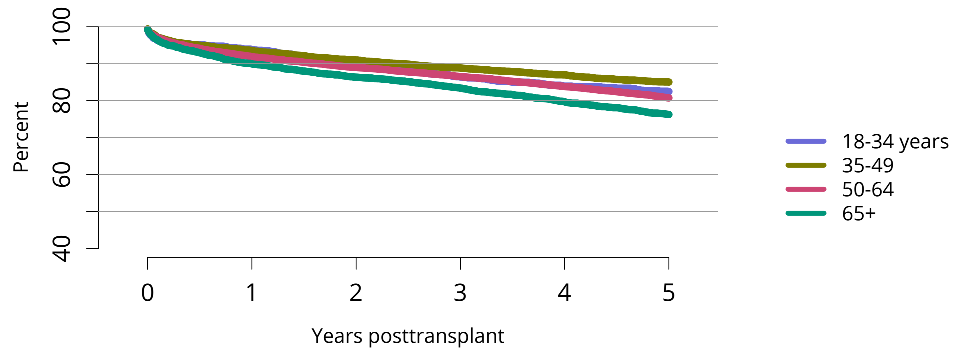
OPTN/SRTR 2022 Annual Data Report

Figure LI 84: Incidence of acute rejection by 1 year posttransplant among adult liver transplant recipients by induction agent. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method. IL2Ab, interleukin-2 receptor antibody; TCD, T-cell depleting.



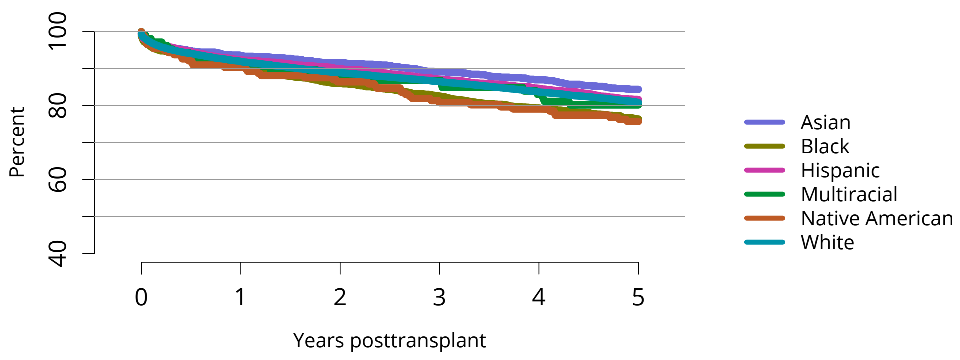
OPTN/SRTR 2022 Annual Data Report

Figure LI 85: Incidence of PTLD among adult liver transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



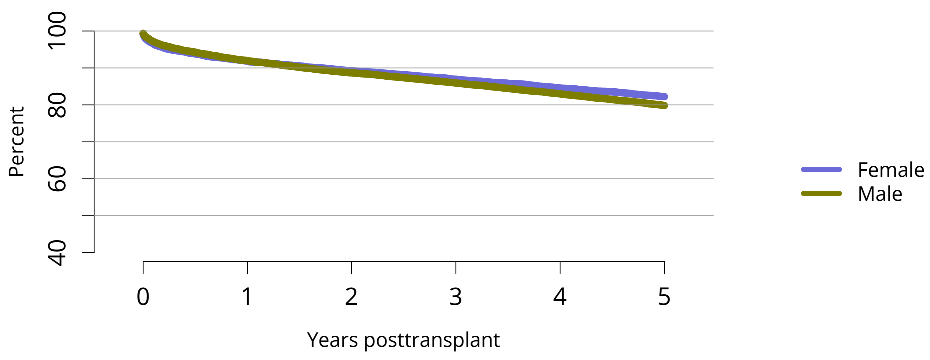
OPTN/SRTR 2022 Annual Data Report

Figure LI 86: Patient survival among adult deceased donor liver transplant recipients, 2015-2017, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.



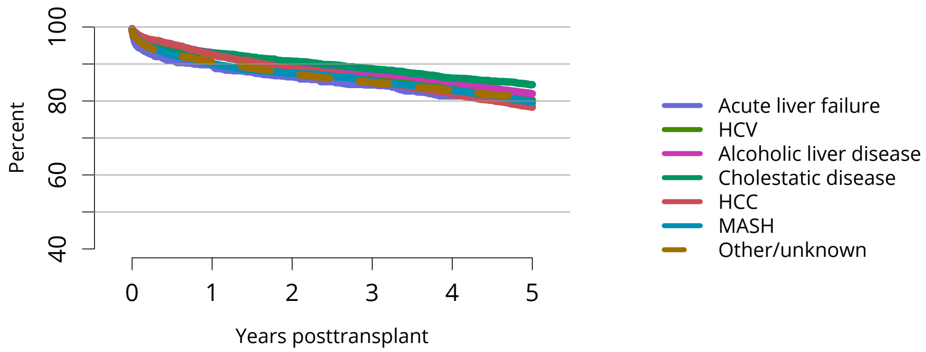
OPTN/SRTR 2022 Annual Data Report

Figure LI 87: Patient survival among adult deceased donor liver transplant recipients, 2015-2017, by race and ethnicity. Patient survival estimated using unadjusted Kaplan-Meier methods.



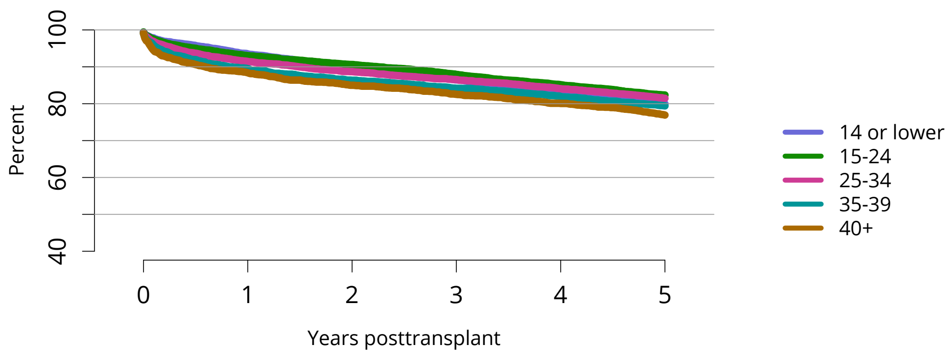
OPTN/SRTR 2022 Annual Data Report

Figure LI 88: Patient survival among adult deceased donor liver transplant recipients, 2015-2017, by sex. Patient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure LI 89: Patient survival among adult deceased donor liver transplant recipients, 2015-2017, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.



OPTN/SRTR 2022 Annual Data Report

Figure LI 90: Patient survival among adult deceased donor liver transplant recipients, 2015-2017, by laboratory MELD score. Patient survival estimated using unadjusted Kaplan-Meier methods. MELD, model for end-stage liver disease.

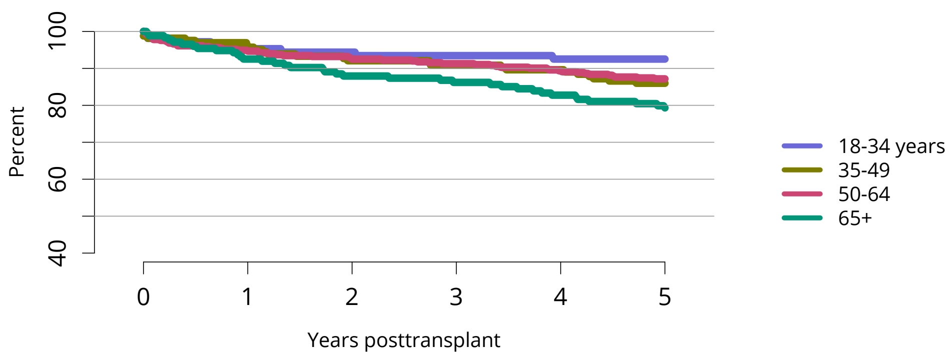


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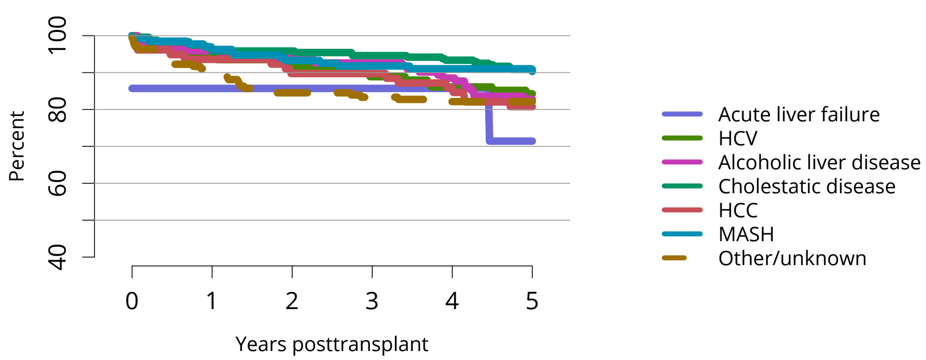
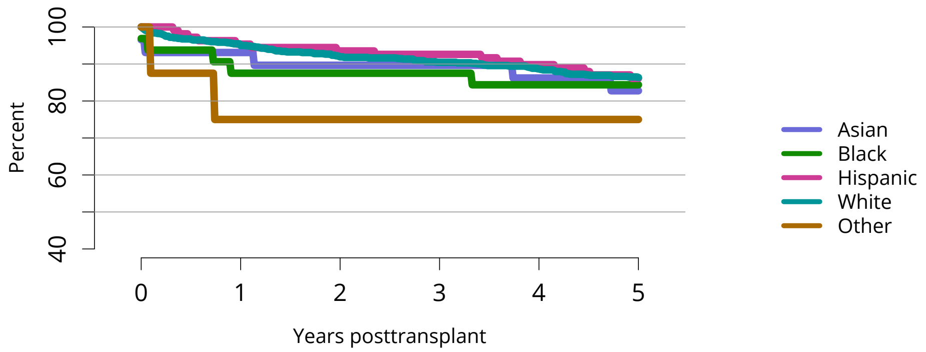
Figure LI 91: Patient survival among adult living donor liver transplant recipients, 2015-2017, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.



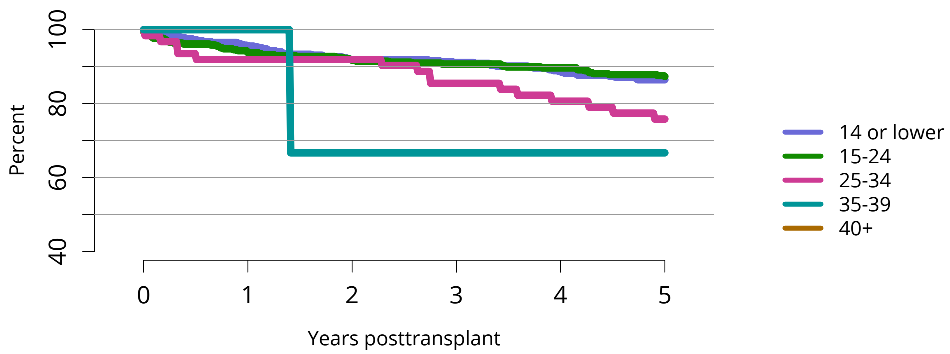
OPTN/SRTR 2022 Annual Data Report

Figure LI 92: Patient survival among adult living donor liver transplant recipients, 2015-2017, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.



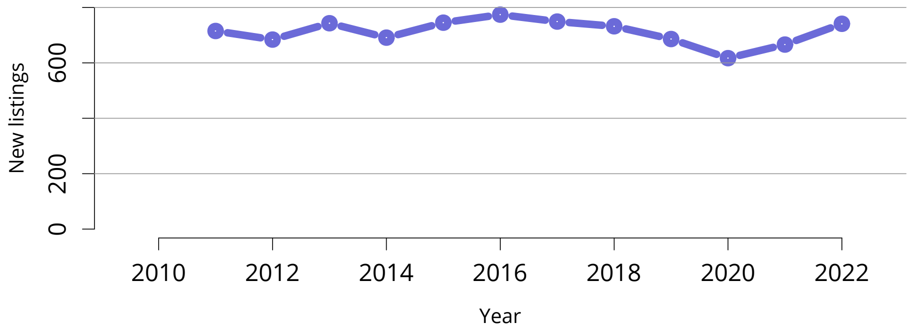
OPTN/SRTR 2022 Annual Data Report

Figure LI 93: Patient survival among adult living donor liver transplant recipients, 2015-2017, by race and ethnicity. Patient survival estimated using unadjusted Kaplan-Meier methods. The Other race category is composed of Native American and Multiracial categories.



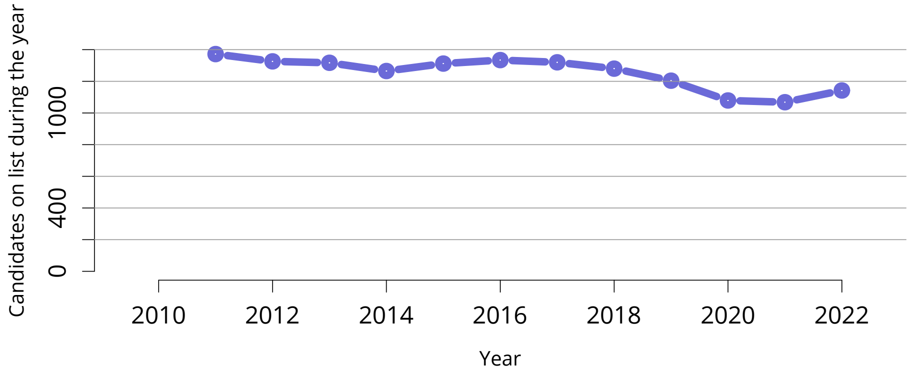
OPTN/SRTR 2022 Annual Data Report

Figure LI 94: Patient survival among adult living donor liver transplant recipients, 2015-2017, by laboratory MELD score. Patient survival estimated using unadjusted Kaplan-Meier methods. MELD, model for end-stage liver disease.



OPTN/SRTR 2022 Annual Data Report

Figure LI 95: New pediatric candidates added to the liver transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure LI 96: All pediatric candidates on the liver transplant waiting list. Pediatric candidates listed at any time during the year. Candidates listed at more than one center are counted once per listing.

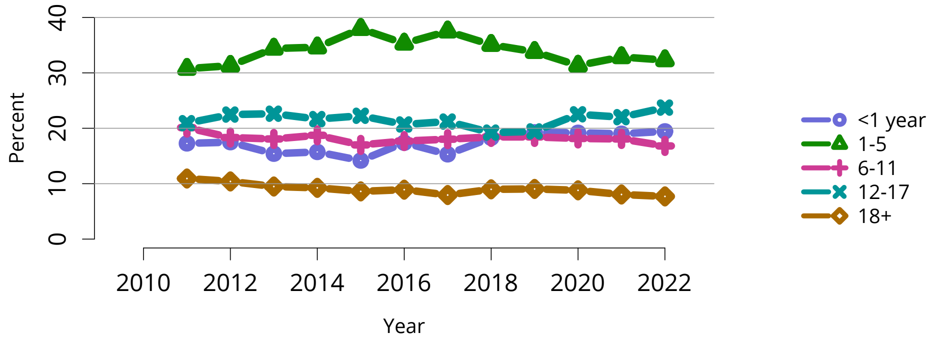


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Figure LI 97: Distribution of pediatric candidates waiting for liver transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.

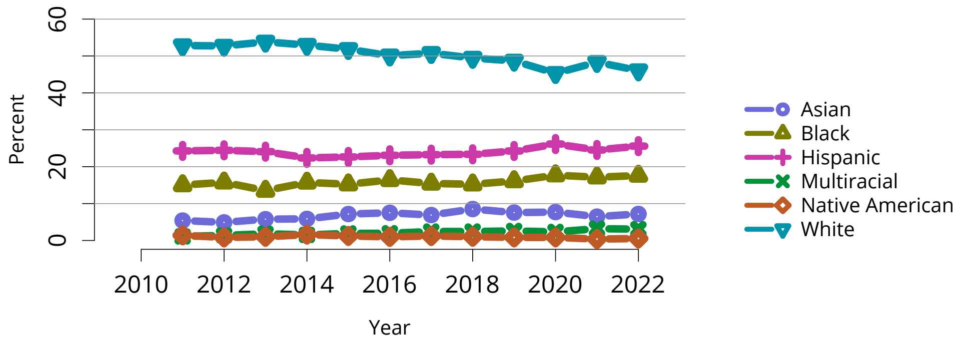

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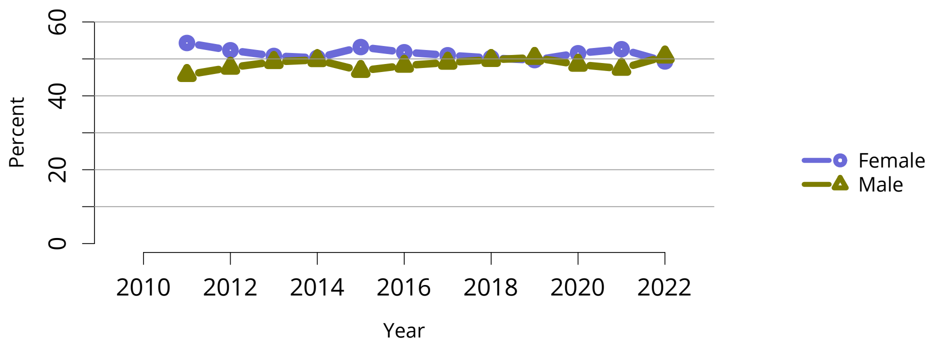
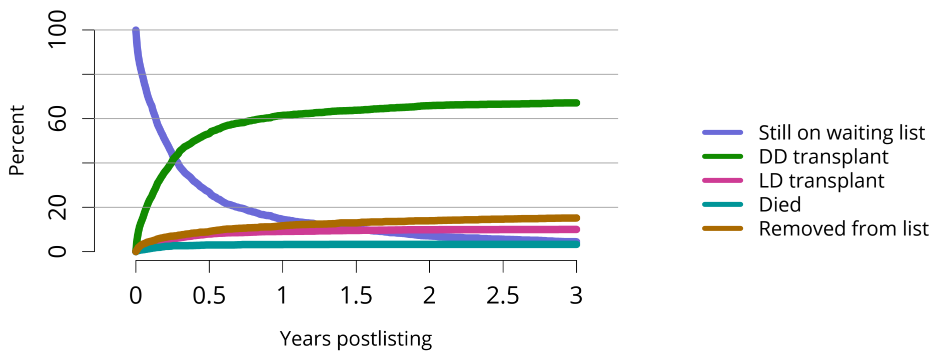
Figure LI 98: Distribution of pediatric candidates waiting for liver transplant by race and ethnicity. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included.



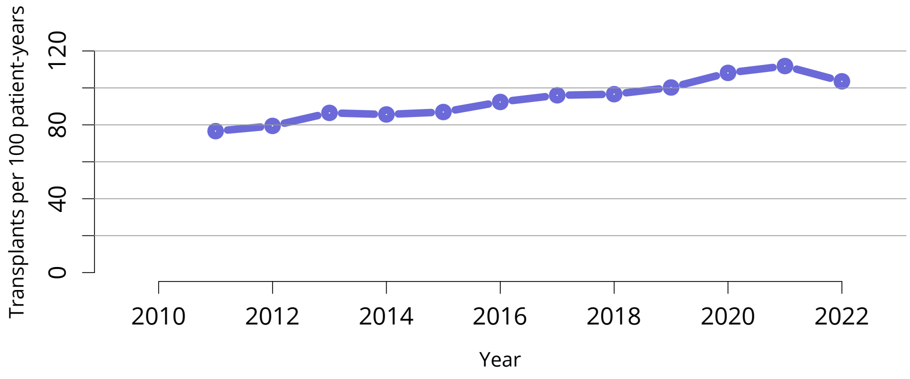
OPTN/SRTR 2022 Annual Data Report

Figure LI 99: Distribution of pediatric candidates waiting for liver transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure LI 100: Three-year outcomes for newly listed pediatric candidates waiting for liver transplant, 2017-2019. Pediatric candidates who joined the waiting list in 2017-2019. Candidates listed at more than one center are counted once per listing. DD, deceased donor; LD, living donor.



OPTN/SRTR 2022 Annual Data Report

Figure LI 101: Overall deceased donor liver transplant rates among pediatric waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

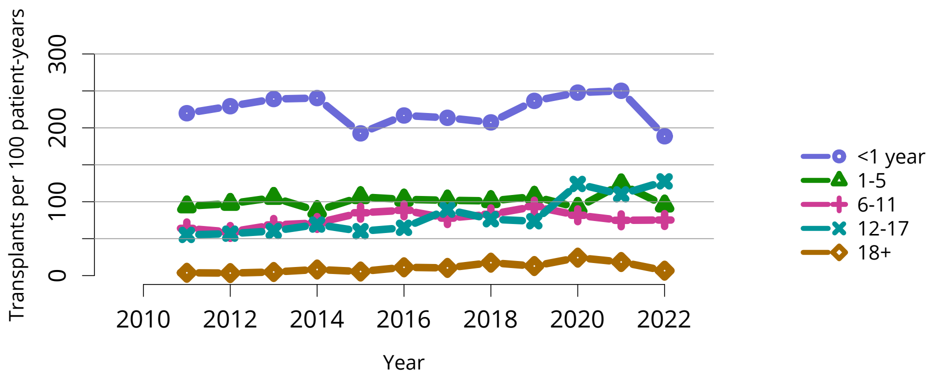


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Figure LI 102: Deceased donor liver transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

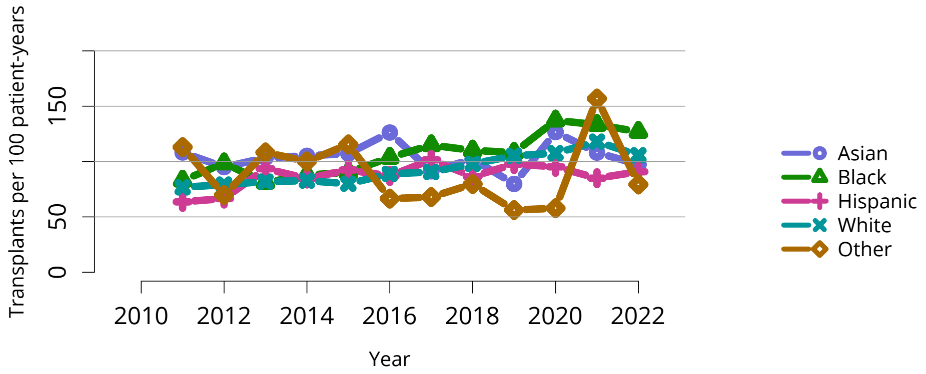

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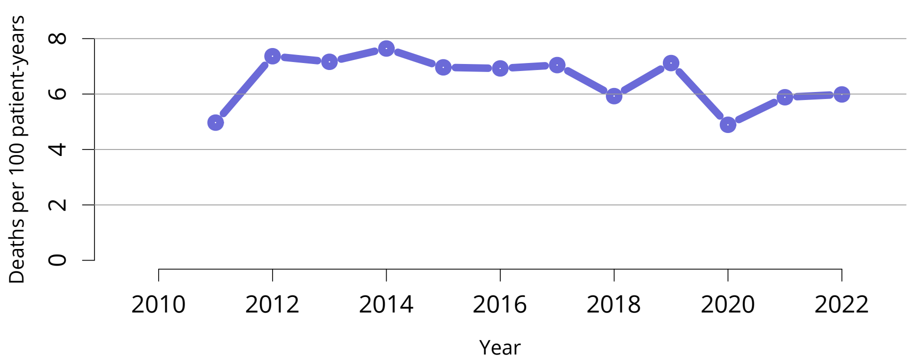
Figure LI 103: Deceased donor liver transplant rates among pediatric waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure LI 104: Overall pretransplant mortality rates among pediatric candidates waitlisted for liver. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

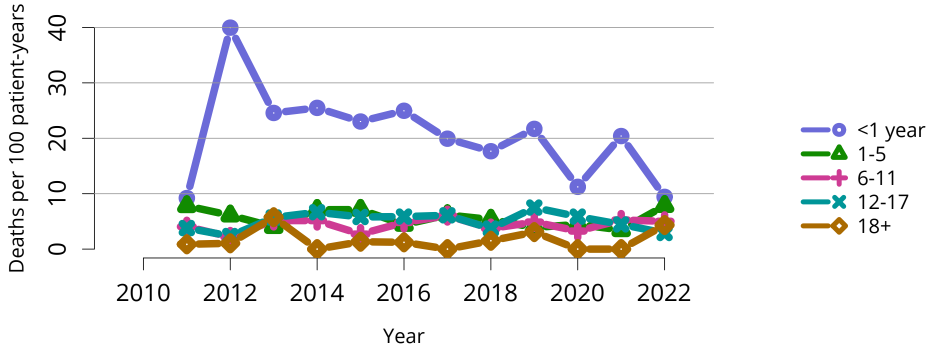


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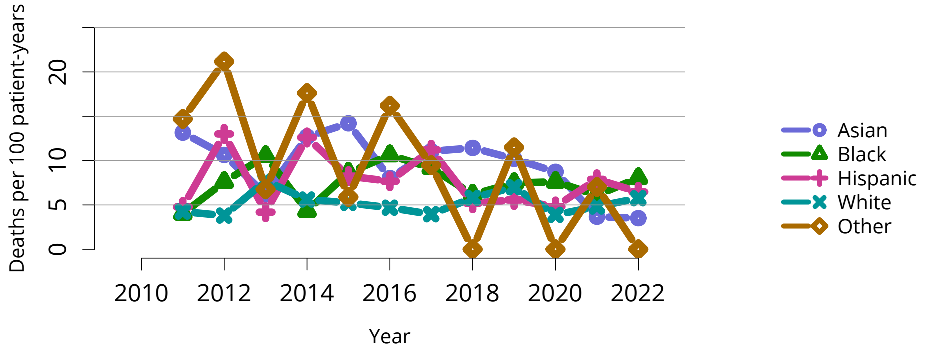
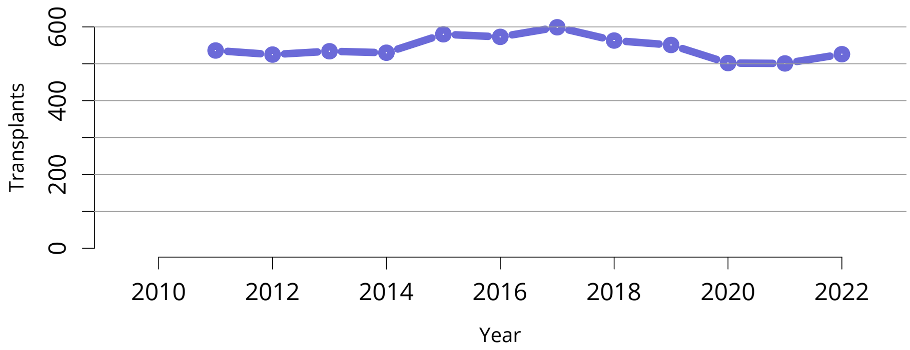
Figure LI 105: Pretransplant mortality rates among pediatric candidates waitlisted for liver transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



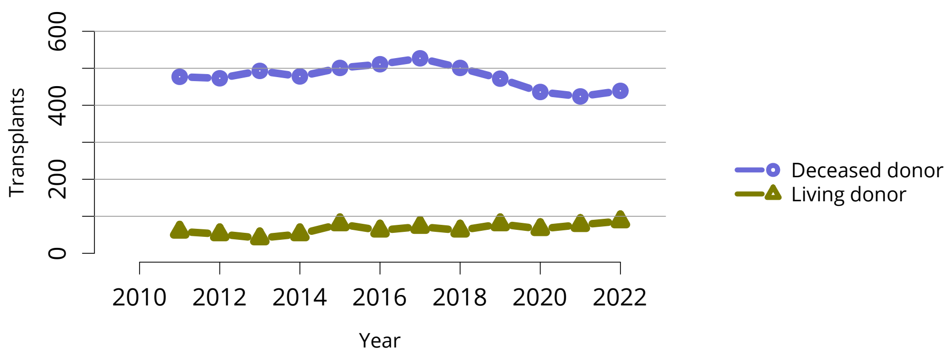
OPTN/SRTR 2022 Annual Data Report

Figure LI 106: Pretransplant mortality rates among pediatric candidates waitlisted for liver transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure LI 107: Overall pediatric liver transplants. All pediatric liver transplant recipients, including retransplant and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LI 108: Pediatric liver transplants by donor type. All pediatric liver transplant recipients, including retransplant and multiorgan recipients.

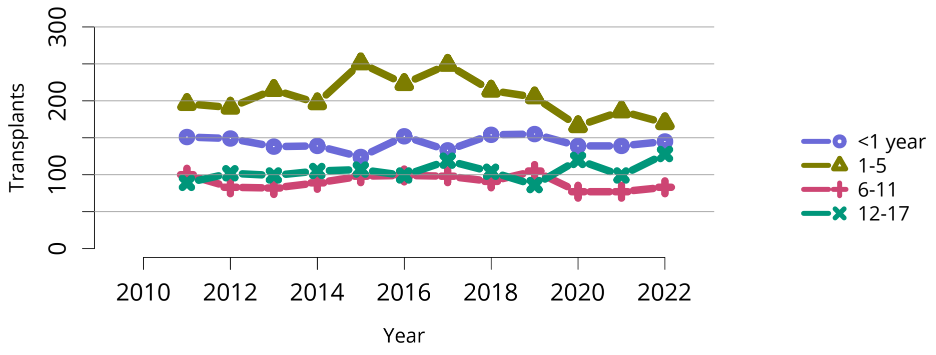


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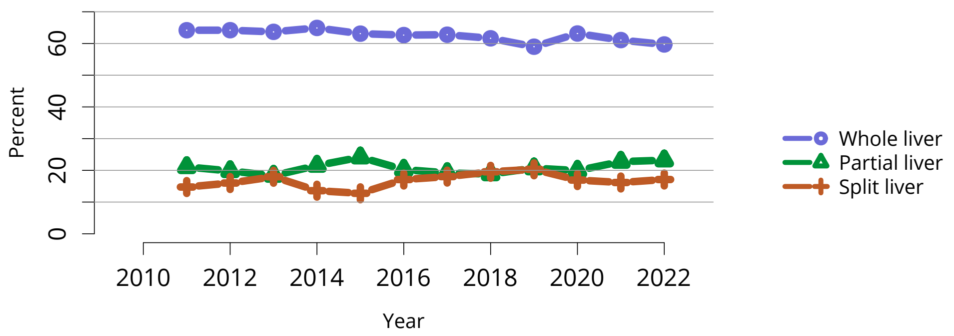
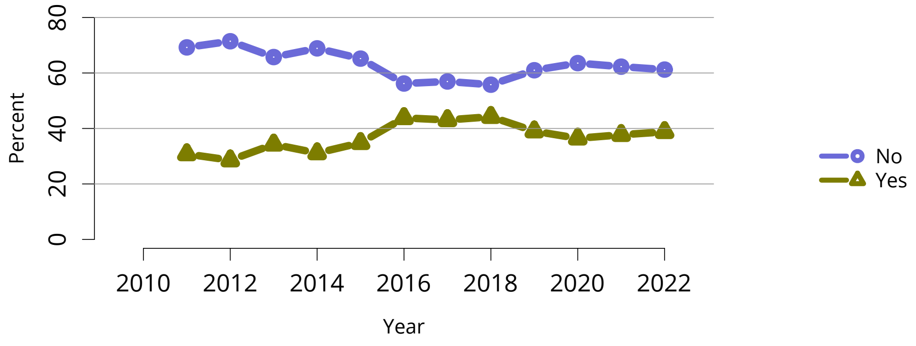
Figure LI 109: Pediatric liver transplants by recipient age. All pediatric liver transplant recipients, including retransplant and multiorgan recipients.



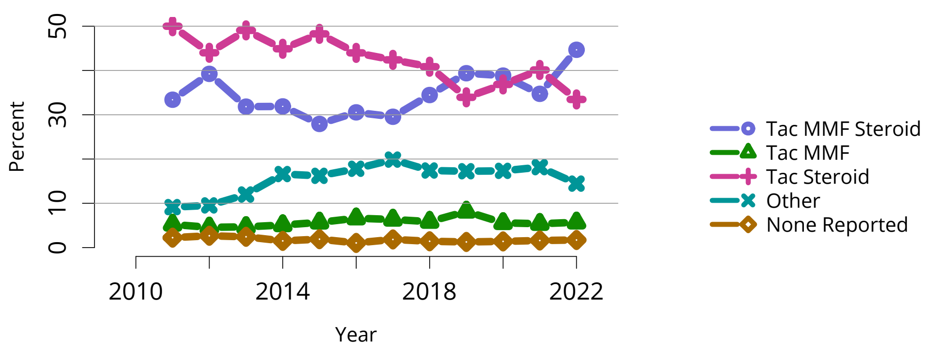
OPTN/SRTR 2022 Annual Data Report

Figure LI 110: Split or partial liver transplants in children. Percent of transplants from a split liver.



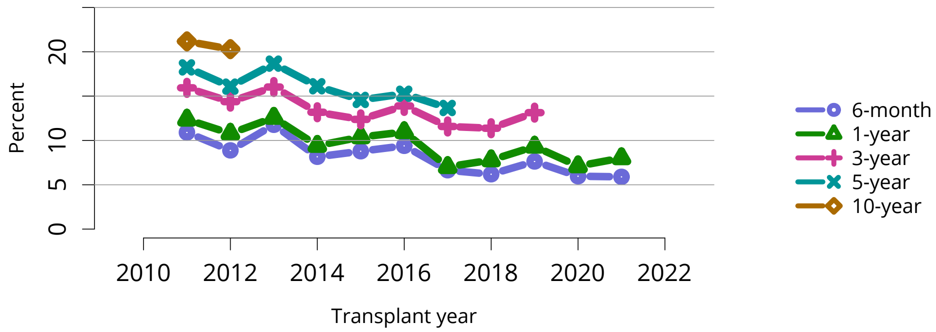
OPTN/SRTR 2022 Annual Data Report

Figure LI 111: Induction agent use in pediatric liver transplant recipients. Immunosuppression at transplant reported to the OPTN.



OPTN/SRTR 2022 Annual Data Report

Figure LI 112: Immunosuppression regimen use in pediatric liver transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



OPTN/SRTR 2022 Annual Data Report

Figure LI 113: Graft failure among pediatric deceased donor liver transplant recipients. All pediatric recipients of deceased donor livers, including multiorgan transplant recipients. Estimates are unadjusted, computed using Kaplan-Meier methods. Recipients are followed to the earliest of retransplant; death; or 6 months, 1, 3, 5, or 10 years posttransplant. All-cause graft failure is defined as any of the prior outcomes prior to 6 months, 1, 3, 5, or 10 years, respectively.

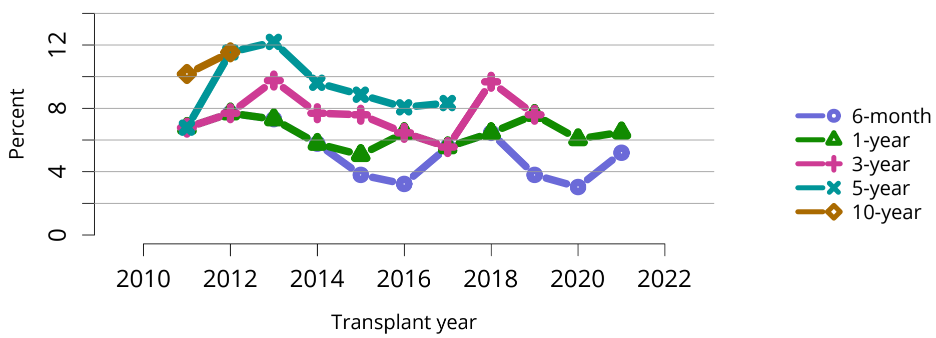


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Figure LI 114: Graft failure among pediatric living donor liver transplant recipients. All pediatric recipients of living donor livers, including multiorgan transplant recipients. Estimates are unadjusted, computed using Kaplan-Meier methods. Recipients are followed to the earliest of retransplant; death; or 6 months, 1, 3, 5, or 10 years posttransplant. All-cause graft failure is defined as any of the prior outcomes prior to 6 months, 1, 3, 5, or 10 years, respectively.

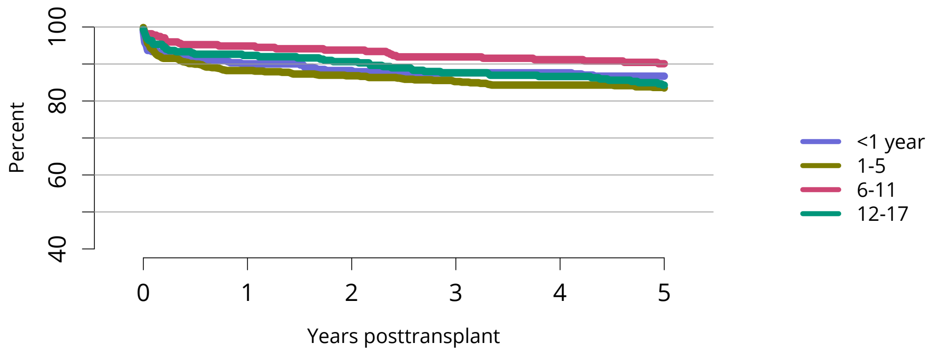

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Figure LI 115: Graft survival among pediatric deceased donor liver transplant recipients, 2015-2017, by age. Recipient survival estimated using unadjusted Kaplan-Meier methods.

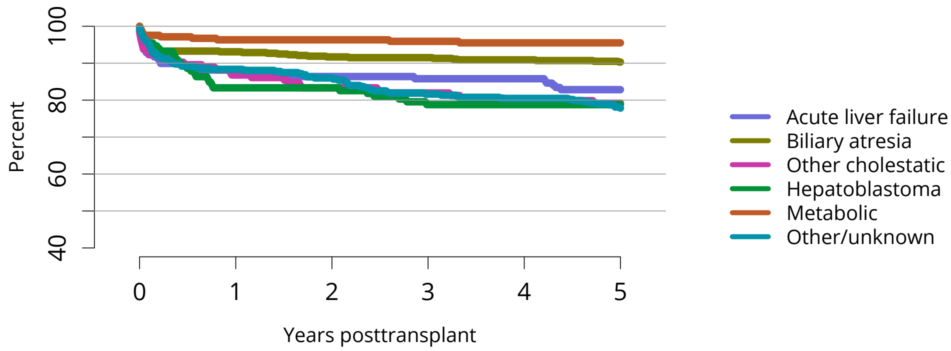

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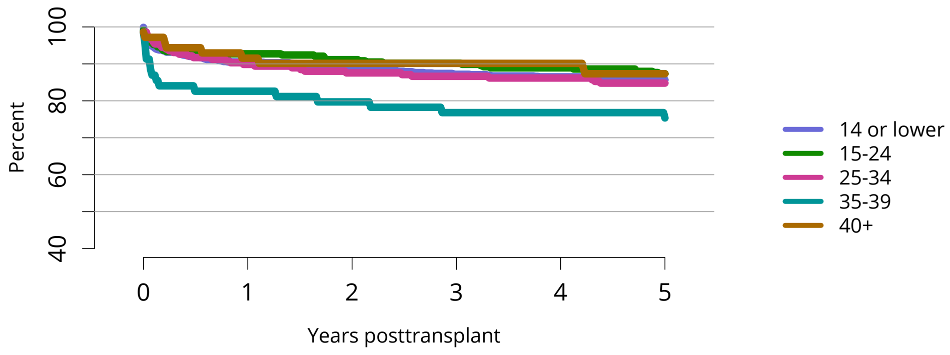
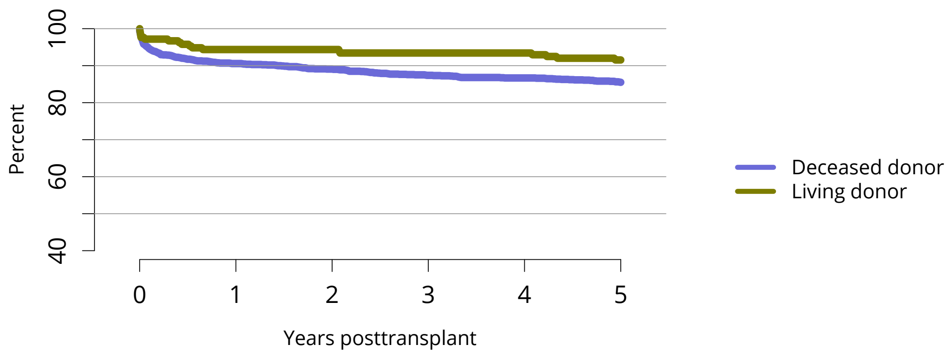
Figure LI 116: Graft survival among pediatric deceased donor liver transplant recipients, 2015-2017, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods.



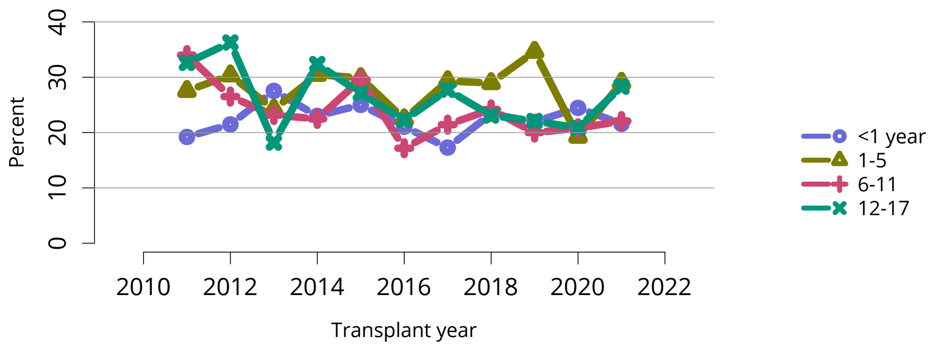
OPTN/SRTR 2022 Annual Data Report

Figure LI 117: Graft survival among pediatric deceased donor liver transplant recipients, 2015-2017, by laboratory MELD score. Graft survival estimated using unadjusted Kaplan-Meier methods. Pediatric candidates aged 12-17 years can be assigned MELD or PELD scores. MELD, model for end-stage liver disease; PELD, pediatric end-stage liver disease.



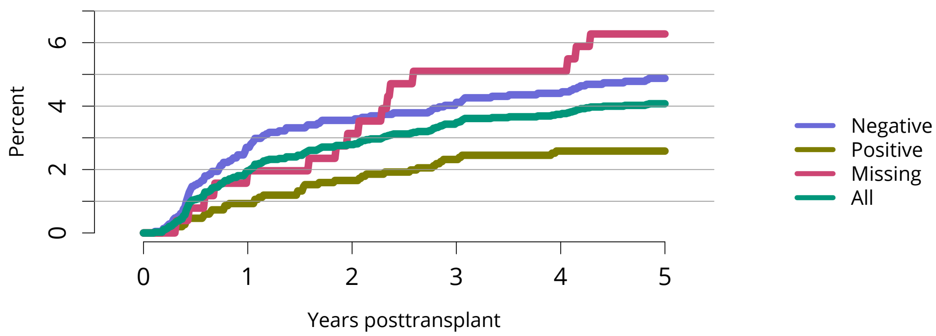
OPTN/SRTR 2022 Annual Data Report

Figure LI 118: Graft survival among pediatric liver transplant recipients, 2015-2017, by donor type. Recipient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure LI 119: Incidence of acute rejection by 1 year posttransplant among pediatric liver transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



OPTN/SRTR 2022 Annual Data Report

Figure LI 120: Incidence of PTLD among pediatric liver transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

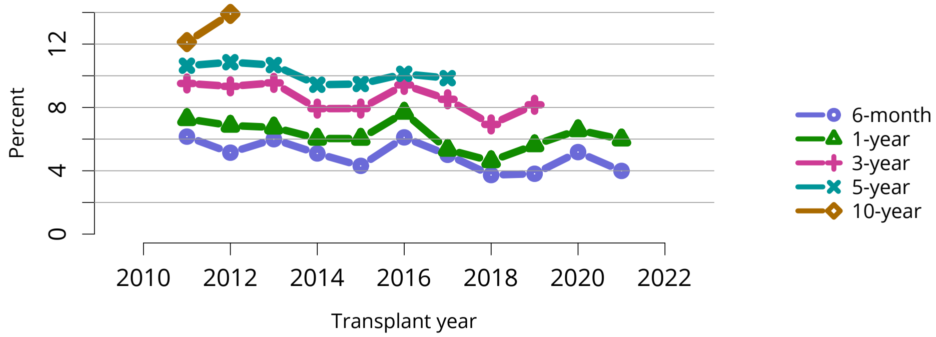


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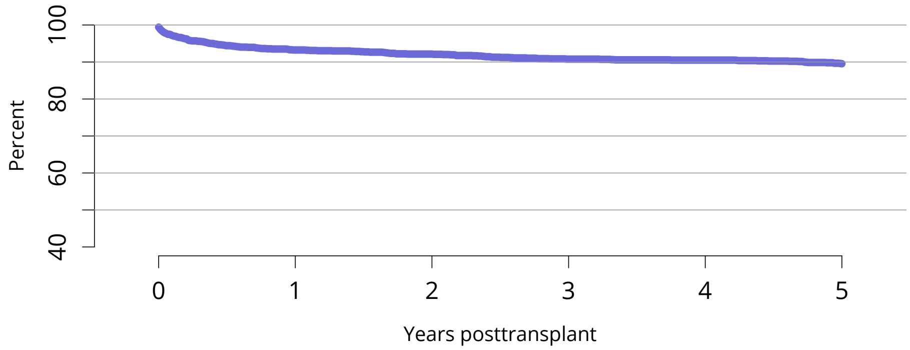
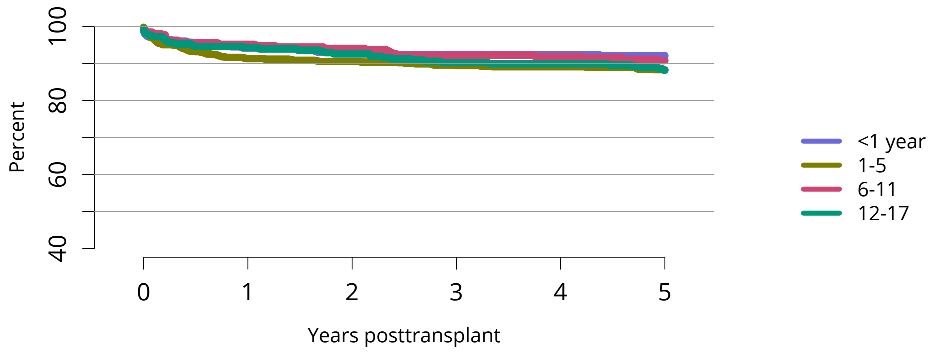
Figure LI 121: Patient death among pediatric liver transplant recipients. All pediatric recipients of deceased donor livers, including multiorgan transplant recipients. Estimates are unadjusted, computed using unadjusted Kaplan-Meier methods.



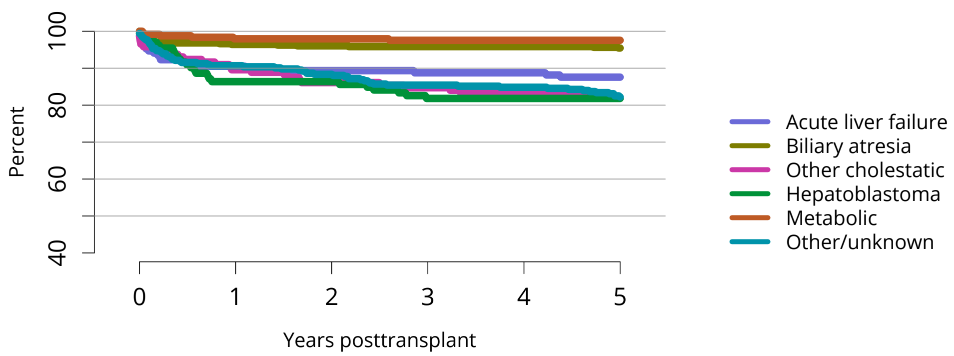
OPTN/SRTR 2022 Annual Data Report

Figure LI 122: Overall patient survival among pediatric deceased donor liver transplant recipients, 2015-2017. Recipient survival estimated using unadjusted Kaplan-Meier methods.



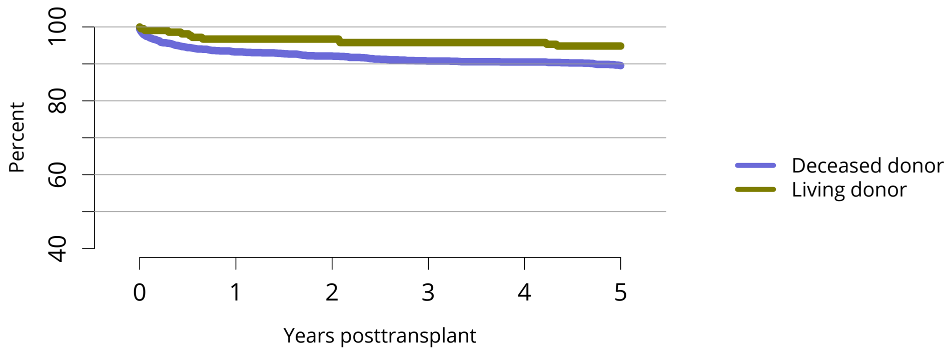
OPTN/SRTR 2022 Annual Data Report

Figure LI 123: Patient survival among pediatric deceased donor liver transplant recipients, 2015-2017, by recipient age. Recipient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure LI 124: Patient survival among pediatric deceased donor liver transplant recipients, 2015-2017, by diagnosis. Recipient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure LI 125: Patient survival among pediatric liver transplant recipients, 2015-2017, by donor type. Recipient survival estimated using unadjusted Kaplan-Meier methods.

Table LI 1: Demographic characteristics of adults on the liver transplant waiting list on December 31, 2012, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center. Age is determined on December 31 of the year.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
18-34 years	689	4.3	575	5.5
35-49	2352	14.8	1812	17.2
50-64	10138	63.7	5095	48.3
65+	2730	17.2	3066	29.1
Sex				
Female	6093	38.3	4103	38.9
Male	9816	61.7	6445	61.1
Race and ethnicity				
Asian	751	4.7	534	5.1
Black	1108	7	685	6.5
Hispanic	2681	16.9	2085	19.8
Multiracial	45	0.3	62	0.6
Native American	101	0.6	109	1
White	11223	70.5	7073	67.1
Geography				
Metropolitan	13346	83.9	8878	84.2
Nonmetropolitan	2416	15.2	1560	14.8
Missing	147	0.9	110	1
Miles between candidate and center				
<50 miles	9113	57.3	5976	56.7
50-<100	2682	16.9	1987	18.8
100-<150	1405	8.8	984	9.3
150-<250	1292	8.1	840	8
250+	1307	8.2	686	6.5
Missing	110	0.7	75	0.7
All candidates				
All candidates	15909	100	10548	100

Table LI 2: Clinical characteristics of adults on the liver transplant waiting list on December 31, 2012, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Acute liver failure	307	1.9	103	1
HCV	4857	30.5	904	8.6
Alcoholic liver disease	3736	23.5	3721	35.3
Cholestatic disease	1418	8.9	859	8.1
HCC	928	5.8	1183	11.2
MASH	1293	8.1	2104	19.9
Other/unknown	3370	21.2	1674	15.9
Blood type				
A	5993	37.7	4084	38.7
AB	397	2.5	213	2
B	1722	10.8	1002	9.5
O	7797	49	5249	49.8
Urgency status				
14 or lower	7695	48.4	4774	45.3
15-24	4008	25.2	3068	29.1
25-34	1150	7.2	226	2.1
35-39	35	0.2	29	0.3
40+	37	0.2	20	0.2
Status 1A	3	0	3	0
Inactive	2968	18.7	2428	23
Missing	13	0.1	0	0
HCC status for liver candidates				
No HCC exception	14492	91.1	8869	84.1
HCC exception	1404	8.8	1679	15.9
Missing	13	0.1	0	0
All candidates				
All candidates	15909	100	10548	100

Table LI 3: Listing characteristics of adults on the liver transplant waiting list on December 31, 2012, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Previous transplant				
No prior transplant	15494	97.4	10289	97.5
Prior transplant	415	2.6	259	2.5
Waiting time				
<90 days	1955	12.3	1939	18.4
3-<6 months	1641	10.3	1383	13.1
6-<12 months	2298	14.4	1902	18
1-<2 years	2992	18.8	2052	19.5
2+ years	7023	44.1	3272	31
All candidates				
All candidates	15909	100	10548	100

Table LI 4: Liver transplant waitlist activity among adults. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	12552	11769	11324
Patients added during year	12401	13165	12862
Patients removed during year	13182	13610	13638
Patients at end of year	11771	11324	10548

Table LI 5: Removal reason among adult liver transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	7930	8213	8462
Living donor transplant	425	492	515
Transplant outside US	1	1	2
Patient died	1123	1150	1031
Patient refused transplant	121	135	117
Improved, transplant not needed	902	1051	983
Too sick for transplant	1226	1177	1091
Other	1453	1388	1434
Still on waiting list	1	3	3

Table LI 6: Demographic characteristics of adult liver transplant recipients, 2012 and 2022. Liver transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
18-34 years	303	5.3	674	7.5
35-49	970	16.9	2049	22.8
50-64	3623	63.2	4305	47.8
65+	835	14.6	1973	21.9
Sex				
Female	1860	32.5	3382	37.6
Male	3871	67.5	5619	62.4
Race and ethnicity				
Asian	260	4.5	381	4.2
Black	576	10.1	563	6.3
Hispanic	755	13.2	1597	17.7
Multiracial	18	0.3	56	0.6
Native American	39	0.7	98	1.1
White	4083	71.2	6306	70.1
Body mass index				
<18.5	111	1.9	190	2.1
18.5-<25	1642	28.7	2366	26.3
25-<30	1920	33.5	2844	31.6
30-<35	1301	22.7	1970	21.9
35+	728	12.7	1393	15.5
Missing	29	0.5	238	2.6
Insurance				
Private	3199	55.8	4626	51.4
Medicare	1500	26.2	2379	26.4
Medicaid	731	12.8	1531	17
Other/unknown	301	5.3	465	5.2
Geography				
Metropolitan	4771	83.2	7507	83.4
Nonmetropolitan	826	14.4	1344	14.9
Missing	134	2.3	150	1.7
Miles between recipient and center				
<50 miles	3175	55.4	5122	56.9
50-<100	966	16.9	1520	16.9
100-<150	538	9.4	880	9.8
150-<250	437	7.6	655	7.3
250+	547	9.5	714	7.9
Missing	68	1.2	110	1.2
All recipients				
All recipients	5731	100	9001	100

Table LI 7: Clinical characteristics of adult liver transplant recipients, 2012 and 2022. Liver transplant recipients, including retransplant recipients. HCC, hepatocellular carcinoma; HCV, hepatitis C virus; MASH, metabolic dysfunction–associated steatohepatitis.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Acute liver failure	203	3.5	211	2.3
HCV	1490	26	398	4.4
Alcoholic liver disease	976	17	3673	40.8
Cholestatic disease	458	8	640	7.1
HCC	1128	19.7	982	10.9
MASH	532	9.3	1789	19.9
Other/unknown	944	16.5	1308	14.5
Blood type				
A	2155	37.6	3273	36.4
AB	277	4.8	426	4.7
B	796	13.9	1207	13.4
O	2503	43.7	4095	45.5
Urgency status at transplant				
14 or lower	169	2.9	1278	14.2
15-24	1923	33.6	2354	26.2
25-34	2418	42.2	3272	36.4
35-39	496	8.7	993	11
40+	532	9.3	882	9.8
Status 1B	0	0	1	0
Status 1A	192	3.4	209	2.3
Inactive	1	0	12	0.1
HCC status for liver recipients				
No HCC exception	4184	73	7604	84.5
HCC exception	1547	27	1397	15.5
All recipients				
All recipients	5731	100	9001	100

Table LI 8: Transplant characteristics of adult liver transplant recipients, 2012 and 2022. Liver transplant recipients, including retransplant recipients. DBD, donation after brain death; DCD, donation after circulatory death.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
None	292	5.1	730	8.1
<90 days	2391	41.7	4765	52.9
3-<6 months	910	15.9	1008	11.2
6-<12 months	905	15.8	1325	14.7
1-<2 years	705	12.3	685	7.6
2+ years	528	9.2	488	5.4
Donor type				
Deceased donor	5537	96.6	8485	94.3
Living donor	194	3.4	516	5.7
Split versus whole liver transplant				
Whole liver	5474	95.5	8411	93.4
Partial liver	189	3.3	511	5.7
Split liver	68	1.2	79	0.9
Donation after circulatory death				
DBD	5276	92.1	7472	83
DCD	261	4.6	1013	11.3
Living donor	194	3.4	516	5.7
Previous transplant for recipients				
No prior transplant	5436	94.9	8688	96.5
Prior transplant	295	5.1	313	3.5
All recipients				
All recipients	5731	100	9001	100

Table LI 9: Demographic characteristics of pediatric candidates on the liver transplant waiting list on December 31, 2012, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date. Age is determined on December 31 of the year. Distance is computed from candidate's home zip code to the transplant center.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
<1 year	37	6.4	44	10
1-5	166	28.9	143	32.6
6-11	119	20.7	84	19.2
12-17	152	26.5	107	24.4
18+	100	17.4	60	13.7
Sex				
Female	297	51.7	213	48.6
Male	277	48.3	225	51.4
Race and ethnicity				
Asian	28	4.9	32	7.3
Black	86	15	76	17.4
Hispanic	140	24.4	109	24.9
Multiracial	7	1.2	17	3.9
Native American	5	0.9	2	0.5
White	308	53.7	202	46.1
Geography				
Metropolitan	502	87.5	381	87
Nonmetropolitan	58	10.1	49	11.2
Missing	14	2.4	8	1.8
Miles between candidate and center				
<50 miles	305	53.1	220	50.2
50-<100	76	13.2	71	16.2
100-<150	50	8.7	44	10
150-<250	55	9.6	45	10.3
250+	77	13.4	50	11.4
Missing	11	1.9	8	1.8
All candidates				
All candidates	574	100	438	100

Table LI 10: Clinical characteristics of pediatric candidates on the liver transplant waiting list on December 31, 2012, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date. Pediatric candidates aged 12-17 years can be assigned MELD or PELD scores. HCC, hepatocellular carcinoma.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Pediatric diagnosis				
Acute liver failure	42	7.3	25	5.7
Biliary atresia	180	31.4	157	35.8
Other cholestatic	42	7.3	31	7.1
Hepatoblastoma	9	1.6	5	1.1
Metabolic	72	12.5	43	9.8
Other/unknown	229	39.9	177	40.4
Blood type				
A	178	31	135	30.8
AB	10	1.7	8	1.8
B	74	12.9	69	15.8
O	312	54.4	226	51.6
Urgency status				
14 or lower	157	27.4	155	35.4
15-24	70	12.2	56	12.8
25-34	59	10.3	19	4.3
35-39	11	1.9	4	0.9
40+	25	4.4	0	0
Status 1B	10	1.7	21	4.8
Status 1A	0	0	2	0.5
Inactive	237	41.3	181	41.3
Missing	5	0.9	0	0
HCC status for liver candidates				
No HCC exception	567	98.8	438	100
HCC exception	2	0.3	0	0
Missing	5	0.9	0	0
All candidates				
All candidates	574	100	438	100

Table LI 11: Listing characteristics of pediatric candidates on the liver transplant waiting list on December 31, 2012, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Previous transplant				
No prior transplant	529	92.2	405	92.5
Prior transplant	45	7.8	33	7.5
Waiting time				
<90 days	90	15.7	107	24.4
3-<6 months	64	11.1	50	11.4
6-<12 months	69	12	84	19.2
1-<2 years	88	15.3	68	15.5
2+ years	263	45.8	129	29.5
All candidates				
All candidates	574	100	438	100

Table LI 12: Liver transplant waitlist activity among pediatric candidates. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	462	402	401
Patients added during year	617	666	741
Patients removed during year	677	667	704
Patients at end of year	402	401	438

Table LI 13: Removal reason among pediatric liver transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	456	435	450
Living donor transplant	66	77	88
Transplant outside US	0	1	0
Patient died	17	20	20
Patient refused transplant	3	5	2
Improved, transplant not needed	74	85	79
Too sick for transplant	16	16	30
Other	45	28	35

Table LI 14: Demographic characteristics of pediatric liver transplant recipients, 2012 and 2022. Pediatric liver transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
<1 year	149	28.4	145	27.6
1-5	191	36.4	170	32.3
6-11	83	15.8	83	15.8
12-17	102	19.4	128	24.3
Sex				
Female	281	53.5	250	47.5
Male	244	46.5	276	52.5
Race and ethnicity				
Asian	30	5.7	35	6.7
Black	90	17.1	92	17.5
Hispanic	110	21	131	24.9
Multiracial	7	1.3	13	2.5
Native American	5	1	3	0.6
White	283	53.9	252	47.9
Insurance				
Private	231	44	213	40.5
Medicare	5	1	2	0.4
Medicaid	234	44.6	231	43.9
Other/unknown	55	10.5	80	15.2
Geography				
Metropolitan	452	86.1	428	81.4
Nonmetropolitan	62	11.8	81	15.4
Missing	11	2.1	17	3.2
Miles between recipient and center				
<50 miles	251	47.8	241	45.8
50-<100	75	14.3	80	15.2
100-<150	54	10.3	52	9.9
150-<250	60	11.4	65	12.4
250+	75	14.3	76	14.4
Missing	10	1.9	12	2.3
All recipients				
All recipients	525	100	526	100

Table LI 15: Clinical characteristics of pediatric liver transplant recipients, 2012 and 2022. Pediatric liver transplant recipients, including retransplant recipients. Pediatric candidates aged 12-17 years can be assigned MELD or PELD scores. HCC, hepatocellular carcinoma.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Acute liver failure	63	12	50	9.5
Biliary atresia	207	39.4	196	37.3
Other cholestatic	47	9	38	7.2
Hepatoblastoma	33	6.3	40	7.6
Metabolic	72	13.7	79	15
Other/unknown	103	19.6	123	23.4
Blood type				
A	175	33.3	179	34
AB	30	5.7	22	4.2
B	68	13	72	13.7
O	252	48	253	48.1
Urgency status at transplant				
14 or lower	66	12.6	144	27.4
15-24	90	17.1	79	15
25-34	119	22.7	53	10.1
35-39	30	5.7	41	7.8
40+	44	8.4	24	4.6
Status 1B	85	16.2	116	22.1
Status 1A	91	17.3	69	13.1
HCC status for liver recipients				
No HCC exception	522	99.4	524	99.6
HCC exception	3	0.6	2	0.4
All recipients				
All recipients	525	100	526	100

Table LI 16: Transplant characteristics of pediatric liver transplant recipients, 2012 and 2022. Pediatric liver transplant recipients, including retransplant recipients. DBD, donation after brain death; DCD, donation after circulatory death.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
None	37	7	43	8.2
<90 days	287	54.7	306	58.2
3-<6 months	90	17.1	90	17.1
6-<12 months	60	11.4	51	9.7
1-<2 years	31	5.9	22	4.2
2+ years	20	3.8	14	2.7
ABO-Incompatible transplant				
Compatible/Identical	512	97.5	504	95.8
Incompatible	13	2.5	22	4.2
Donor type				
Deceased donor	473	90.1	439	83.5
Living donor	52	9.9	87	16.5
Split versus whole liver transplant				
Whole liver	337	64.2	314	59.7
Partial liver	104	19.8	122	23.2
Split liver	84	16	90	17.1
Donation after circulatory death				
DBD	471	89.7	438	83.3
DCD	2	0.4	1	0.2
Living donor	52	9.9	87	16.5
Previous transplant for recipients				
No prior transplant	476	90.7	496	94.3
Prior transplant	49	9.3	30	5.7
All recipients				
All recipients	525	100	526	100

OPTN/SRTR 2022 Annual Data Report: Intestine

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Abstract

Intestine remains the least frequently transplanted solid organ, although the survival and quality-of-life benefits of transplant to individuals with irreversible intestinal failure have been well demonstrated. The trend seen over the past 15 years of fewer listings and fewer transplants appears to be continuing, most noticeably in infants, children, and adolescents. There were only 146 additions to the intestine waiting list in 2022, and the proportion of adult candidates continues to increase, so that now 61% of the intestine waiting list are adult candidates. There has been little change in the distribution by sex, race and ethnicity, or primary diagnosis on the waiting list, or for those receiving transplant. The transplant rate for adults has decreased to 55.6 transplants per 100 patient-years, but the pediatric transplant rate remains relatively stable at 22.8 transplants per 100 patient-years. The decrease in transplant rates for adults is primarily the result of falling rates for those listed for combined intestine-liver, and this is reflected in the pretransplant mortality rates, which are twice as high for candidates in need of both organs compared with those listed for intestine alone. Overall, intestine transplant numbers decreased to a total of 82 intestine transplants in 2022, only one above the lowest ever value of 81 in 2019. No major changes were seen in the immunosuppression protocols, with most recipients having induction therapy and tacrolimus-based maintenance. Graft failure rates appear to have improved at 1, 3, and 5 years for intestine without liver, but this is not seen for combined intestine-liver. Graft and patient survival are better for pediatric recipients compared with adult recipients for both liver-inclusive

and liver-exclusive transplant. Rates of posttransplant lymphoproliferative disorder are higher for recipients of intestine without liver.
Keywords: Intestinal failure, intestine transplant, intestine-liver transplant, outcomes, pediatric, waiting list

1 Introduction

In this 2022 Annual Data Report, pediatric data have been separated from adult data to a greater extent than in previous years; but unlike chapters for other specific organs, there has not been a need for a completely separate pediatric section.

As has been the trend for more than a decade now, the overall activity in intestine transplantation has been in decline; waitlist additions, prevalent candidates on the waiting list, total number of intestine donors, and the overall number of intestine transplants all appear to have been decreasing. There were some noticeable dips in numbers in 2019, but the subsequent 3 years of data have not altered the overall trends. Again, as seen in previous Annual Data Reports, the decreasing numbers of candidates for and recipients of an intestine allograft are most marked in the pediatric populations, largely due to the well documented advances in medical and nontransplant surgical care for intestinal failure. Adults now account for 61% of the prevalent waiting list, where once pediatric candidates heavily outweighed the number of adults listed.

Despite a reduced demand for intestine transplant, there has not been a proportional reduction in waitlist deaths or removals due to being “too sick for transplant” among waitlist candidates, especially for the sicker patients listed for combined intestine-liver. There were 32 transplants of this type in 2022, but 16 candidates either died or were removed from the waiting list due to being “too sick for transplant.” Transplant rates have decreased, particularly for adults in need of a liver-inclusive graft, since the most recent changes to the liver allocation policy. A proposal to increase the priority for allocation has been approved by the OPTN Board of Directors and implemented, and it is hoped that this change will improve transplant rates for these candidates in the future.

In terms of posttransplant outcomes, there may be a gradual trend toward reduced graft failure rates in those receiving an intestine without liver, but this trend was not seen among recipients of intestine-with-liver allografts. Patient survival remains better for pediatric recipients and for those receiving an isolated intestine transplant.

The incidence of posttransplant lymphoproliferative disorder (PTLD) is higher for those who received a graft without a liver, especially for those recipients who were Epstein-Barr virus (EBV) negative at transplant. The reason for this increased incidence is unclear but may relate to the need for greater immunosuppression in recipients of isolated intestine transplant, as the risk of rejection is thought to be higher.

In this chapter, information on the waiting list, transplants, and outcomes in the United States is presented for intestine transplants either alone or in combination with liver. Both types include multivisceral transplants distinguished by inclusion or exclusion of liver.

2 Waiting List

The total number of new candidates awaiting an intestine-containing allograft in 2022 was 146, which is similar to the number of additions in 2020 and 2021 and higher than the 103 additions in 2019; the peak in the past decade was 211 additions in 2014. The number of candidates listed for intestine alone exceeded that for combined intestine-liver for the first time since 2011 (78 and 68 candidates, respectively) (Figure IN 1). The number of prevalent patients awaiting intestine transplant continues to decrease, with 167 awaiting intestine alone and 180 candidates awaiting intestine with liver (Figure IN 2). The distribution of adult candidates listed in 2021 surpassed, for the first time, that of pediatric candidates, and the trend has continued in 2022 with 61% of the waiting list being candidates aged 18 years or older; this is a complete reversal from a decade ago when 60% of the waiting list were pediatric candidates (Figure IN 3). In terms of the sex distribution of candidates, there has always been a slight predominance of males, which, over the 12-year period of 2011 through 2022, averages 52.6% male and 47.4% female candidates (Figure IN 4). The racial and ethnic mix of the waiting list has been relatively consistent over the past decade (2013-2022), with White patients making up between 57.3% and 61.5% of the list; Black patients, 17.5% to 21.4%; Hispanic patients, 14.6% to 18.7%; and Asian patients, 2.5% to 4.4% (Figure IN 5). The most common etiology of intestinal failure on the waiting list remained short-gut syndrome, which encompasses both congenital and noncongenital forms of the syndrome, as well as necrotizing enterocolitis and probably a significant number in the Other/unknown group (Figure IN 6). However, it is notable that there has been a decrease in the proportion of congenital causes of short-gut syndrome and necrotizing enterocolitis, both pediatric diagnoses, although interpretation is somewhat obscured by the more than 30% of candidates in the Other/unknown category. Enteropathies and intestinal pseudo-obstruction syndromes are rare and collectively continue to account for only about 10% of all indications for listing for intestine transplant (Figure IN 6).

Table IN 1 shows the demographic characteristics of intestine transplant candidates by whether they are simultaneously awaiting a liver transplant. Generally, these demographics are similar between the two cohorts, although it appears that listing for combined intestine-liver is more common in candidates who are male and/or White. Candidates tend to come from metropolitan areas close to the transplant center or from distances of 150 miles or greater, presumably from other metropolitan centers without an intestine transplant program. Medical characteristics of the two groups are shown in Table IN 2. Individuals with chronic intestinal pseudo-obstruction are proportionately more likely to be listed for isolated intestine, while pediatric candidates with a history of necrotizing enterocolitis are twice as likely to need a combined intestine-liver transplant. Other diagnostic groups were equally likely to be listed for isolated intestine and combined intestine-liver transplant. Major ABO blood groups were equally represented between intestine alone and combined intestine-liver, and approximately in line with the distribution of blood groups in the US population.

The proportion of candidates with waiting times on the intestine transplant list of less than 90 days has remained stable in the past 3 years at around 20%. The proportion waiting less than 90 days decreased in 2019 and was accompanied by a peak in those waiting over 2 years (Figure IN 7). The significant number of candidates for intestine transplant who are on the waiting list for more than 2 years is also shown in Table IN 3. The distributions of adult and pediatric candidates listed for either intestine-alone or intestine-liver transplant both cluster around 50% (Figure IN 8 and Figure IN 9). Most candidates for intestine-alone or combined intestine-liver transplant are awaiting their first transplant, but of those awaiting retransplant, a greater number are listed for a liver-containing allograft (Table IN 3).

Figure IN 10 shows that overall transplant rates for adults have decreased over the past 7 years from 114.8 transplants per 100 patient-years of waiting time in 2016 to 55.6 transplants per 100 patient-years in 2022. Pediatric transplant rates have fluctuated between 20.3-34.9 transplants per 100 patient-years over the past 12 years (Figure IN 11), with the overall pediatric transplant rate in 2022 being 22.8 transplants per 100 patient-years. When looking at transplant rates by age group in adults, the most noticeable decrease in transplant rates occurred among those aged 18-34 and 35-49 years (Figure IN 12). In children and adolescents, transplant rates have remained relatively stable (Figure IN 13), although for all age groups, both adults and pediatric, the total numbers are very small so year-to-year variability in transplant rates tends to fluctuate. The extent of this fluctuation is also evident in transplant rates by race and ethnicity. On average over the past 12 years, transplant rates for White candidates have tended to be higher than those for other groups (51.2 transplants per 100 patient-years for White candidates compared with 33.8, 34.2, and 39.2 transplants per 100 patient-years for Asian, Hispanic, and Black candidates, respectively), but beyond this no other trends are apparent (Figure

IN 14). The transplant rate for candidates awaiting intestine alone is currently higher than that for those in need of a liver-containing allograft; the latter decreased from 45.5 transplants per 100 patient-years in 2011 to 27.6 transplants per 100 patient-years in 2022 (Figure IN 15).

In 2022, 71 candidates were removed from the isolated intestine waiting list (Table IN 4): of these, 49 (69.0%) underwent deceased donor transplant, 8 (11.3%) died or were too sick for transplant, 7 (9.9%) were removed from the list because their condition improved, 6 (8.5%) were removed for other, unspecified reasons, and 1 (1.4%) refused transplant (Table IN 5). Outcomes at 3 years for newly listed candidates for isolated intestine transplant in 2017 through 2019 show that 67.7% underwent deceased donor transplant, 4.3% died, 14.5% were removed from the list, and 13.4% were still waiting 3 years after listing (Figure IN 16). Likewise, 61 candidates were removed from the intestine-liver waiting list in 2022; of these, 33 (54.1%) underwent deceased donor transplant, 16 (26.2%) died or were too sick for transplant, 4 (6.6%) were removed from the list because their condition improved, 6 (9.8%) were removed for other, unspecified reasons, and 2 (3.3%) refused transplant (Table IN 5). Of intestine-liver candidates listed from 2017 through 2019, 65.0% underwent deceased donor transplant within 3 years, 10.6% were removed from the list for reasons other than death or transplant, 11.1% died, and 13.4% were still waiting after 3 years on the waiting list (Figure IN 17).

Pretransplant mortality rates for intestine transplant candidates by race and ethnicity average less than 8.0 deaths per 100 patient-years for all groups from 2011 to 2022, although with considerable variation from year to year (Figure IN 18). Again, pretransplant mortality rates for male and female candidates also average less than 8.4 deaths per 100 patient-years, but there appears to be a trend toward fewer deaths in female candidates, with rates in 2011 at 15.7 deaths per 100 patient-years decreasing to 4.9 deaths per 100 patient-years in 2022 (Figure IN 19). The pretransplant mortality rate in 2022 for candidates listed for intestine with liver (10.4 deaths per 100 patient-years), as has always been the case, exceeds that of those awaiting intestine-alone transplant (5.4 deaths per 100 patient-years) (Figure IN 20). When broken out by adult or pediatric candidates, the adults have higher pretransplant mortality rates for both intestine alone and intestine with liver (Figure IN 21 and Figure IN 22). Noticeably, pediatric pretransplant mortality rates for those listed for a liver-inclusive graft have decreased quite dramatically over the past few years (Figure IN 22).

3 Donation

The year 2022 saw only 87 intestines recovered for transplant, only one more than the lowest number per year in 2019 (Figure IN 23). The greatest proportion of intestine donors in 2022 were younger than 18 years, but this age group also showed the greatest decline in absolute number of intestines recovered (Figure IN 24) and a modest decline in the proportion of intestines recovered compared with other age groups (Figure IN 25). A little over 60% of intestine donors were male (Figure IN 26) and also just over 60% were White (Figure IN 27). The overall rate of intestines recovered for transplant and not transplanted was 4.6% in 2022 (Figure IN 28). The most common cause of death among deceased intestine donors has historically always been head trauma, and this was again the case in 2022 with 50.6% of deceased intestine donors dying as a result of head injury (Figure IN 30).

4 Transplant

In 2022, a total of 82 intestine-containing transplants were carried out across the United States; this was only one more than in 2019, which saw the lowest number of intestine transplants done in any one year in the past 12 years (Figure IN 31). Of these, 60 intestines were transplanted into an adult recipient (41 isolated intestines and 19 intestine-liver) (Figure IN 32) and only 22 in children and adolescents (9 isolated and 13 intestine-liver) (Figure IN 33). There were fairly similar numbers of female and male recipients over the past decade; in 2022, there were 39 and 43 transplants, respectively (Figure IN 34). Overall, the numbers of intestine transplants have proportionately decreased for Black, Hispanic, and White candidates since 2011; the numbers for other racial and ethnic groups are too small to draw any conclusions (Figure IN 35).

Table IN 6 shows the demographic characteristics of intestine transplant recipients; approximately 40% of intestine-liver recipients, but only 18% of intestine-without-liver recipients, were of pediatric age. About 45% of intestine transplants were paid for by private insurance and about 35% by Medicaid, with most of the remaining cases supported by Medicare (15%) (Table IN 6). Most recipients lived in metropolitan areas (Table IN 6). Short-gut syndrome remains the main cause of disease leading to both intestine and intestine-liver transplant (Table IN 7).

Most recipients of an intestine-containing allograft in 2022 waited less than a year from listing to their transplant: 80% of recipients of isolated intestine and 72% of recipients of intestine-liver (Table IN 8). Less than 10% of recipients had had a previous intestine transplant, and, of these, two received an isolated intestine and five received an intestine-liver allograft (Table IN 8).

5 Immunosuppression

The use of induction immunosuppression with a lymphocyte-depleting agent or interleukin-2 receptor blocking antibody is common in intestine transplant and was used in over 80% of cases in 2022 (Figure IN 37). Tacrolimus remains the mainstay for maintenance immunosuppression, used mainly in combination with corticosteroids or mycophenolate mofetil or both (Figure IN 38).

6 Outcomes

Graft failure rates for intestine without liver have slightly improved over the past 12 years, and the 3- and 5-year graft failure rates for the latest cohorts are the best seen during this 2011-2022 period at 26.7% and 42.4%, respectively (Figure IN 39). These improvements, however, are not seen in the graft failure rates for liver-containing allografts, with 6- and 12-month graft failure rates at over 50%. There also appears to be a worsening trend in 3-year graft failure rates for intestine-liver grafts up until 2019 and no noticeable improvement since 2011 in 5-year graft survival (Figure IN 40). For adults who received an intestine transplant during 2015 through 2017, intestine allograft survival is clearly better for intestine without liver at 1-year posttransplant (82.1% versus 62.2%, respectively), but this advantage is all but lost by 5-year post-transplant (47.6% versus 42.2%) (Figure IN 41). From 2015 through 2017, graft survival for pediatric recipients is overall better than that for adult recipients, and the difference between graft survival for intestine with or without liver favors the liver-containing allografts (1-year survival: 71.9% intestine alone and 79% with liver; 5-year graft survival: 52.6% and 61%, respectively) (Figure IN 42).

The incidence of acute rejection by 1-year posttransplant varies from year to year and is generally in the range of 21.7%-50% for both adult and pediatric intestine transplant recipients, although on average a slightly higher incidence is seen in the pediatric population (Figure IN 44). There is no clear benefit of any of the induction immunosuppressive regimens on the incidence of acute rejection within the first year after transplant (Figure IN 45). The incidence of PTLD is higher in recipients of an intestine without liver (up to 10% in those with negative EBV serology prior to transplant) than in recipients of intestine-liver transplant. Also of note is that the incidence of PTLD in the intestine-liver group of recipients does not seem to be different based on pretransplant EBV serology, with incidence of PTLD of less than 4% in both the negative and positive serology groups

(Figure IN 46 and Figure IN 47).

For intestine transplants received during 2015-2017, patient survival after transplant is also better for pediatric populations than for adults. This observation is clearest at 5 years, when patient survival for those who underwent transplant as children and adolescents is 77.2% if they received an intestine alone and 66.7% if intestine-liver, whereas for adult recipients the survival percentages are 61.3% and 46.7%, respectively (Figure IN 48 and Figure IN 49).

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This report is available at https://srtr.transplant.hrsa.gov. Individual chapters may be downloaded.

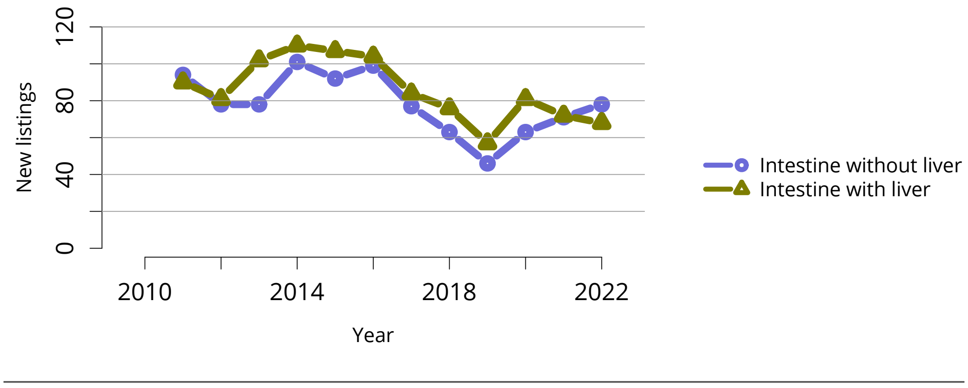

Figure IN 1: New candidates added to the intestine transplant waiting list by liver colisting. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing. New intestine-liver candidates are those listed for both organs on the same day.

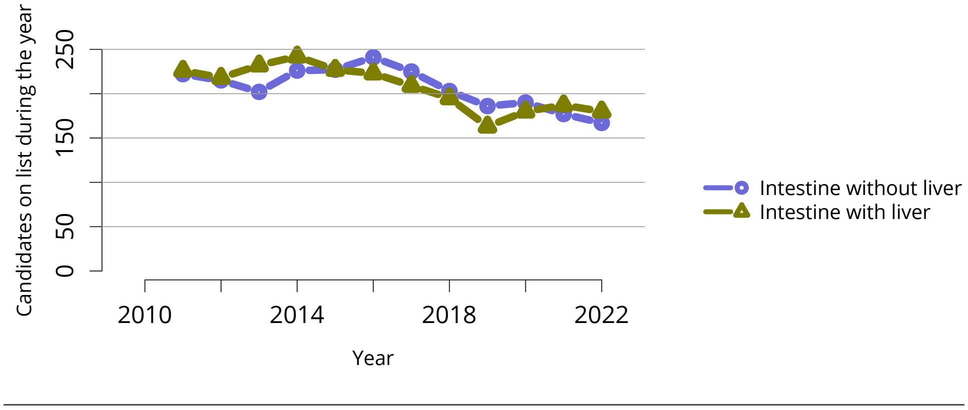

Figure IN 2: All candidates on the intestine transplant waiting list by liver colisting. Candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing.

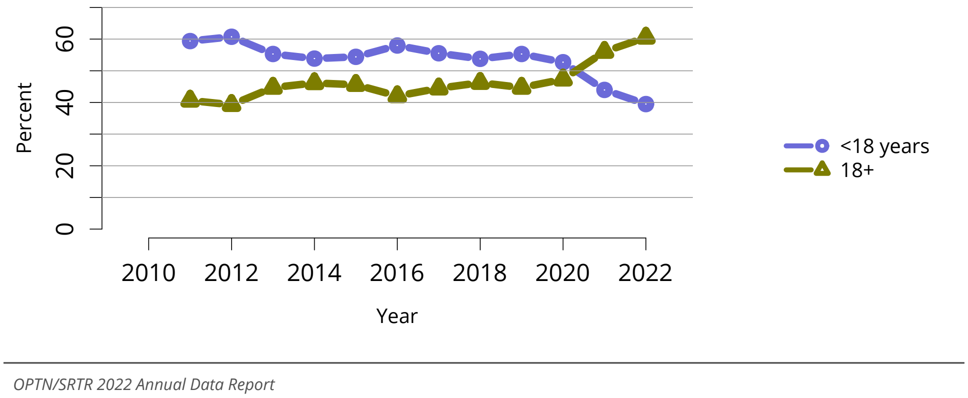

Figure IN 3: Distribution of candidates waiting for intestine transplant by age. Candidates waiting for transplant at any time in the given year. Active and inactive candidates are included. Candidates listed at more than one center are counted once per listing. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.

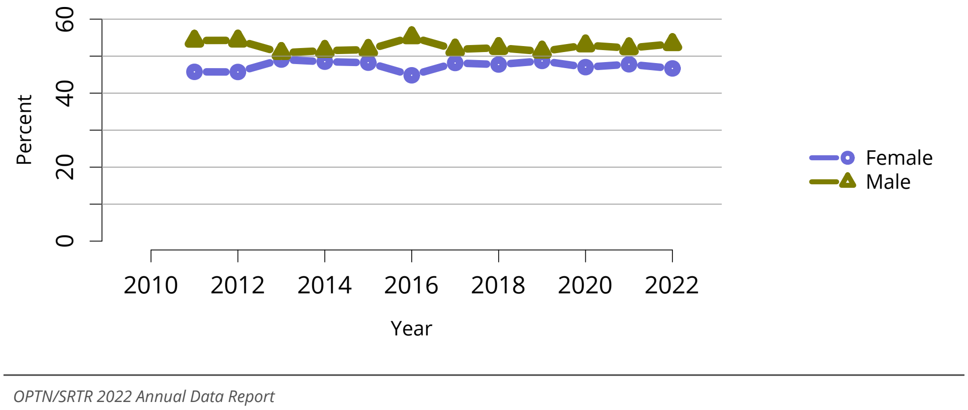

Figure IN 4: Distribution of candidates waiting for intestine transplant by sex. Candidates waiting for transplant at any time in the given year. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing.

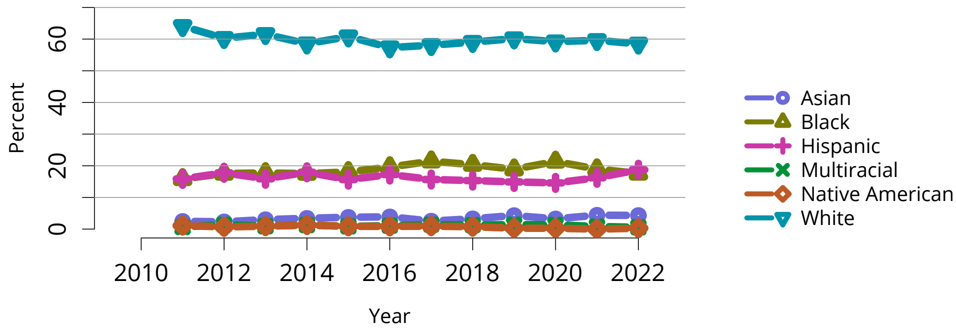

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Figure IN 5: Distribution of candidates waiting for intestine transplant by race and ethnicity. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

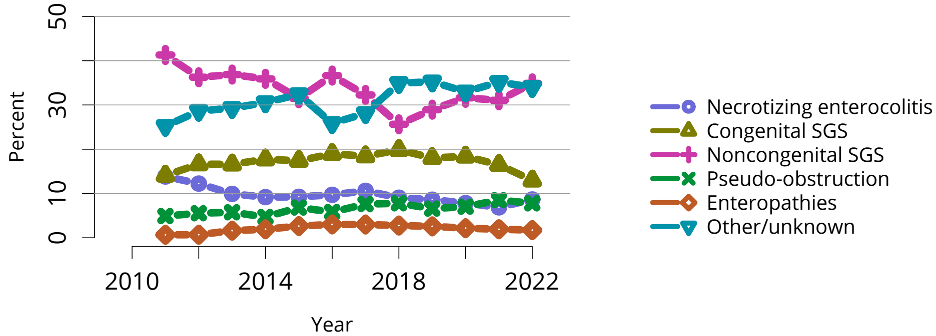

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Figure IN 6: Distribution of candidates waiting for intestine transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing. SGS, short-gut syndrome.

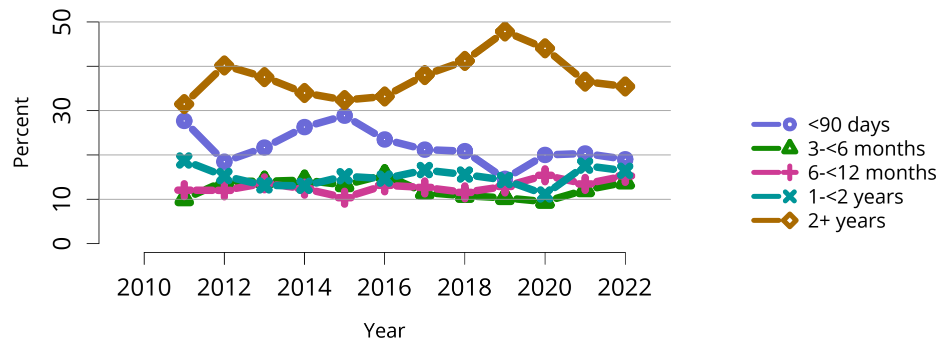

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Figure IN 7: Distribution of candidates waiting for intestine transplant by waiting time. Candidates waiting for transplant at any time in the given year. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included. Candidates listed at more than one center are counted once per listing.

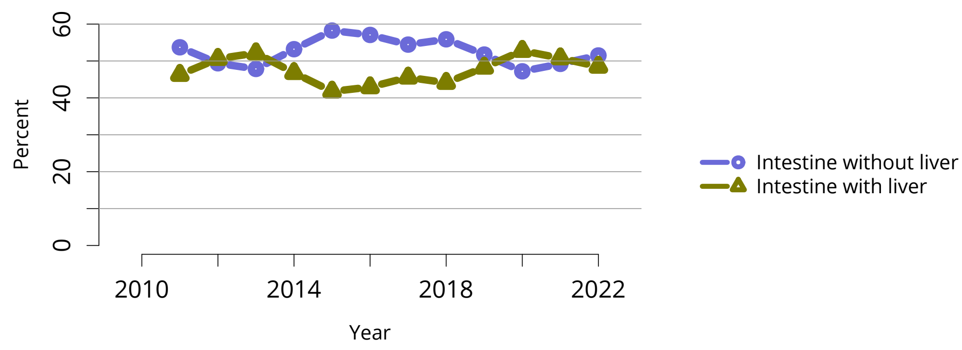

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Figure IN 8: Distribution of adult candidates waiting for intestine transplant by liver colisting. Adult candidates waiting for transplant at any time in the given year. Intestine-liver candidates were dually listed on at least one day during the year. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing.

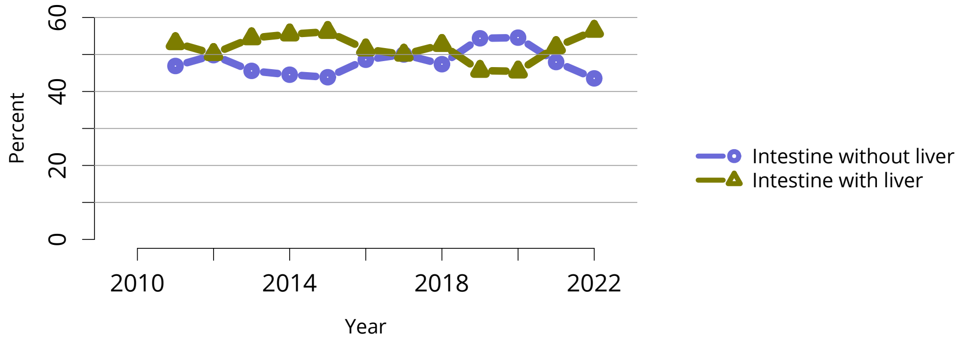

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Figure IN 9: Distribution of pediatric candidates waiting for intestine transplant by liver colisting. Pediatric candidates waiting for transplant at any time in the given year. Intestine-liver candidates were dually listed on at least one day during the year. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing.

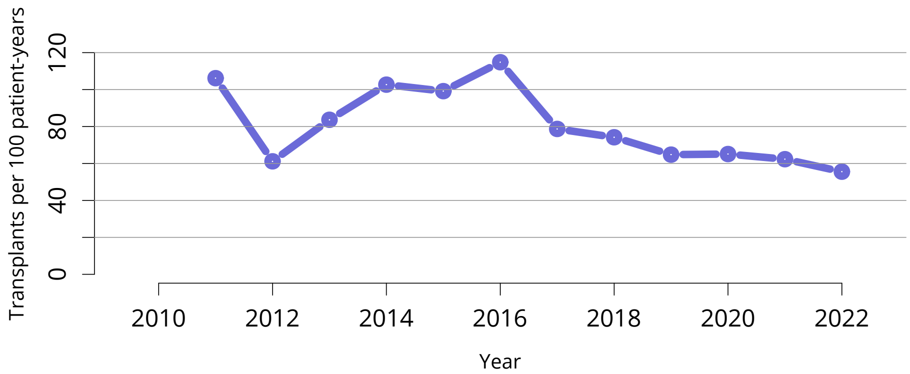

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Figure IN 10: Overall donor intestine transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

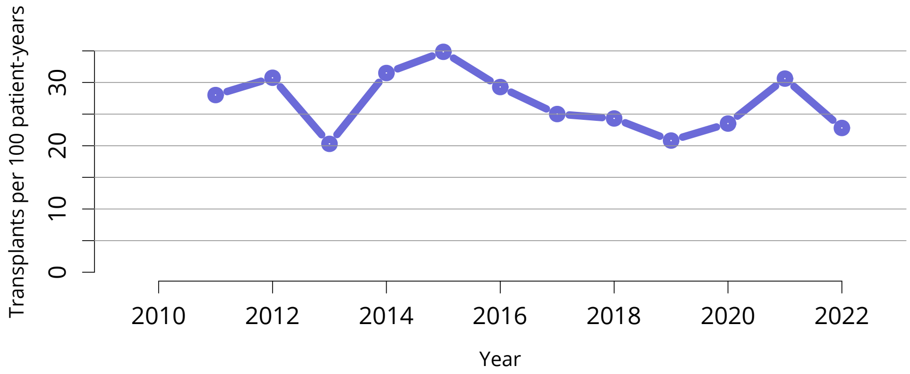

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Figure IN 11: Overall donor intestine transplant rates among pediatric waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

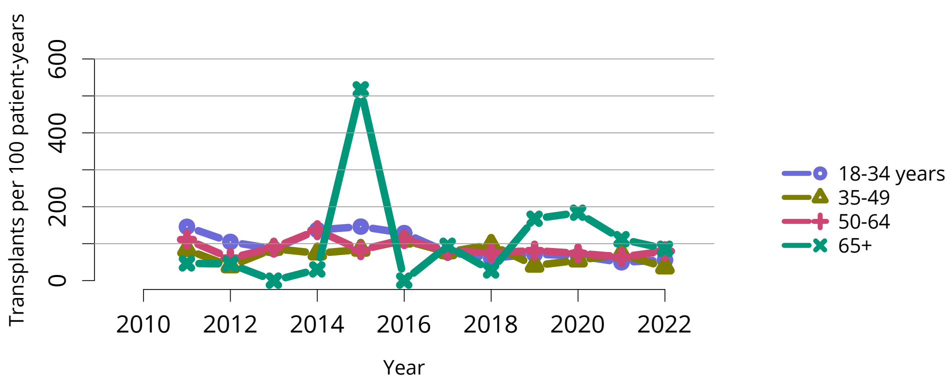

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Figure IN 12: Deceased donor intestine transplant rates among adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

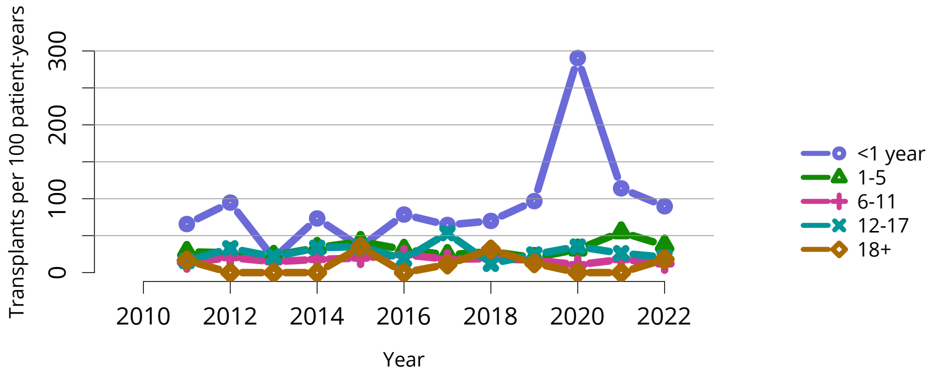

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Figure IN 13: Deceased donor intestine transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.

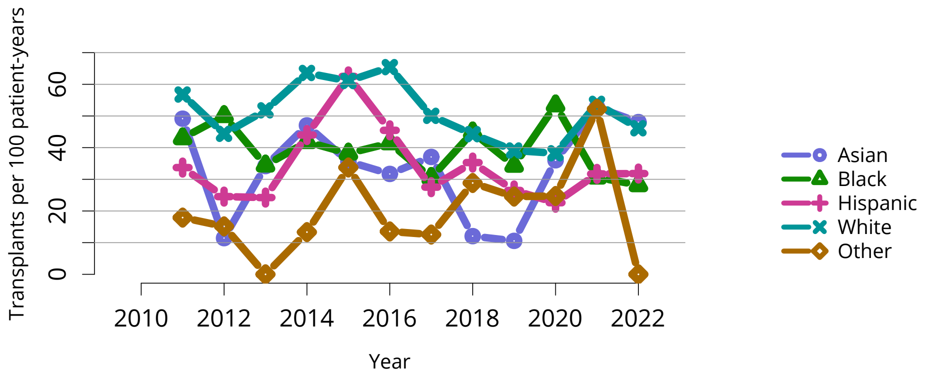

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Figure IN 14: Deceased donor intestine transplant rates among waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.

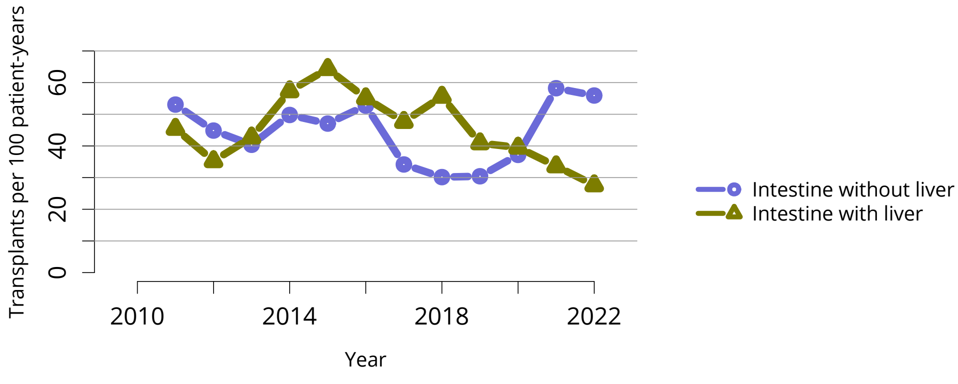

Figure IN 15: Deceased donor intestine transplant rates among waitlisted candidates by liver colisting. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Intestine-liver colisting is determined at the time of listing.

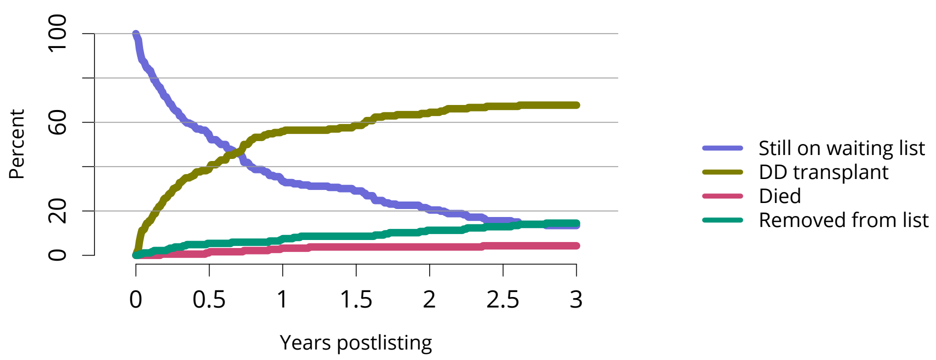

Figure IN 16: Three-year outcomes for candidates waiting for intestine transplant without liver, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.

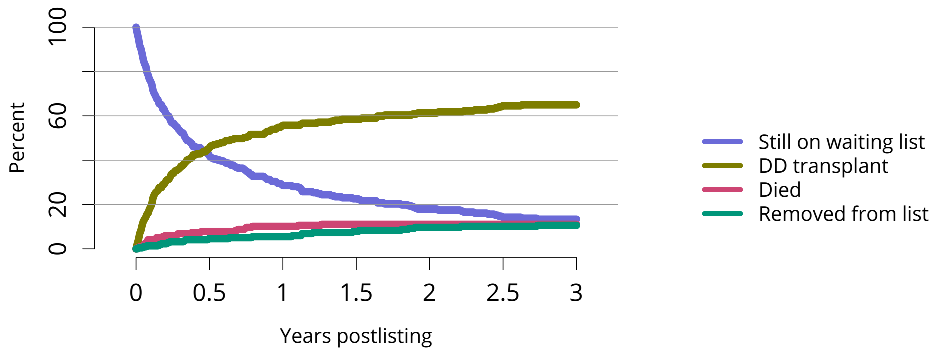

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Figure IN 17: Three-year outcomes for candidates waiting for intestine transplant with liver, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.

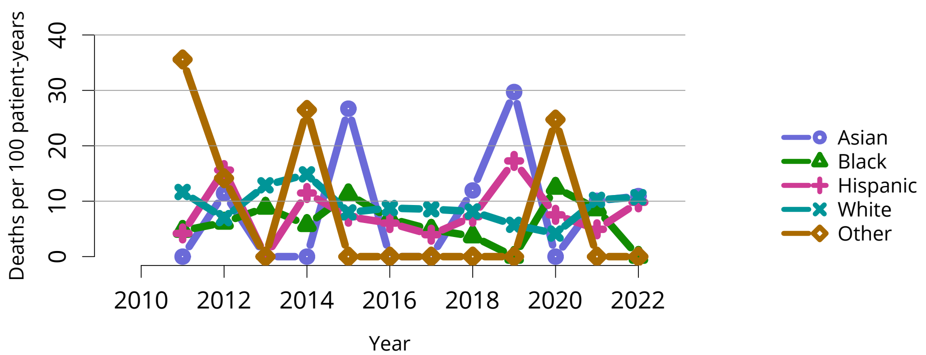

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Figure IN 18: Pretransplant mortality rates among candidates waitlisted for intestine transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Candidates listed at more than one center are counted once per listing. The Other race category is composed of Native American and Multiracial categories.

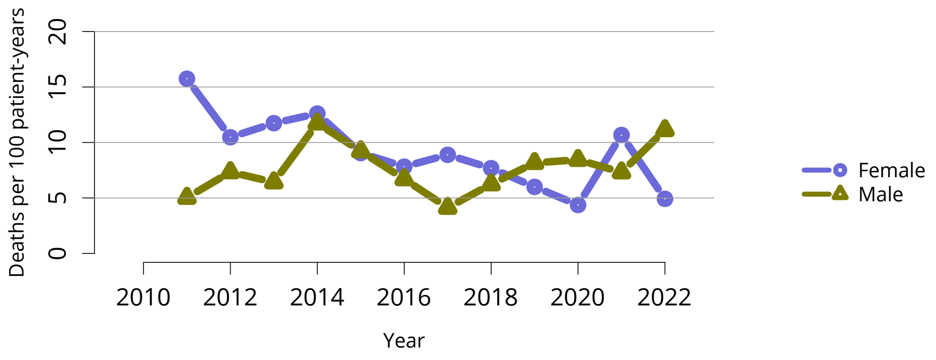

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Figure IN 19: Pretransplant mortality rates among candidates waitlisted for intestine transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Candidates listed at more than one center are counted once per listing.

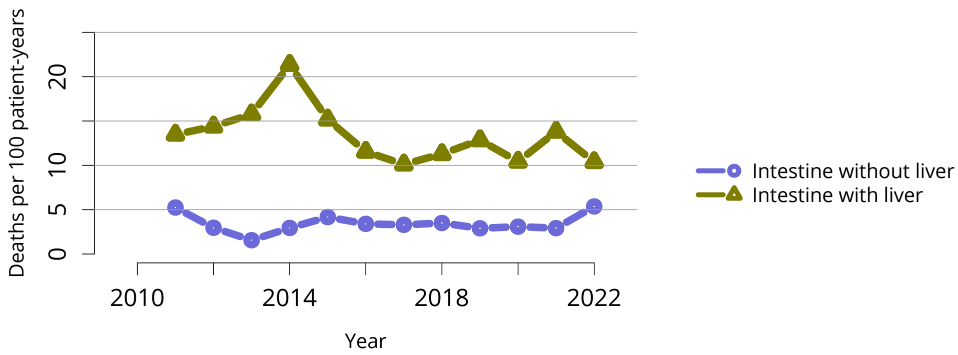

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Figure IN 20: Pretransplant mortality rates among candidates waitlisted for intestine transplant by liver colisting. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Candidates listed at more than one center are counted once per listing. Intestine-liver colisting is determined at the later of listing date or January 1 of the year.

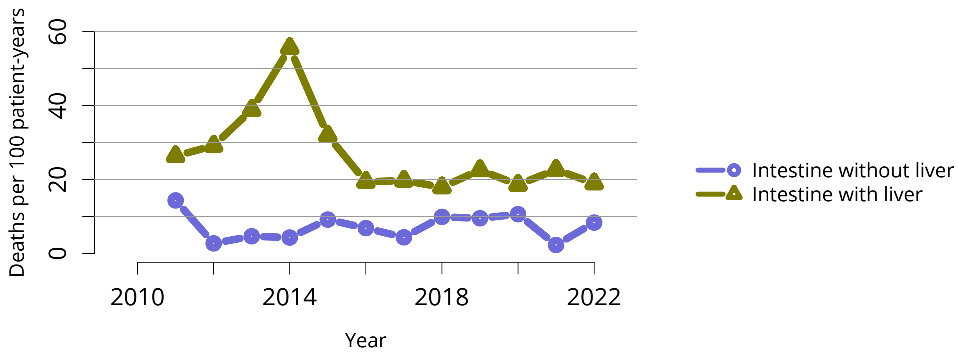

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Figure IN 21: Pretransplant mortality rates among adult candidates waitlisted for intestine transplant by liver colisting. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Candidates listed at more than one center are counted once per listing. Intestine-liver colisting is determined at the later of listing date or January 1 of the year.

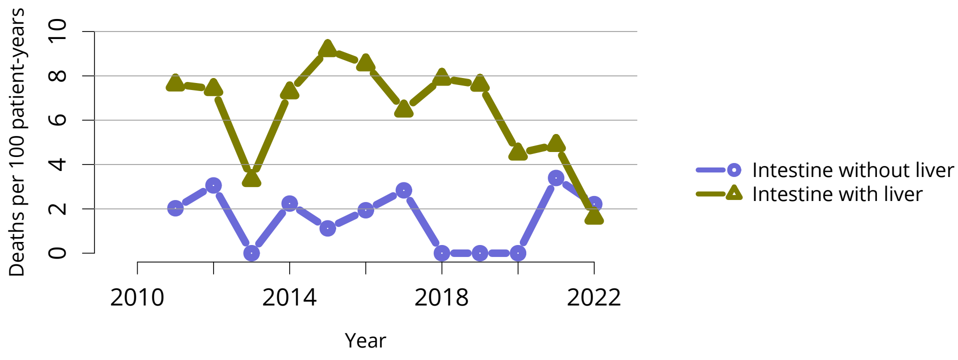

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Figure IN 22: Pretransplant mortality rates among pediatric candidates waitlisted for intestine transplant by liver colisting. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Candidates listed at more than one center are counted once per listing. Intestine-liver colisting is determined at the later of listing date or January 1 of the year.

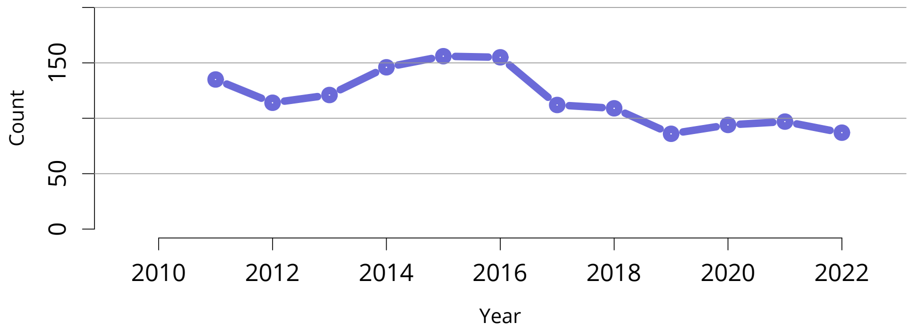

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Figure IN 23: Overall deceased intestine donor count. Count of deceased donors whose intestines were recovered for transplant.

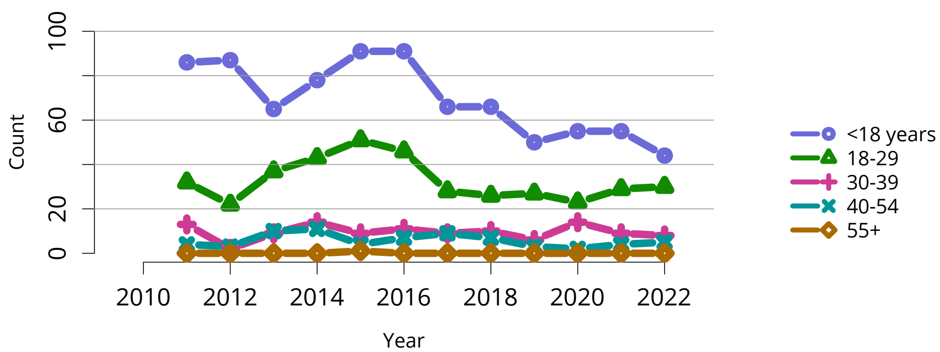

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Figure IN 24: Deceased intestine donor count by age. Count of deceased donors whose intestines were recovered for transplant.

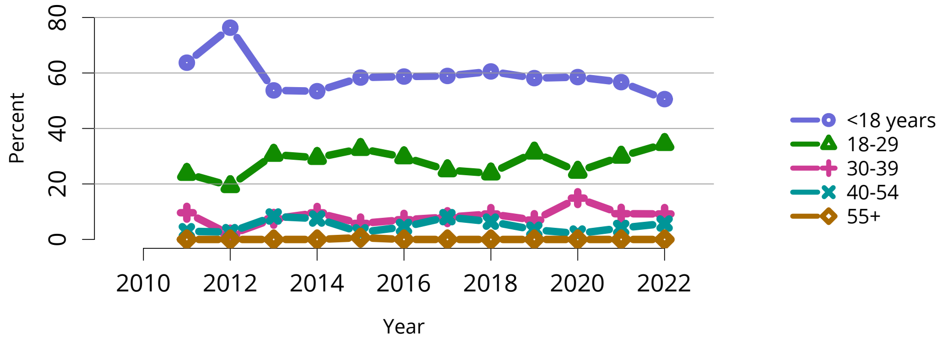

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Figure IN 25: Distribution of deceased intestine donors by age. Deceased donors whose intestines were recovered for transplant.

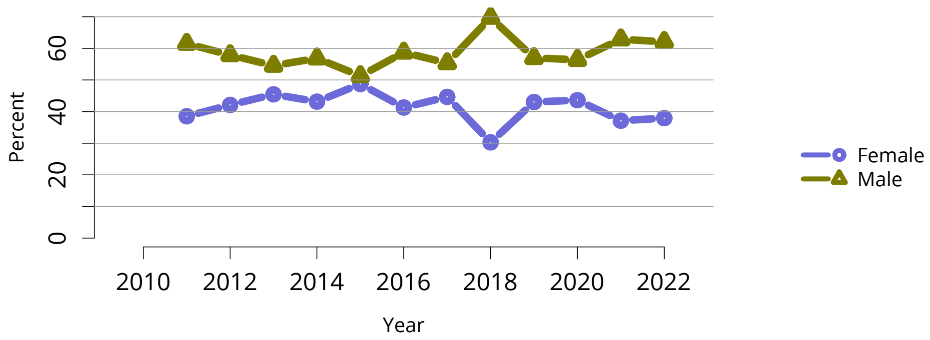

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Figure IN 26: Distribution of deceased intestine donors by sex. Deceased donors whose intestines were recovered for transplant.

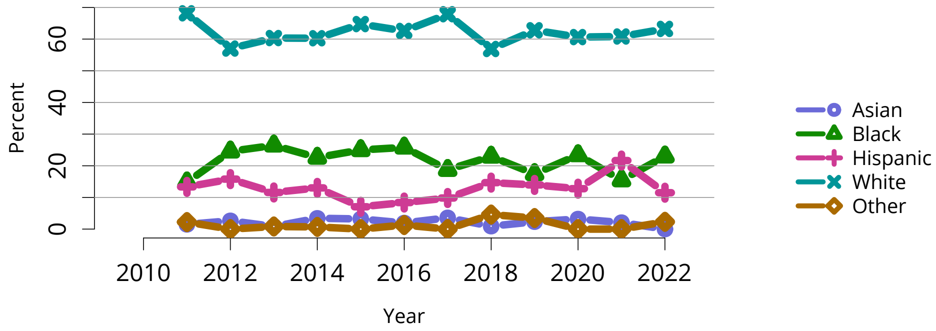

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Figure IN 27: Distribution of deceased intestine donors by race and ethnicity. Deceased donors whose intestines were recovered for transplant. The Other race category is composed of Native American and Multiracial categories.

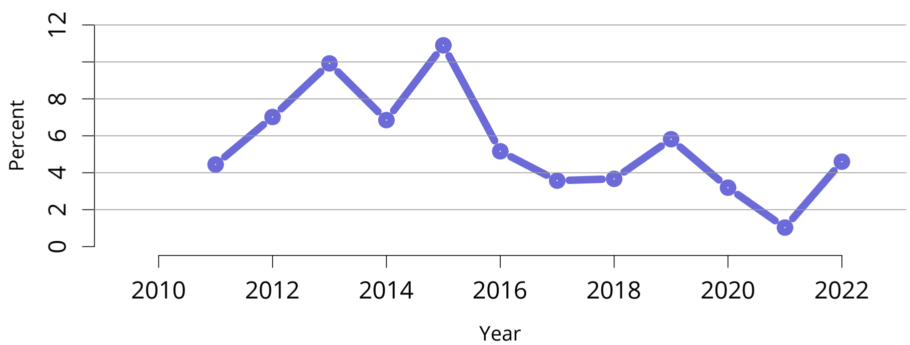

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Figure IN 28: Overall percent of intestines recovered for transplant and not transplanted. Percentages of intestines not transplanted out of all intestines recovered for transplant.

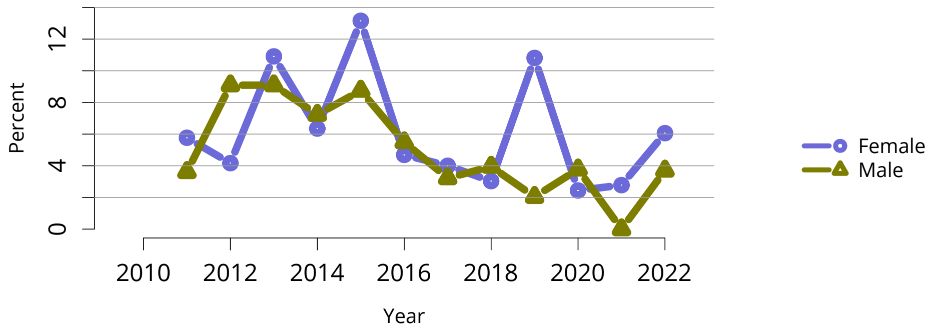

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Figure IN 29: Percent of intestines recovered for transplant and not transplanted by donor sex. Percentages of intestines not transplanted out of all intestines recovered for transplant.

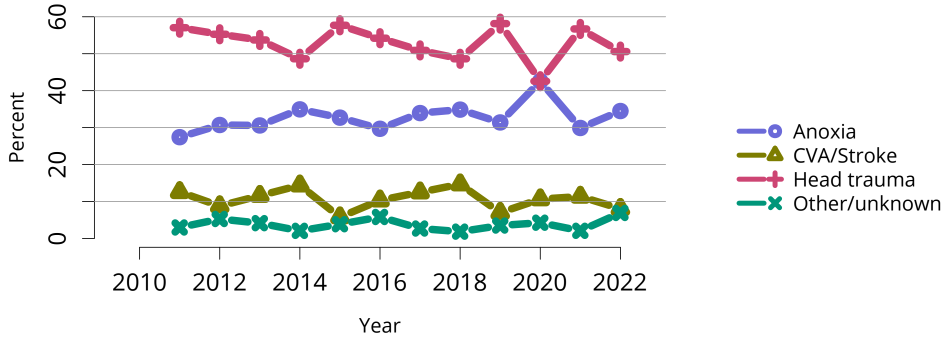

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Figure IN 30: Cause of death among deceased intestine donors. Deceased donors whose intestines were transplanted. CVA, cerebrovascular accident.

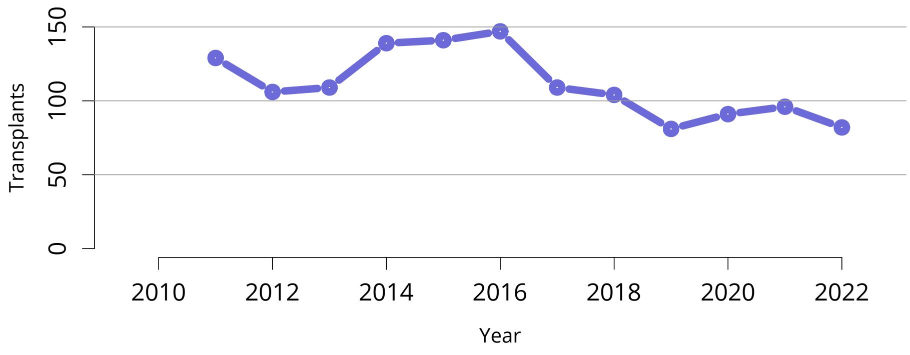

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Figure IN 31: Overall intestine transplants. All intestine transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

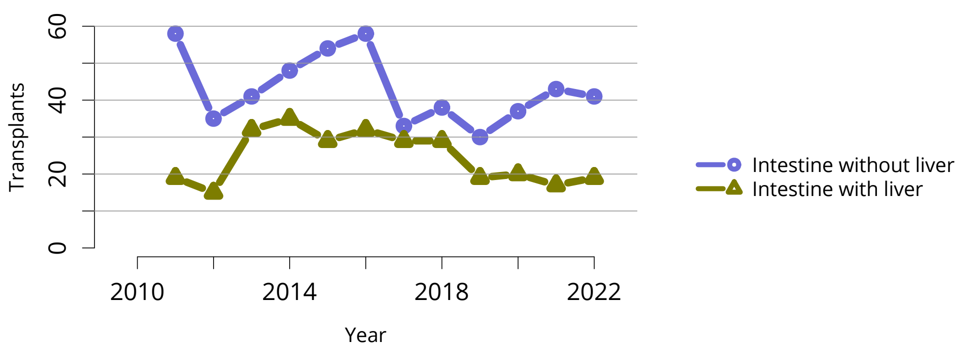

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Figure IN 32: Adult intestine transplants by transplant type. Adult intestine transplant recipients, including retransplant and multiorgan recipients.

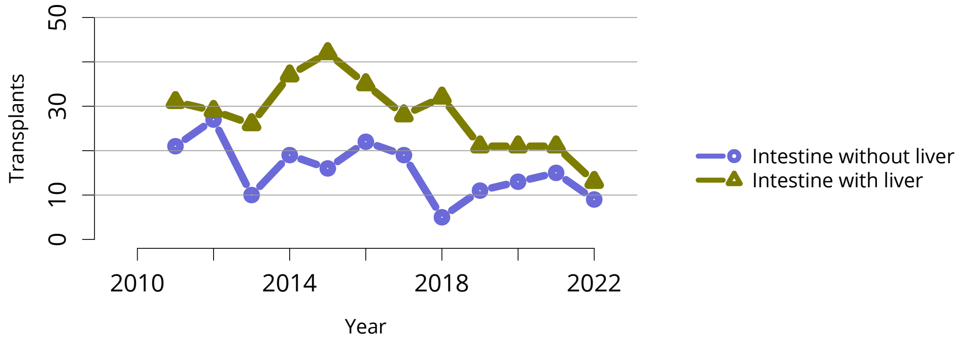

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Figure IN 33: Pediatric intestine transplants by transplant type. Pediatric intestine transplant recipients, including retransplant and multiorgan recipients.

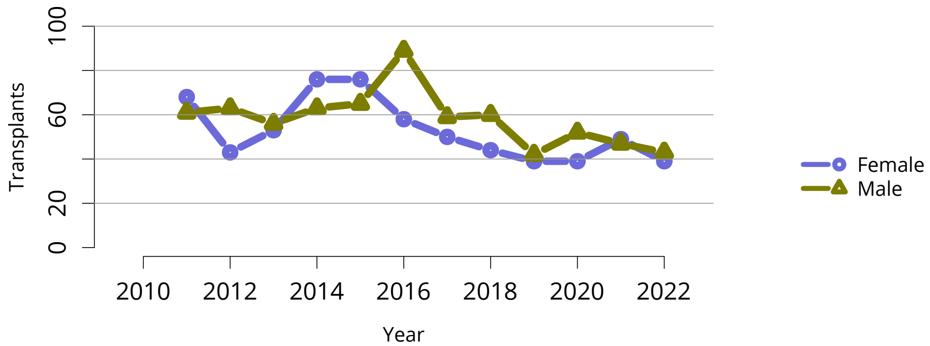

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Figure IN 34: Total intestine transplants by sex. All intestine transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

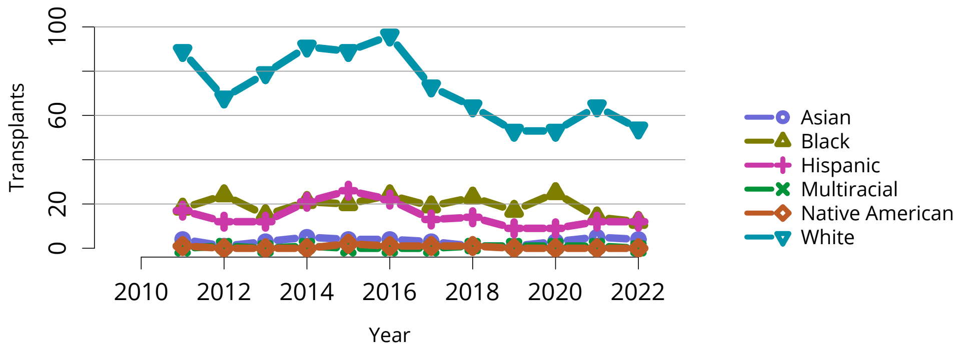

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Figure IN 35: Total intestine transplants by race and ethnicity. All intestine transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

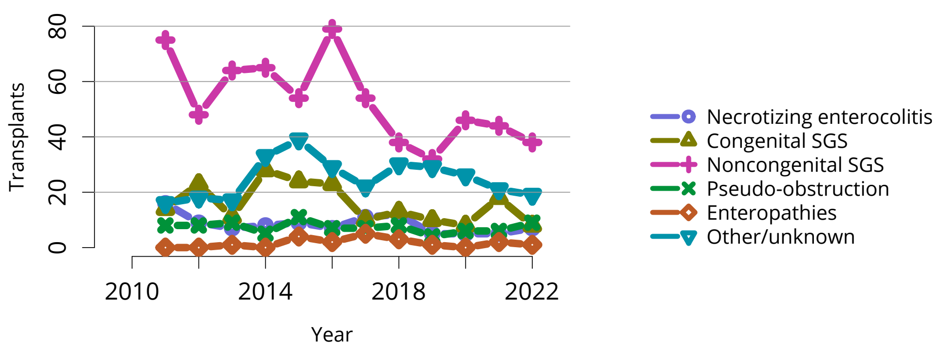

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Figure IN 36: Total intestine transplants by diagnosis. All intestine transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. SGS, short-gut syndrome.

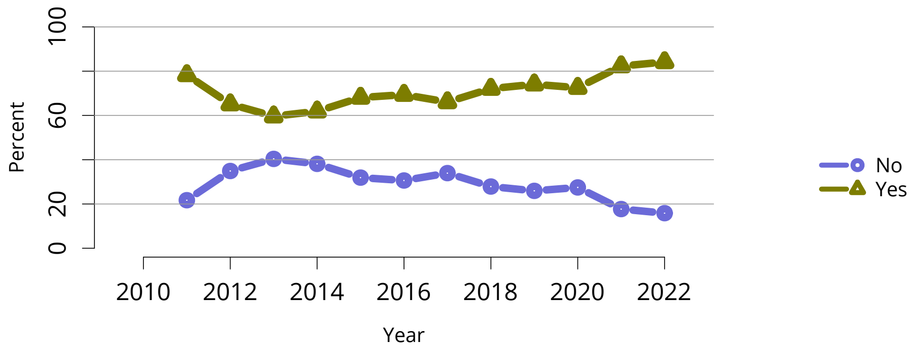

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Figure IN 37: Induction agent use in intestine transplant recipients. Immunosuppression at transplant reported to the OPTN.

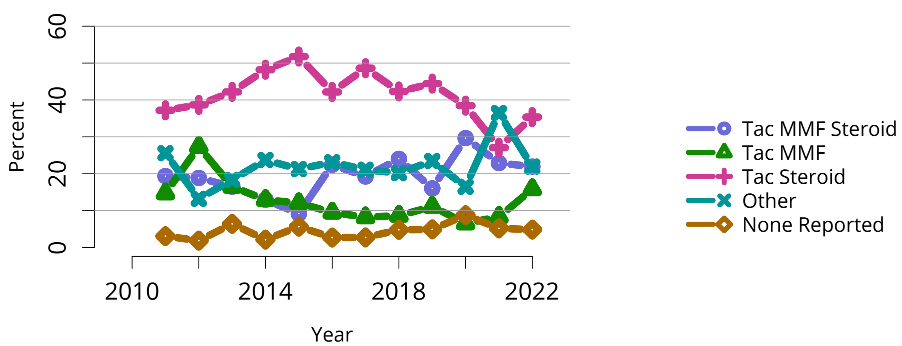

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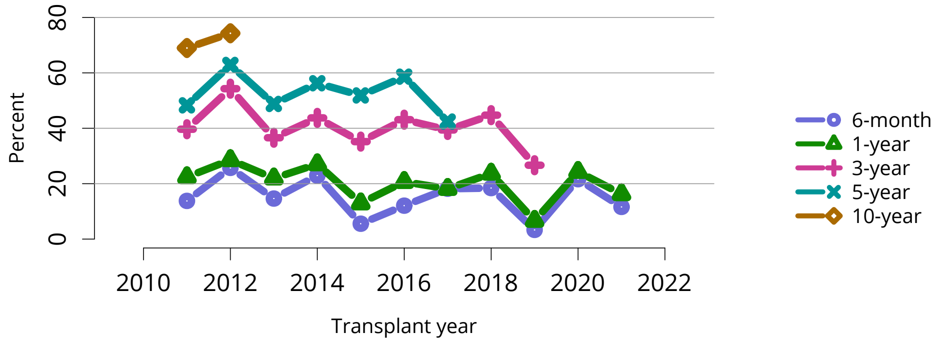
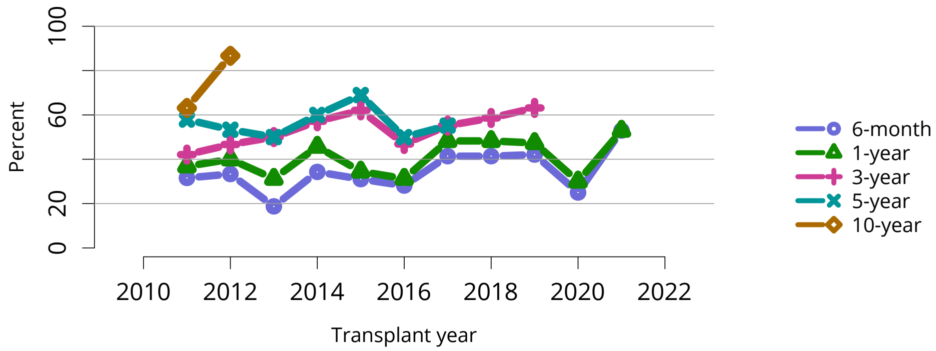
Figure IN 38: Distribution of immunosuppression regimen use in intestine transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



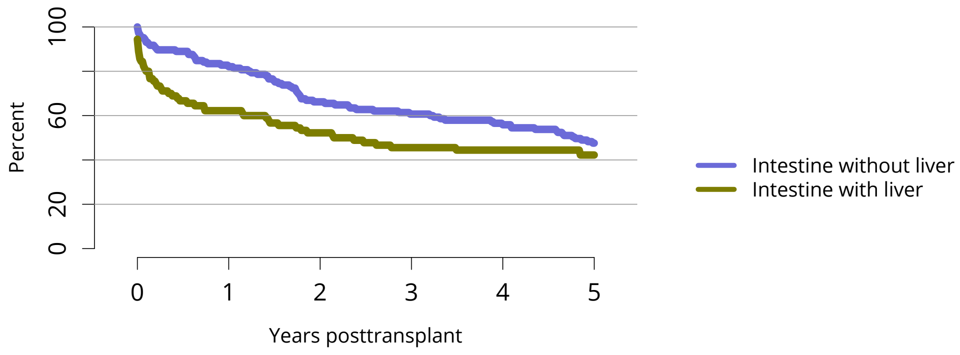
OPTN/SRTR 2022 Annual Data Report

Figure IN 39: Graft failure among transplant recipients of intestine without liver. All recipients of deceased donor intestines, including multiorgan transplant recipients.



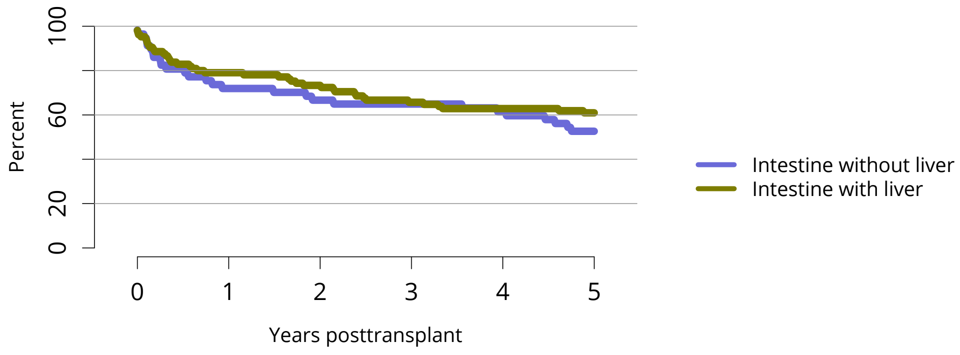
OPTN/SRTR 2022 Annual Data Report

Figure IN 40: Graft failure among transplant recipients of intestine with liver. All recipients of deceased donor intestines, including multiorgan transplant recipients.



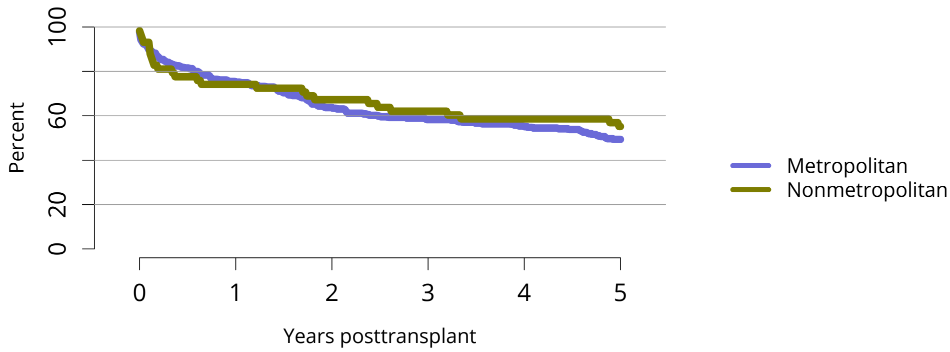
OPTN/SRTR 2022 Annual Data Report

Figure IN 41: Graft survival among deceased donor adult intestine transplant recipients, 2015-2017, by transplant type. Intestine graft survival estimated using unadjusted Kaplan-Meier methods.



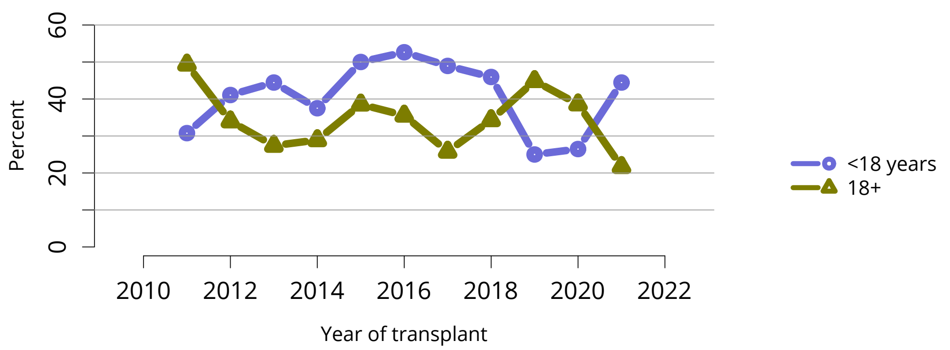
OPTN/SRTR 2022 Annual Data Report

Figure IN 42: Graft survival among deceased donor pediatric intestine transplant recipients, 2015-2017, by transplant type. Intestine graft survival estimated using unadjusted Kaplan-Meier methods.



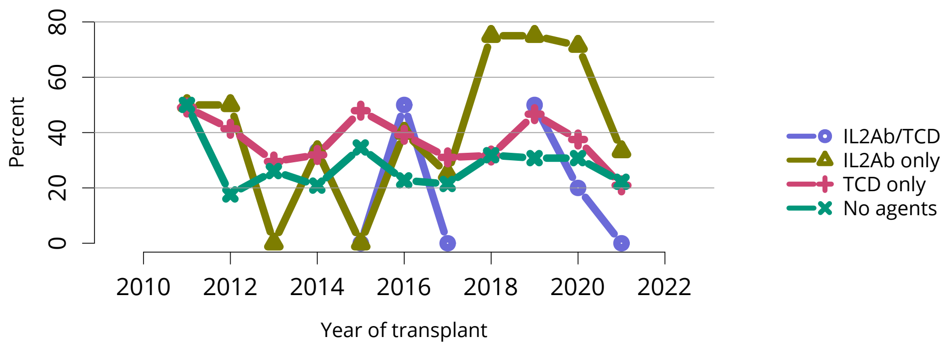
OPTN/SRTR 2022 Annual Data Report

Figure IN 43: Graft survival among deceased donor intestine transplant recipients, 2015-2017, by metropolitan versus nonmetropolitan recipient residence. Graft survival estimated using unadjusted Kaplan-Meier methods.



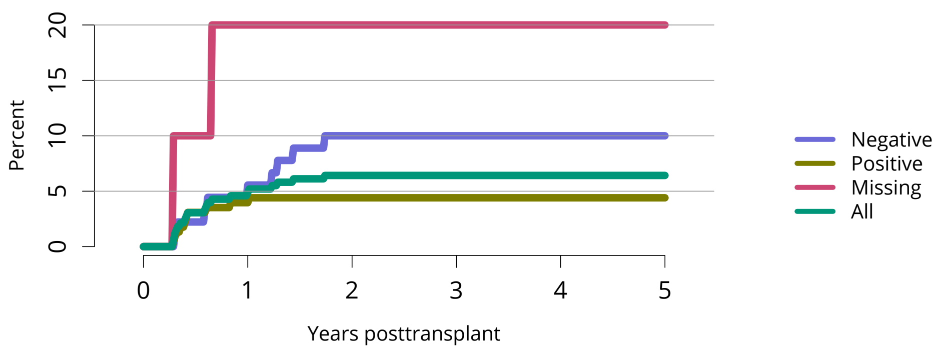
OPTN/SRTR 2022 Annual Data Report

Figure IN 44: Incidence of acute rejection by 1 year posttransplant among intestine transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



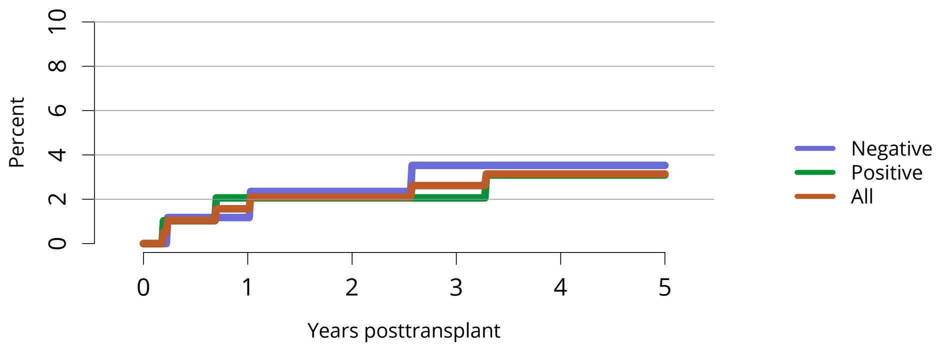
OPTN/SRTR 2022 Annual Data Report

Figure IN 45: Incidence of acute rejection by 1 year posttransplant among adult intestine transplant recipients by induction agent. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method. IL2Ab, interleukin-2 receptor antibody; TCD, T-cell depleting.



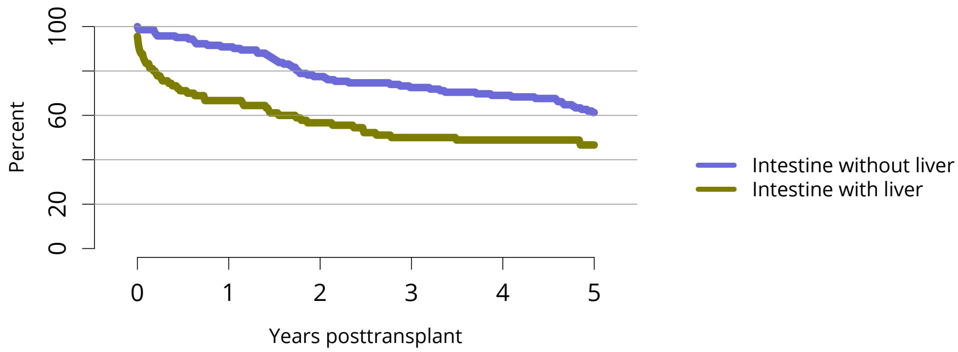
OPTN/SRTR 2022 Annual Data Report

Figure IN 46: Incidence of PTLD among recipients of intestine transplant without liver by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



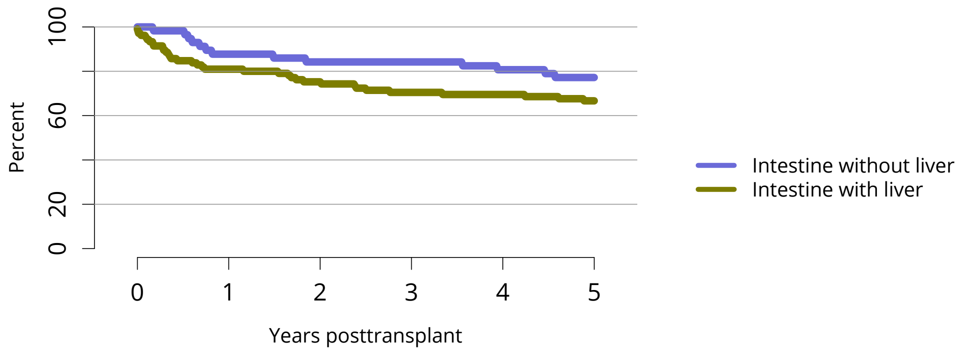
OPTN/SRTR 2022 Annual Data Report

Figure IN 47: Incidence of PTLD among recipients of intestine transplant with liver by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



OPTN/SRTR 2022 Annual Data Report

Figure IN 48: Patient survival among deceased donor adult intestine transplant recipients, 2015-2017, by transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure IN 49: Patient survival among deceased donor pediatric intestine transplant recipients, 2015-2017, by transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods.

Table IN 1: Demographic characteristics of candidates on the intestine transplant waiting list on December 31, 2022. Candidates waiting for intestines with and without liver on December 31, 2022, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center.

	IN		IN-LI	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
<18 years	42	43.8	52	43.7
18-34	16	16.7	26	21.8
35-49	23	24	18	15.1
50-64	14	14.6	22	18.5
65+	1	1	1	0.8
Sex				
Female	54	56.2	48	40.3
Male	42	43.8	71	59.7
Race and ethnicity				
Asian	6	6.2	3	2.5
Black	21	21.9	22	18.5
Hispanic	17	17.7	22	18.5
Multiracial	2	2.1	0	0
Native American	1	1	0	0
White	49	51	72	60.5
Geography				
Metropolitan	87	90.6	100	84
Nonmetropolitan	8	8.3	13	10.9
Missing	1	1	6	5
Miles between candidate and center				
<50 miles	29	30.2	36	30.3
50-<100	5	5.2	11	9.2
100-<150	9	9.4	14	11.8
150-<250	13	13.5	18	15.1
250+	39	40.6	34	28.6
Missing	1	1	6	5
All candidates				
All candidates	96	100	119	100

Table IN 2: Clinical characteristics of candidates on the intestine transplant waiting list on December 31, 2022. Candidates waiting for intestines with and without liver on December 31, 2022, regardless of first listing date. SGS, short-gut syndrome.

	IN		IN-LI	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Necrotizing enterocolitis	5	5.2	13	10.9
Congenital SGS	14	14.6	19	16
Noncongenital SGS	32	33.3	32	26.9
Pseudo-obstruction	13	13.5	6	5
Enteropathies	1	1	2	1.7
Other/unknown	31	32.3	47	39.5
Blood type				
A	38	39.6	42	35.3
AB	3	3.1	3	2.5
B	16	16.7	19	16
O	39	40.6	55	46.2
All candidates				
All candidates	96	100	119	100

Table IN 3: Listing characteristics of candidates on the intestine transplant waiting list on December 31, 2022. Candidates waiting for intestines with and without liver on December 31, 2022, regardless of first listing date.

	IN		IN-LI	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
<90 days	17	17.7	12	10.1
3-<6 months	17	17.7	7	5.9
6-<12 months	8	8.3	25	21
1-<2 years	18	18.8	17	14.3
2+ years	36	37.5	58	48.7
Previous transplant				
No prior transplant	89	92.7	98	82.4
Prior transplant	7	7.3	21	17.6
All candidates				
All candidates	96	100	119	100

Table IN 4: Intestine transplant waitlist activity, 2022. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	IN	IN-LI
Waiting list state		
Patients at start of year	89	112
Patients added during year	78	68
Patients removed during year	71	61
Patients at end of year	96	119

Table IN 5: Removal reason among intestine transplant candidates, 2022. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	IN	IN-LI
Removal reason		
Deceased donor transplant	49	33
Patient died	5	10
Patient refused transplant	1	2
Improved, transplant not needed	7	4
Too sick for transplant	3	6
Other	6	6

Table IN 6: Demographic characteristics of intestine transplant recipients, 2022. Intestine transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	IN		IN-LI	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
<18 years	9	18	13	40.6
18-34	18	36	4	12.5
35-49	10	20	3	9.4
50-64	11	22	12	37.5
65+	2	4	0	0
Sex				
Female	28	56	11	34.4
Male	22	44	21	65.6
Race and ethnicity				
Asian	3	6	1	3.1
Black	6	12	6	18.8
Hispanic	8	16	4	12.5
White	33	66	21	65.6
Insurance				
Private	26	52	12	37.5
Medicare	6	12	6	18.8
Medicaid	15	30	13	40.6
Other/unknown	3	6	1	3.1
Geography				
Metropolitan	43	86	26	81.2
Nonmetropolitan	7	14	6	18.8
Miles between recipient and center				
<50 miles	21	42	14	43.8
50-<100	8	16	2	6.2
100-<150	2	4	0	0
150-<250	7	14	7	21.9
250+	12	24	9	28.1
All recipients				
All recipients	50	100	32	100

Table IN 7: Clinical characteristics of intestine transplant recipients, 2022. Intestine transplant recipients, including retransplant recipients. SGS, short-gut syndrome.

	IN		IN-LI	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Necrotizing enterocolitis	2	4	5	15.6
Congenital SGS	4	8	4	12.5
Noncongenital SGS	26	52	12	37.5
Pseudo-obstruction	7	14	2	6.2
Enteropathies	1	2	0	0
Other/unknown	10	20	9	28.1
Blood type				
A	21	42	12	37.5
AB	2	4	1	3.1
B	6	12	3	9.4
O	21	42	16	50
All recipients				
All recipients	50	100	32	100

Table IN 8: Transplant characteristics of intestine transplant recipients, 2022. Intestine transplant recipients, including retransplant recipients.

	IN		IN-LI	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
<90 days	21	42	11	34.4
3-<6 months	13	26	5	15.6
6-<12 months	6	12	7	21.9
1-<2 years	6	12	6	18.8
2+ years	4	8	3	9.4
Donor type				
Deceased donor	50	100	32	100
Previous transplant for recipients				
No prior transplant	48	96	27	84.4
Prior transplant	2	4	5	15.6
All recipients				
All recipients	50	100	32	100

OPTN/SRTR 2022 Annual Data Report: Heart

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Abstract

The number of heart transplants in the United States has continued to increase. Since 2011, pediatric heart transplants have increased 31.7% to 494 and adult heart transplants have increased 85.8% to 3,668 in 2022. The numbers of new candidates for pediatric and adult heart transplants have also increased, with 703 new pediatric candidates and 4,446 new adult candidates in 2022. Adult heart transplant rates continue to rise, peaking at 122.5 transplants per 100 patient-years in 2022; however, the pediatric heart transplant rate decreased to its lowest rate in the past decade, 104.2 transplants per 100 patient-years, a decrease of 13.9% from 121 transplants per 100 patient-years in 2011. Despite this, pretransplant mortality among pediatric candidates has decreased by 52.2%, from 20.8 deaths per 100 patient-years in 2011 to 10.0 deaths per 100 patient-years in 2022, but remains excessive for candidates younger than 1 year at 25.7 deaths per 100 patient-years. Among adult candidates, pretransplant mortality declined from 15 deaths per 100 patient-years in 2011 to 8.7 deaths per 100 patient-years in 2022. Since 2011, posttransplant mortality has been stable to slightly better; among recipients who

underwent transplant in 2015-2017, the 1-, 3-, and 5-year pediatric survival rates were 93.7%, 89.2%, and 85.0%, respectively, and the adult survival rates were 91.3%, 85.7%, and 80.4%. Donor trends have been favorable, with an increase in the numbers of hearts recovered and growing numbers of hearts procured after circulatory death.
Keywords: Allocation, donor, heart failure, heart transplant, left ventricular assist device, mechanical circulatory support, outcomes

1 Introduction

Heart allocation policy, particularly the adult heart allocation policy, has evolved and has universally changed practice.[1,2] Although the 2018 policy may have contributed to better access and faster transplant rates,[3] particularly in high-urgency candidates, and lower overall pretransplant mortality rates, the policy changes inadvertently promoted short-term circulatory support devices as a means to transplant[4,5] and resulted in excessive requests for exceptions.[6] Despite increased transplant rates among candidates listed at statuses 1 and 2, pretransplant mortality, which was previously declining, increased between 2021 and 2022, a concerning signal. Nevertheless, the promise of continuous distribution and a points-based allocation policy may help to mitigate some of the unintended consequences of the policy by removing hard boundaries for listing and for moving to a higher status, and by providing weights to clinically relevant attributes. The Annual Data Report provides an evaluation of trends in adult and pediatric heart transplant waiting lists, donation, transplants, and outcomes in the United States. This year, the race and ethnicity category has been expanded to include Multiracial and Native American, and limited data are available for hearts recovered after circulatory death. Inherent differences in calculations during 2018 should be considered when assessing status-specific rates obtained during 2018 among adult candidates and recipients. As a result, trends in adult heart transplant that are stratified by status are compared to 2019 as opposed to 2018 where appropriate.

2 Adult Heart Transplant

2.1 Adult Waitlist Trends

In 2022, 4,446 new adult heart candidates were added to the heart transplant waiting list; a total of 7,519 candidates aged 18 years and older were awaiting heart transplant, a 28.1% increase from 5,869 candidates in 2011 (Figure HR 1 and Figure HR 2). The largest adult age group on the waiting list in 2022 continues to be 50-64 years (46.7%), followed by 35-49 years (21.7%), 65 years or older (20.3%), and 18-34 years (11.3%) (Figure HR 3). Over the past decade, the proportion of all racial and ethnic groups increased except for White, which decreased by 18.4%, and Multiracial, which remained constant (Figure HR 5). In 2022, more than half of adult heart transplant candidates were White (56.3%), 28.2% were Black, 10.8% were Hispanic, 3.8% were Asian, and 0.4% were Native American; 0.5% identified as Multiracial (Figure HR 5). Cardiomyopathy continued to be the leading diagnosis among adult heart transplant candidates, at 60.2% in 2022, which is an increase of 18.7% since 2011. The proportion of adults awaiting transplant for coronary artery disease has declined by 28.2% over the past decade (Figure HR 6). Time on the waiting list, which is determined by the earliest of transplant, death, removal, or December 31 of the year, appears to be decreasing, with 45.8% of candidates waiting less than 90 days, an increase of 54.5% since 2011. There was an appreciable increase in waiting times of less than 90 days while longer waiting times decreased (Figure HR 7).

More than half (61.6%) of adult heart transplant candidates lived less than 50 miles from the transplant center in 2022 (Table HR 1). The proportion of candidates on the waiting list with a ventricular assist device at listing increased from 22.4% in 2012 to 35.0% in 2022 (Table HR 2). On December 31, 2022, almost half of candidates, 47%, were awaiting transplant as status 4; the second largest group was waiting as status 6, 19.9% (Table HR 2). Between 2021 and 2022, there were increases in candidates awaiting heart transplant as status 1 and status 2 in all regions except regions 6, 7, and 9, where status 1 candidates decreased or remained constant. In 2022, the proportion of candidates awaiting transplant as status 1 ranged from 4.3% to 7.5% across regions and from 20.5% to 33.5% for status 2 (Table HR 4). There has been an increase in both waitlist removals and candidates added to the waiting list between 2020 and 2022; however, removals have exceeded additions, resulting in a decline in candidates on the list at the end of the year (Table HR 5). Since 2019, the first full year of the new heart allocation policy, the proportion of candidates awaiting transplant at statuses 1, 2, 5, and 6 has increased by 1.9%, 7.7%, 0.5%, and 1.8%, respectively, while there has been a decrease in candidates at statuses 3 and 4, by 3.2% and 4.5%, respectively (Figure HR 9). Among the candidates removed from the waiting list in 2022, 3,652 (78.7%) were removed due to transplant, 171 (3.7%) died, 157 (3.4%) were removed due to improved condition, and 212 (4.6%) were considered too sick to undergo transplant (Table HR 6).

2.2 Adult Heart Transplant Rates

Transplant rates have been increasing since 2015, and in 2022, the overall transplant rate was 122.5 transplants per 100 patient-years; this is an increase of 81.8% since 2011, when the rate was 67.4 transplants per 100 patient-years (Figure HR 13). Similar increases were seen in all age groups, with the greatest increase occurring in candidates aged 18-34 years. Candidates aged 65 years or older received transplants most rapidly at 138.8 transplants per 100 patient-years in 2022 (Figure HR 14). Regarding race and ethnicity, candidates in the Asian category underwent transplant at the highest rate, at 175.6 transplants per 100 patient-years, followed by those in the Hispanic, White, Black, and Other categories. In all categories, there was an increase in transplant rate since 2011, with the greatest change, 173.4%, occurring in the category classified as Other (Figure HR 15). By diagnosis, candidates with valvular heart disease had the highest transplant rate (145.6 transplants per 100 patient-years), followed by cardiomyopathy, Other/unknown, coronary artery disease, and congenital heart disease (128.7, 122.9, 113.5, and 98.0 transplants per 100 patient-years, respectively) (Figure HR 16). The transplant rate for all blood types continues to increase, with the greatest increase since 2011 (110%) occurring in blood type A. The transplant rate for blood type AB increased 89% since 2018 and remains the highest rate of all blood types, at 376.6 transplants per 100 patient-years in 2022, more than twice that of blood type A, which has the second highest transplant rate (Figure HR 17). The transplant rate among women exceeds that of men: 143.1 versus 116.4 transplants per 100 patient-years (Figure HR 18). Since 2019, transplant rates have declined slightly for statuses 1 and 2 and increased for the other active statuses (Figure HR 20). Status 1 candidates continue to have the highest rate of transplant: 1,640 transplants per 100 patient-years in 2022. Most patients who were newly listed in 2019 underwent transplant within the first year of listing (63.8%); by 3 years, 71.8% had undergone transplant, 6.5% were still waiting, 4.0% had died, and 17.7% were removed for other reasons (Figure HR 23).

2.3 Adult Pretransplant Mortality

Overall pretransplant mortality declined from 15 deaths per 100 patient-years in 2011 to 8.7 deaths per 100 patient-years in 2019 and has remained at a plateau in 2022 (Figure HR 25). Since 2011, pretransplant mortality has declined for all age groups but remains highest for persons aged 65 years or older, at 14.4 deaths per 100 patient-years in 2022 (Figure HR 26). Pretransplant mortality declined for all race and ethnicity categories since 2011 except for Asian. Candidates in the Asian category had slightly higher pretransplant mortality in 2022, at 9.7 deaths per 100 patient-years, compared with 8.5 deaths per 100 patient-years in 2012, while pretransplant mortality decreased substantially in other race and ethnicity categories (Figure HR 27). Candidates with congenital heart disease had the greatest improvement in pretransplant mortality rate, with a decline of 51.3% since 2011 to 6.2 deaths per 100 patient-years in 2022, the lowest of all the diagnoses. Pretransplant mortality increased 50.1% in the valvular heart disease group, from 8.77 deaths per 100 patient-years in 2011 to 13.2 deaths per 100 patient-years in 2022. This was second to candidates classified with an "Other/unknown" diagnosis, who had the highest pretransplant mortality in 2022: 15.7 deaths per 100 patient-years (Figure HR 29).

Following the 2018 heart allocation policy, there was an increase in the prevalence of short-term circulatory support devices prior to transplant.[4] In 2022, the proportion of patients on any life support declined to 74.4% compared with 82.3% in 2019. There was an increase in use of all circulatory support devices, except for total artificial heart, which declined to only eight cases in 2022 (Table HR 7). The OPTN policy to collect data on Impella 5.5 became effective on August 16, 2023; therefore, this device is not included in this analysis.

Since 2019, pretransplant mortality increased among candidates listed at statuses 1, 2, and 3 and improved in those listed as statuses 4, 5, and 6 (Figure HR 32). Pretransplant mortality among status 1 candidates had declined to 81.2 deaths per 100 patient-years in 2021, but increased again to 143 deaths per 100 patient-years in 2022, which far exceeds that of candidates listed as status 2 (46.0 deaths per 100 patient-years). Candidates listed as status 6 had the lowest pretransplant mortality rate in 2022 (3.6 deaths per 100 patient-years), followed by status 4 (4.8 deaths per 100 patient-years). Candidates listed as status 5 continue to have a higher pretransplant mortality rate (10.4 deaths per 100 patient-years) than candidates listed at status 4 (Figure HR 32). While there remains concern in the community regarding the slower rate of transplant for candidates listed as status 4, namely those with a left ventricular assist device, the rate of transplant does not appear to affect mortality among candidates listed as status 4. Candidates listed as status 4 had the second lowest pretransplant mortality, while pretransplant mortality continues to be highest among the statuses associated with hemodynamic instability or multiorgan failure (statuses 1, 2, 3, and 5) (Figure HR 32). Pretransplant mortality rates in 2022 varied widely by donation service area: from 0 to 44.92 deaths per 100 patient-years, with a mean of 9.6 deaths per 100 patient-years (Figure HR 33).

Deaths within 6 months of removal from the transplant list for reasons other than transplant or death have declined since 2011, although these percentages slightly increased from 11.5% in 2021 to 14.8% in 2022 (Figure HR 34). Death within 6 months of removal was highest in 2022 among candidates aged 65 years or older (23.7%) and lowest among candidates aged 18-34 years (7.0%) (Figure HR 35). In 2022, Asian candidates had the highest percentage of death within 6 months of removal; there was a 62% increase from 2011 (14.3%) to 2022 (23.1%). Death within 6 months of removal also increased for candidates in the Hispanic category and declined for those in the Black, White, and Other categories (Figure HR 36). Death within 6 months of removal from the list also increased among candidates listed as status 1, from 15% in 2019 to 44.4% in 2022, while decreasing in all other statuses. Death within 6 months of removal was second highest in temporarily inactive candidates (16.5%), followed by candidates listed as status 5 (11.1%) (Figure HR 38).

2.4 Trends in Donor Hearts

The number of deceased donor hearts recovered for transplant (including adult and pediatric) continues to rise, and in 2022, reached 4,223, a 77.4% increase from 2,380 in 2011 (Figure HR 39). The largest annual increase, 384 donors, occurred from 2015 to 2016, followed by 323 from 2021 to 2022. The greatest increase in donors from 2011 to 2022 occurred in those aged 30-39 years, from 461 to 1,353 (a 194% increase); this approximates the number of donors aged 18-29 years, which reached 1,432 in 2022 and is typically the largest donor age group. There has also been a 78% increase in donors aged 40-54 years, from 479 in 2011 to 851 in 2022, while the number of donors aged 55 years or older declined to 47 in 2022 from 58 in 2011, following a peak of 97 in 2019 (Figure HR 40). In 2022, the age group 18-29 years comprised 33.9% of donors, followed by age group 30-39 years, which comprised 32% of donors (Figure HR 41). There were no major changes in donor distributions by race and ethnicity or sex (Figure HR 42 and Figure HR 43). Donors who were hepatitis C virus positive increased substantially from 2011 to 2022 (11,763%) and reached a plateau of about 10% of all donors in 2019 through 2022 (Figure HR 44).

In 2022, 8.8% of the hearts recovered for transplant were procured after circulatory death (ie, donation after circulatory death [DCD]), a substantial increase from 0.04% in 2011 and 0.0% in 2018, from which time there has been a steady increase (Figure HR 45). In 2019, anoxia emerged as the leading cause of death for heart donors and continues to increase in prevalence; in 2022, 48.5% of heart donors died from anoxia (Figure HR 46). Nonuse of recovered hearts remains uncommon but is at the highest level this decade at 1.3%, a value twice that of 2011 (Figure HR 47). Most of the unused hearts are from donors aged 55 years and older (6.4%), while less than 1% of unused hearts are from donors younger than 18 years (Figure HR 48). Since 2011, rates of nonuse have increased among all race and ethnicity groups except Other, and most notably among Hispanic donors. The highest nonuse rate in 2022 is among Asian donors (2.7%), followed by Black donors (1.9%), Hispanic donors (1.5%), White donors (1%), and donors in the Other category (0%) (Figure HR 50). Hearts from donors with hypertension continue to be unused at higher rates than from those without hypertension: 1.7% versus 1.2% in 2022. This nonuse of hearts from donors with hypertension is overall lower since 2011, while nonuse of hearts from donors without hypertension appears to be increasing (Figure HR 51). Regarding donor causes of death, hearts from donors who died of cerebrovascular accident/stroke were the most often not used in 2022 (2.5%), followed by head trauma (1.3%); nonuse in both groups has increased tremendously since 2011 (increases of 92.2% and 740.5%, respectively). Donors whose cause of death was classified as Other/unknown have had widely fluctuating nonuse rates, with a peak of 3.3% in 2017 and a low of 0% in some years, including 2022 (Figure HR 53). These fluctuations may be due to variations in categorization or due to sample size. Nonuse rates among donors with standard risk of disease transmission and those with increased risk of disease transmission have fluctuated, and in 2022, nonuse rates among standard-risk donors were higher than those among increased-risk donors (1.5% versus 0.6%) (Figure HR 54).

2.5 Adult Heart Transplant Trends

Mirroring the increase in donors, heart transplants in the United States continue to gradually increase, with 3,668 adult heart transplants achieved in 2022 (Figure HR 55). In 2022, most adult heart transplant recipients were aged 50-64 years (46.6%). The number of recipients aged 65 years or older and 18-34 years increased 122.1% and 104.9%, respectively, since 2011 (Figure HR 56). The proportion of male recipients has increased faster than that of female recipients, and in 2022, there were 2,680 heart transplants performed in men compared with 988 in women (Figure HR 57). Between 2011 and 2022, the numbers of heart transplants increased in all race and ethnicity groups. This year, we have also added Native American as a category, and in 2022, there were 14 Native American heart transplant recipients compared to 1 reported cased in 2011 (Figure HR 58). The number of recipients who received transplants for cardiomyopathy continues to increase; however, the greatest changes occurred in congenital heart disease, increasing 149.3% between 2011 and 2022 (from 75 to 187), and in Other/unknown, which increased 381.8% (from 22 to 106). In 2022, there were 2,350 heart transplants performed in patients with cardiomyopathy compared to 950 in those with coronary artery disease, the next highest category, while only 39 transplants were performed for valvular heart disease (Figure HR 59). Since 2019 (the first full year after the 2018 heart allocation policy), there have been increases in transplants in all urgency categories except status 3, which declined 26.7%: from 644 recipients in 2019 to 472 in 2022 (Figure HR 60).

In 2022, 14.0% of heart transplants were combined with transplant of other organs compared with 5.7% in 2011. Multiorgan transplant has increased more rapidly than heart transplant alone. From 2011 to 2022, heart-kidney transplants increased 442.3%, from 71 to 385. Similarly, heart-liver transplants increased 393.3% (from 15 to 74) and heart-lung increased 87.5% (from 24 to 45), while heart-alone transplant increased by only 69.4% (Figure HR 61).

The demographic characteristics of the typical heart transplant recipient—White, male, 50-64 years—have not shifted substantially since 2012; however, there is an increasing prevalence of younger (18-34 years) and older (65+ years) recipients, more racial and ethnic diversity, and a more diverse payer mix, with an increase in Medicare and Medicaid and a decline in private payers from 50.9% to 44.8%. Most recipients reside within 50 miles of their transplant center, although there has been a slight decline since 2012 (Table HR 8). Most recipients have a calculated panel-reactive antibody (cPRA) value of <1%. It is noteworthy that in 2022, 27.2% of recipients had missing cPRA values. Most recipients (52.2%) were listed as status 2 at the time of transplant (Table HR 9). In 2022, 69.8% of patients waited fewer than 90 days (waiting time of 0 days and <90 days) for heart transplant compared with 50.0% in 2012 (Table HR 10). This was mirrored by a decrease in longer waiting times, although waiting time of 2 or more years changed minimally.

2.6 Adult Posttransplant Survival and Morbidity

Posttransplant mortality has been stable to slightly better since 2011, except for 10-year mortality, which increased slightly from 35.7% in 2011 to 37.4% in 2012. In 2022, 6-month and 1-year mortality were 7.3% and 9.2%, respectively. Three-year mortality was 15.3% and 5-year mortality was 19.9% (Figure HR 64). Early reductions in survival were seen in age groups older than 34 years, most notably in the 65 years or older group; by 6 months, survival among recipients who received a heart in 2015-2017 was 90.7% in recipients 65 years or older compared with 95.1% in those aged 18-34 years. This trend continued until year 2, after which there was a more pronounced decline in survival for recipients aged 18-34 years relative to the other age groups. By year 5, survival was slightly lower in recipients aged 18-34 years (78.9%) and 65 years or older (77.8%) compared with the other age groups (35-49 and 50-64 years, 82.1% and 81.0%, respectively) (Figure HR 66).

Early survival among recipients who received a heart in 2015-2017 declined more rapidly in the Native American category compared with other race and ethnicity groups, and by 3 months, was 88.0% compared with 92.0%-96.6% in the other categories; this may be affected by the low numbers of Native American transplant recipients. One-year mortality ranged from 88.0% to 92.3% among the race and ethnicity groups. Hispanic recipients also had early declines in mortality. By year 5, survival was highest in recipients categorized as White (81.9%), followed by Asian, Multiracial, Black, Hispanic, and Native American, ranging from 76.0% to 80.4% (Figure HR 67).

Short-term and long-term survival among recipients who received a heart in 2015-2017 were lowest in those with congenital heart disease, reaching 89.7% at 3 months and 75.0% at 5 years. Short-term survival was best among patients with cardiomyopathy, 92.4% at 1 year, but by 5 years, survival in recipients with cardiomyopathy had been surpassed by those with an Other/unknown diagnosis, 82.2% versus 86.6%, respectively (Figure HR 68). Five-year survival in recipients who received a heart in 2015-2017 was slightly worse among patients with a ventricular assist device compared to those without one, at 78.7% versus 82.1%, respectively (Figure HR 70). For the recipients who received a heart in 2019-2020, posttransplant survival was worse at all time points for recipients who underwent transplant at status 5; their survival was only 88.0% at 3 months, compared with 91.7%-95.8% for the other status categories. By 5 years, survival in recipients who underwent transplant at status 5 was only 77.3%, compared with 84.6%-88.7% in the other status groups (Figure HR 72).

Dual organ transplants have increased in heart recipients, and the 5-year survival rate for heart-liver and heart-kidney transplants in 2015-2017 (Figure HR 74) appears comparable to overall heart transplant survival from Figure HR 65. On the other hand, heart-lung continues to have lower survival compared with other heart transplant combinations. Five-year survival for heart-lung transplant is 64.8% and for Other multiorgan transplant is 75% (small numbers), compared with 80.6% for heart-kidney and 82.2% for heart-liver (Figure HR 74). Status 5, the category reserved for multiorgan transplant, tends to have the lowest posttransplant survival of all statuses, which may be driven by heart-lung transplant and Other multiorgan transplant. The decrement in survival for heart-lung transplant occurs during the first month of transplant. By 3 months, 25.0% of Other multiorgan recipients had died, and by 6 months, 14.8% of heart-lung recipients had died. Since 2011, the incidence of acute rejection by 1-year posttransplant has declined for all age groups except recipients aged 65 years or older. The most notable decline, 37% in 2011 to 29% in 2021, occurred in recipients aged 18-34 years, the group with the highest incidence of rejection. Acute rejection was lowest for recipients aged 65 years or older, at 17.9% in 2021, a slight increase from 17.3% in 2011 (Figure HR 75).

3 Pediatric Heart Transplant

3.1 Pediatric Waitlist Trends

In 2022, there were 703 new pediatric candidates added to the heart transplant waiting list, and a total of 1,188 candidates aged 17 years or younger were awaiting heart transplant, which is a 36.7% increase from 2011 (Figure HR 77 and Figure HR 78). The largest pediatric age group on the waiting list in 2022 was 12-17 years (29.0%), followed by 1-5 years (23.6%), younger than 1 year (21.4%), and 6-11 years (20.5%) (Figure HR 79). Almost half of pediatric heart transplant candidates were White (48.1%), 23.7% were Hispanic, 20.2% were Black, 4.2% were Asian, and 0.6% were Native American (Figure HR 80). Looking at changes over the past decade, the proportion of Asian candidates increased by 82.9% since 2011; Hispanic candidates increased by 23.8%, and the proportion of Black candidates has remained constant (Figure HR 80). Congenital defects continued to be the leading diagnosis among pediatric heart transplant candidates, at 60.4% in 2022, an increase of 32.3% since 2011 (Figure HR 81). Almost half, 47.9%, of pediatric heart transplant candidates live less than 50 miles from the transplant center (Table HR 11). The proportion of candidates listed with a ventricular assist device increased from 6.0% in 2012 to 8.6% in 2022 (Table HR 12). Among the 677 candidates removed from the waiting list in 2022, 509 (75.1%) were removed due to undergoing transplant, 48 (7.1%) died, 52 (7.7%) were removed due to improved condition, and 35 (5.2%) were considered too sick to undergo transplant (Table HR 15).

In 2022, 37.5% of pediatric heart transplant candidates on the waiting list had been waiting for less than 90 days, a decrease of 23.7% from 49.1% in 2011 (Figure HR 83). The proportion of candidates waiting 3 to less than 6 months increased by 41.5%, from 14.5% in 2011 to 20.5% in 2022. Almost half (47.1%) of candidates were listed as status 1A in 2022, followed by 19.2% status 1B and 10.9% status 2 (Figure HR 84). Just over 70% of pediatric candidates newly listed during 2017-2019 underwent transplant within 3 years, 9.7% died, 14.8% were removed from the list, and 4.7% were still waiting (Figure HR 85). In 2022, the heart transplant rate decreased to its lowest rate in the past decade, 104.2 transplants per 100 patient-years, which is a decrease of 13.9% from 121 transplants per 100 patient years in 2011 (Figure HR 86).

Transplant rates in 2022 varied by age, with the highest rates for candidates aged 12-17 years (163.5 transplants per 100 patient-years) and younger than 1 year (158.6 transplants per 100 patient-years), followed by 6-11 years (81.4 transplants per 100 patient-years) and 1-5 years (61.0 transplants per 100 patient-years) (Figure HR 87). Over the past decade, transplant rates in candidates younger than 1 year decreased by 41.8%; in those aged 1-5 years, decreased by 37.0%; in those aged 12-17 years, increased by 14.1%; and in those aged 6-11 years, remained relatively constant (Figure HR 87). Transplant rates in 2022 were similar among pediatric waitlist candidates by race and ethnicity (Figure HR 88).

Pretransplant mortality decreased by 52.2% from 2011 to 2022: from 20.8 deaths per 100 patient-years to 10.0 deaths per 100 patient-years (Figure HR 90). Pretransplant mortality rates in 2022 varied by age, with the highest rates in candidates younger than 1 year, at 25.7 deaths per 100 patient-years, followed by those aged 1-5 years, 12-17 years, and 6-11 years at 9.4, 6.5, and 5.1 deaths per 100 patient-years, respectively (Figure HR 91). From 2011 to 2022, pretransplant mortality has decreased in all age groups: by 62.0% among candidates younger than 1 year, by 50.6% among candidates aged 1- 5 years, by 64.5% in candidates aged 6-11 years, and by 35.9% among candidates aged 12-17 years (Figure HR 91). Looking at pretransplant mortality in 2022 by race and ethnicity, rates among Asian, Black, Hispanic, and White candidates were 14.7, 11.4, 10.8, and 8.2 deaths per 100 patient-years, respectively (Figure HR 92). By medical urgency, pretransplant mortality in 2022 was highest for candidates listed as status 1A (24.8 deaths per 100 patient-years), followed by status 1B (5.0 deaths per 100 patient-years) and status 2 (4.8 deaths per 100 patient-years) among active statuses (Figure HR 94). Pretransplant mortality rates were similar for heart transplant candidates listed in metropolitan and nonmetropolitan areas in 2022 (Figure HR 95).

3.2 Pediatric Trends in Heart Transplant

The number of pediatric heart transplants performed increased to 494 in 2022, a 31.7% increase from 2011 (Figure HR 96). There were 192 (38.9%) heart transplants performed in recipients aged 12-17 years, 114 (23.1%) in recipients younger than 1 year, 97 (19.6%) in recipients aged 1-5 years, and 91 (18.4%) in recipients aged 6-11 years (Figure HR 97). Looking at 2022 pediatric heart transplant counts by race and ethnicity, there were 223 heart transplants in White recipients, 126 in Hispanic recipients, 106 in Black recipients, 24 in Asian recipients, 12 in Multiracial recipients, and 3 in Native American recipients (Figure HR 99). Over the past decade, the proportion of transplant recipients aged 12-17 years has increased from 27.7% in 2012 to 38.9% in 2022 (Table HR 17). Just over half of pediatric heart transplant recipients in 2022 had congenital defect as their primary cause of disease, an increase from 44.1% in 2012 to 54.0% in 2022 (Table HR 18). From 2012 to 2022, the proportion who underwent transplant at status 1A declined from 87.4% to 81.2%, whereas the proportion who underwent transplant at status 1B increased from 7.8% to 16.4% and the proportion at status 2 declined from 4.8% to 2.4%. The proportion of pediatric heart transplant recipients with a ventricular assist device at transplant increased from 23.4% in 2012 to 37.7% in 2022 (Table HR 18). The proportion of ABO-incompatible transplants has increased from 3.0% in 2012 to 9.1% in 2022 (Table HR 19).

Over the past decade, induction therapy use has increased, to 83.6% of pediatric heart transplant recipients in 2022 (Figure HR 102). In 2022, for the first time, the initial immunosuppression regimen used most commonly in pediatric heart transplant recipients was tacrolimus and mycophenolate (in 46.4%, an increase of 114.6% since 2011), followed by tacrolimus, mycophenolate, and steroids (in 43.3%) (Figure HR 103).

3.3 Pediatric Posttransplant Survival and Morbidity

Among pediatric heart transplant recipients in 2021, the rate of acute rejection in the first year was 19.6% in recipients aged 12-17 years, 12.5% in those aged 6-11 years, 10.8% in those younger than 1 year, and 10.3% in those aged 1-5 years (Figure HR 104).

Recipient death occurred in 6.1% of patients at 6-months posttransplant and in 8.0% at 1-year posttransplant among pediatric heart transplants performed in 2021, in 11.8% at 3 years for transplants performed in 2019, in 15.7% at 5 years for transplants performed in 2017, and in 22.0% at 10 years for transplants performed in 2012 (Figure HR 106). Overall, 1-, 3-, and 5-year patient survival rates were 93.7%, 89.2%, and 85.0%, respectively, among recipients who underwent transplant in 2015-2017 (Figure HR 107). By age, 5-year patient survival was 83.2% for recipients younger than 1 year, 84.9% for those aged 1-5 years, 87.1% for those aged 6-11 years, and 85.7% for those aged 12-17 years among recipients who underwent transplant in 2015-2017 (Figure HR 108). By etiology of disease, 5-year patient survival was lowest among children with congenital defects at 81.0% and highest for children with idiopathic-related cardiomyopathy at 93.4% (Figure HR 110). By urgency status, the 5-year patient survival was 84.5% for status 1A pediatric recipients, 90.0% for status 1B recipients, and 77.5% for status 2 recipients (Figure HR 111).

Among pediatric heart transplant recipients in 2011-2017, the overall incidence of posttransplant lymphoproliferative disorder was 5.1% at 5 years; the incidence was 6.6% among recipients who were Epstein Barr virus negative and 3.5% among recipients who were Epstein-Barr virus positive (Figure HR 105).

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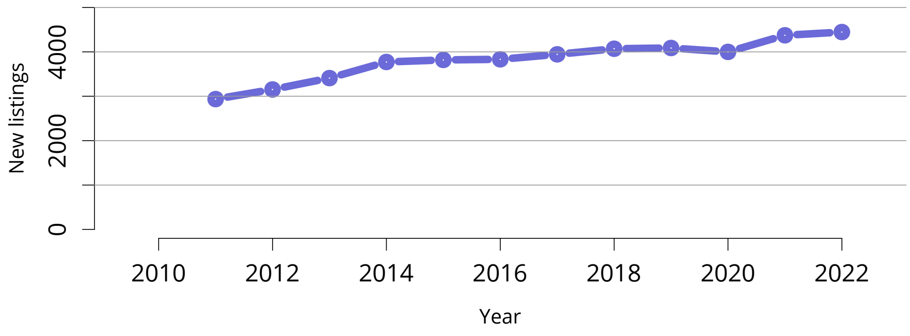

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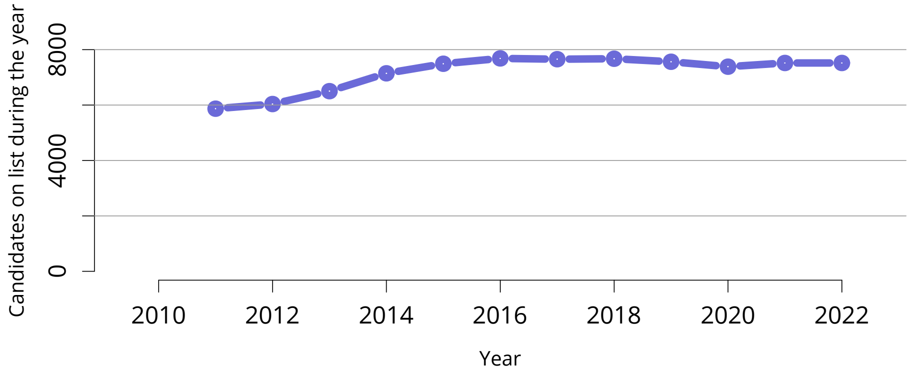
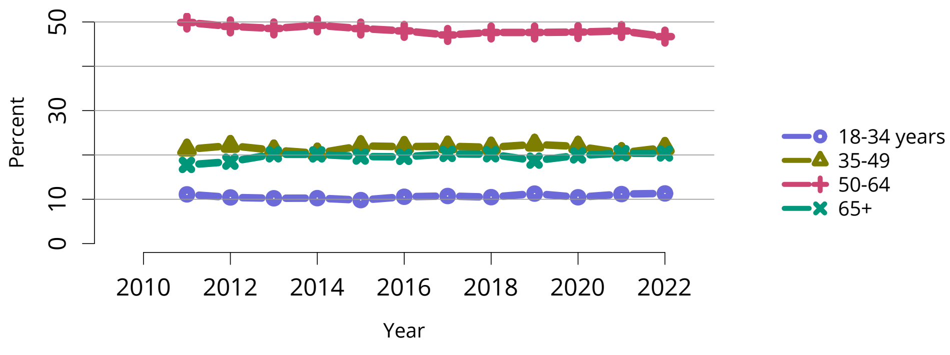
Figure HR 1: New adult candidates added to the heart transplant waiting list. A new adult candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included.



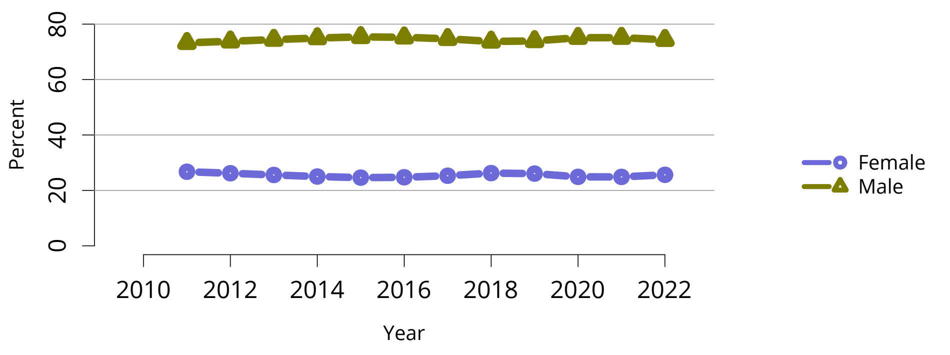
OPTN/SRTR 2022 Annual Data Report

Figure HR 2: All adult candidates on the heart transplant waiting list. Adult candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing.



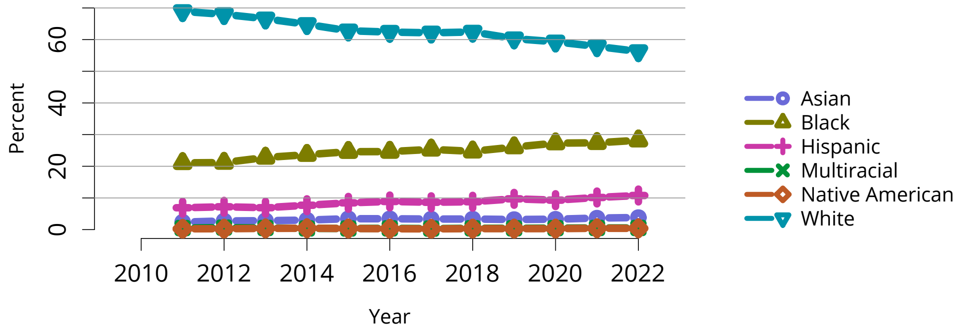
OPTN/SRTR 2022 Annual Data Report

Figure HR 3: Distribution of adults waiting for heart transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.



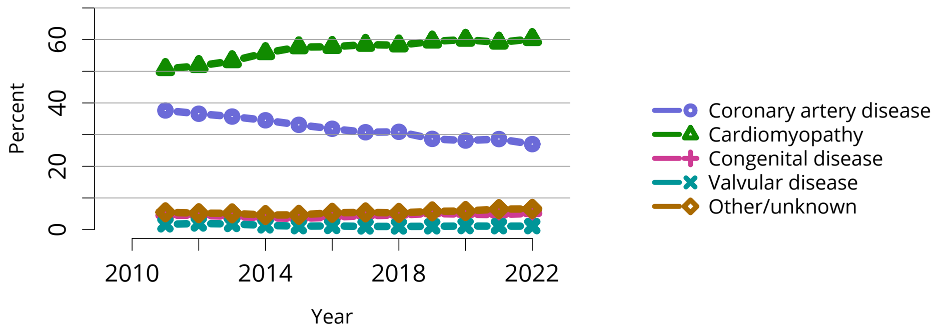
OPTN/SRTR 2022 Annual Data Report

Figure HR 4: Distribution of adults waiting for heart transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



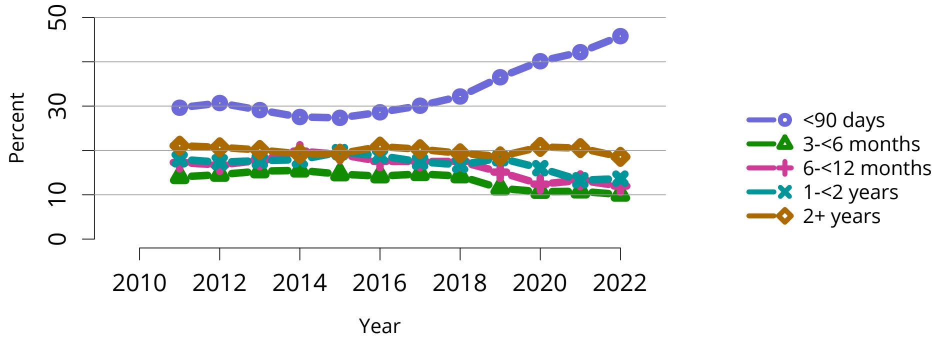
OPTN/SRTR 2022 Annual Data Report

Figure HR 5: Distribution of adults waiting for heart transplant by race and ethnicity. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure HR 6: Distribution of adults waiting for heart transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Active and inactive patients are included. Candidates listed at more than one center are counted once per listing.



OPTN/SRTR 2022 Annual Data Report

Figure HR 7: Distribution of adults waiting for heart transplant by waiting time. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included.

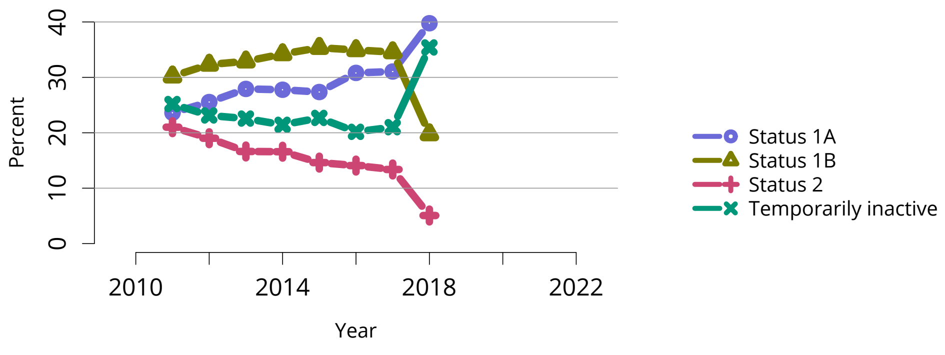


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Figure HR 8: Distribution of adults waiting for heart transplant by former medical urgency groups through October 17, 2018. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. The October 2018 OPTN heart allocation policy update changed the status groups. Medical urgency for 2017 and earlier is determined at the earliest of transplant, death, removal, or December 31 of the year. For 2018 medical urgency statuses, statuses 1A, 1B, and 2 were determined at the earliest of transplant, death, or removal. For candidates who stayed active on the waiting list on or after October 18, 2018, and for candidates who were newly waitlisted on or after that date, their statuses are shown in Figure HR 9. Inactive statuses with new listings on or after October 18, 2018, are excluded here in Figure HR 8.

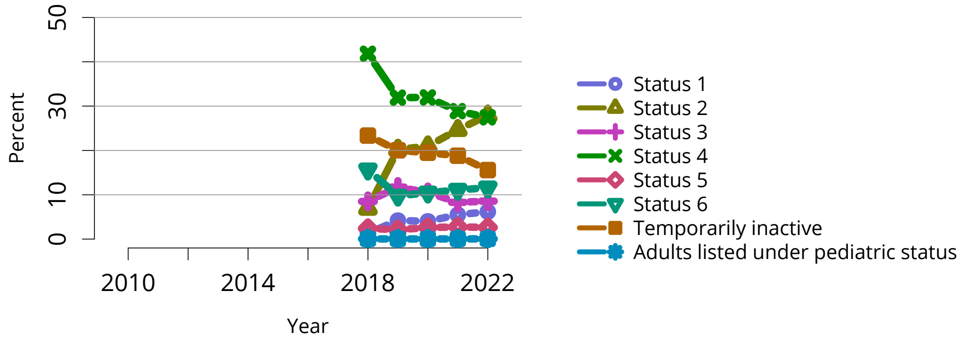

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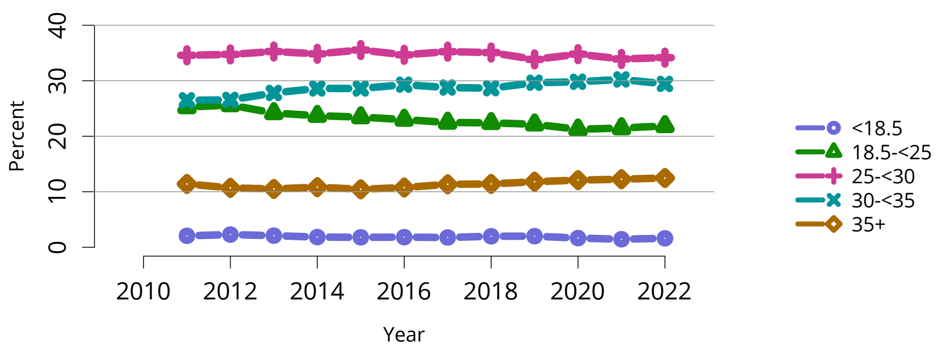
Figure HR 9: Distribution of adults waiting for heart transplant by new medical urgency groups, October 18, 2018, through 2022. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. The October 2018 OPTN heart allocation policy update changed the status groups. Medical urgency is determined at the earliest of transplant, death, removal, or December 31 of the year. For 2018 medical urgency statuses, statuses 1-6 and inactive status contain new listings on or after October 18, 2018, or existing listings from before the policy change.



OPTN/SRTR 2022 Annual Data Report

Figure HR 10: Distribution of adults waiting for heart transplant by BMI. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. BMI, body mass index.

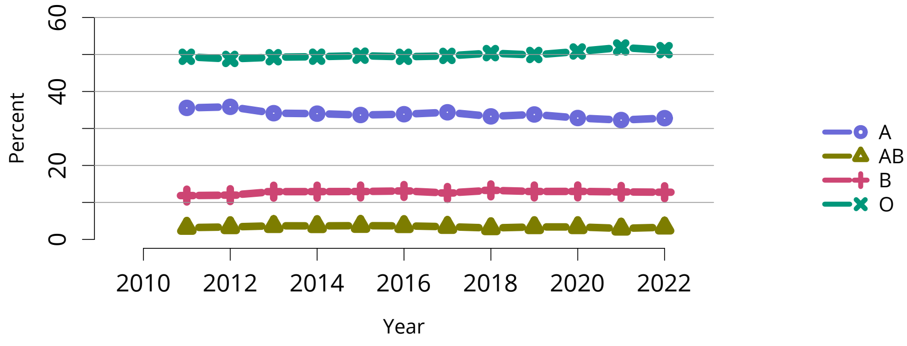


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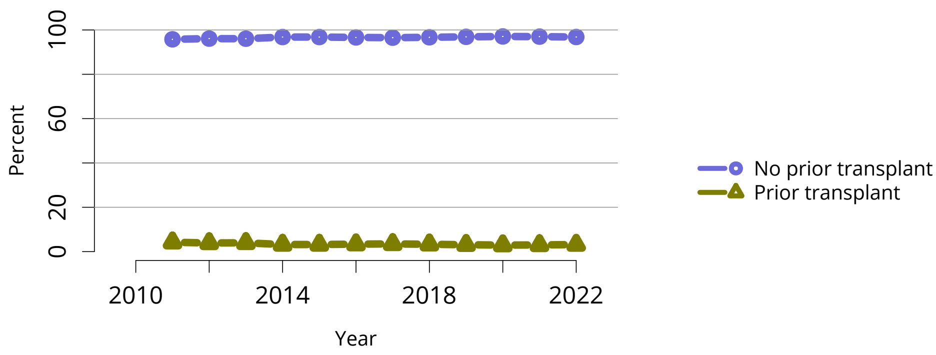
Figure HR 11: Distribution of adults waiting for heart transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure HR 12: Distribution of adults waiting for heart transplant by prior transplant status. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

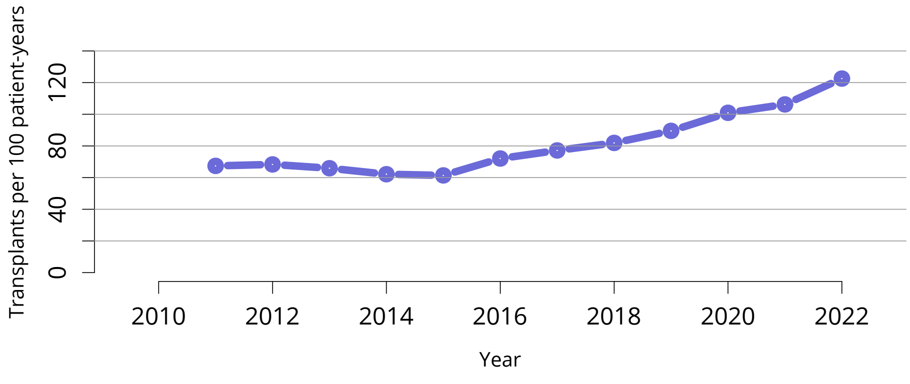


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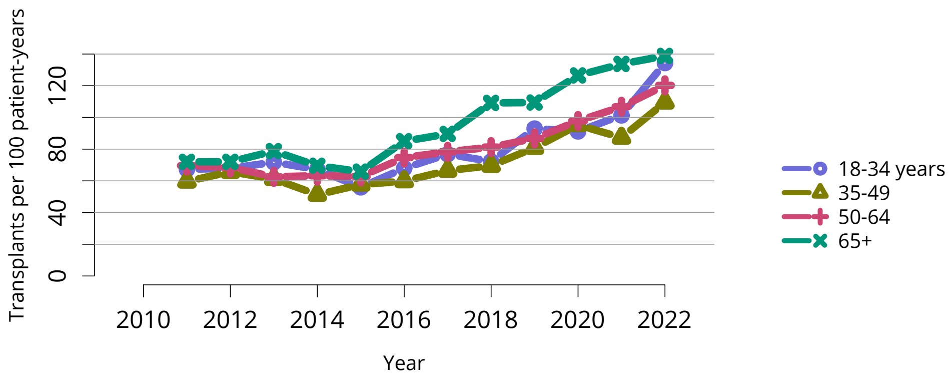
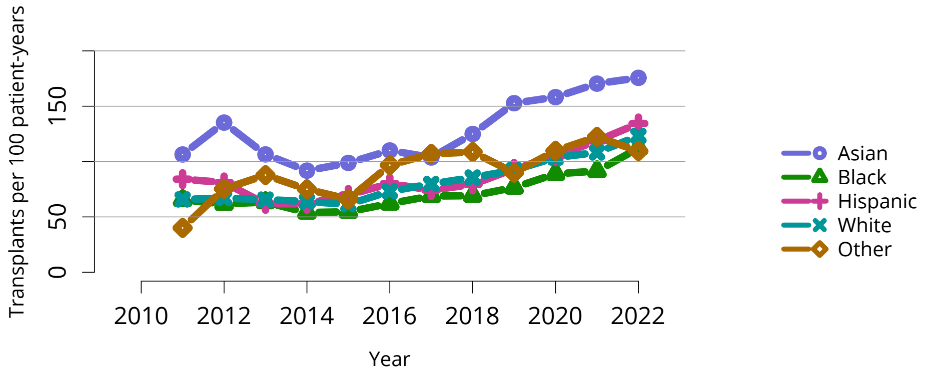
Figure HR 13: Overall deceased donor heart transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



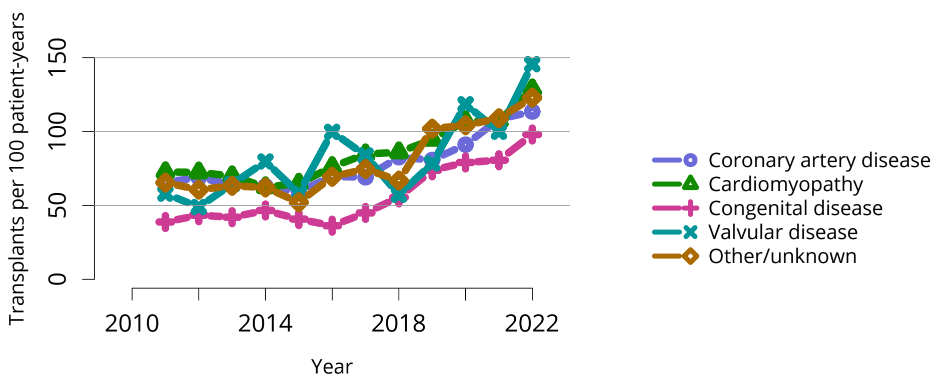
OPTN/SRTR 2022 Annual Data Report

Figure HR 14: Deceased donor heart transplant rates among adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



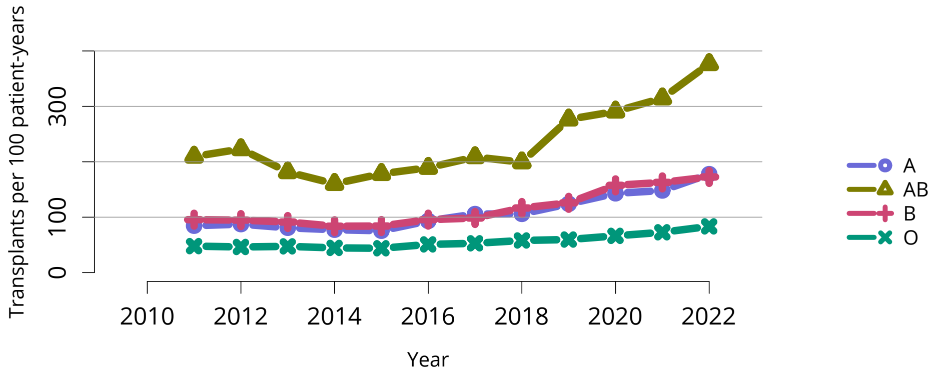
OPTN/SRTR 2022 Annual Data Report

Figure HR 15: Deceased donor heart transplant rates among adult waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



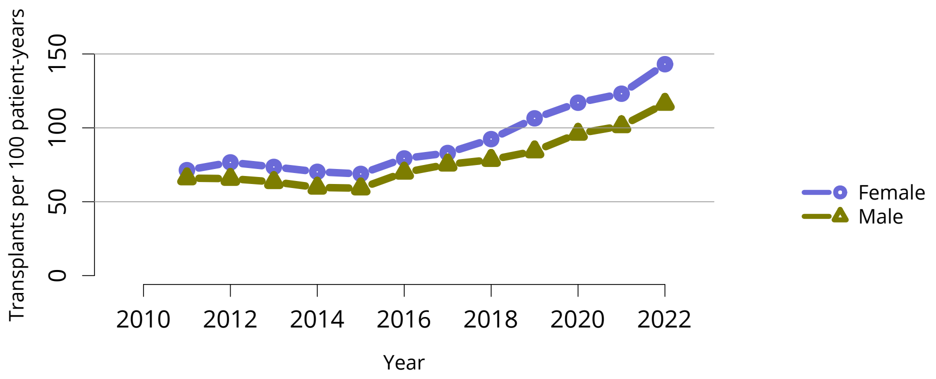
OPTN/SRTR 2022 Annual Data Report

Figure HR 16: Deceased donor heart transplant rates among adult waitlist candidates by diagnosis. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



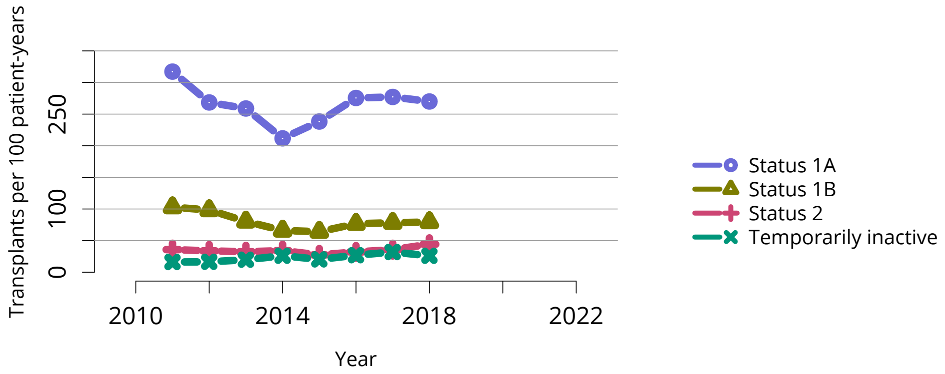
OPTN/SRTR 2022 Annual Data Report

Figure HR 17: Deceased donor heart transplant rates among adult waitlist candidates by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



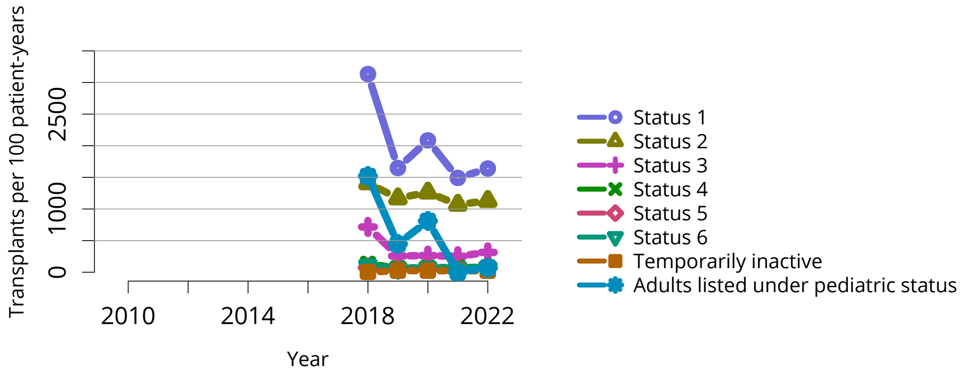
OPTN/SRTR 2022 Annual Data Report

Figure HR 18: Deceased donor heart transplant rates among adult waitlist candidates by sex. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



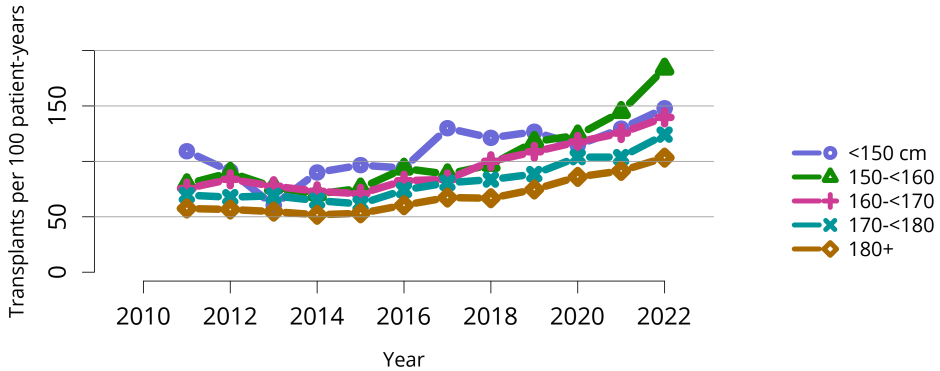
OPTN/SRTR 2022 Annual Data Report

Figure HR 19: Deceased donor heart transplant rates among adult waitlist candidates by former medical urgency groups through October 17, 2018. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The October 2018 OPTN heart allocation policy update changed the status groups. Medical urgency is determined at the later of listing date or January 1 of the given year. For new listings on or after October 18, 2018, and for candidates who were newly waitlisted on or after that date, their medical urgency statuses are shown in Figure HR 20. Inactive statuses with new listings on or after October 18, 2018, are excluded here in Figure HR 19.



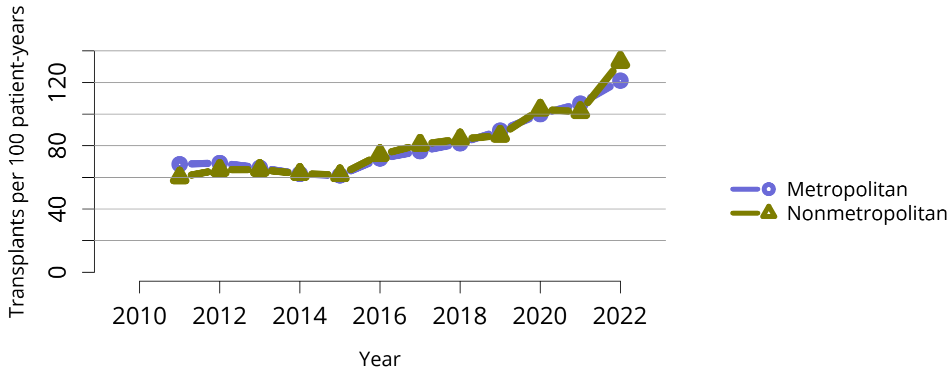
OPTN/SRTR 2022 Annual Data Report

Figure HR 20: Deceased donor heart transplant rates among adult waitlist candidates by new medical urgency groups, October 18, 2018, through 2022. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The October 2018 OPTN heart allocation policy update changed the status groups. Medical urgency is determined at the later of listing date or January 1 of the given year. For 2018 medical urgency statuses, statuses 1-6 and inactive status contain new listings on or after October 18, 2018.



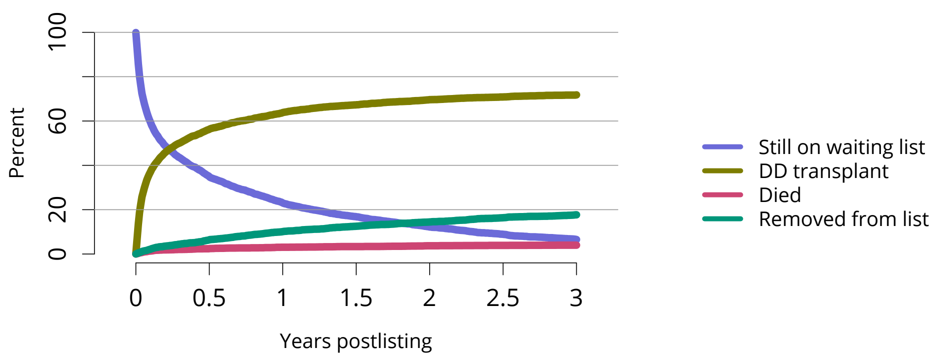
OPTN/SRTR 2022 Annual Data Report

Figure HR 21: Deceased donor heart transplant rates among adult waitlist candidates by height. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



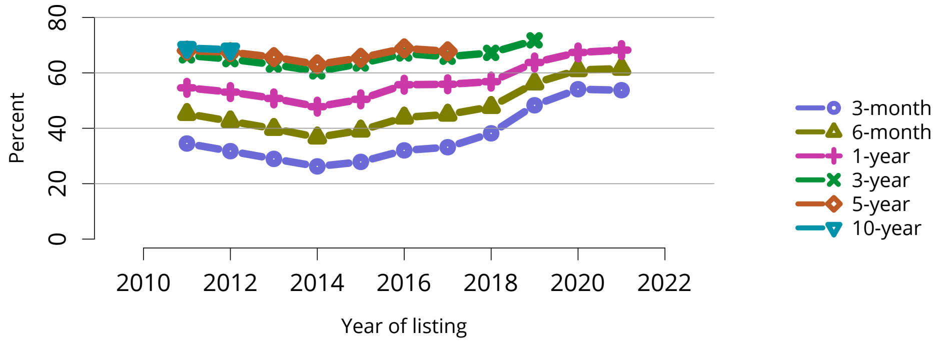
OPTN/SRTR 2022 Annual Data Report

Figure HR 22: Deceased donor heart transplant rates among adult waitlist candidates by metropolitan versus nonmetropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Urban/rural determination is made using the RUCA (rural-urban commuting area) designation of the candidate's permanent zip code.



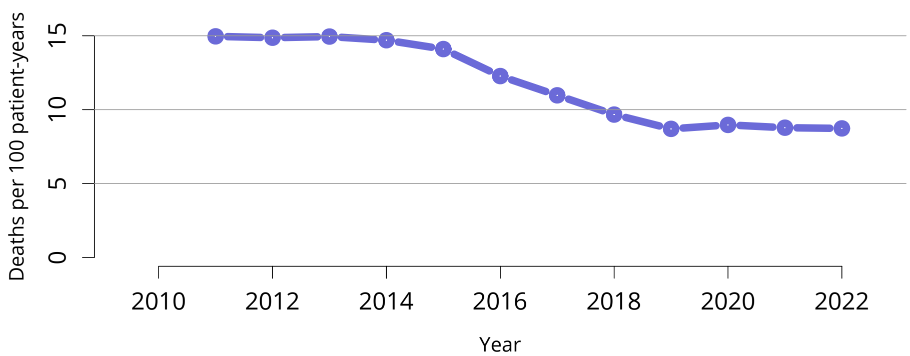
OPTN/SRTR 2022 Annual Data Report

Figure HR 23: Three-year outcomes for adults waiting for heart transplant, new listings in 2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.



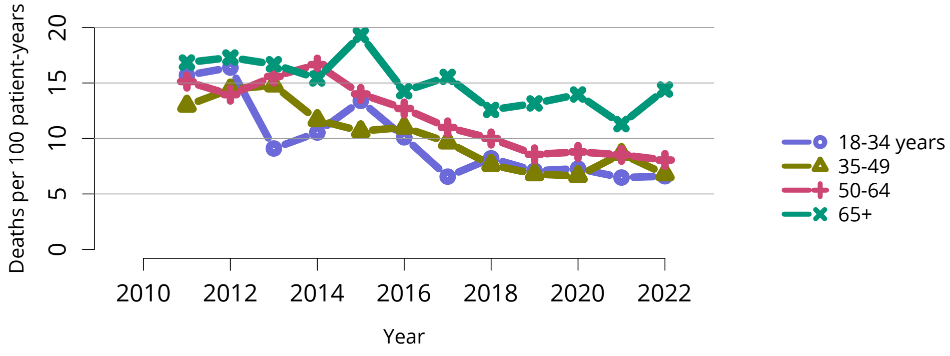
OPTN/SRTR 2022 Annual Data Report

Figure HR 24: Percentage of adults who underwent deceased donor heart transplant within a given period of listing. Candidates listed at more than one center are counted once per listing.



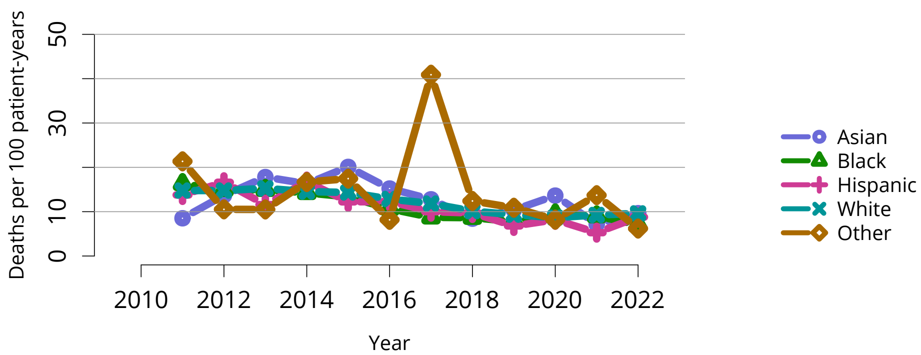
OPTN/SRTR 2022 Annual Data Report

Figure HR 25: Overall pretransplant mortality rates among adults waitlisted for heart transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



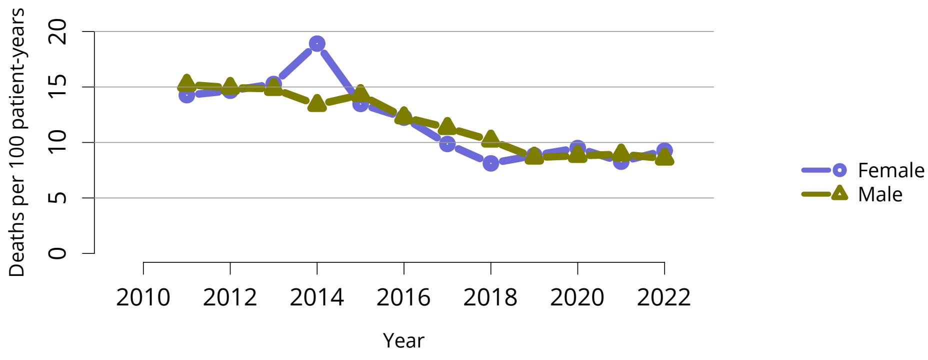
OPTN/SRTR 2022 Annual Data Report

Figure HR 26: Pretransplant mortality rates among adults waitlisted for heart transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



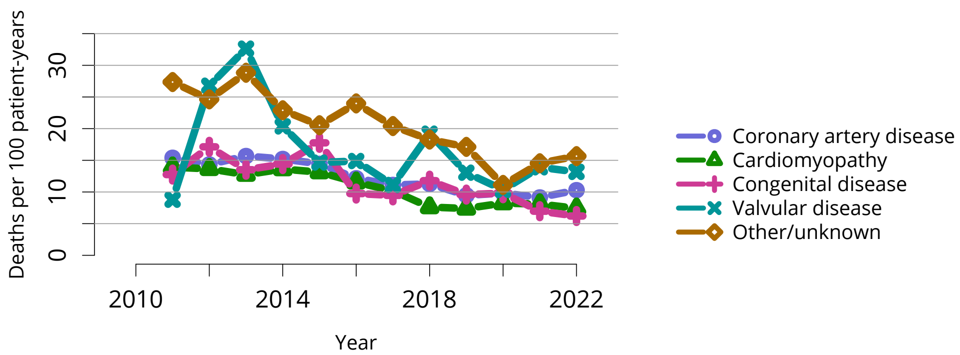
OPTN/SRTR 2022 Annual Data Report

Figure HR 27: Pretransplant mortality rates among adults waitlisted for heart transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



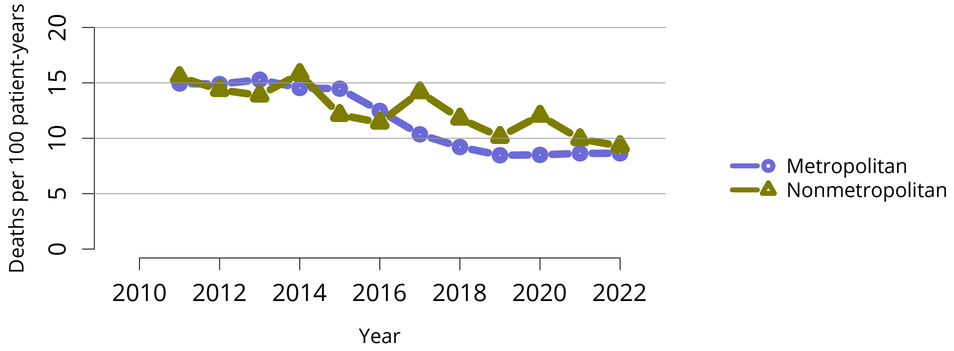
OPTN/SRTR 2022 Annual Data Report

Figure HR 28: Pretransplant mortality rates among adults waitlisted for heart transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure HR 29: Pretransplant mortality rates among adults waitlisted for heart transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure HR 30: Pretransplant mortality rates among adults waitlisted for heart transplant by metropolitan versus nonmetropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Urban/rural determination is made using the RUCA (rural-urban commuting area) designation of the candidate's permanent zip code.

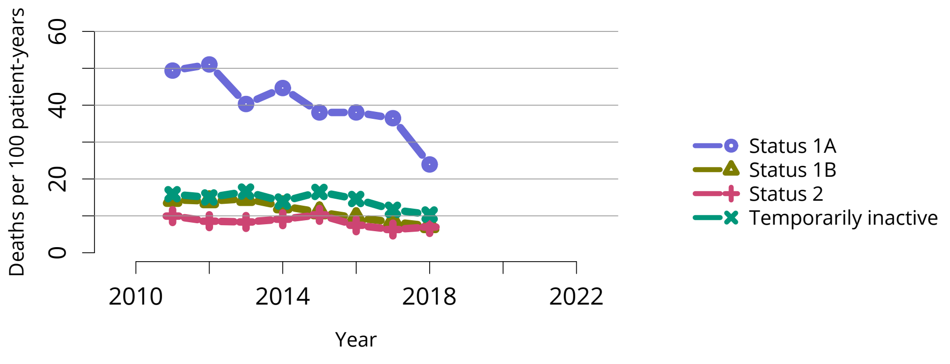
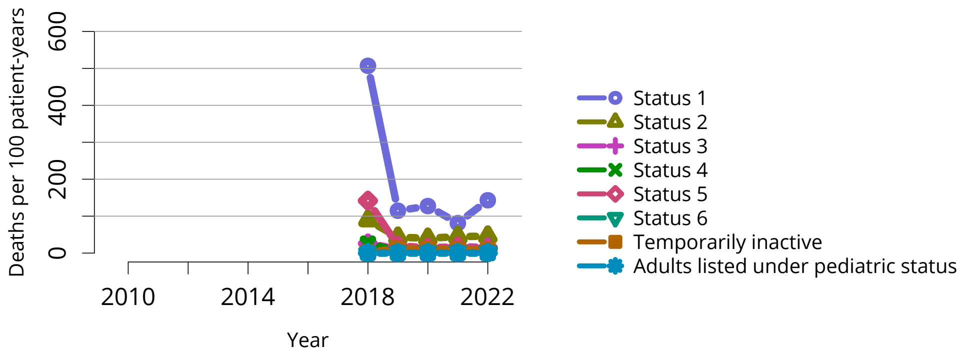
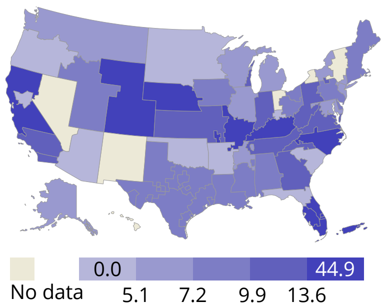


Figure HR 31: Pretransplant mortality rates among adults waitlisted for heart transplant by former medical urgency groups through October 17, 2018. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Medical urgency is determined at the later of listing date or January 1 of the given year. The October 2018 OPTN heart allocation policy update changed the status groups. For 2018 medical urgency statuses, new listings on or after October 18, 2018, are not shown in this figure.



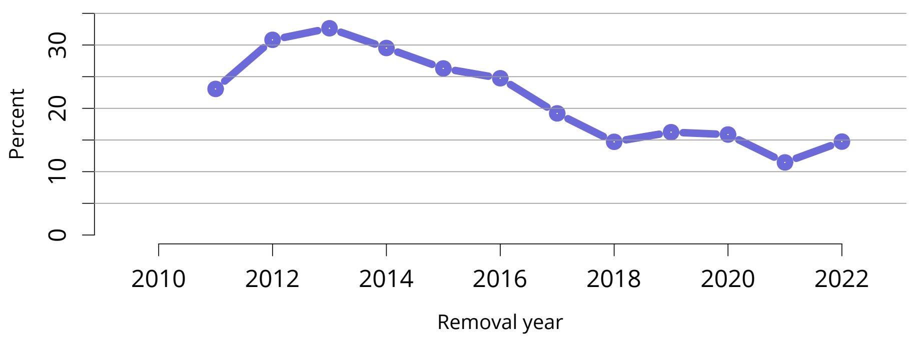
OPTN/SRTR 2022 Annual Data Report

Figure HR 32: Pretransplant mortality rates among adults waitlisted for heart transplant by new medical urgency groups, October 18, 2018, through 2022. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Medical urgency is determined at the later of listing date or January 1 of the given year. The October 2018 OPTN heart allocation policy update changed the status groups. For 2018 medical urgency statuses, statuses 1-6 and inactive status contain new listings on or after October 18, 2018.



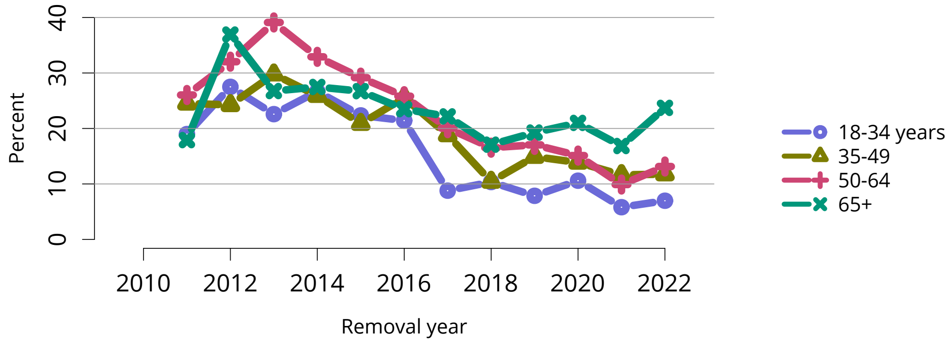
OPTN/SRTR 2022 Annual Data Report

Figure HR 33: Pretransplant mortality rates among adults waitlisted for heart transplant in 2022 by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. DSA, donation service area.



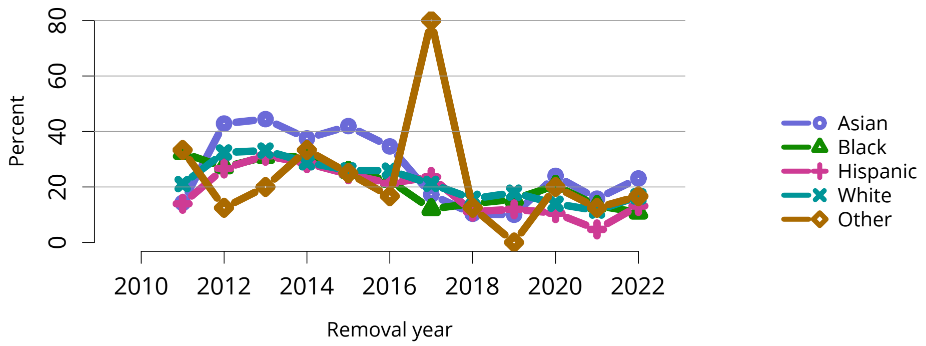
OPTN/SRTR 2022 Annual Data Report

Figure HR 34: Deaths within 6 months after removal among adult heart waitlist candidates, overall. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.



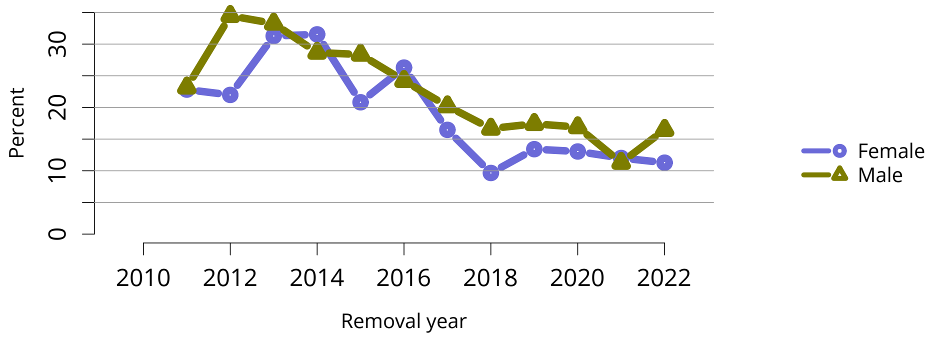
OPTN/SRTR 2022 Annual Data Report

Figure HR 35: Deaths within 6 months after removal among adult heart waitlist candidates, by age. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. Age is determined at removal.



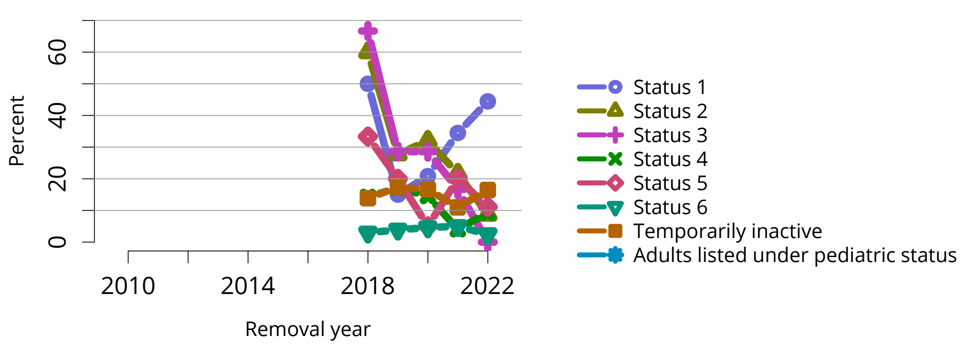
OPTN/SRTR 2022 Annual Data Report

Figure HR 36: Deaths within 6 months after removal among adult heart waitlist candidates by race and ethnicity. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. The Other race category is composed of Native American and Multiracial categories.



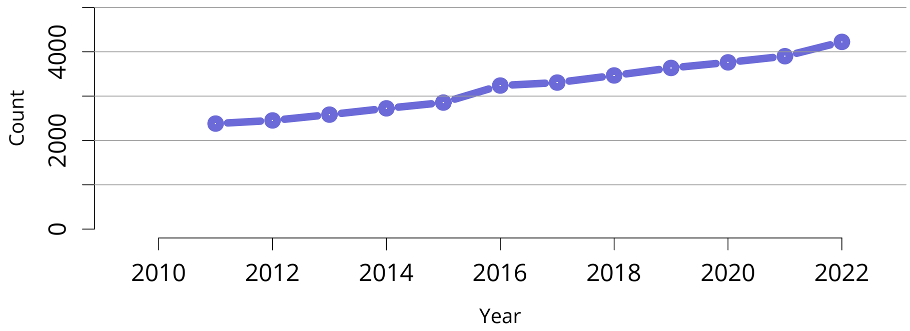
OPTN/SRTR 2022 Annual Data Report

Figure HR 37: Deaths within 6 months after removal among adult heart waitlist candidates, by sex. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.



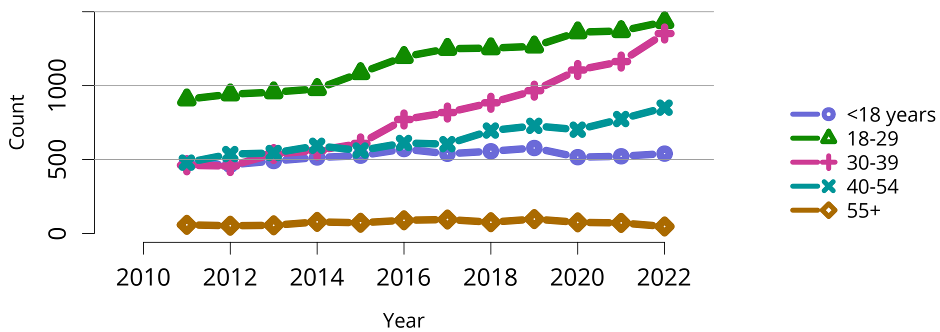
OPTN/SRTR 2022 Annual Data Report

Figure HR 38: Deaths within 6 months after removal among adult heart waitlist candidates, by status at removal. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. The October 2018 OPTN heart allocation policy update changed the status groups. The statuses 1A, 1B, and 2 listed first are through October 17, 2018, the last day before the policy update; the adult statuses listed are for October 18, 2018, and onward. Medical urgency is determined at the earliest of transplant, death, removal, or December 31 of the year.



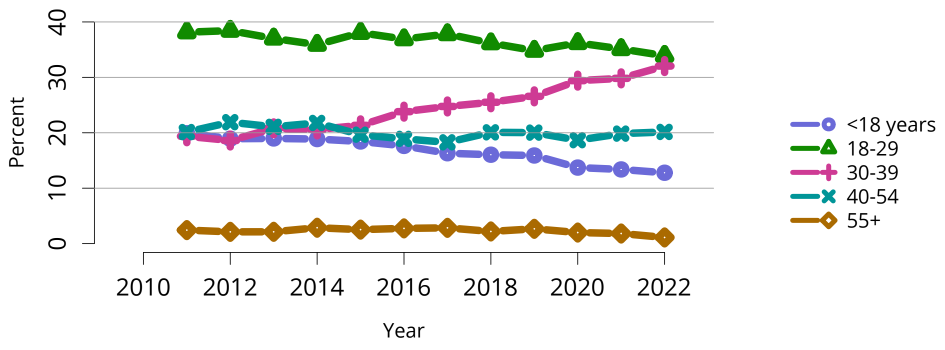
OPTN/SRTR 2022 Annual Data Report

Figure HR 39: Overall deceased heart donor count. Count of deceased donors whose hearts were recovered for transplant.



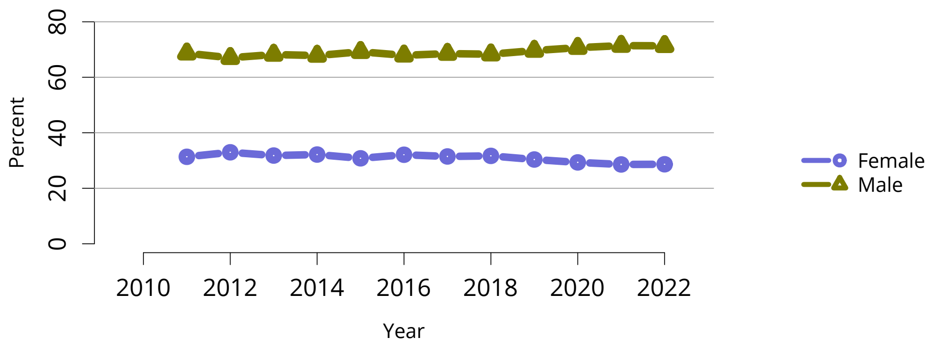
OPTN/SRTR 2022 Annual Data Report

Figure HR 40: Deceased heart donor count by age. Count of deceased donors whose hearts were recovered for transplant.



OPTN/SRTR 2022 Annual Data Report

Figure HR 41: Distribution of deceased heart donors by age. Deceased donors whose hearts were recovered for transplant.



OPTN/SRTR 2022 Annual Data Report

Figure HR 42: Distribution of deceased heart donors by sex. Deceased donors whose hearts were recovered for transplant.

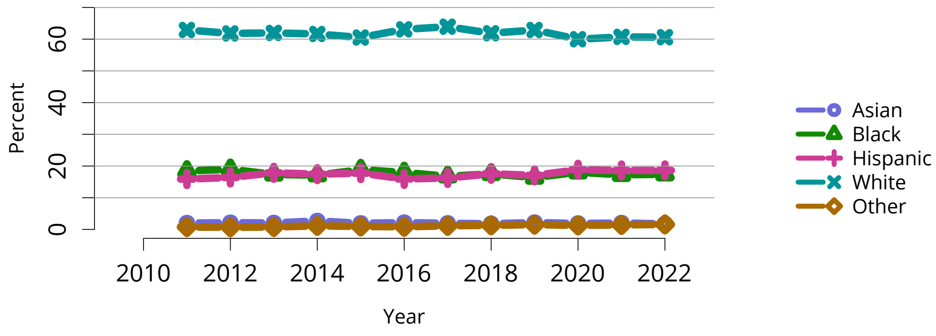


Figure HR 43: Distribution of deceased heart donors by race and ethnicity. Deceased donors whose hearts were recovered for transplant. The Other race category is composed of Native American and Multiracial categories.

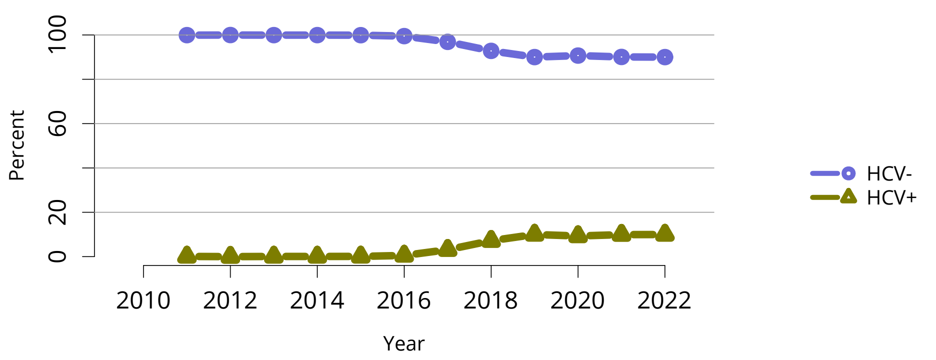
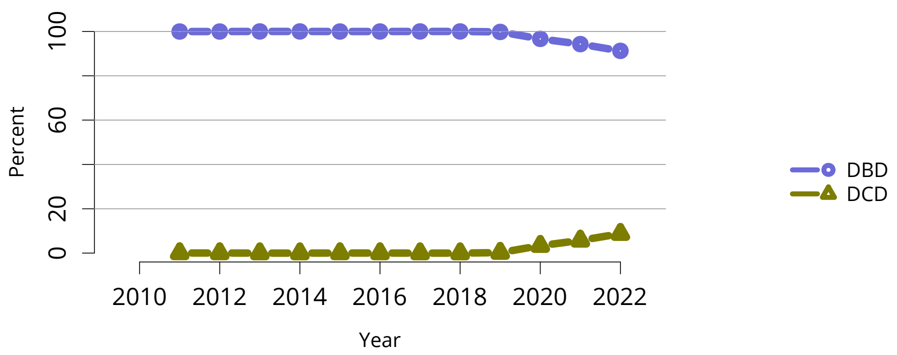
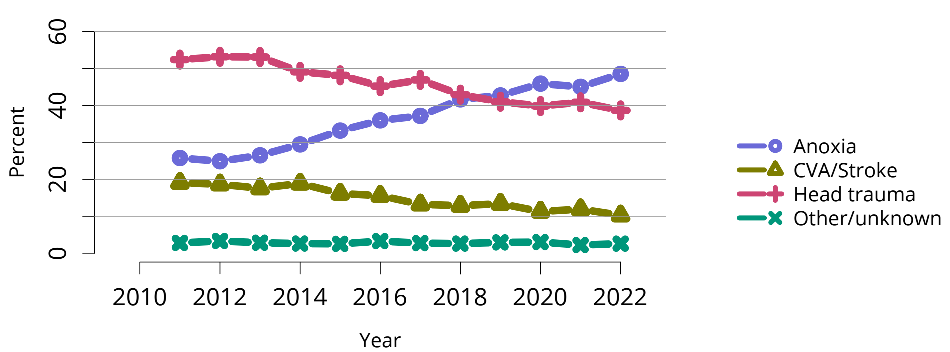


Figure HR 44: Distribution of deceased heart donors by donor HCV status. Deceased donors whose hearts were recovered for transplant. Donor HCV status was based on an antibody test. HCV, hepatitis C virus.



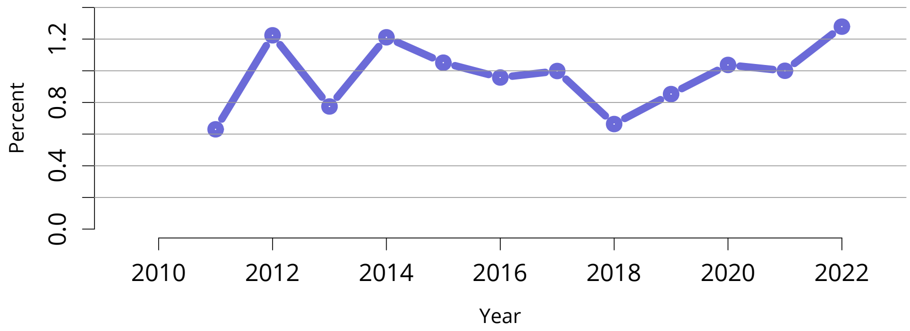
OPTN/SRTR 2022 Annual Data Report

Figure HR 45: Distribution of deceased heart donors by donor type. Deceased donors whose hearts were recovered for transplant. DBD, donation after brain death; DCD, donation after circulatory death.



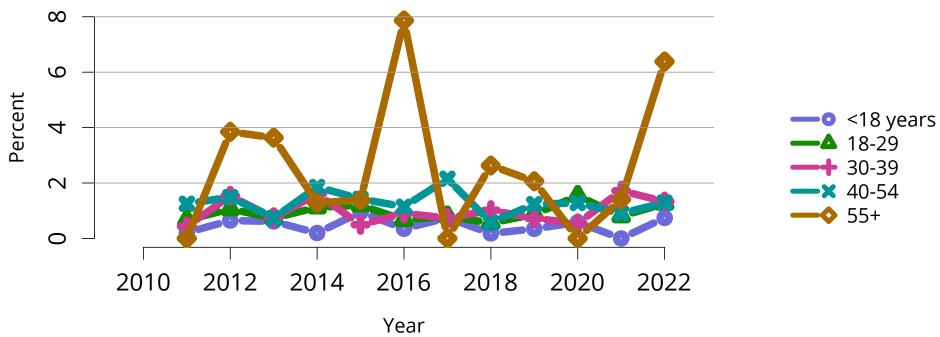
OPTN/SRTR 2022 Annual Data Report

Figure HR 46: Cause of death among deceased heart donors. Deceased donors with a heart recovered for the purposes of transplant. CVA, cerebrovascular accident.



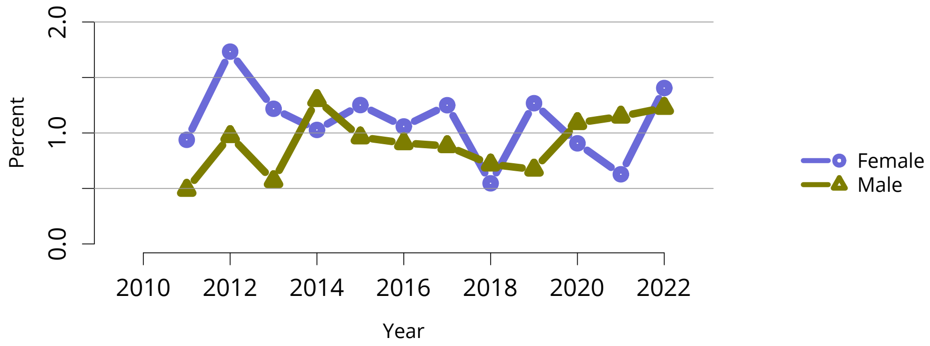
OPTN/SRTR 2022 Annual Data Report

Figure HR 47: Overall percent of hearts recovered for transplant and not transplanted. Percentages of hearts not transplanted out of all hearts recovered for transplant.



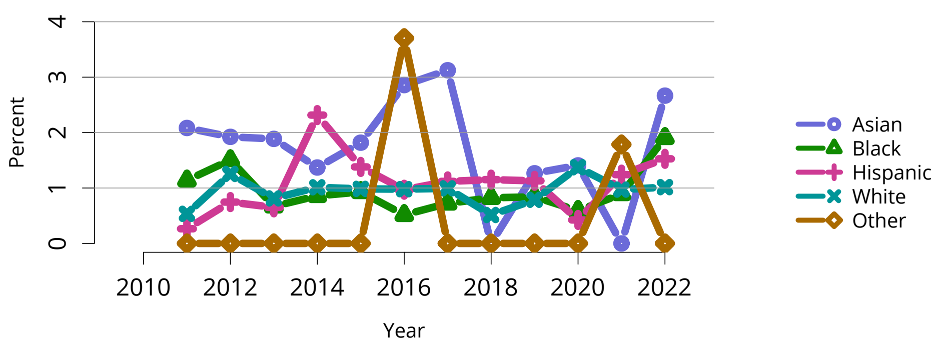
OPTN/SRTR 2022 Annual Data Report

Figure HR 48: Percent of hearts recovered for transplant and not transplanted by donor age. Percentages of hearts not transplanted out of all hearts recovered for transplant.



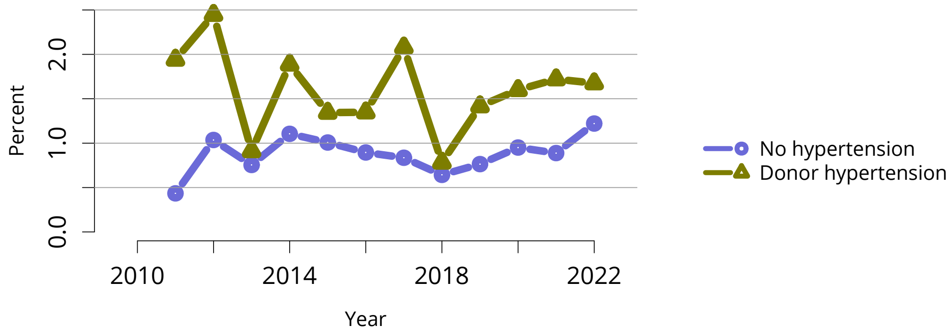
OPTN/SRTR 2022 Annual Data Report

Figure HR 49: Percent of hearts recovered for transplant and not transplanted by donor sex. Percentages of hearts not transplanted out of all hearts recovered for transplant.



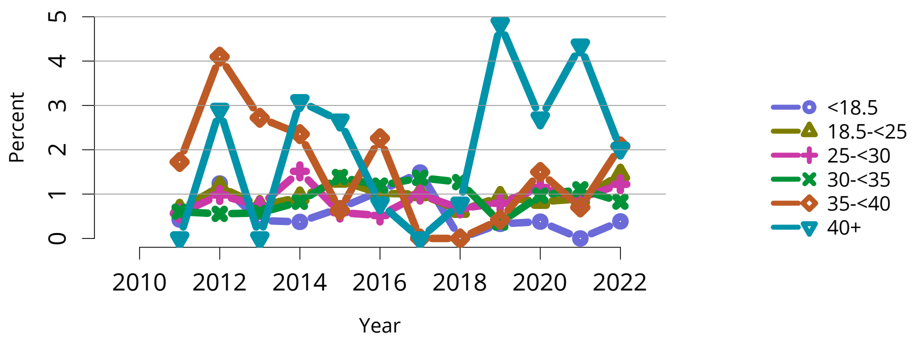
OPTN/SRTR 2022 Annual Data Report

Figure HR 50: Percent of hearts recovered for transplant and not transplanted by donor race and ethnicity. Percentages of hearts not transplanted out of all hearts recovered for transplant. The Other race category is composed of Native American and Multiracial categories.



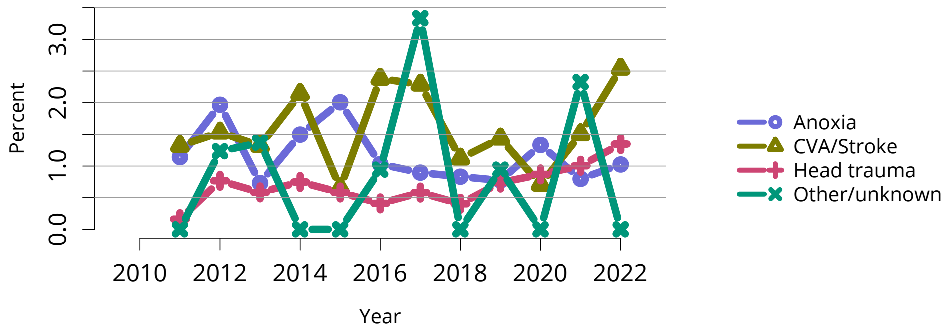
OPTN/SRTR 2022 Annual Data Report

Figure HR 51: Percent of hearts recovered for transplant and not transplanted by donor hypertension status. Percentages of hearts not transplanted out of all hearts recovered for transplant.



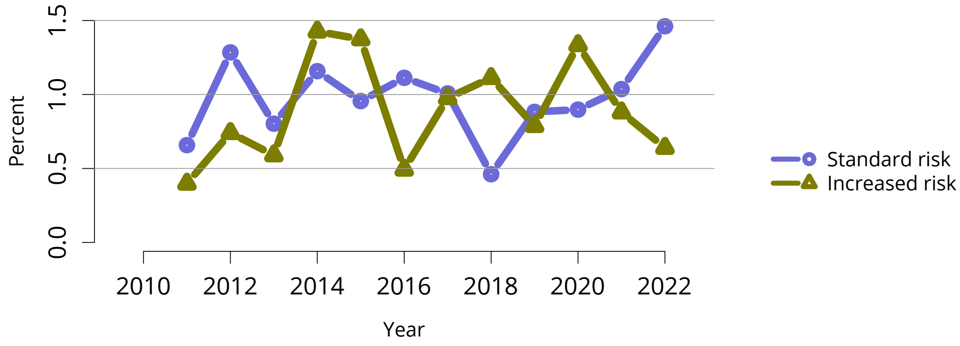
OPTN/SRTR 2022 Annual Data Report

Figure HR 52: Percent of hearts recovered for transplant and not transplanted by donor BMI. Percentages of hearts not transplanted out of all hearts recovered for transplant. BMI, body mass index.



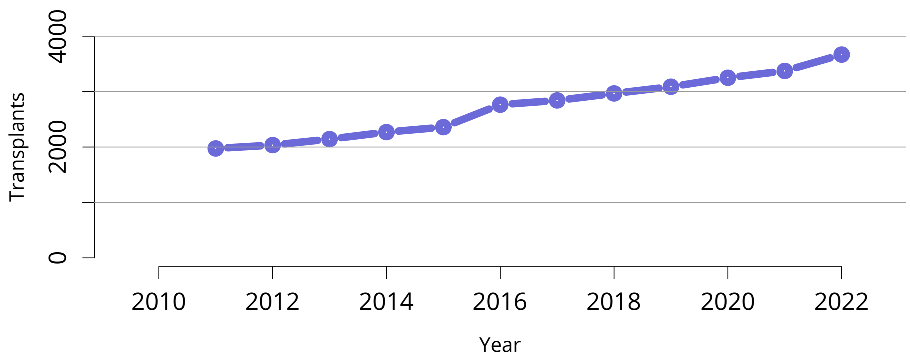
OPTN/SRTR 2022 Annual Data Report

Figure HR 53: Percent of hearts recovered for transplant and not transplanted by donor cause of death. Percentages of hearts not transplanted out of all hearts recovered for transplant. CVA, cerebrovascular accident.



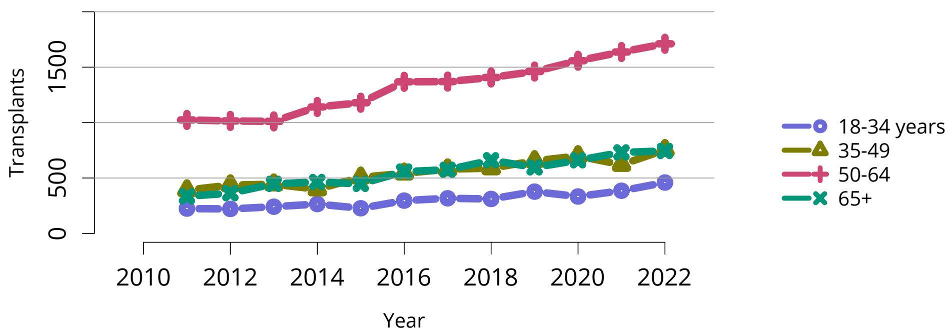
OPTN/SRTR 2022 Annual Data Report

Figure HR 54: Percent of hearts recovered for transplant and not transplanted, by donor risk of disease transmission. Percentages of hearts not transplanted out of all hearts recovered for transplant. “Increased risk” is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B, and hepatitis C transmission.



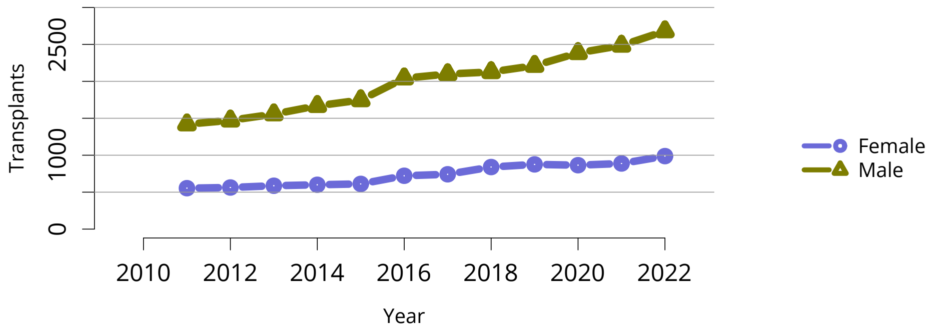
OPTN/SRTR 2022 Annual Data Report

Figure HR 55: Overall adult heart transplants. All adult heart transplant recipients, including retransplant and multiorgan recipients.



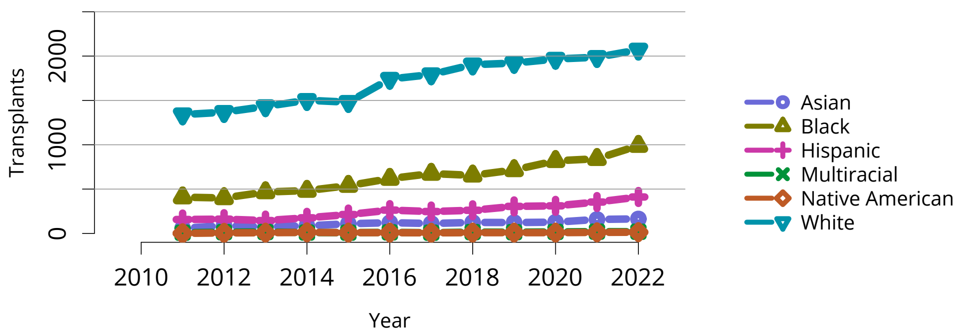
OPTN/SRTR 2022 Annual Data Report

Figure HR 56: Adult heart transplants by age. All adult heart transplant recipients, including retransplant and multiorgan recipients.



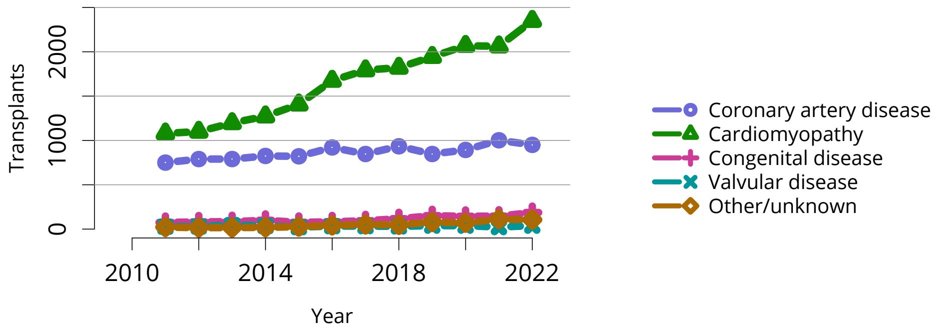
OPTN/SRTR 2022 Annual Data Report

Figure HR 57: Adult heart transplants by sex. All adult heart transplant recipients, including retransplant and multiorgan recipients.



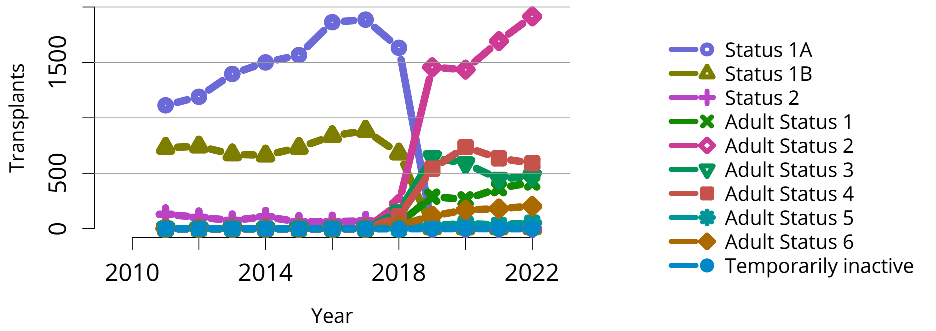
OPTN/SRTR 2022 Annual Data Report

Figure HR 58: Adult heart transplants by race and ethnicity. All adult heart transplant recipients, including retransplant and multiorgan recipients.



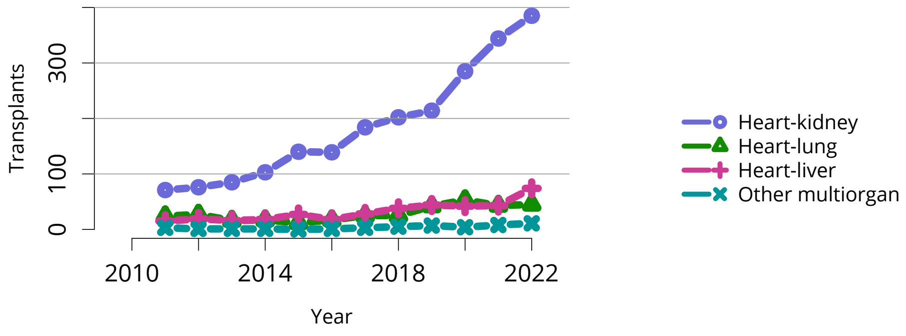
OPTN/SRTR 2022 Annual Data Report

Figure HR 59: Adult heart transplants by diagnosis. All adult heart transplant recipients, including retransplant and multiorgan recipients.



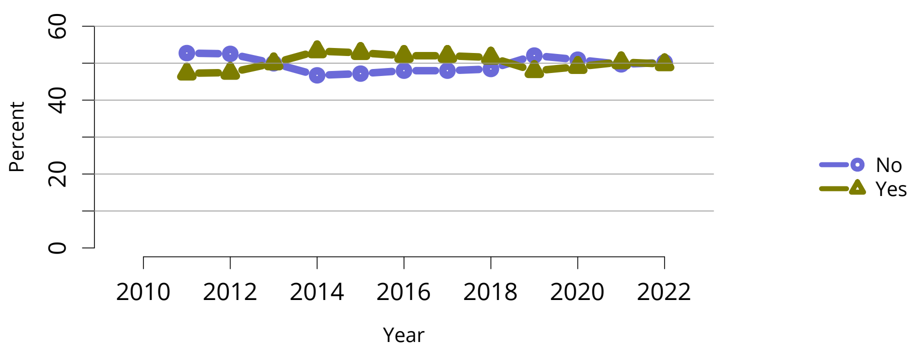
OPTN/SRTR 2022 Annual Data Report

Figure HR 60: Adult heart transplants by medical urgency. All adult heart transplant recipients, including retransplant and multiorgan recipients. The October 2018 OPTN heart allocation policy update changed the status groups. The statuses 1A, 1B, and 2 listed first are through October 17, 2018, the last day before the policy update; the adult statuses listed are for October 18, 2018, and onward.



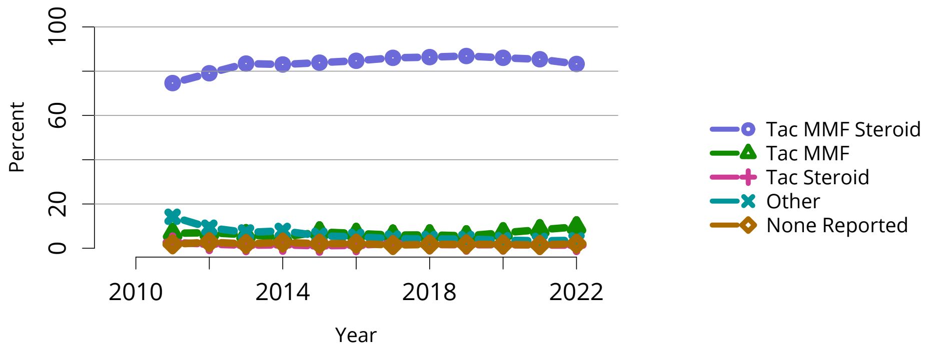
OPTN/SRTR 2022 Annual Data Report

Figure HR 61: Adult heart transplants by multiorgan transplant type. All adult heart transplant recipients, including retransplant and multiorgan recipients.



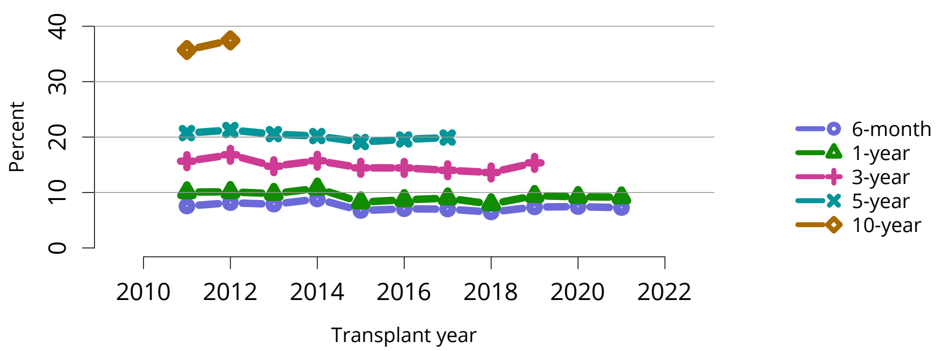
OPTN/SRTR 2022 Annual Data Report

Figure HR 62: Induction agent use in adult heart transplant recipients. Immunosuppression at transplant reported to the OPTN.



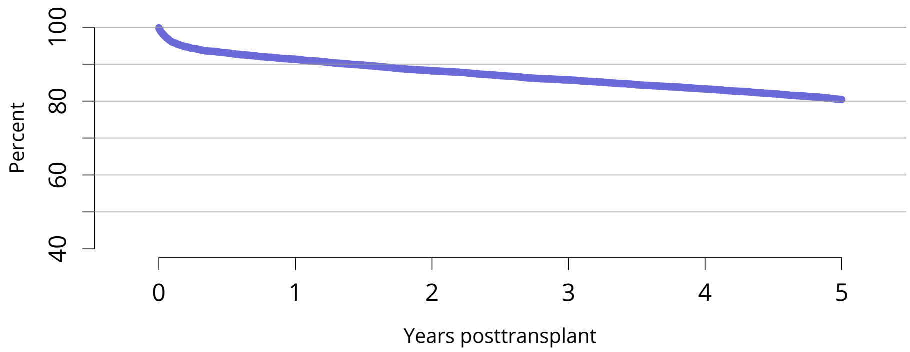
OPTN/SRTR 2022 Annual Data Report

Figure HR 63: Immunosuppression regimen use in adult heart transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



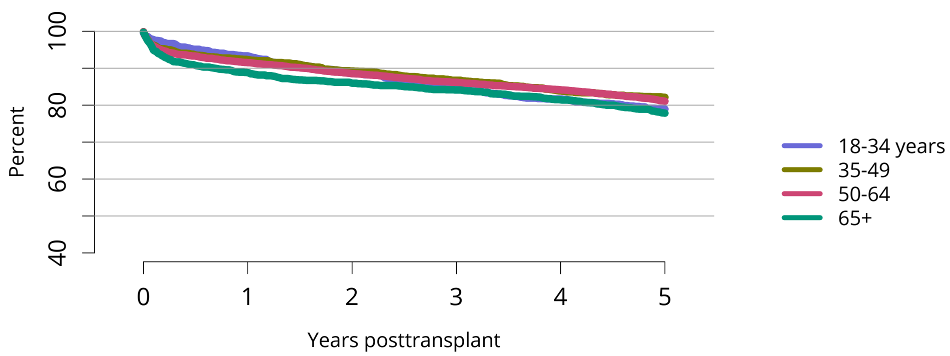
OPTN/SRTR 2022 Annual Data Report

Figure HR 64: Patient death among adult heart transplant recipients. All adult recipients of deceased donor hearts, including multiorgan transplant recipients.



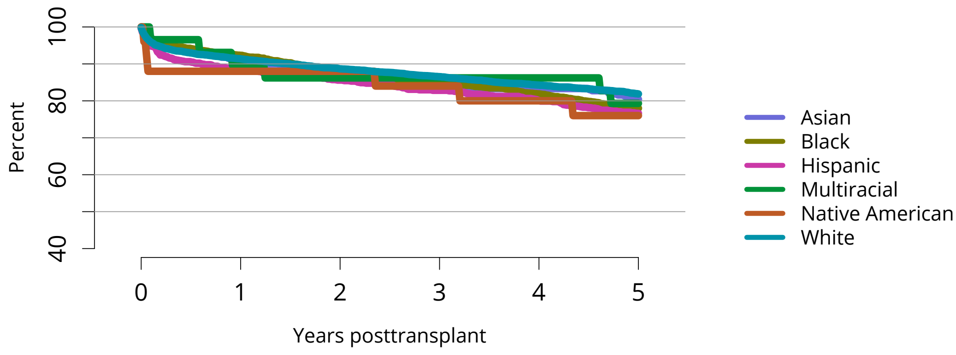
OPTN/SRTR 2022 Annual Data Report

Figure HR 65: Patient survival among adult heart transplant recipients, 2015-2017. Patient survival estimated using unadjusted Kaplan-Meier methods.



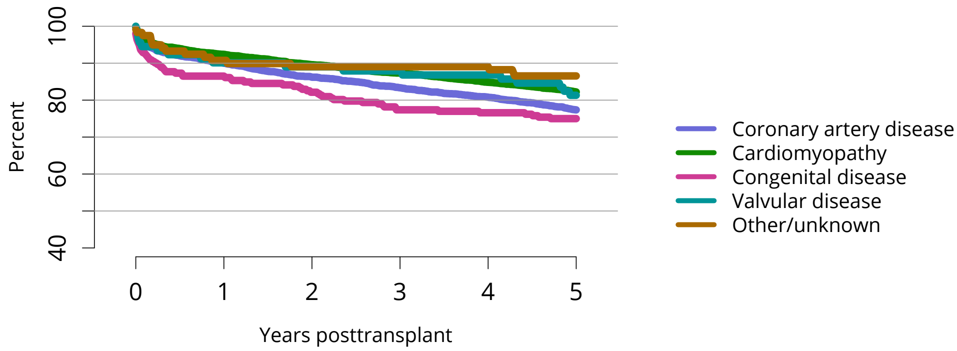
OPTN/SRTR 2022 Annual Data Report

Figure HR 66: Patient survival among adult heart transplant recipients, 2015-2017, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.



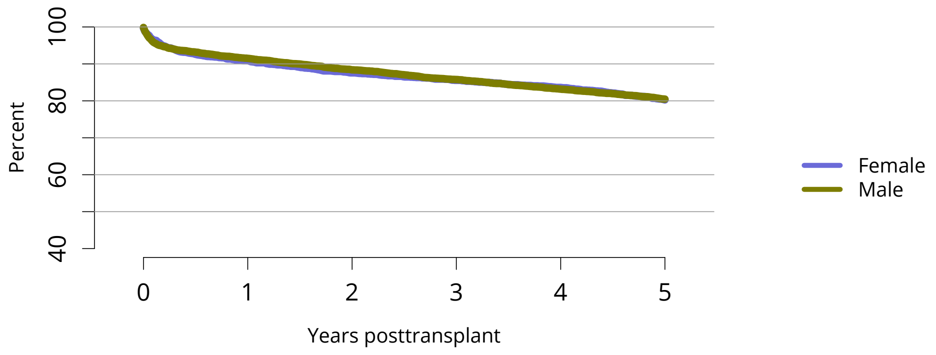
OPTN/SRTR 2022 Annual Data Report

Figure HR 67: Patient survival among adult heart transplant recipients, 2015-2017, by race and ethnicity. Patient survival estimated using unadjusted Kaplan-Meier methods.



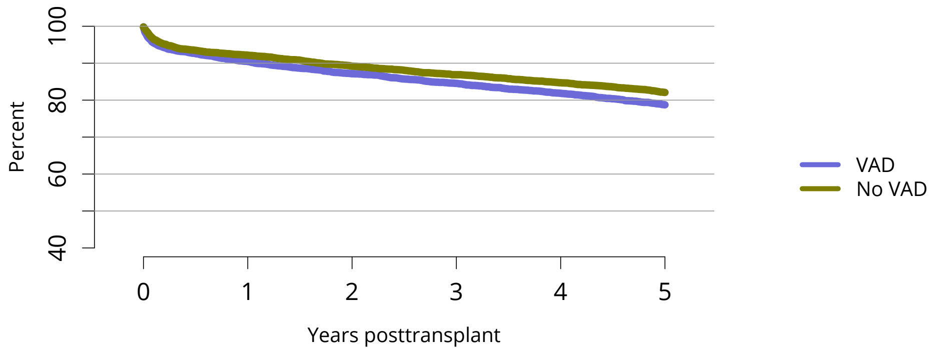
OPTN/SRTR 2022 Annual Data Report

Figure HR 68: Patient survival among adult heart transplant recipients, 2015-2017, by diagnosis group. Patient survival estimated using unadjusted Kaplan-Meier methods.



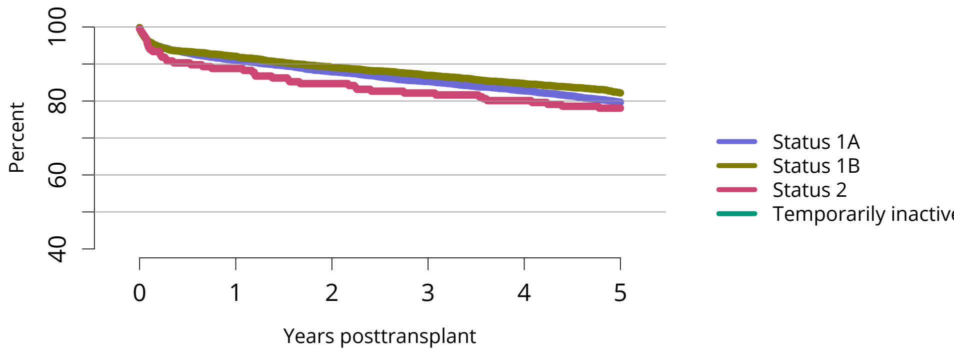
OPTN/SRTR 2022 Annual Data Report

Figure HR 69: Patient survival among adult heart transplant recipients, 2015-2017, by sex. Patient survival estimated using unadjusted Kaplan-Meier methods.



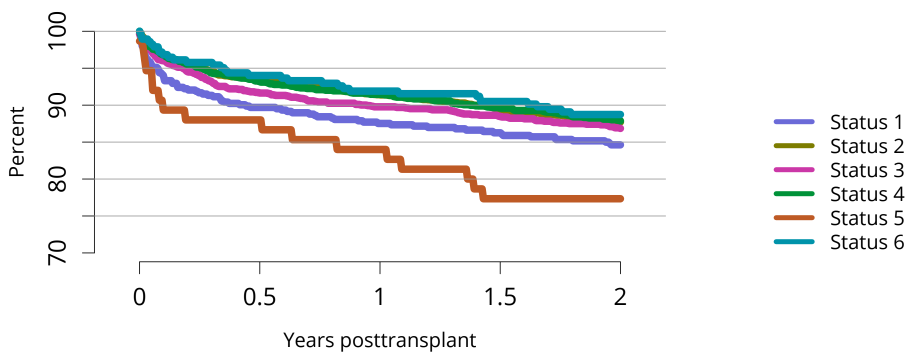
OPTN/SRTR 2022 Annual Data Report

Figure HR 70: Patient survival among adult heart transplant recipients, 2015-2017, by VAD status. Patient survival estimated using unadjusted Kaplan-Meier methods. VAD status at time of transplant. VAD, ventricular assist device.



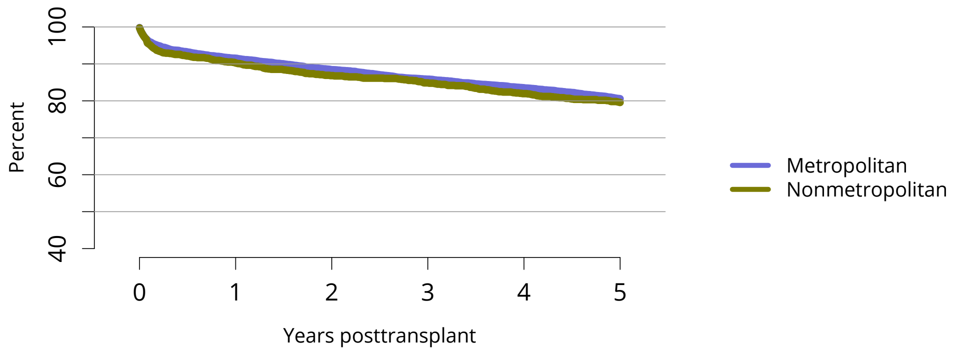
OPTN/SRTR 2022 Annual Data Report

Figure HR 71: Patient survival among adult heart transplant recipients, 2015-2017, by former medical urgency. Patient survival estimated using unadjusted Kaplan-Meier methods.



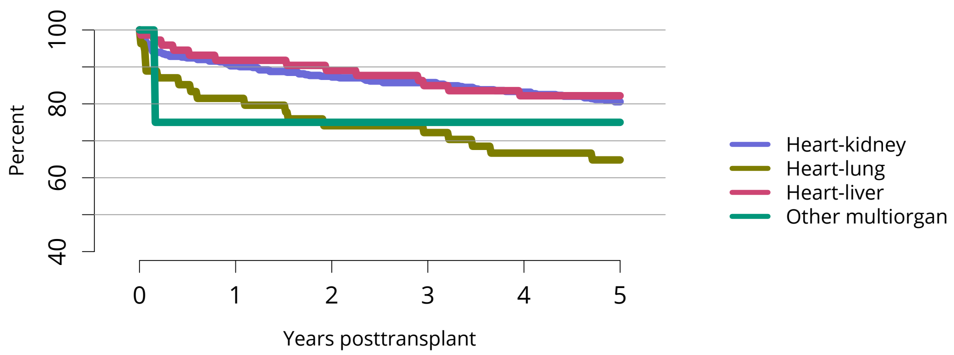
OPTN/SRTR 2022 Annual Data Report

Figure HR 72: Patient survival among adult heart transplant recipients, 2019-2020, by new medical urgency. Patient survival estimated using unadjusted Kaplan-Meier methods.



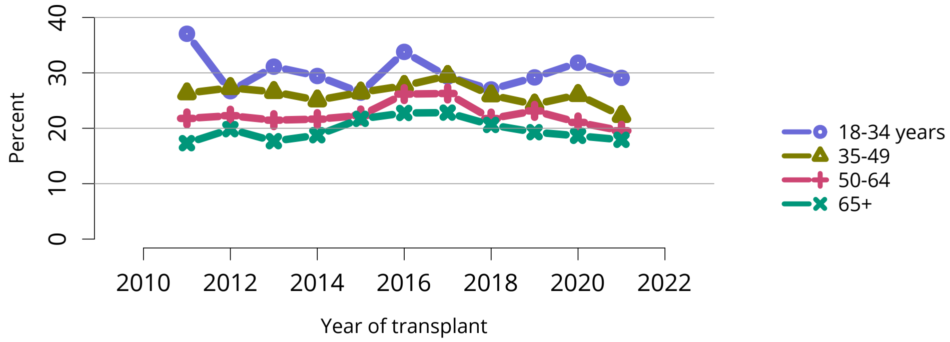
OPTN/SRTR 2022 Annual Data Report

Figure HR 73: Patient survival among adult heart transplant recipients, 2015-2017, by metropolitan versus nonmetropolitan recipient residence. Patient survival estimated using unadjusted Kaplan-Meier methods.



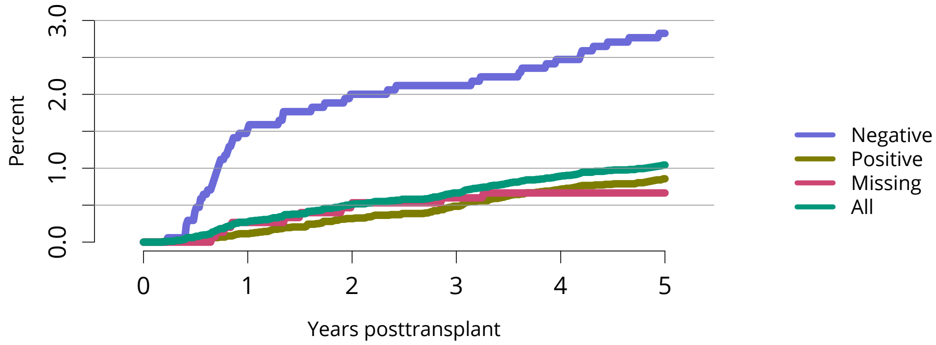
OPTN/SRTR 2022 Annual Data Report

Figure HR 74: Patient survival among adult heart transplant recipients, 2015-2017, by multiorgan transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods.



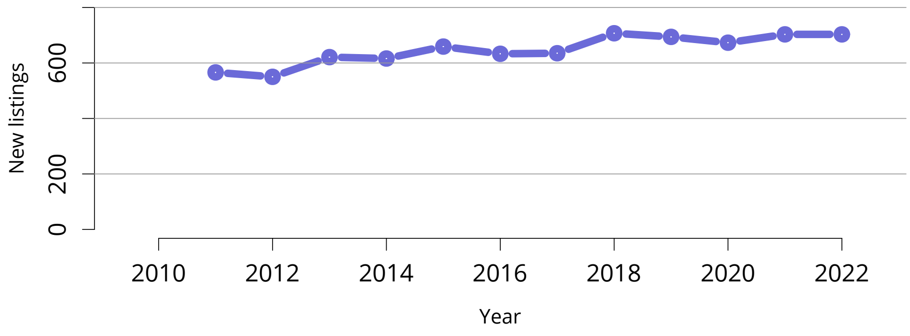
OPTN/SRTR 2022 Annual Data Report

Figure HR 75: Incidence of acute rejection by 1 year posttransplant among adult heart transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



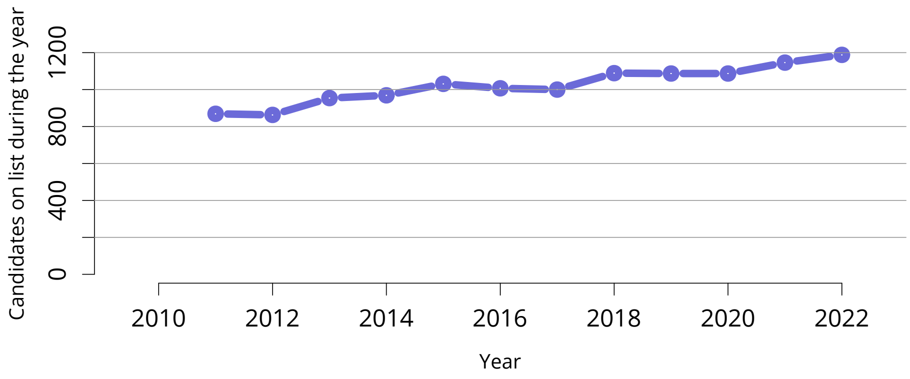
OPTN/SRTR 2022 Annual Data Report

Figure HR 76: Incidence of PTLD among adult heart transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



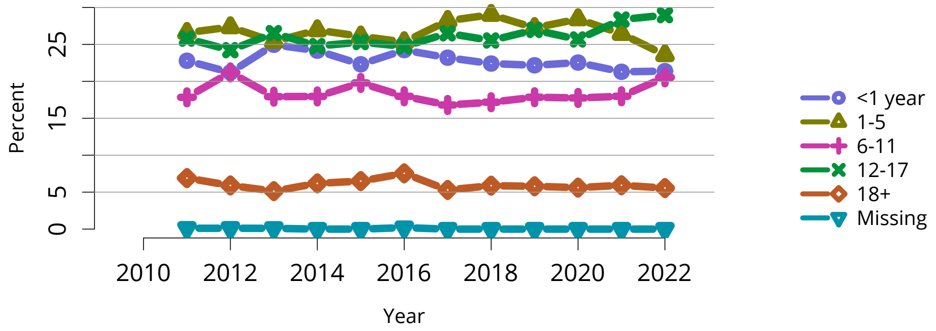
OPTN/SRTR 2022 Annual Data Report

Figure HR 77: New pediatric candidates added to the heart transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



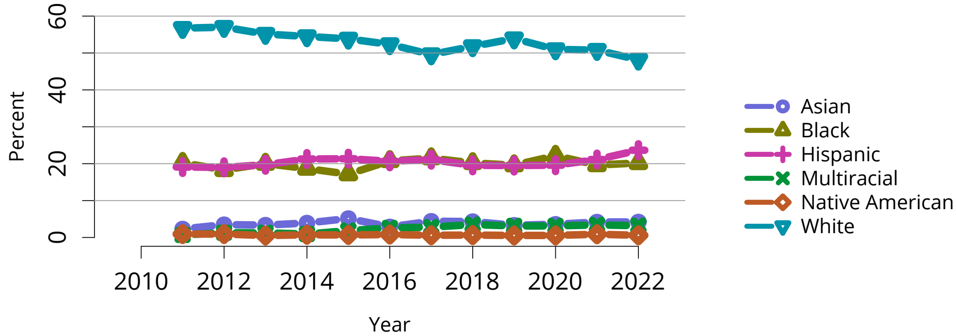
OPTN/SRTR 2022 Annual Data Report

Figure HR 78: All pediatric candidates on the heart transplant waiting list. Pediatric candidates listed at any time during the year. Candidates listed at more than one center are counted once per listing.



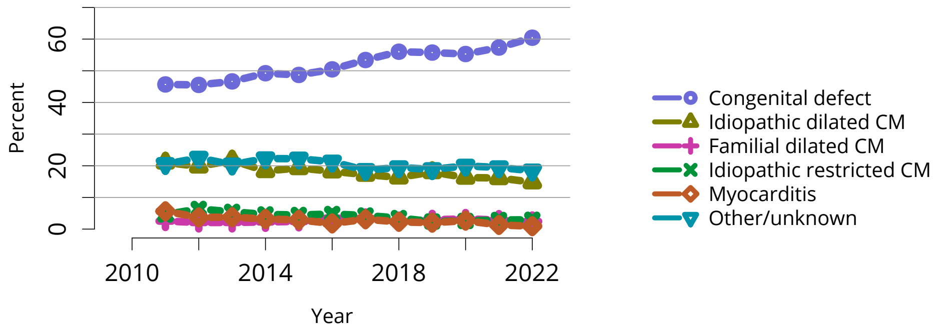
OPTN/SRTR 2022 Annual Data Report

Figure HR 79: Distribution of pediatric candidates waiting for heart transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.



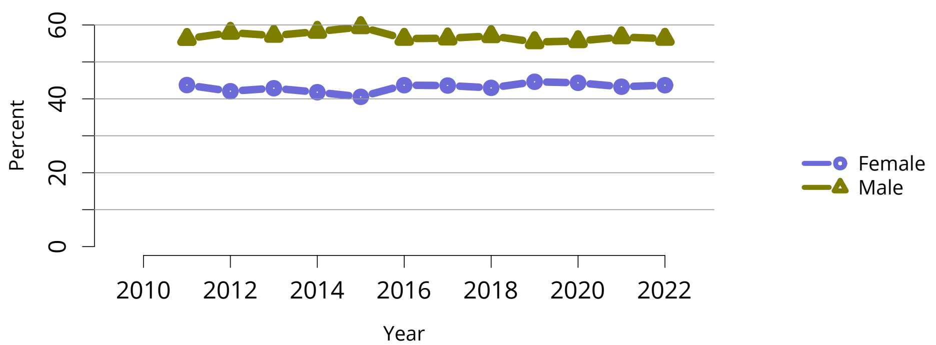
OPTN/SRTR 2022 Annual Data Report

Figure HR 80: Distribution of pediatric candidates waiting for heart transplant by race and ethnicity. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included.



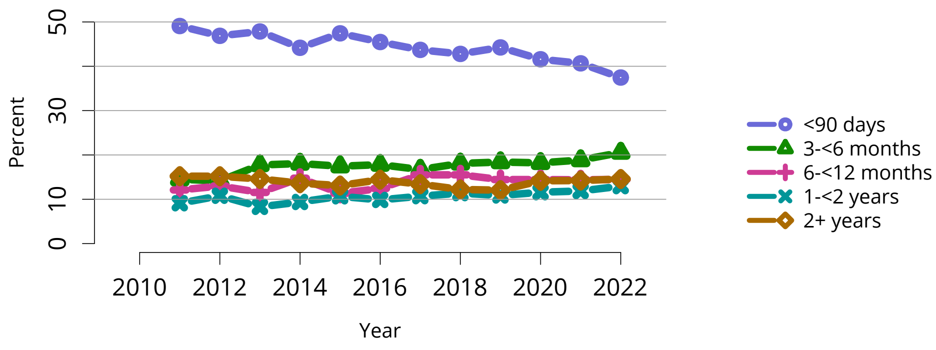
OPTN/SRTR 2022 Annual Data Report

Figure HR 81: Distribution of pediatric candidates waiting for heart transplant by diagnosis. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. CM, cardiomyopathy.



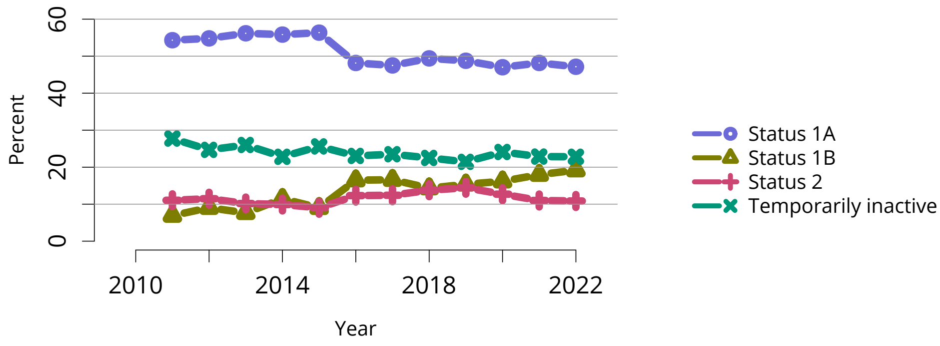
OPTN/SRTR 2022 Annual Data Report

Figure HR 82: Distribution of pediatric candidates waiting for heart transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



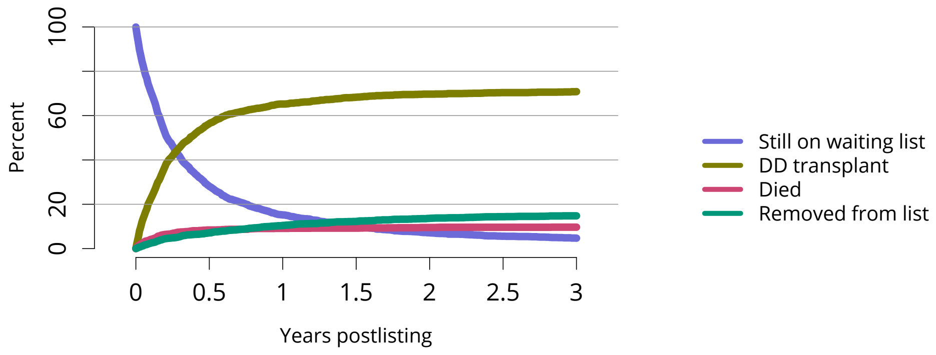
OPTN/SRTR 2022 Annual Data Report

Figure HR 83: Distribution of pediatric candidates waiting for heart transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included.



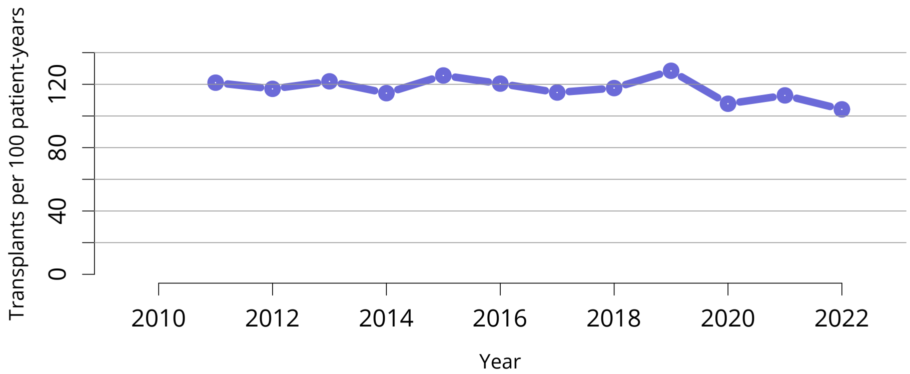
OPTN/SRTR 2022 Annual Data Report

Figure HR 84: Distribution of pediatric candidates waiting for heart transplant by medical urgency. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Medical urgency is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive patients are included.



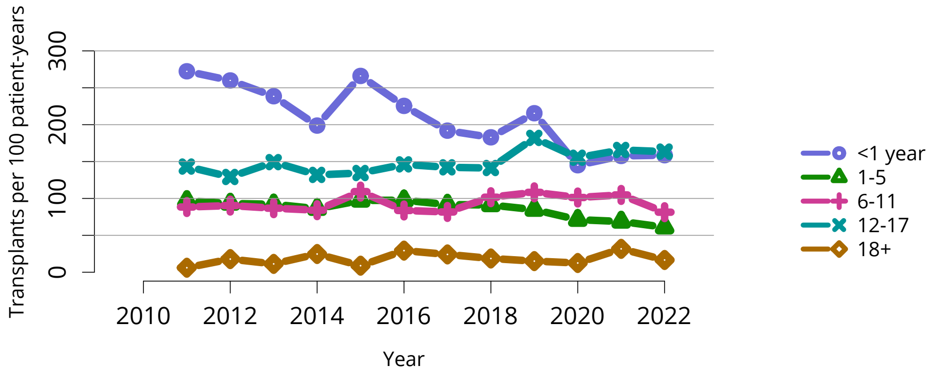
OPTN/SRTR 2022 Annual Data Report

Figure HR 85: Three-year outcomes for newly listed pediatric candidates waiting for heart transplant, 2017-2019. Pediatric candidates who joined the waiting list in 2017-2019. Pediatric candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.



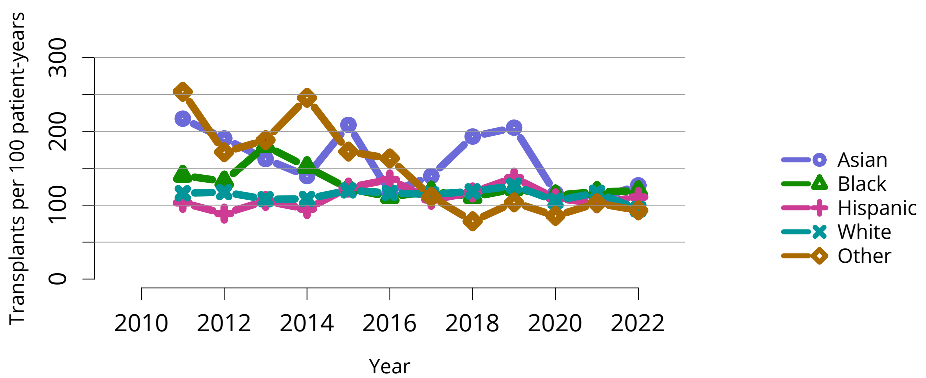
OPTN/SRTR 2022 Annual Data Report

Figure HR 86: Overall deceased donor heart transplant rates among pediatric waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



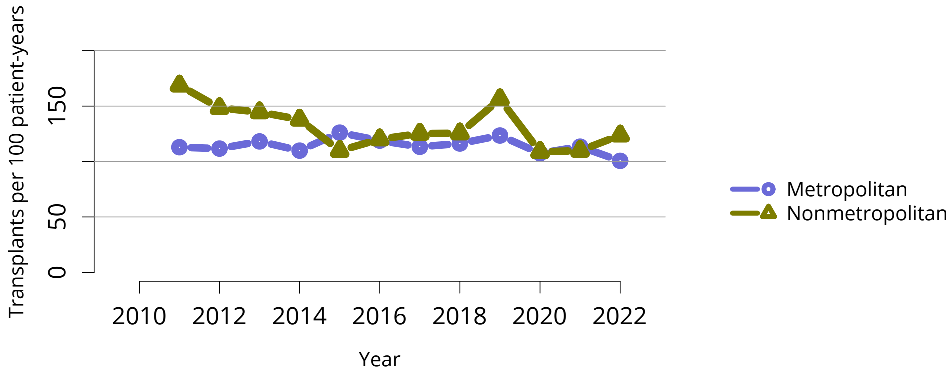
OPTN/SRTR 2022 Annual Data Report

Figure HR 87: Deceased donor heart transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



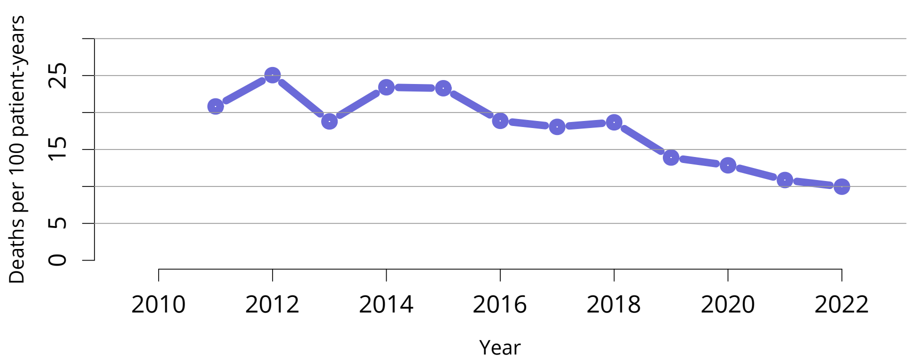
OPTN/SRTR 2022 Annual Data Report

Figure HR 88: Deceased donor heart transplant rates among pediatric waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



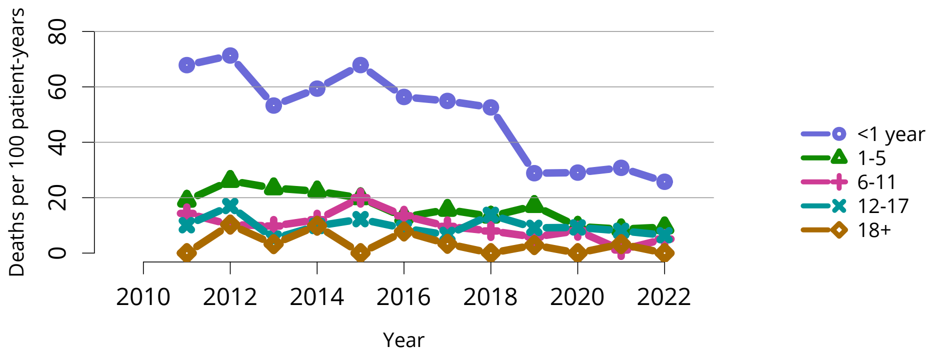
OPTN/SRTR 2022 Annual Data Report

Figure HR 89: Deceased donor heart transplant rates among pediatric waitlist candidates by metropolitan versus nonmetropolitan residence. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



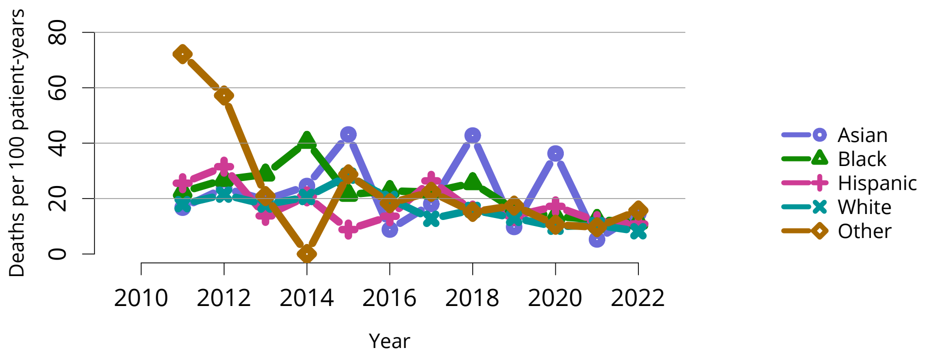
OPTN/SRTR 2022 Annual Data Report

Figure HR 90: Overall pretransplant mortality rates among pediatric candidates waitlisted for heart. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



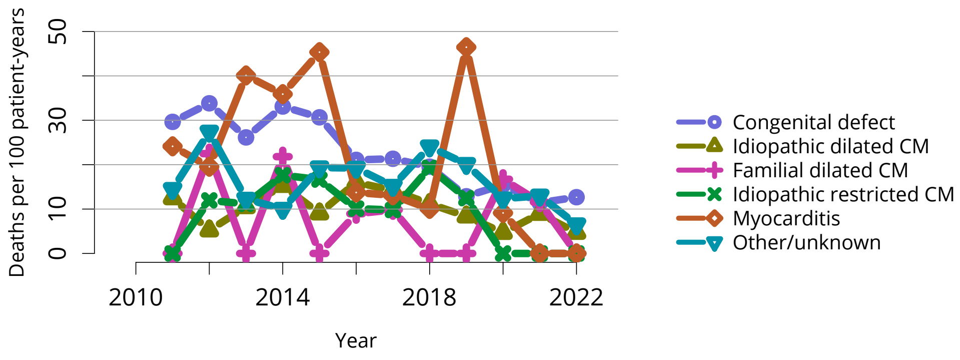
OPTN/SRTR 2022 Annual Data Report

Figure HR 91: Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



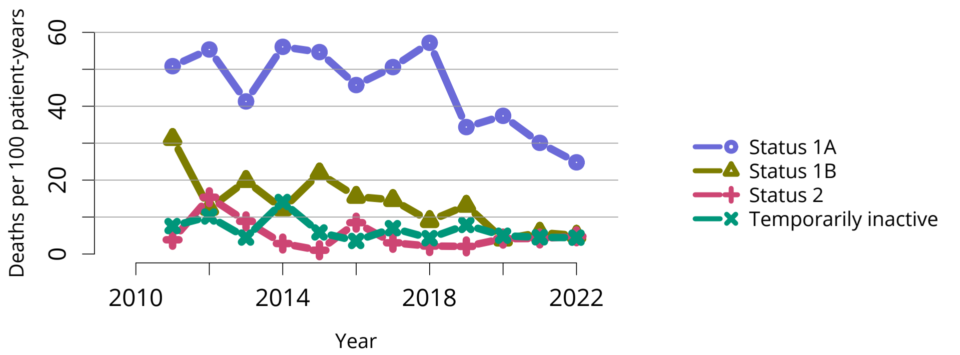
OPTN/SRTR 2022 Annual Data Report

Figure HR 92: Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



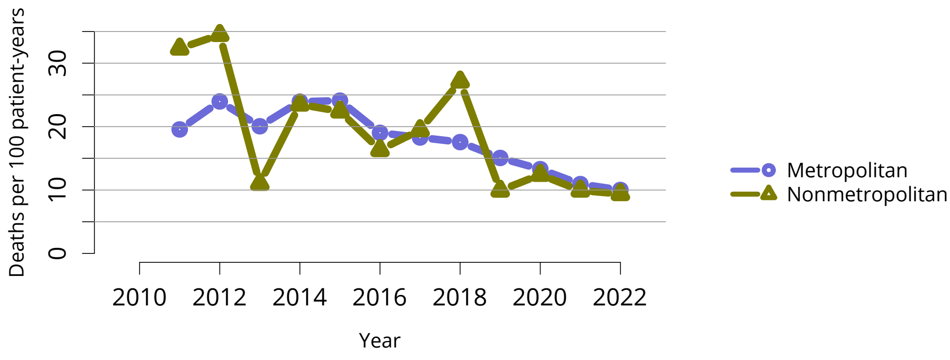
OPTN/SRTR 2022 Annual Data Report

Figure HR 93: Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. CM, cardiomyopathy.



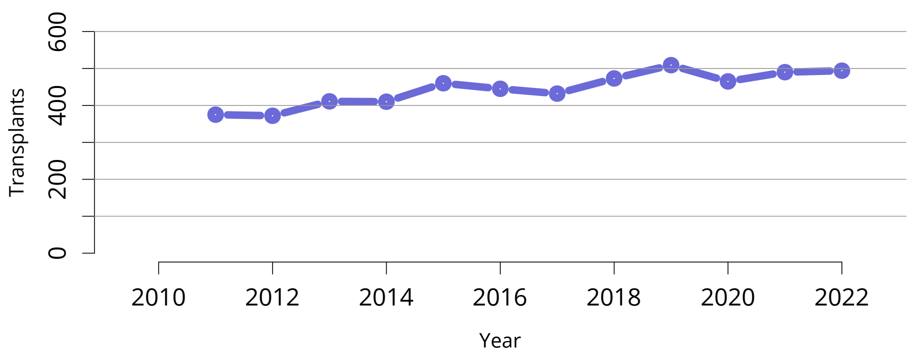
OPTN/SRTR 2022 Annual Data Report

Figure HR 94: Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by medical urgency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Medical urgency is determined at the later of listing date or January 1 of the given year.



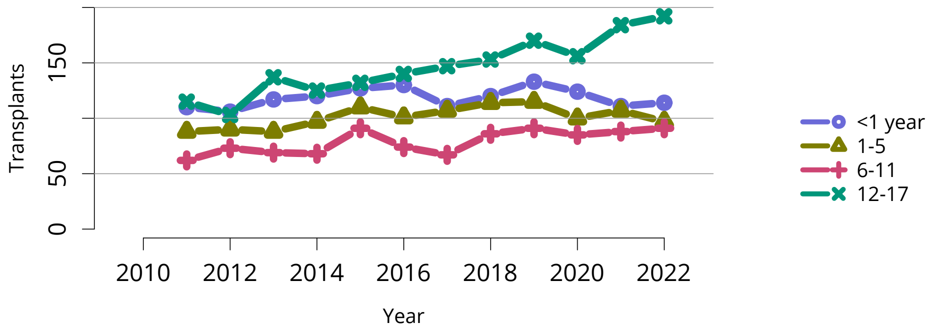
OPTN/SRTR 2022 Annual Data Report

Figure HR 95: Pretransplant mortality rates among pediatric candidates waitlisted for heart transplant by metropolitan versus nonmetropolitan residence. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Urban/rural determination is made using the RUCA (rural-urban commuting area) designation of the candidate's permanent zip code.



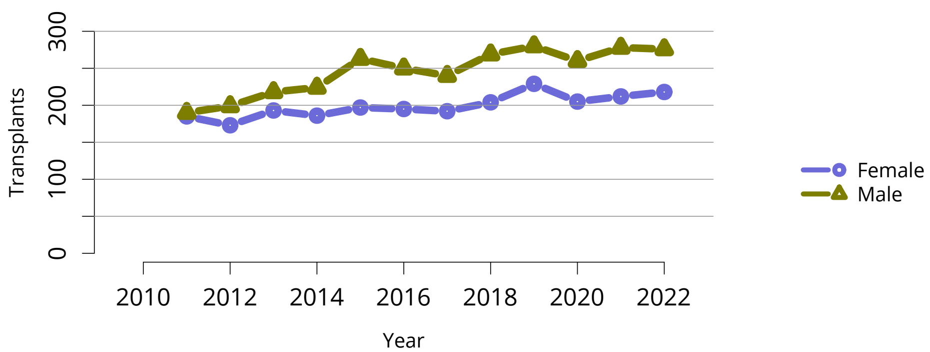
OPTN/SRTR 2022 Annual Data Report

Figure HR 96: Overall pediatric heart transplants. All pediatric heart transplant recipients, including retransplant and multiorgan recipients.



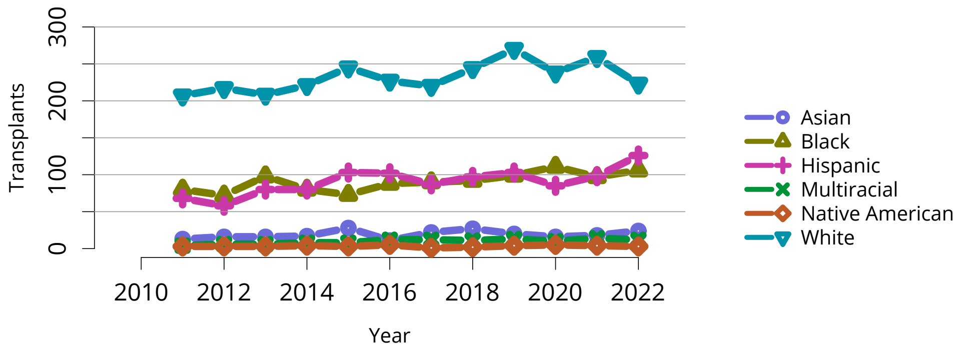
OPTN/SRTR 2022 Annual Data Report

Figure HR 97: Pediatric heart transplants by recipient age. All pediatric heart transplant recipients, including retransplant and multiorgan recipients.



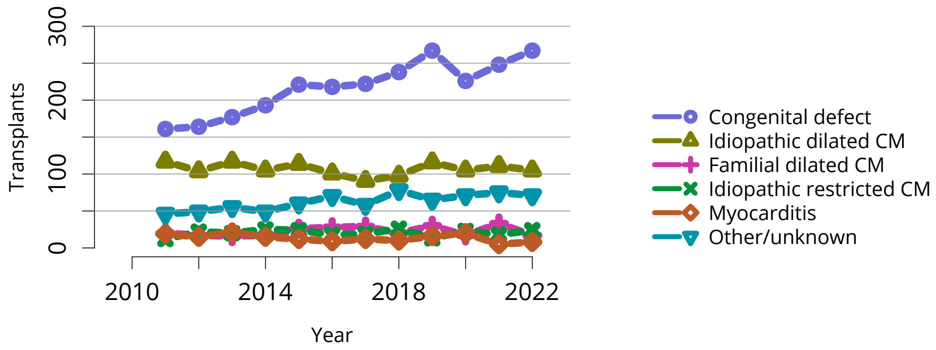
OPTN/SRTR 2022 Annual Data Report

Figure HR 98: Pediatric heart transplants by sex. All pediatric heart transplant recipients, including retransplant and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure HR 99: Pediatric heart transplants by race and ethnicity. All pediatric heart transplant recipients, including retransplant and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure HR 100: Pediatric heart transplants by diagnosis. All pediatric heart transplant recipients, including retransplant and multiorgan recipients. CM, cardiomyopathy.

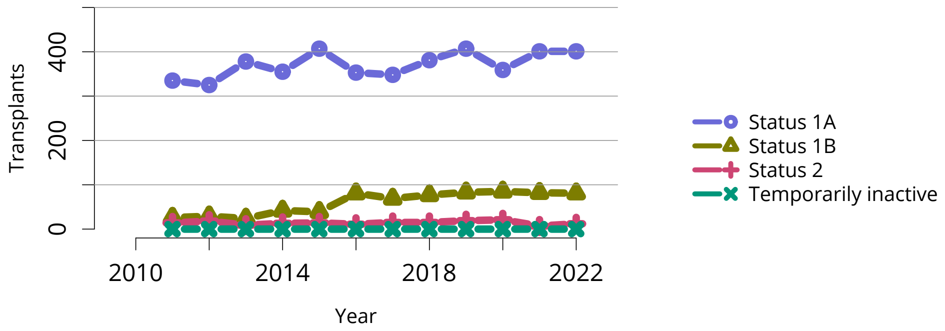


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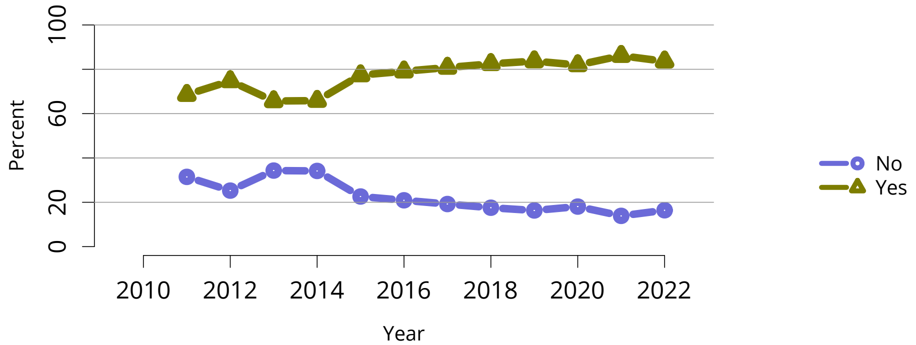
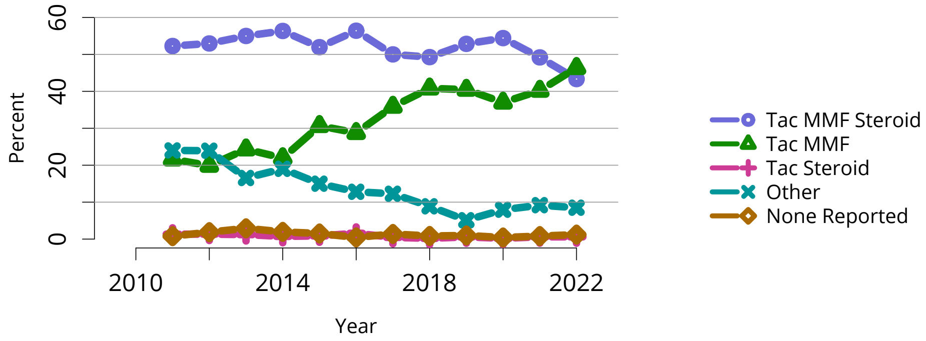
Figure HR 101: Pediatric heart transplants by medical urgency. All pediatric heart transplant recipients, including retransplant and multiorgan recipients. The OPTN heart allocation policy changed the status groups in October 2018.



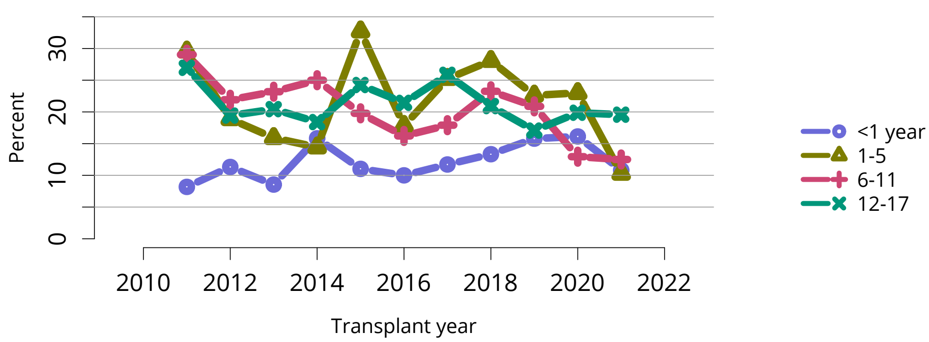
OPTN/SRTR 2022 Annual Data Report

Figure HR 102: Induction agent use in pediatric heart transplant recipients. Immunosuppression at transplant reported to the OPTN.



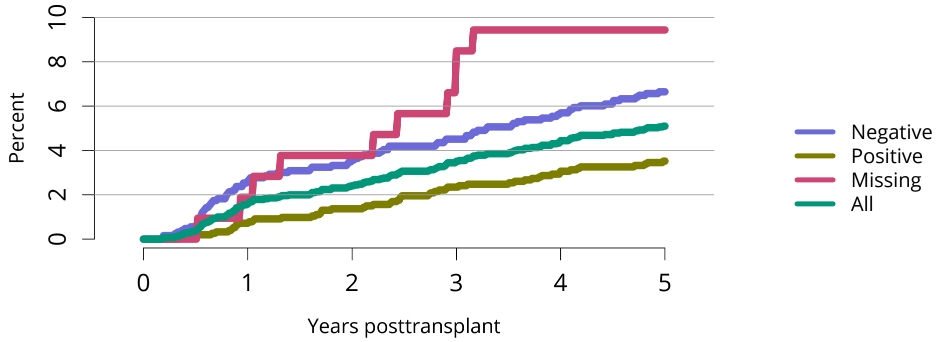
OPTN/SRTR 2022 Annual Data Report

Figure HR 103: Immunosuppression regimen use in pediatric heart transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



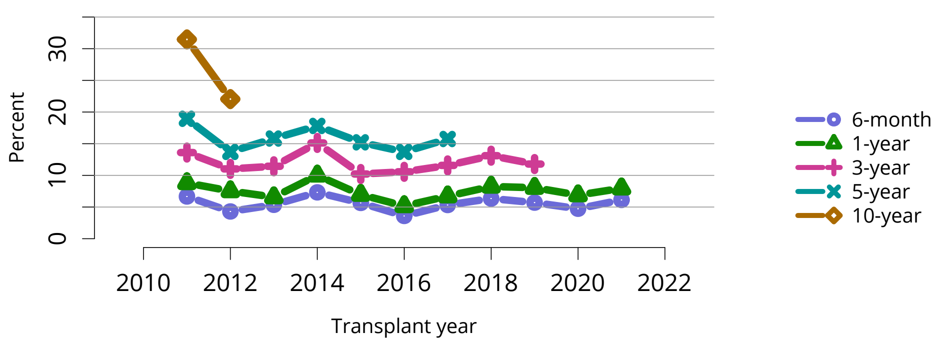
OPTN/SRTR 2022 Annual Data Report

Figure HR 104: Incidence of acute rejection by 1 year posttransplant among pediatric heart transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



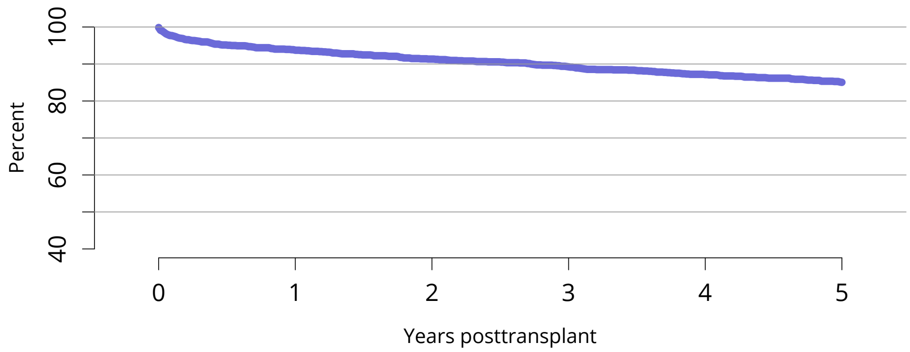
OPTN/SRTR 2022 Annual Data Report

Figure HR 105: Incidence of PTLD among pediatric heart transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



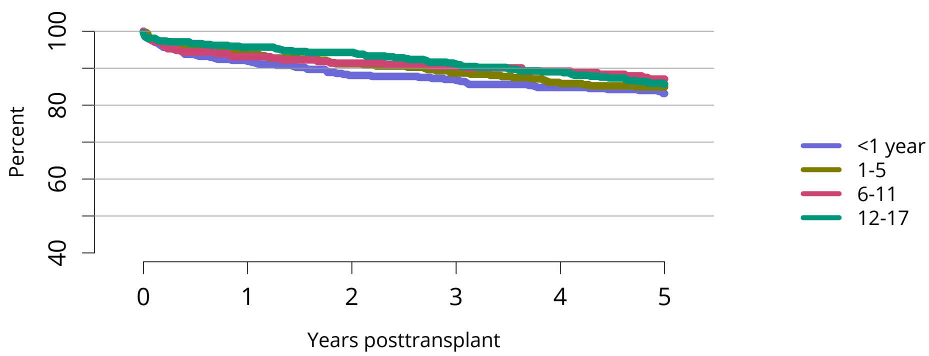
OPTN/SRTR 2022 Annual Data Report

Figure HR 106: Patient death among pediatric heart transplant recipients. All pediatric recipients of deceased donor hearts, including multiorgan transplant recipients. Estimates are unadjusted, computed using unadjusted Kaplan-Meier methods.



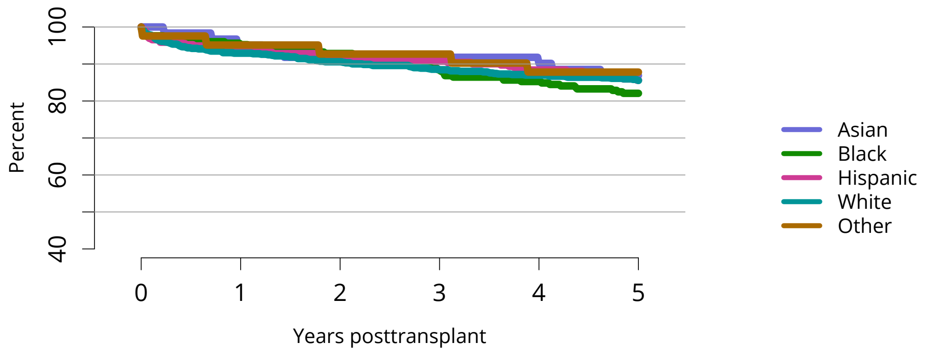
OPTN/SRTR 2022 Annual Data Report

Figure HR 107: Overall patient survival among pediatric deceased donor heart transplant recipients, 2015-2017. Recipient survival estimated using unadjusted Kaplan-Meier methods.



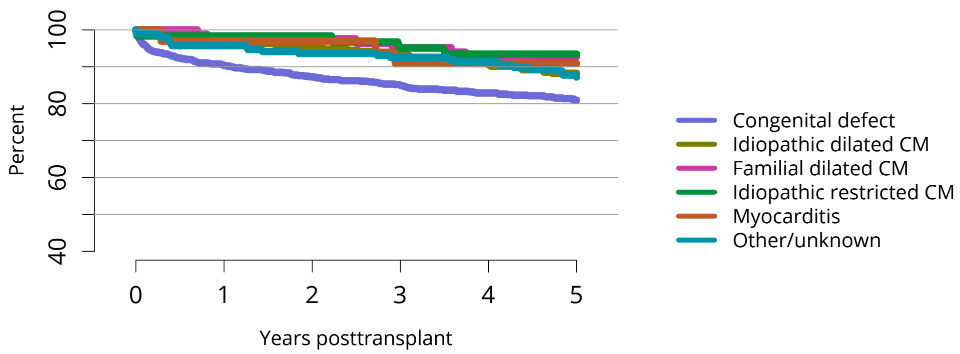
OPTN/SRTR 2022 Annual Data Report

Figure HR 108: Patient survival among pediatric deceased donor heart transplant recipients, 2015-2017, by recipient age. Recipient survival estimated using unadjusted Kaplan-Meier methods.



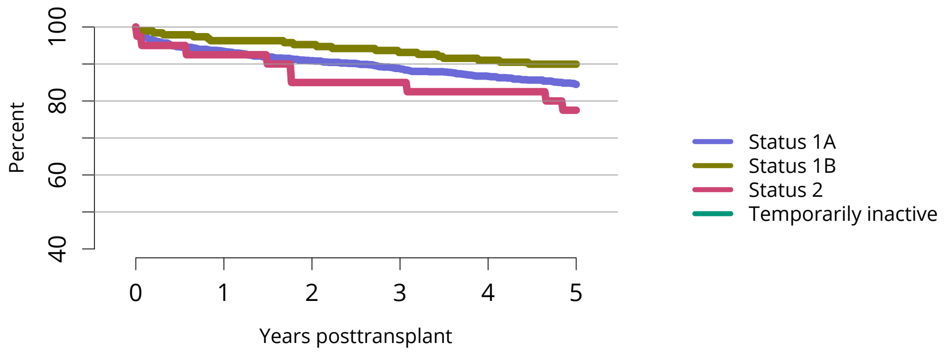
OPTN/SRTR 2022 Annual Data Report

Figure HR 109: Patient survival among pediatric deceased donor heart transplant recipients, 2015-2017, by race and ethnicity. Recipient survival estimated using unadjusted Kaplan-Meier methods. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure HR 110: Patient survival among pediatric deceased donor heart transplant recipients, 2015-2017, by diagnosis. Recipient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure HR 111: Patient survival among pediatric deceased donor heart transplant recipients, 2015-2017, by medical urgency. Recipient survival estimated using unadjusted Kaplan-Meier methods.

Table HR 1: Demographic characteristics of adults on the heart transplant waiting list on December 31, 2012, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center. Age is determined on December 31 of the year.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
18-34 years	299	9.7	300	10.4
35-49	693	22.4	673	23.4
50-64	1527	49.4	1358	47.2
65+	574	18.6	549	19.1
Sex				
Female	765	24.7	651	22.6
Male	2328	75.3	2229	77.4
Race and ethnicity				
Asian	66	2.1	83	2.9
Black	675	21.8	851	29.5
Hispanic	217	7	300	10.4
Multiracial	18	0.6	19	0.7
Native American	7	0.2	10	0.3
White	2110	68.2	1617	56.1
Geography				
Metropolitan	2566	83	2474	85.9
Nonmetropolitan	494	16	372	12.9
Missing	33	1.1	34	1.2
Miles between candidate and center				
<50 miles	1815	58.7	1773	61.6
50-<100	492	15.9	458	15.9
100-<150	291	9.4	269	9.3
150-<250	276	8.9	186	6.5
250+	190	6.1	165	5.7
Missing	29	0.9	29	1
All candidates				
All candidates	3093	100	2880	100

Table HR 2: Clinical characteristics of adults on the heart transplant waiting list on December 31, 2012, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. VAD, ventricular assist device.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Coronary artery disease	1138	36.8	798	27.7
Cardiomyopathy	1581	51.1	1701	59.1
Congenital disease	159	5.1	168	5.8
Valvular disease	64	2.1	29	1
Other/unknown	145	4.7	184	6.4
NA	6	0.2	0	0
Blood type				
A	992	32.1	759	26.4
AB	55	1.8	50	1.7
B	325	10.5	297	10.3
O	1721	55.6	1774	61.6
VAD status at listing				
No VAD	2368	76.6	1863	64.7
VAD	693	22.4	1007	35
Missing	32	1	10	0.3
Urgency status for heart candidates				
Status 1A	272	8.8	0	0
Status 1B	1089	35.2	0	0
Status 2	915	29.6	0	0
Adult Status 1	0	0	15	0.5
Adult Status 2	0	0	124	4.3
Adult Status 3	0	0	146	5.1
Adult Status 4	0	0	1353	47
Adult Status 5	0	0	119	4.1
Adult Status 6	0	0	573	19.9
Temporarily inactive	817	26.4	547	19
Adults listed under pediatric status	0	0	3	0.1
All candidates				
All candidates	3093	100	2880	100

Table HR 3: Listing characteristics of adults on the heart transplant waiting list on December 31, 2012, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Previous transplant				
No prior transplant	2990	96.7	2780	96.5
Prior transplant	103	3.3	100	3.5
Waiting time				
<90 days	589	19	605	21
3-<6 months	418	13.5	337	11.7
6-<12 months	576	18.6	483	16.8
1-<2 years	633	20.5	589	20.5
2+ years	877	28.4	866	30.1
All candidates				
All candidates	3093	100	2880	100

Table HR 4: Medical urgency statuses 1 and 2 of adults on the heart transplant waiting list by OPTN region during 2021 and 2022. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Urgency status is determined at the earliest of transplant, death, removal, or December 31 of the year.

	2021		2022	
OPTN Region	**N**	**Percent**	**N**	**Percent**
Region 1				
Adult Status 1	28	6.2	30	6.6
Adult Status 2	82	18	93	20.5
Region 2				
Adult Status 1	45	6.3	51	7.4
Adult Status 2	164	23	175	25.3
Region 3				
Adult Status 1	51	5.6	55	5.9
Adult Status 2	225	24.5	276	29.8
Region 4				
Adult Status 1	32	4.2	33	4.3
Adult Status 2	186	24.4	205	27
Region 5				
Adult Status 1	59	5.9	69	6.7
Adult Status 2	296	29.7	345	33.5
Region 6				
Adult Status 1	13	6.6	11	5.1
Adult Status 2	33	16.8	53	24.5
Region 7				
Adult Status 1	45	6.3	31	4.8
Adult Status 2	179	25.1	195	30
Region 8				
Adult Status 1	11	2.6	29	7.1
Adult Status 2	115	26.9	130	31.7
Region 9				
Adult Status 1	44	6.6	44	6
Adult Status 2	179	26.8	216	29.5
Region 10				
Adult Status 1	26	3.5	41	5.8
Adult Status 2	145	19.7	144	20.5
Region 11				
Adult Status 1	59	6.3	71	7.5
Adult Status 2	250	26.8	268	28.3

Table HR 5: Heart transplant waitlist activity among adults. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	3386	3146	3073
Patients added during year	3999	4373	4446
Patients removed during year	4239	4446	4639
Patients at end of year	3146	3073	2880

Table HR 6: Removal reason among adult heart transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	3240	3355	3652
Transplant outside US	0	0	1
Patient died	191	210	171
Patient refused transplant	19	23	20
Improved, transplant not needed	147	198	157
Too sick for transplant	243	252	212
Other	399	408	425
Still on waiting list	0	0	1

Table HR 7: Adult heart transplant recipients on life support before transplant. Patients may have more than one type of life support. Circulatory support: left ventricular assist device, right ventricular assist device, total artificial heart, extracorporeal membrane oxygenation, and intra-aortic balloon pump.

	2019		2022	
Life support type	**N**	**Percent**	**N**	**Percent**
Life support type				
Any life support	2542	82.3	2730	74.4
Left ventricular assist device	1057	34.2	1191	32.5
Intravenous inotropes	1195	38.7	1349	36.8
Intra-aortic balloon pump	932	30.2	945	25.8
Right ventricular assist device	70	2.3	81	2.2
Extra corporeal membrane oxygenation	185	6	228	6.2
Total artificial heart	26	0.8	8	0.2
Ventilator	78	2.5	75	2
Inhaled nitric oxide	8	0.3	20	0.5
Prostaglandins	7	0.2	3	0.1

Table HR 8: Demographic characteristics of adult heart transplant recipients, 2012 and 2022. Heart transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
18-34 years	221	10.9	459	12.5
35-49	436	21.4	754	20.6
50-64	1015	49.9	1711	46.6
65+	363	17.8	744	20.3
Sex				
Female	563	27.7	988	26.9
Male	1472	72.3	2680	73.1
Race and ethnicity				
Asian	87	4.3	164	4.5
Black	400	19.7	990	27
Hispanic	161	7.9	411	11.2
Multiracial	14	0.7	19	0.5
Native American	6	0.3	14	0.4
White	1367	67.2	2070	56.4
Insurance				
Private	1035	50.9	1642	44.8
Medicare	684	33.6	1255	34.2
Medicaid	247	12.1	577	15.7
Other/unknown	69	3.4	194	5.3
Geography				
Metropolitan	1706	83.8	3067	83.6
Nonmetropolitan	310	15.2	531	14.5
Missing	19	0.9	70	1.9
Miles between recipient and center				
<50 miles	1265	62.2	2170	59.2
50-<100	317	15.6	595	16.2
100-<150	177	8.7	334	9.1
150-<250	144	7.1	273	7.4
250+	121	5.9	230	6.3
Missing	11	0.5	66	1.8
All recipients				
All recipients	2035	100	3668	100

Table HR 9: Clinical characteristics of adult heart transplant recipients, 2012 and 2022. Heart transplant recipients, including retransplant recipients. VAD information is from the OPTN Transplant Recipient Registration Form and includes left VAD, right VAD, total artificial heart, and left + right VAD. Collection of cPRA began March 31, 2015. Prior to that, PRA class I and II values were used. Missing/temporarily inactive urgency statuses are regarded as listing errors since they should not have received a transplant. cPRA, calculated panel-reactive antibody; VAD, ventricular assist device.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Coronary artery disease	790	38.8	950	25.9
Cardiomyopathy	1100	54.1	2350	64.1
Congenital disease	81	4	187	5.1
Valvular disease	29	1.4	39	1.1
Other/unknown	17	0.8	106	2.9
NA	18	0.9	36	1
Blood type				
A	858	42.2	1413	38.5
AB	128	6.3	177	4.8
B	295	14.5	546	14.9
O	754	37.1	1532	41.8
VAD at transplant				
VAD	843	41.4	1291	35.2
No VAD	1192	58.6	2358	64.3
Missing	0	0	19	0.5
cPRA				
<1%	1050	51.6	1768	48.2
1-<20%	429	21.1	389	10.6
20-<80%	373	18.3	428	11.7
80-<98%	62	3	65	1.8
98-100%	33	1.6	20	0.5
Missing	88	4.3	998	27.2
Urgency status for heart recipients				
Status 1A	1190	58.5	9	0.2
Status 1B	743	36.5	5	0.1
Status 2	102	5	2	0.1
Adult Status 1	0	0	417	11.4
Adult Status 2	0	0	1915	52.2
Adult Status 3	0	0	472	12.9
Adult Status 4	0	0	591	16.1
Adult Status 5	0	0	54	1.5
Adult Status 6	0	0	203	5.5
All recipients				
All recipients	2035	100	3668	100

Table HR 10: Transplant characteristics of adult heart transplant recipients, 2012 and 2022. Heart transplant recipients, including retransplant recipients.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
None	48	2.4	144	3.9
<90 days	969	47.6	2418	65.9
3-<6 months	354	17.4	324	8.8
6-<12 months	291	14.3	284	7.7
1-<2 years	227	11.2	261	7.1
2+ years	146	7.2	237	6.5
Previous transplant for recipients				
No prior transplant	1969	96.8	3561	97.1
Prior transplant	66	3.2	107	2.9
Transplant type				
Heart only	1912	94	3153	86
Heart-kidney	76	3.7	385	10.5
Heart-lung	27	1.3	45	1.2
Heart-liver	19	0.9	74	2
Other multiorgan	1	0	11	0.3
All recipients				
All recipients	2035	100	3668	100

Table HR 11: Demographic characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2012, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date. Age is determined on December 31 of the year. Distance is computed from candidate's home zip code to the transplant center.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
<1 year	33	9.9	86	16.8
1-5	93	27.9	123	24.1
6-11	87	26.1	133	26
12-17	84	25.2	125	24.5
18+	36	10.8	44	8.6
Sex				
Female	126	37.8	219	42.9
Male	207	62.2	292	57.1
Race and ethnicity				
Asian	9	2.7	14	2.7
Black	53	15.9	90	17.6
Hispanic	67	20.1	115	22.5
Multiracial	4	1.2	16	3.1
Native American	3	0.9	3	0.6
White	197	59.2	273	53.4
Geography				
Metropolitan	274	82.3	418	81.8
Nonmetropolitan	51	15.3	86	16.8
Missing	8	2.4	7	1.4
Miles between candidate and center				
<50 miles	152	45.6	245	47.9
50-<100	61	18.3	101	19.8
100-<150	38	11.4	56	11
150-<250	37	11.1	56	11
250+	37	11.1	47	9.2
Missing	8	2.4	6	1.2
All candidates				
All candidates	333	100	511	100

Table HR 12: Clinical characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2012, and December 31, 2022. CM, cardiomyopathy; VAD, ventricular assist device.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Pediatric diagnosis				
Congenital defect	146	43.8	337	65.9
Idiopathic dilated CM	63	18.9	60	11.7
Familial dilated CM	5	1.5	9	1.8
Idiopathic restricted CM	27	8.1	8	1.6
Myocarditis	11	3.3	8	1.6
Other/unknown	81	24.3	89	17.4
Blood type				
A	105	31.5	147	28.8
AB	7	2.1	10	2
B	33	9.9	60	11.7
O	188	56.5	294	57.5
VAD status at listing				
No VAD	302	90.7	467	91.4
VAD	20	6	44	8.6
Missing	11	3.3	0	0
Urgency status for heart candidates				
Status 1A	96	28.8	123	24.1
Status 1B	40	12	130	25.4
Status 2	70	21	102	20
Temporarily inactive	127	38.1	156	30.5
All candidates				
All candidates	333	100	511	100

Table HR 13: Listing characteristics of pediatric candidates on the heart transplant waiting list on December 31, 2012, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Previous transplant				
No prior transplant	304	91.3	483	94.5
Prior transplant	29	8.7	28	5.5
Waiting time				
<90 days	86	25.8	129	25.2
3-<6 months	46	13.8	91	17.8
6-<12 months	53	15.9	82	16
1-<2 years	51	15.3	88	17.2
2+ years	97	29.1	121	23.7
All candidates				
All candidates	333	100	511	100

Table HR 14: Heart transplant waitlist activity among pediatric candidates. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	414	443	485
Patients added during year	673	703	703
Patients removed during year	644	661	677
Patients at end of year	443	485	511

Table HR 15: Removal reason among pediatric heart transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	475	505	509
Patient died	57	46	48
Patient refused transplant	2	3	2
Improved, transplant not needed	48	40	52
Too sick for transplant	33	33	35
Other	29	34	31

Table HR 16: Pediatric heart transplant recipients on life support before transplant. Patients may have more than one type of life support. Circulatory support: left ventricular assist device, right ventricular assist device, total artificial heart, extracorporeal membrane oxygenation, and intra-aortic balloon pump.

	2017		2022	
Life support type	N	Percent	N	Percent
Life support type				
Any life support	315	72.9	313	63.4
Left ventricular assist device	123	28.5	176	35.6
Intravenous inotropes	207	47.9	167	33.8
Intra-aortic balloon pump	2	0.5	1	0.2
Right ventricular assist device	19	4.4	24	4.9
Extra corporeal membrane oxygenation	17	3.9	21	4.3
Total artificial heart	1	0.2	1	0.2
Ventilator	75	17.4	33	6.7
Inhaled nitric oxide	6	1.4	6	1.2
Prostaglandins	13	3	2	0.4

Table HR 17: Demographic characteristics of pediatric heart transplant recipients, 2012 and 2022. Pediatric heart transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
<1 year	106	28.5	114	23.1
1-5	90	24.2	97	19.6
6-11	73	19.6	91	18.4
12-17	103	27.7	192	38.9
Sex				
Female	173	46.5	218	44.1
Male	199	53.5	276	55.9
Race and ethnicity				
Asian	16	4.3	24	4.9
Black	72	19.4	106	21.5
Hispanic	58	15.6	126	25.5
Multiracial	6	1.6	12	2.4
Native American	3	0.8	3	0.6
White	217	58.3	223	45.1
Insurance				
Private	179	48.1	207	41.9
Medicare	0	0	3	0.6
Medicaid	162	43.5	233	47.2
Other/unknown	31	8.3	51	10.3
Geography				
Metropolitan	301	80.9	394	79.8
Nonmetropolitan	61	16.4	88	17.8
Missing	10	2.7	12	2.4
Miles between recipient and center				
<50 miles	179	48.1	246	49.8
50-<100	56	15.1	100	20.2
100-<150	44	11.8	55	11.1
150-<250	43	11.6	37	7.5
250+	40	10.8	46	9.3
Missing	10	2.7	10	2
All recipients				
All recipients	372	100	494	100

Table HR 18: Clinical characteristics of pediatric heart transplant recipients, 2012 and 2022. Pediatric heart transplant recipients, including retransplant recipients. cPRA began March 31, 2015. Prior to that, measured PRA values were used. CM, cardiomyopathy; cPRA, calculated panel-reactive antibody; VAD, ventricular assist device.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis				
Congenital defect	164	44.1	267	54
Idiopathic dilated CM	104	28	105	21.3
Familial dilated CM	17	4.6	17	3.4
Idiopathic restricted CM	22	5.9	24	4.9
Myocarditis	15	4	8	1.6
Other/unknown	49	13.2	71	14.4
NA	1	0.3	2	0.4
Blood type				
A	138	37.1	178	36
AB	18	4.8	13	2.6
B	51	13.7	53	10.7
O	165	44.4	250	50.6
VAD at transplant				
VAD	87	23.4	186	37.7
No VAD	285	76.6	308	62.3
cPRA				
<1%	152	40.9	259	52.4
1-<20%	62	16.7	50	10.1
20-<80%	78	21	56	11.3
80-<98%	19	5.1	10	2
98-100%	14	3.8	8	1.6
Missing	47	12.6	111	22.5
Urgency status for heart recipients				
Status 1A	325	87.4	401	81.2
Status 1B	29	7.8	81	16.4
Status 2	18	4.8	12	2.4
All recipients				
All recipients	372	100	494	100

Table HR 19: Transplant characteristics of pediatric heart transplant recipients, 2012 and 2022. Pediatric heart transplant recipients, including retransplant recipients.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
None	6	1.6	11	2.2
<90 days	238	64	240	48.6
3-<6 months	63	16.9	127	25.7
6-<12 months	43	11.6	68	13.8
1-<2 years	15	4	33	6.7
2+ years	7	1.9	15	3
ABO-Incompatible transplant				
Compatible/Identical	361	97	449	90.9
Incompatible	11	3	45	9.1
Previous transplant for recipients				
No prior transplant	346	93	471	95.3
Prior transplant	26	7	23	4.7
Transplant type				
Heart only	365	98.1	482	97.6
Heart-kidney	2	0.5	4	0.8
Heart-lung	2	0.5	3	0.6
Heart-liver	3	0.8	5	1
All recipients				
All recipients	372	100	494	100

OPTN/SRTR 2022 Annual Data Report: Lung

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Abstract

For the first time since the COVID-19 pandemic, the annual number of lung transplants performed in the United States increased. The year 2022, encompassed in this report, marks the last full calendar year where the Lung Allocation Score was used for ranking transplant candidates based on their estimated transplant benefit and donor lung allocation in the United States. In March 2023, a major change in transplant allocation policy occurred with the implementation of the Composite Allocation Score. Transplant rates have increased over the past decade, although there is variability among age, diagnosis, racial and ethnic, and blood groups. Over half of candidates received a lung transplant within 3 months of placement on the waiting list, with nearly 75% of candidates accessing transplant by 1 year. Pretransplant mortality rates remained stable, with approximately 13% of lung transplant candidates dying or being removed from the waiting list within a year of listing. Posttransplant survival remained stable; however, variability exists by age, diagnosis, and racial and ethnic groups.

Keywords: End-stage lung disease, Lung Allocation Score, lung transplant, organ allocation, transplant outcomes

1 Introduction

In the year 2022, there were 2,743 lung transplants performed in the United States, representing an increase of 174 lung transplants from 2,569 in 2021 (Figure LU 44). The number of lung transplants performed did not reach the pre–COVID-19 pandemic national transplant volumes noted in 2019. The number of new adult candidates added to the waiting list annually continued to increase following the nadir noted in 2020, with 3,161 candidates added in 2022 (Figure LU 1).

Data from 2022 must be understood in the context of related policy changes. Lung allocation policy changes were implemented on September 30, 2021, to prepare for the eventual implementation of the Composite Allocation Score system, which occurred on March 9, 2023. The changes on September 30, 2021, affected the Lung Allocation Score (LAS) calculation and reflected an updated candidate and recipient cohort to improve the predictions of the waitlist and posttransplant mortality models used to calculate the LAS. Multiple variables were removed from the LAS risk models, including the diagnoses of obliterative bronchiolitis, lymphangioleiomyomatosis, and Eisenmenger syndrome; bilirubin increase of 50% or greater; diabetes; forced vital capacity; cardiac index; and central venous pressure from the waitlist survival model. The variables for functional status; creatinine increase of at least 150%; and the diagnoses of lymphangioleiomyomatosis, Eisenmenger's syndrome, and "pulmonary fibrosis, other" were removed from the posttransplant survival model. The remaining variable parameterizations were updated to reflect the updated candidate and recipient cohorts. The LAS in use in 2022 continued to use a 2:1 ratio of 1-year waitlist and 1-year posttransplant survival estimates.

The LAS used waitlist and posttransplant mortality models to estimate transplant benefit and was used to rank candidates aged 12 years and older for transplant after accounting for geography, blood type, size compatibility, and HLA antibodies. Pulmonary diseases were characterized into four main diagnosis groups in the system: group A, obstructive lung disease; group B, pulmonary vascular disease; group C, cystic fibrosis and immunodeficiency disorders; and group D, restrictive lung diseases. These groupings were derived to aggregate individuals based on disease pathophysiology and survival probability. Allocation system changes that must be taken into consideration when interpreting longitudinal data in this report include: 1) the 2015 update using a contemporary cohort and new variables for group B candidates; 2) the 2017 update that changed the first unit of allocation to a 250–nautical-mile radius from the donor hospital; and 3) the 2021 update using a contemporary cohort, updated variable parameterizations, and with fewer variables in the waitlist and posttransplant mortality models. Allocation rules differed for individuals younger than 12 years and were determined by geography, age, blood-type compatibility, illness-based priority status, and waiting time.

The Adult Lung Transplantation section in this report includes information on all lung transplant candidates and recipients aged 18 years or older at the time of placement on the waiting list. The Pediatric Lung Transplantation section includes information on all lung transplant candidates and recipients younger than 18 years at the time of placement on the waiting list. Reports from 2019 and earlier separated adult and pediatric sections at the age of 12 years, but this was changed in 2020 to align with international reporting. This chapter includes data on all US lung and heart-lung candidates and transplant recipients.

2 Adult Lung Transplantation in the United States

2.1 Waiting List

2.1.1 Characteristics of adult candidates listed for lung transplant

In 2022, there were 3,161 candidates added to the lung transplant waiting list (Figure LU 1). There were 4,228 candidates on the lung transplant waiting list during the year, a number which has remained relatively constant since 2011 (Figure LU 2). In 2022, 6.0% of candidates were aged 18-34 years, 12.8% were 35-49 years, 44.2% were 50-64 years, and 36.9% were 65 years or older. The percent of candidates aged 65 years or older increased by 63.5% while the percent of candidates aged 18-34 years decreased by 50.2% from years 2011 to 2022 (Figure LU 3). In terms of sex distribution, 44.7% of waitlist candidates were women, with an overall decrease of 13.7% in female candidates since 2011 (Figure LU 4). The proportion of candidates by self-identified racial and ethnic group has remained relatively stable since 2021. In 2022, 4.8% of candidates identified as Asian, 11.3% as Black, 14.7% as Hispanic, and 68.4% as White. However, changes have emerged over time, with an increase of 163.8% Asian, 18.0% Black, and 153.2% Hispanic candidates and a decrease of 16.7% White candidates since 2011 (Figure LU 5). The proportion of candidates in group D continued to increase, representing 69.1% of the waiting list in 2022, while group A candidates decreased to 20.6%, and group C has decreased to only 1.8% of the waitlist population (Figure LU 6).

The proportion of candidates with the lowest LAS values (<35) decreased from 34.9% in 2011 to 22.8% in 2022, while those with the highest LAS values (60 or greater) have increased from 14.0% in 2011 to 22.9% in 2022 (Figure LU 8). Trends in candidate height ranges remained stable, with 3.3% of candidates < 150 cm and 16.8% of candidates > 180 cm (Figure LU 9). For ABO blood type, the greatest proportion of transplant candidates had type O blood (49.0%), followed by type A (36.5%), type B (11.6%), and type AB (2.9%) (Figure LU 10). The proportion of candidates who were awaiting a retransplant remained stable at 3.2% (Figure LU 11).

2.1.2 Outcomes of adult candidates listed for lung transplant

Transplant rates continued to climb, with a 148.3% increase since 2011 for a transplant rate of 258.7 lung transplants per 100 patient-years; the greatest increase was for candidates aged 65 years or older (Figure LU 12, Figure LU 13). Lung transplant rates were lowest for Black candidates at 184.8 transplants per 100 patient-years compared with a range of 223.5-278.2 transplants per 100 patient-years for candidates of other racial and ethnic groups (Figure LU 14). Transplant rates were expectedly highest for candidates in diagnosis group D at 339.4 transplants per 100 patient-years and lowest for those in diagnosis group C at 140.4 transplants per 100 patient-years (Figure LU 15). Transplant rates were highest for those with blood type AB at 445.2 transplants per 100 patient-years (Figure LU 16). Those of the shortest stature had the lowest transplant rates, with sequential increases across candidate height (Figure LU 17).

Most candidates (61.4%) spent less than 90 days on the waiting list, 13.9% spent 3-<6 months on the waiting list, 12.2% spent 6-12 months on the waiting list, and 12.5% spent 1 year or longer on the waiting list (Figure LU 7). By 1 year on the waiting list, 74.5% of candidates underwent a deceased donor transplant, 12.2% remained on the list, 5.7% died, and 7.6% were removed from the list (Figure LU 18). Pretransplant mortality rates have remained relatively stable at 18.8 deaths per 100 patient-years, but trends by age have varied over time with increases in mortality rates over the past year for individuals aged 18-34 and 35-49 years (Figure LU 20, Figure LU 21). Pretransplant mortality rates were higher for men (23.0 deaths per 100 patient-years) compared with women (15.8 deaths per 100 patient-years) (Figure LU 23). Pretransplant mortality rates were highest for group D, followed by groups B, A, and C, respectively (Figure LU 24). As expected, pretransplant mortality rates were consistent with LAS values; that is, those with higher LAS values had higher pretransplant mortality (Figure LU 25). Blood groups A and O had the lowest pretransplant mortality rates while group AB had the highest (Figure LU 26). Pretransplant mortality rates were highest for those 180 cm or taller followed closely by those < 150 cm, with individuals 150-<180 cm in height trending closely together (Figure LU 27). Of candidates removed from the waiting list for reasons other than transplant or death, 23.2% died within 6 months, with the highest rates for diagnosis groups B and D and for older candidates, but with similar rates by sex and racial and ethnic groups (Figure LU 28, Figure LU 29, Figure LU 30, Figure LU 31, Figure LU 32).

2.2 Donors

The year 2022 had the highest number of deceased donors at 2,852, representing a 62.4% increase since 2011 (Figure LU 33). The distribution of donor age was as follows: younger than 18 years, 6.3%; 18-29 years, 28.4%; 30-39 years, 26.5%; 40-54 years, 26.9%; and 55 years or older, 11.9% (Figure LU 34). The proportion of donors remained stable by sex, with 60.3% male donors, and by race and ethnicity, with 59.3% White donors followed by 18.9% Black donors and 17.4% Hispanic donors (Figure LU 35, Figure LU 36). The nonuse rate (lungs recovered for transplant and not transplanted) has risen over time, from 4.2% in 2011 to 9.0% in 2022 (a 112.1% increase), with the highest nonuse rate of 14.0% for donors aged 55 or older (Figure LU 37, Figure LU 38). Nonuse rates did not differ meaningfully by sex (Figure LU 39), but differences by race and ethnicity exist, with the highest rates of nonuse for Black and White donors and with lower rates for Hispanic and Asian donors (Figure LU 40). Nonuse rates differed by donor cause of death, with the highest rates for causes of death including anoxia and cerebrovascular accident/stroke (Figure LU 41). Standard-risk donor lungs had higher rates of nonuse (9.5%) compared with US Public Health Service increased-risk donors (6.9%) (Figure LU 42). In 2022, anoxia was the most common cause of donor death, followed by head trauma, cerebrovascular accident/stroke, and other/unknown causes (Figure LU 43). The use of donation after circulatory death donors increased from 3.7% in 2017 to 7.4% in 2022 (Table LU 8).

2.3 Transplant

2.3.1 Characteristics of lung transplant recipients

In 2022, there were 2,743 lung transplants (adult and pediatric) performed and, of these, 2,196 (80.0%) were bilateral transplants (Figure LU 44, Figure LU 45). By age, there were 21 transplants performed in recipients younger than 18 years; 125, in those aged 18-35 years; 307, in those aged 35-49 years; 1,168, in those aged 50-64 years; and 1,112, in those aged 65 years and older (Figure LU 46). There were 1,701 male and 1,042 female transplant recipients (Figure LU 47). By racial and ethnic groups, 1,939 transplant recipients were White; 402, Hispanic; 257, Black; 123, Asian; 15, Native American; and 7, Multiracial (Figure LU 48). The greatest number of transplants occurred for individuals in group D at 2,031, followed by 498 transplants in group A, 168 in group B, and 46 in group C (Figure LU 49). For recipients with an LAS of 35 or less, 35-<40, 40-<50, 50-<60, and 60 or greater, the number of transplants that occurred were 480, 597, 698, 259, and 701, respectively (Figure LU 50). The percentage of adult candidates supported with extracorporeal membrane oxygenation (ECMO) continued to increase, from 5.2% in 2017 to 8.7% in 2022 (Table LU 7).

2.3.2 Outcomes of adult lung transplant recipients

Induction was used in 86.8% of transplant recipients, while 82.5% received subsequent immunosuppression with tacrolimus, mycophenolate mofetil, and a steroid agent (Figure LU 51, Figure LU 52). Notably, rates of acute cellular rejection in the first year have decreased over time with similar rates by racial and ethnic groups (Figure LU 62). The incidence of posttransplant lymphoproliferative disorder is 1.8% by 5 years, with variation by recipient Epstein-Barr virus status (Figure LU 63). For transplants performed in 2021, 1-year post-transplant mortality was 12.2%, and for transplants performed in 2017, 5-year posttransplant mortality was 40.4% (Figure LU 53). Transplant recipients aged 35-49 years had the highest survival and those aged 65 years or older had the lowest survival by 5 years posttransplant (Figure LU 55). By 5 years posttransplant, survival differed across racial and ethnic groups, with those of Hispanic ethnicity having the greatest survival followed by those of White, Black, Asian, Multiracial, and Native American racial groups (Figure LU 56). By 5 years, survival by LAS group only differed by 6.04%: 62.6% for the 35-or-less LAS group and 56.5% for the 60-or-greater group (Figure LU 57). Percent survival for bilateral transplant was higher by 6 months posttransplant compared with single transplant, but it is important to acknowledge that this is an unadjusted analysis and does not consider potential confounders in procedure selection and candidate condition at time of listing and transplant (Figure LU 58). Percent survival differed by diagnosis group at 5 years, with the highest percent survival for those in diagnosis group C and the lowest in diagnosis group D, an effect likely affected by recipient age (Figure LU 59).

3 Pediatric Lung Transplantation in the United States

3.1 Waiting List

3.1.1 Characteristics of pediatric candidates listed for lung transplant

In 2022, 47 new pediatric candidates (younger than 18 years at listing) were added to the lung transplant waiting list, a 49% decrease from 92 new listings in 2011 (Figure LU 64). The total number of pediatric waitlist candidates decreased by 67.0%, from 221 in 2011 to 73 in 2022 (Figure LU 65). The largest age group of pediatric candidates on the waiting list continues to be the 12- to 17-year cohort (52.1%), followed by other age groups: 6-

11 years (24.7%), 1-5 years (15.1%), and younger than 1 year (5.5%) (Figure LU 66). By race and ethnicity, the highest percentage of pediatric lung transplant candidates were White (46.6%), followed by Hispanic (28.8%), Black (13.7%), Asian (8.2%), and Multiracial (2.7%) (Figure LU 67). Looking at changes over time, the proportions of Asian, Black, Hispanic, and Multiracial candidates have increased since 2011 while the proportion of White candidates has decreased. Pediatric candidates who have been on the list fewer than 90 days represent the highest proportion (41.1%) in terms of waiting time (Figure LU 69). The etiology of lung disease among pediatric candidates has changed over time, with a decrease in the proportion of candidates with cystic fibrosis from 40.0% in 2017 to 9.7% in 2022 (Table LU 10).

3.1.2 Outcomes of pediatric candidates listed for lung transplant

Of 42 candidates removed from the waiting list in 2022, 22 (52.4%) were removed after undergoing transplant; 7 (16.7%), due to patient death; 2 (4.8%), due to becoming too sick to undergo transplant; 1 (2.3%), after refusing transplant; and 10 (23.8%), for other reasons (Table LU 12, Table LU 13). Among pediatric lung transplant candidates listed in 2017-2019, 64.1% underwent deceased donor transplant within 3 years, 20.6% were removed from the list for reasons other than transplant or death, 14.4% died waiting, and 1.0% were still waiting (Figure LU 70). The overall pediatric lung transplant rate has decreased to 76.8 transplants per 100 patient-years in 2022, from a peak of 150.3 transplants per 100 patient-years in 2019 (Figure LU 71). Transplant rates varied with age and were highest for pediatric candidates aged 12-17 years (137.8 transplants per 100 patient-years), followed by candidates younger than 1 year (92.8 per 100 patient-years), 6-11 years (39.3 per 100 patient-years), and 1-5 years (32.6 per 100 patient-years) (Figure LU 72). Transplant rates also varied by race and ethnicity, with the highest rates among those in the "Other" category, likely due to the small size of the group (317.4 transplants per 100 patient-years), followed by Asian candidates (140.4 per 100 patient-years), Hispanic candidates (92.6 per 100 patient-years), White candidates (67.4 per 100 patient-years), and Black candidates (44.5 per 100 patient-years) (Figure LU 73). Pretransplant mortality was 20.6 per 100 patient-years in 2022, down from a peak of 42.9 deaths per 100 patient-years in 2015 (Figure LU 74). Pretransplant mortality varied by age: 46.4 deaths per 100 patient-years among candidates aged younger than 1 year, zero among candidates aged 1-5 years, 37.8 deaths per 100 patient-years among candidates aged 6-11 years, and 14.6 deaths per 100 patient-years among candidates aged 12-17 years (Figure LU 75).

3.2 Transplant

3.2.1 Characteristics of pediatric lung transplant recipients

In 2022, 21 lung transplants were performed in pediatric recipients aged 0-17 years at the time of listing, a decrease of 53% since 2011 when there were 45 transplants (Figure LU 76): one in those younger than 1 year, three in those aged 1-5 years, four in those aged 6-11 years, and thirteen in those aged 12-17 years (Figure LU 77). As seen in the waitlist candidate characteristics, there has been a change in the etiology of lung disease among pediatric transplant recipients, with a decrease of the proportion of recipients with cystic fibrosis from 55.6% in 2017 to only 19% in 2022 (Table LU 15). In 2022, almost 40% of pediatric recipients were bridged to transplant (in contrast to 10.5% of adult recipients): 19.0% required mechanical ventilation and ECMO; 14.3%, mechanical ventilation only; and 4.8%, ECMO only (Table LU 15). Induction therapy was reported in 81.0% of pediatric lung transplant recipients in 2022 (Figure LU 78). The most common initial immunosuppression regimen was tacrolimus, mycophenolate, and steroids, reported in 66.7% of pediatric lung recipients (Figure LU 79). There appears to have been a shift over time, with a 16.7% decrease in this triple immunosuppression regimen, from 80% in 2011 to 66.7% in 2022; a 114.3% increase in the tacrolimus and mycophenolate mofetil combination, from 4.4% in 2011 to 9.5% in 2022; and a 221% increase in the tacrolimus-steroid regimen, from 4.4% in 2011 to 14.3% in 2022 (Figure LU 79).

3.2.2 Outcomes of pediatric lung transplant recipients

Across all pediatric recipients who underwent lung transplant in 2015-2017, 1-, 3-, and 5-year patient survival were 84.4%, 64.8%, and 56.3%, respectively (Figure LU 82). Incidence of death was 16.0% at 6 months and 16.0% at 1 year for transplants in 2021, 36.5% at 3 years for transplants in 2019, 48.9% at 5 years for transplants in 2017, and 55.9% at 10 years for transplants in 2012 (Figure LU 81). The incidence of posttransplant lymphoproliferative disorder among Epstein-Barr–negative recipients who underwent transplant in 2011-2017 was 7.1% at 5 years posttransplant, compared with 1.9% among Epstein-Barr–positive recipients (Figure LU 80).

Support, Copyright, and Citation Information

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This report is available at https://srtr.transplant.hrsa.gov. Individual chapters may be downloaded.

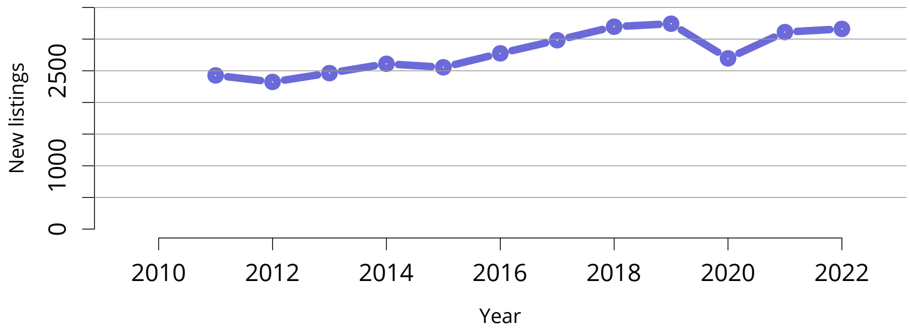

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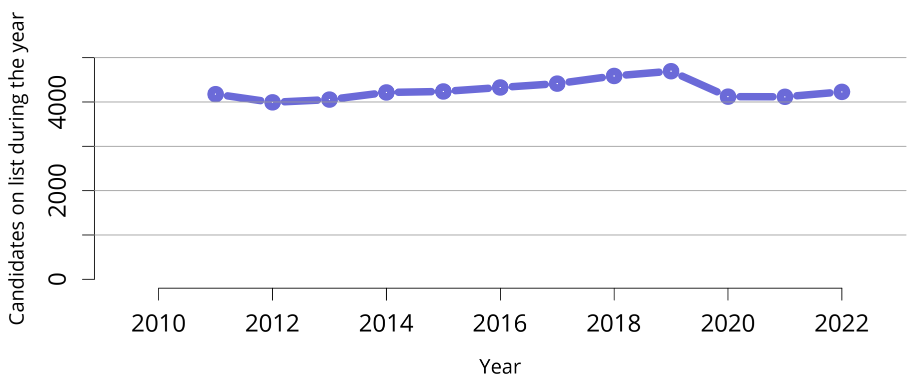
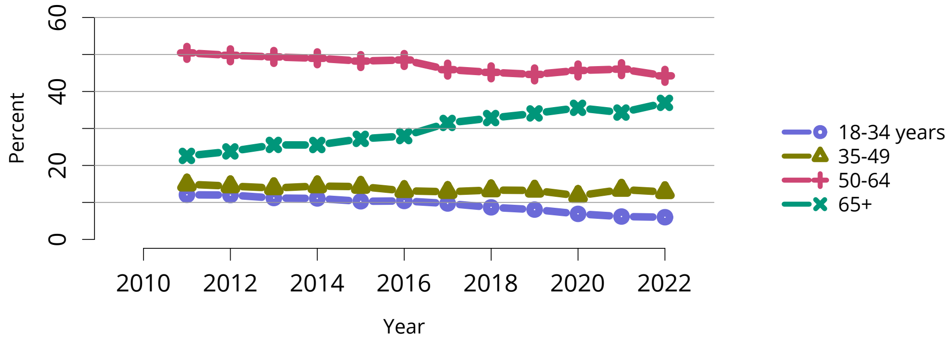
Figure LU 1: New adult candidates added to the lung transplant waiting list. A new adult candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Active and inactive patients are included.



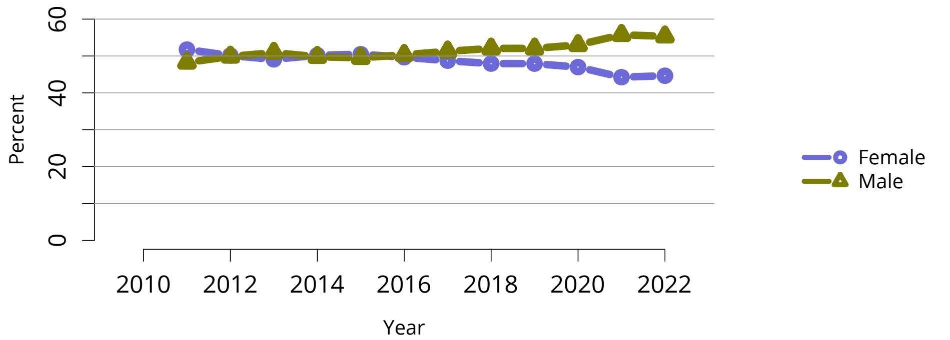
OPTN/SRTR 2022 Annual Data Report

Figure LU 2: All adult candidates on the lung transplant waiting list. Adult candidates on the list at any time during the year. Candidates listed at more than one center are counted once per listing.



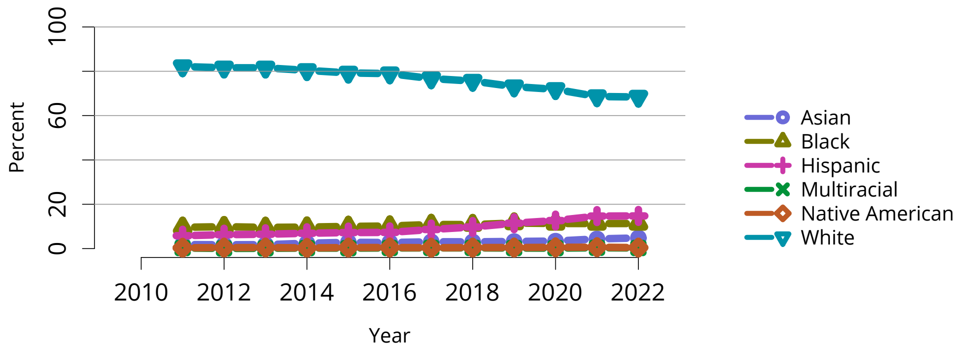
OPTN/SRTR 2022 Annual Data Report

Figure LU 3: Distribution of adults waiting for lung transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.



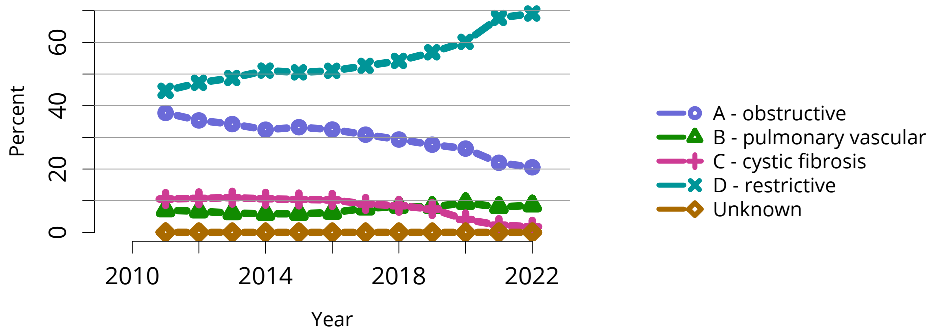
OPTN/SRTR 2022 Annual Data Report

Figure LU 4: Distribution of adults waiting for lung transplant by sex. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure LU 5: Distribution of adults waiting for lung transplant by race and ethnicity. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



OPTN/SRTR 2022 Annual Data Report

Figure LU 6: Distribution of adults waiting for lung transplant by diagnosis group. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included. The unknown group includes a small number of heart-lung candidates prior to 2015 who did not have an A/B/C/D diagnosis group specified.

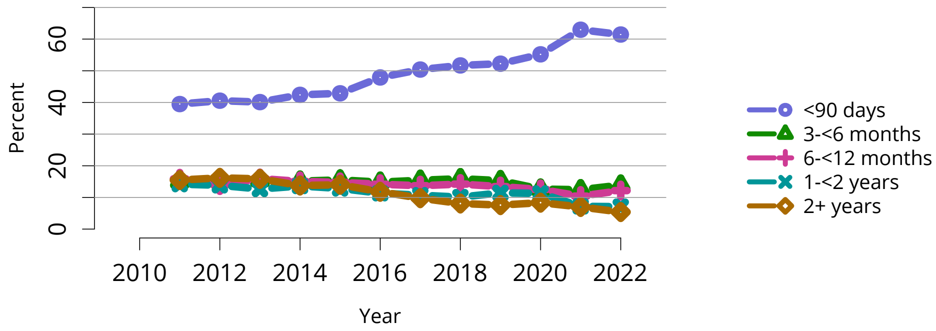


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Figure LU 7: Distribution of adults waiting for lung transplant by waiting time. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included.

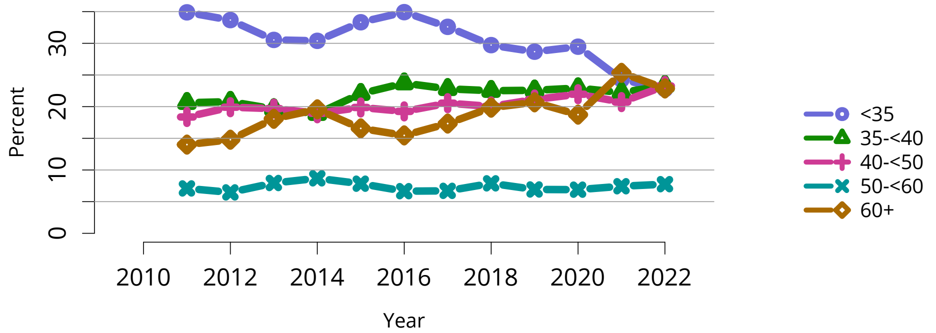

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Figure LU 8: Distribution of adult candidates waiting for lung transplant by LAS. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. LAS is determined at the earliest of transplant, death, removal, or December 31 of the year. LAS, lung allocation score.

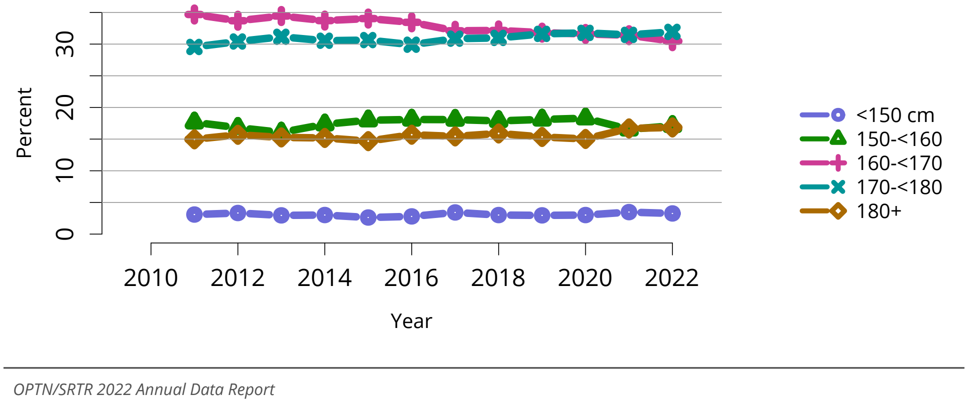

Figure LU 9: Distribution of adult candidates waiting for lung transplant by height. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

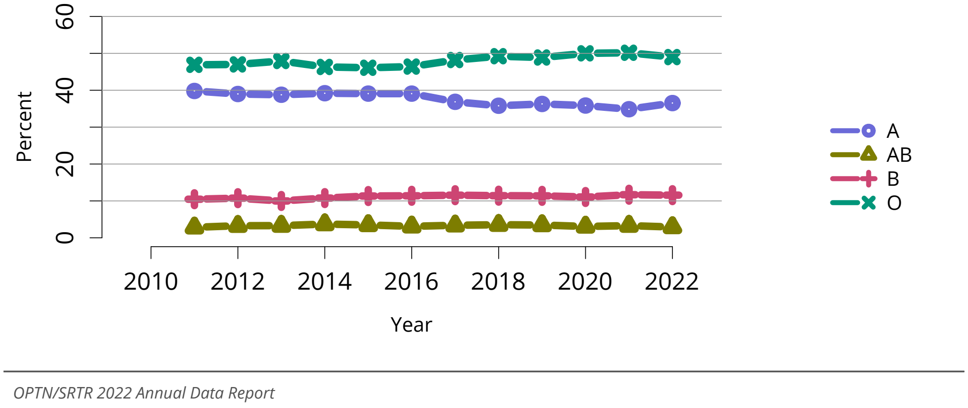

Figure LU 10: Distribution of adults waiting for lung transplant by blood type. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

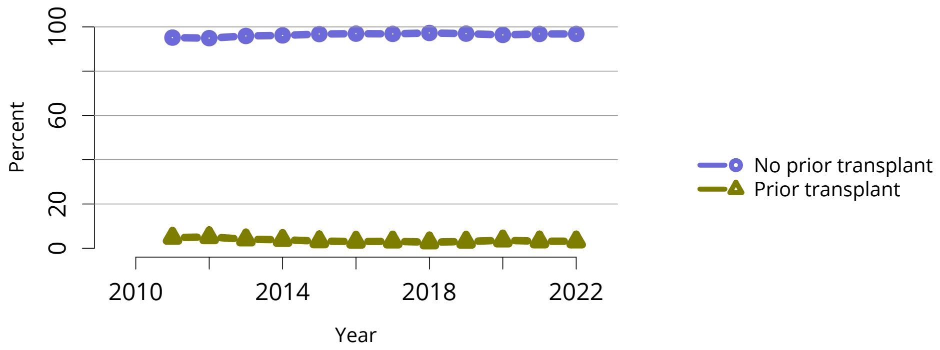

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Figure LU 11: Distribution of adults waiting for lung transplant by prior transplant status. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

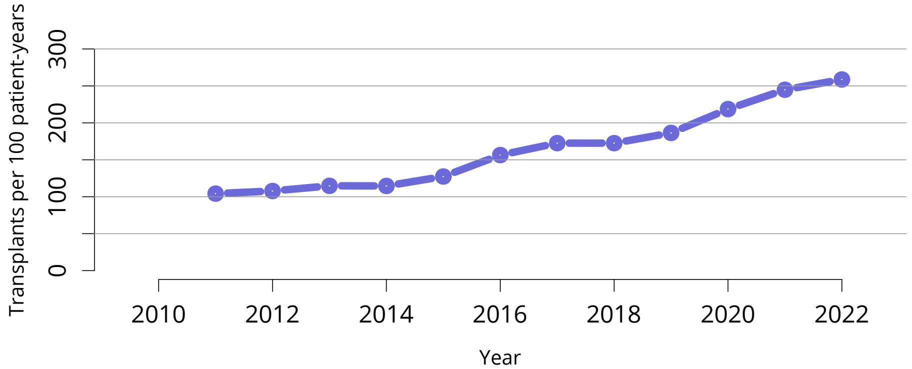

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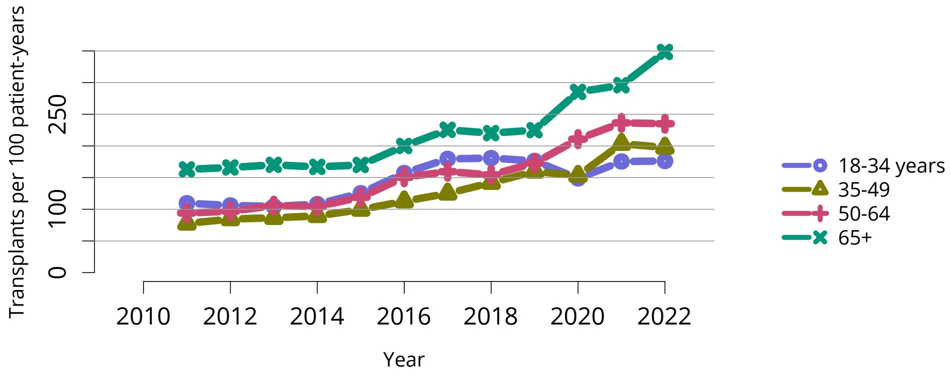
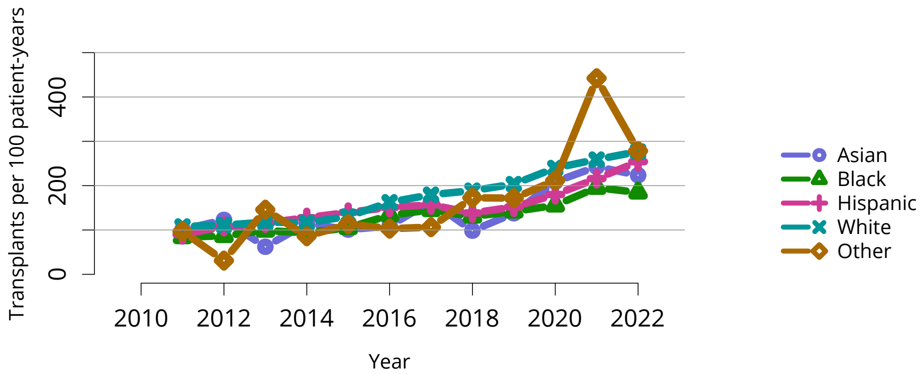
Figure LU 12: Overall deceased donor lung transplant rates among adult waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



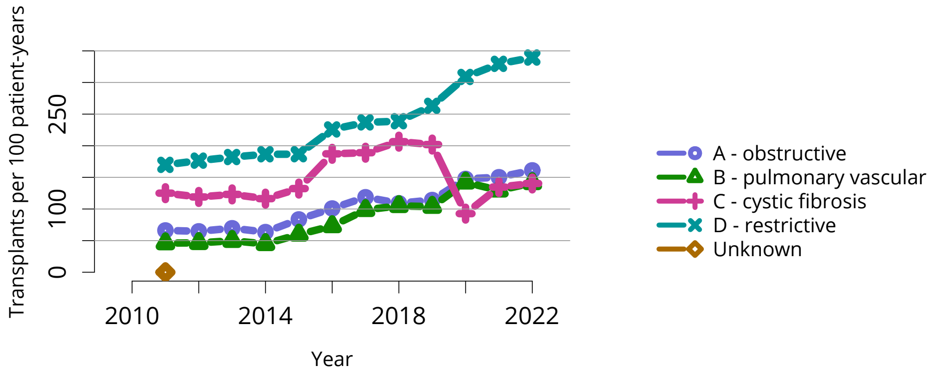
OPTN/SRTR 2022 Annual Data Report

Figure LU 13: Deceased donor lung transplant rates among adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



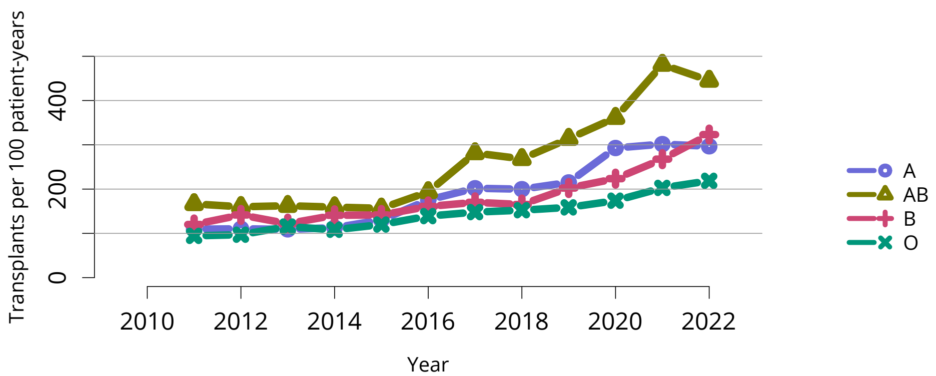
OPTN/SRTR 2022 Annual Data Report

Figure LU 14: Deceased donor lung transplant rates among adult waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure LU 15: Deceased donor lung transplant rates among adult waitlist candidates by diagnosis group. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The unknown group includes a small number of heart-lung candidates prior to 2015 who did not have an A/B/C/D diagnosis group specified.



OPTN/SRTR 2022 Annual Data Report

Figure LU 16: Deceased donor lung transplant rates among adult waitlist candidates by blood type. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

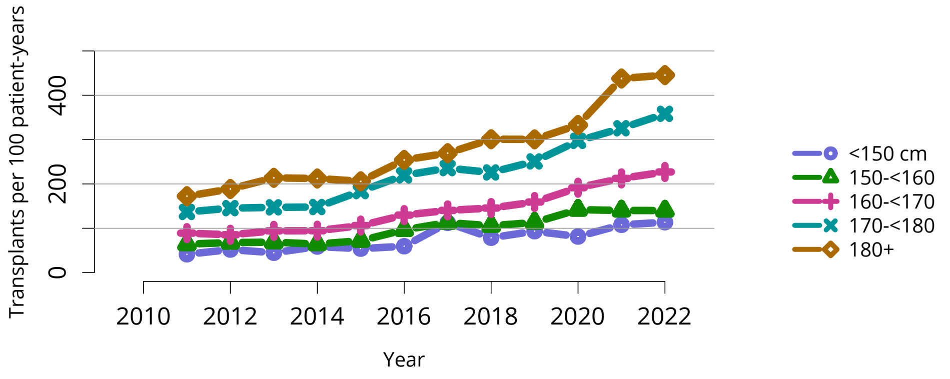


Figure LU 17: Deceased donor lung transplant rates among adult waitlist candidates by height. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.

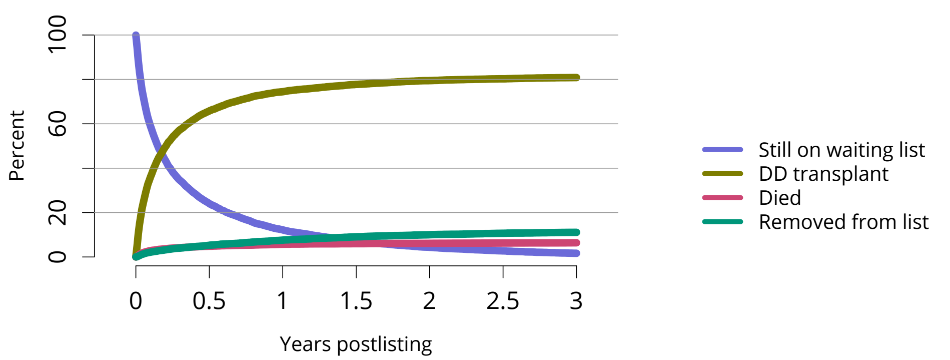
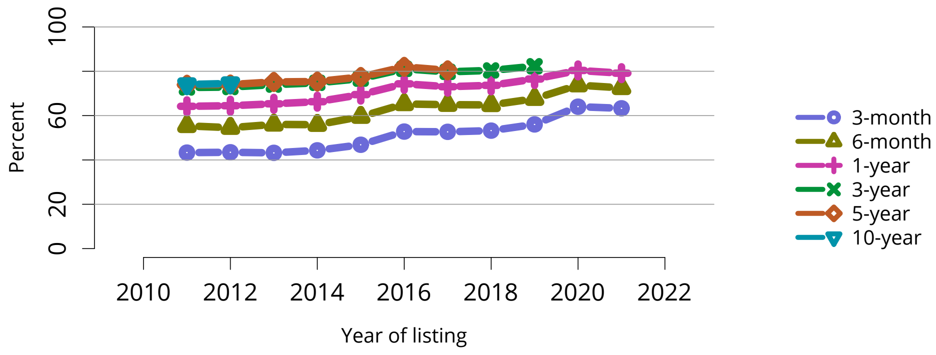
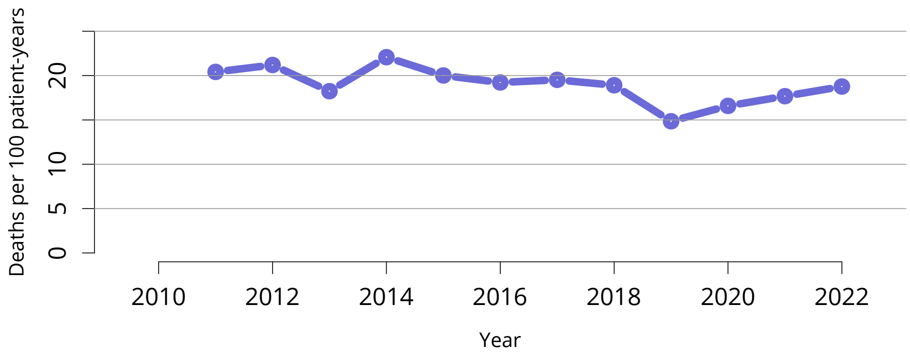


Figure LU 18: Three-year outcomes for adults waiting for lung transplant, new listings in 2017-2019. Candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.



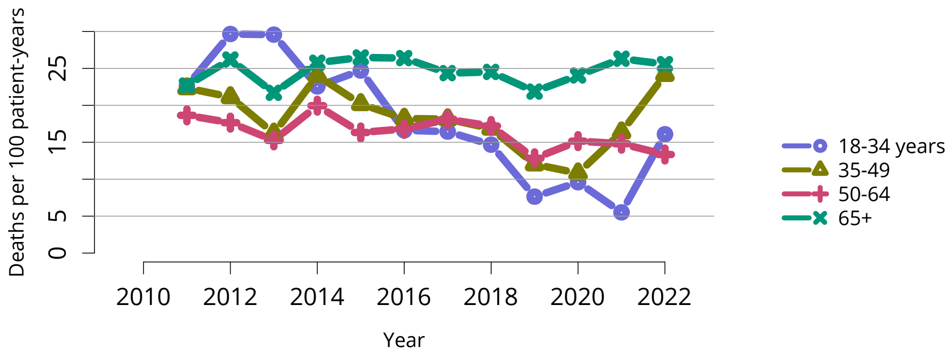
OPTN/SRTR 2022 Annual Data Report

Figure LU 19: Percentage of adults who underwent deceased donor lung transplant within a given period of listing. Candidates listed at more than one center are counted once per listing.



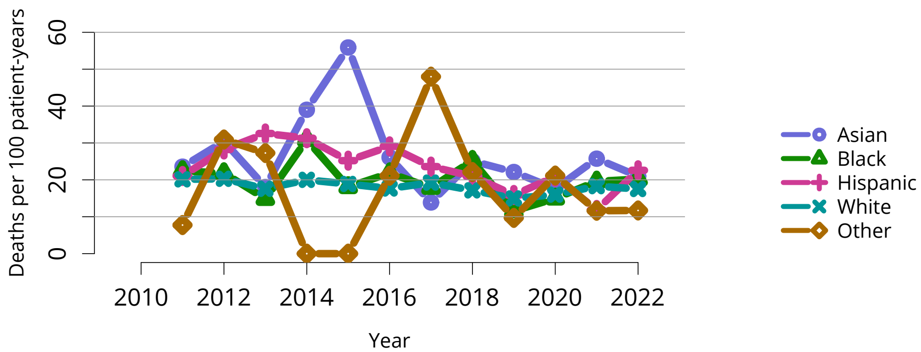
OPTN/SRTR 2022 Annual Data Report

Figure LU 20: Overall pretransplant mortality rates among adults waitlisted for lung transplant. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



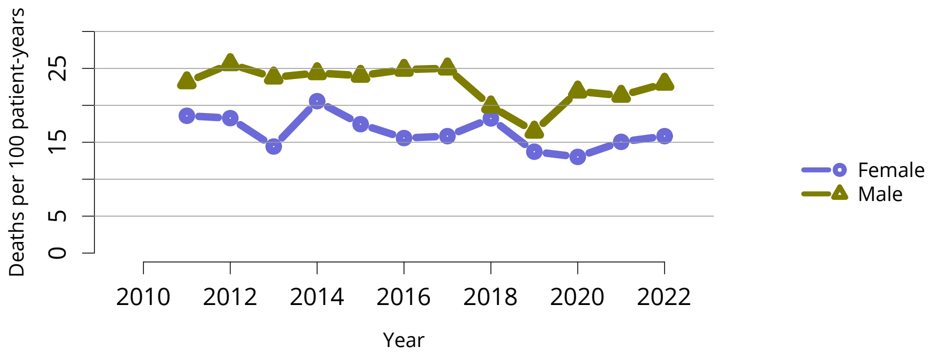
OPTN/SRTR 2022 Annual Data Report

Figure LU 21: Pretransplant mortality rates among adults waitlisted for lung transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



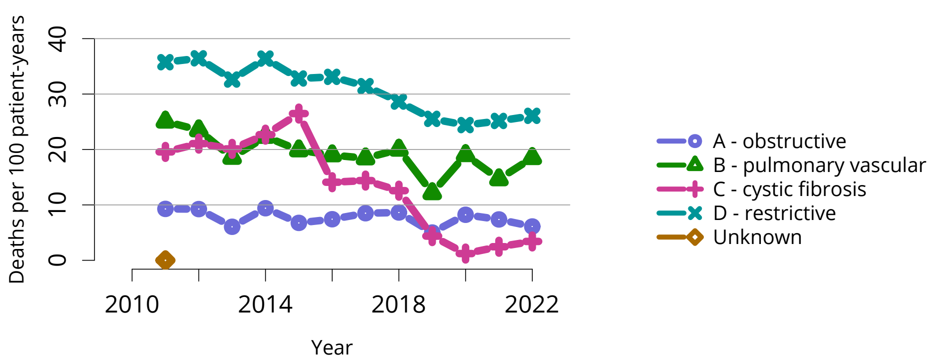
OPTN/SRTR 2022 Annual Data Report

Figure LU 22: Pretransplant mortality rates among adults waitlisted for lung transplant by race and ethnicity. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



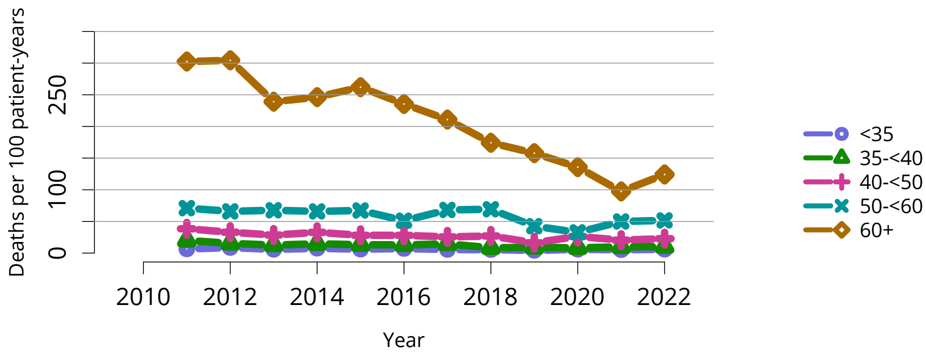
OPTN/SRTR 2022 Annual Data Report

Figure LU 23: Pretransplant mortality rates among adults waitlisted for lung transplant by sex. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



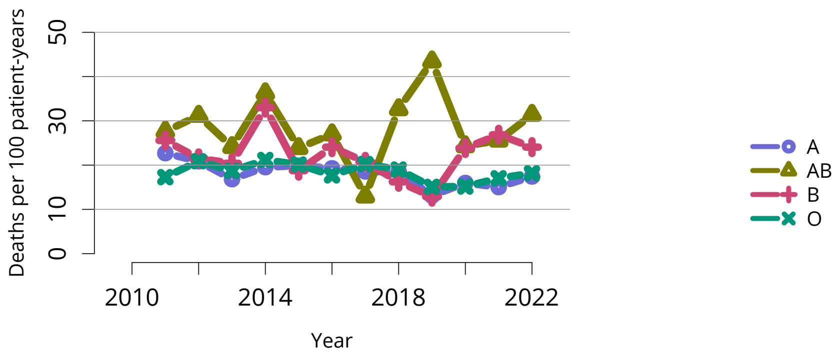
OPTN/SRTR 2022 Annual Data Report

Figure LU 24: Pretransplant mortality rates among adults waitlisted for lung transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. The unknown group includes a small number of heart-lung candidates prior to 2015 who did not have an A/B/C/D diagnosis group specified.



OPTN/SRTR 2022 Annual Data Report

Figure LU 25: Pretransplant mortality rates among adults waitlisted for lung transplant by LAS. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. LAS is determined at the later of listing date or January 1 of the given year. LAS, lung allocation score.



OPTN/SRTR 2022 Annual Data Report

Figure LU 26: Pretransplant mortality rates among adults waitlisted for lung transplant by blood type. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

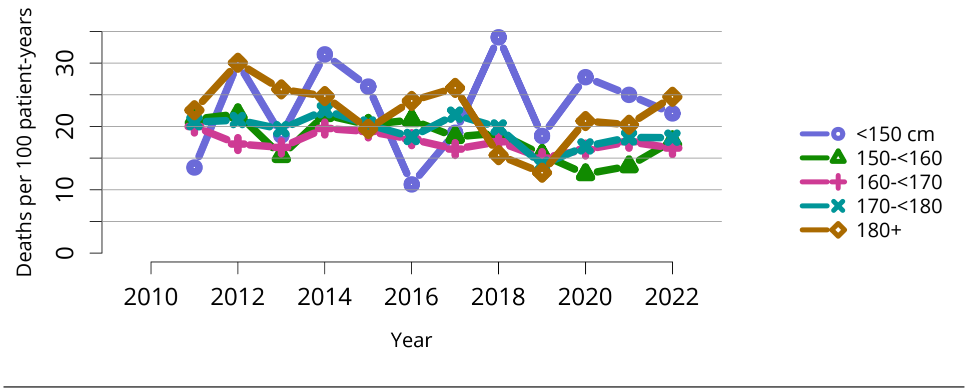


Figure LU 27: Pretransplant mortality rates among adults waitlisted for lung transplant by height. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

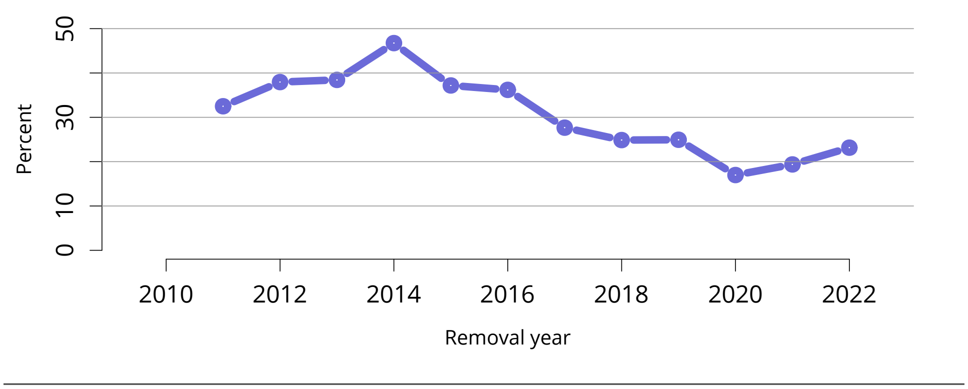
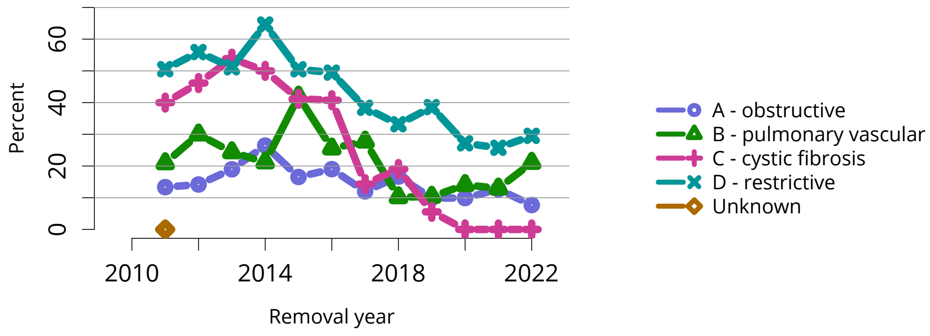
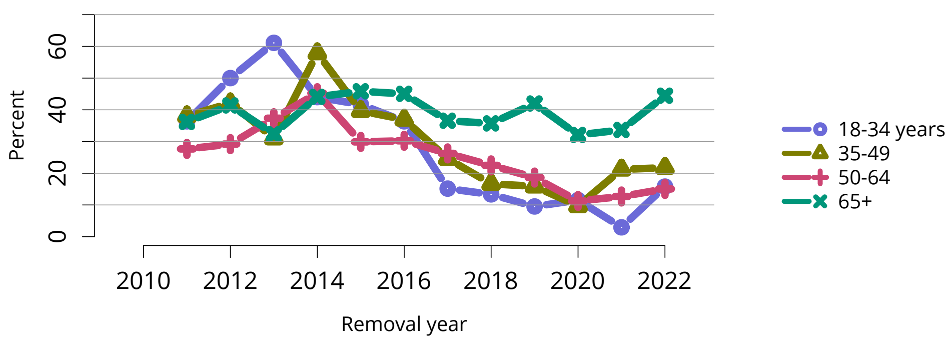


Figure LU 28: Deaths within 6 months after removal among adult lung waitlist candidates, overall. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.



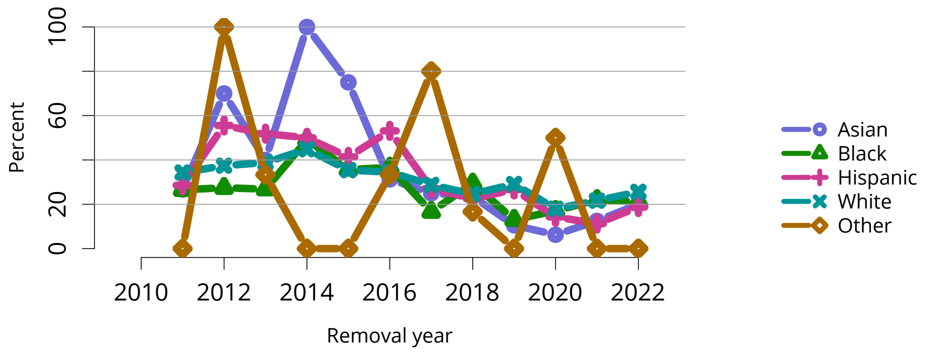
OPTN/SRTR 2022 Annual Data Report

Figure LU 29: Deaths within 6 months after removal among adult lung waitlist candidates, by diagnosis. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. The unknown group includes a small number of heart-lung candidates prior to 2015 who did not have an A/B/C/D diagnosis group specified.



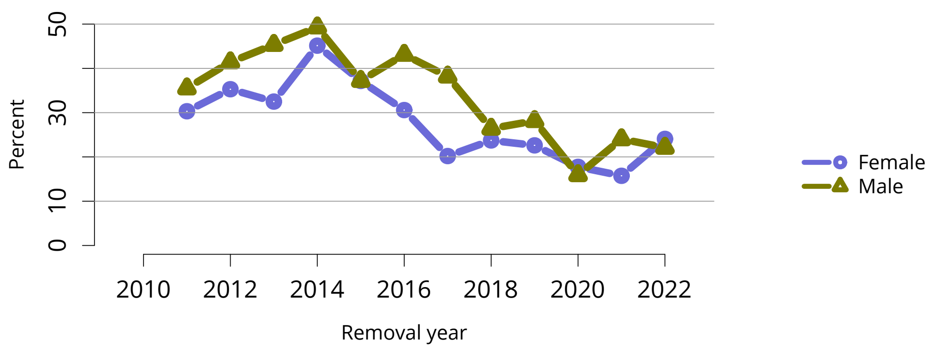
OPTN/SRTR 2022 Annual Data Report

Figure LU 30: Deaths within 6 months after removal among adult lung waitlist candidates, by age. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. Age is determined at removal.



OPTN/SRTR 2022 Annual Data Report

Figure LU 31: Deaths within 6 months after removal among adult lung waitlist candidates by race and ethnicity. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure LU 32: Deaths within 6 months after removal among adult lung waitlist candidates, by sex. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

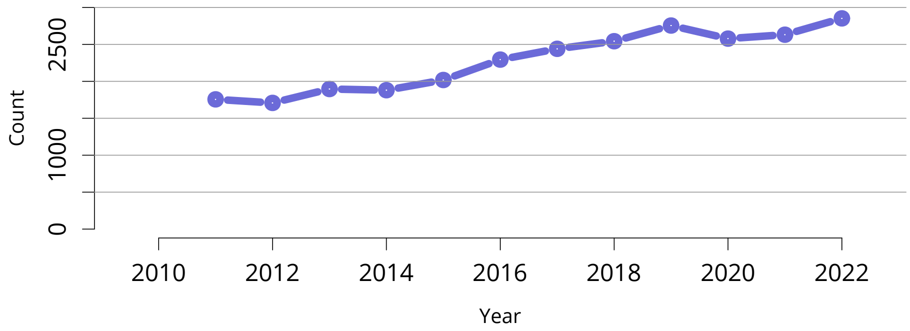


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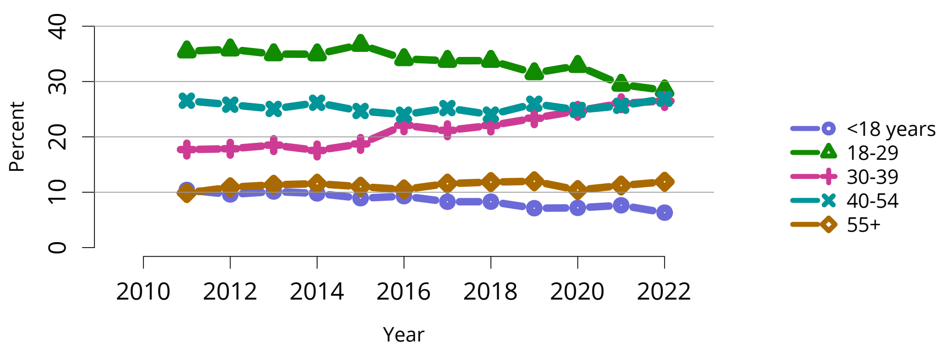
Figure LU 33: Overall deceased lung donor count. Count of deceased donors with at least one lung recovered. Donors are counted once, regardless of the number of lungs recovered.



OPTN/SRTR 2022 Annual Data Report

Figure LU 34: Distribution of deceased lung donors by age. Deceased donors whose lungs were recovered for transplant. Donors are counted once, regardless of the number of lungs recovered.

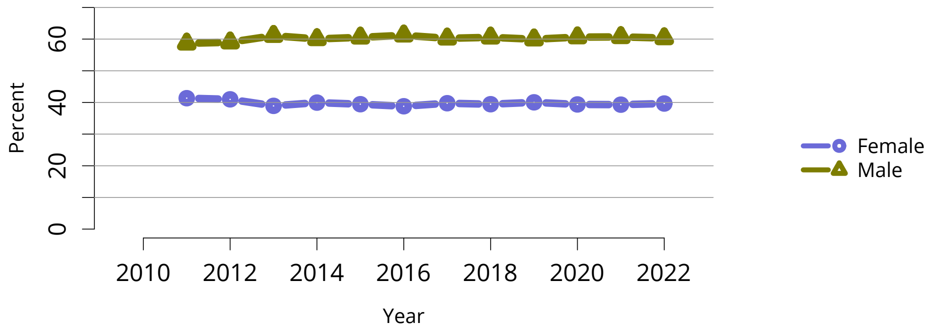


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Figure LU 35: Distribution of deceased lung donors by sex. Deceased donors whose lungs were recovered for transplant. Donors are counted once, regardless of the number of lungs recovered.

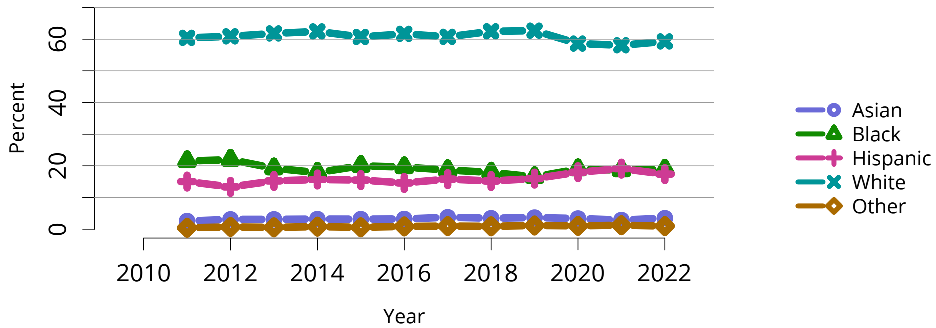

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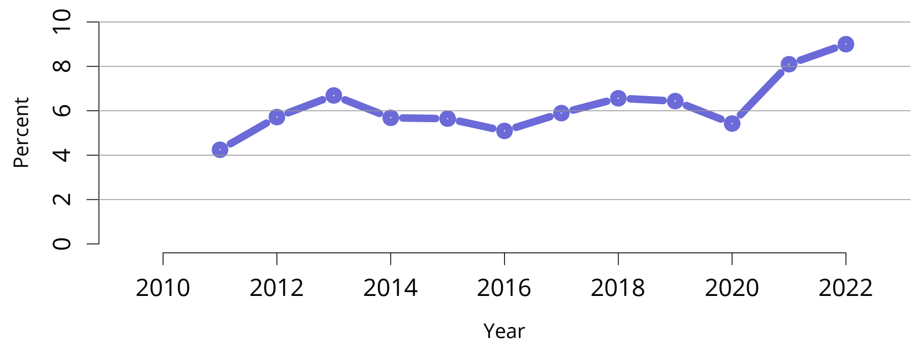
Figure LU 36: Distribution of deceased lung donors by race and ethnicity. Deceased donors whose lungs were recovered for transplant. Donors are counted once, regardless of the number of lungs recovered. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure LU 37: Overall percent of lungs recovered for transplant and not transplanted. Percentages of lungs not transplanted out of all lungs recovered for transplant.

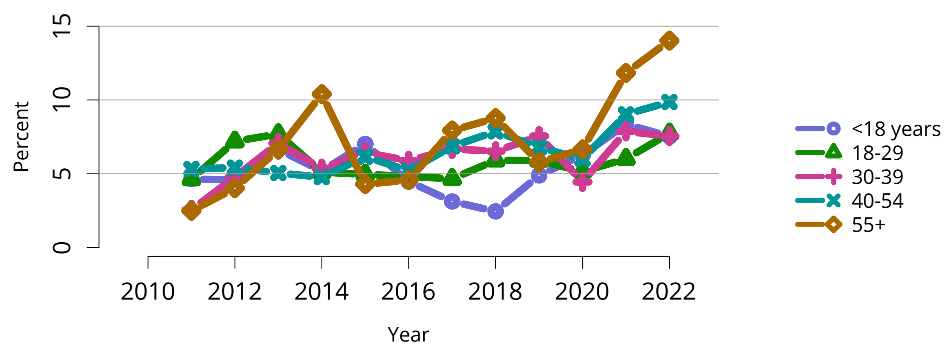


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Figure LU 38: Percent of lungs recovered for transplant and not transplanted by donor age. Percentages of lungs not transplanted out of all lungs recovered for transplant.

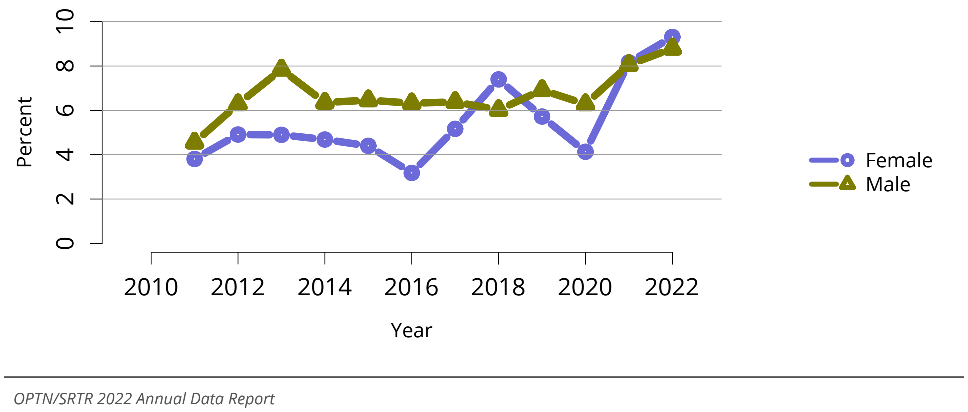


Figure LU 39: Percent of lungs recovered for transplant and not transplanted by donor sex. Percentages of lungs not transplanted out of all lungs recovered for transplant.

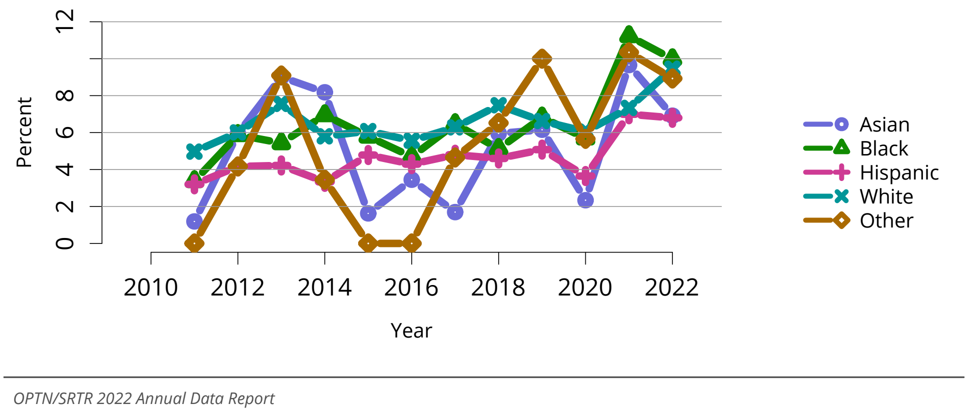
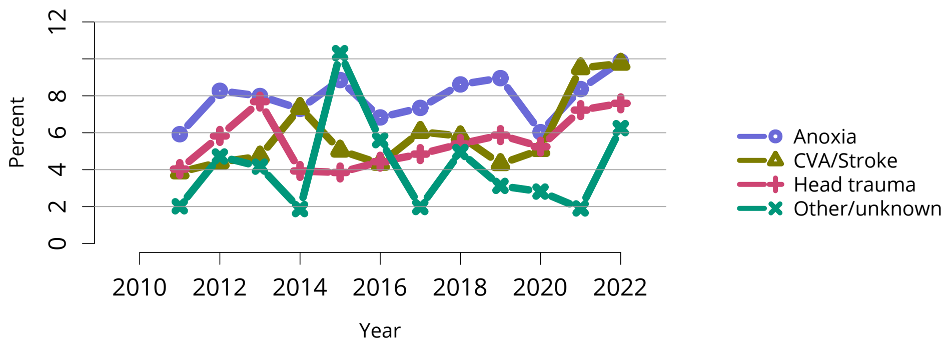
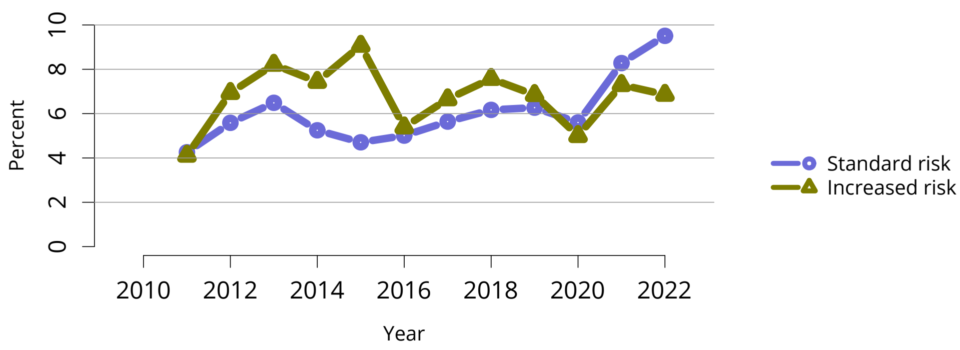


Figure LU 40: Percent of lungs recovered for transplant and not transplanted by donor race and ethnicity. Percentages of lungs not transplanted out of all lungs recovered for transplant. The Other race category is composed of Native American and Multiracial categories.



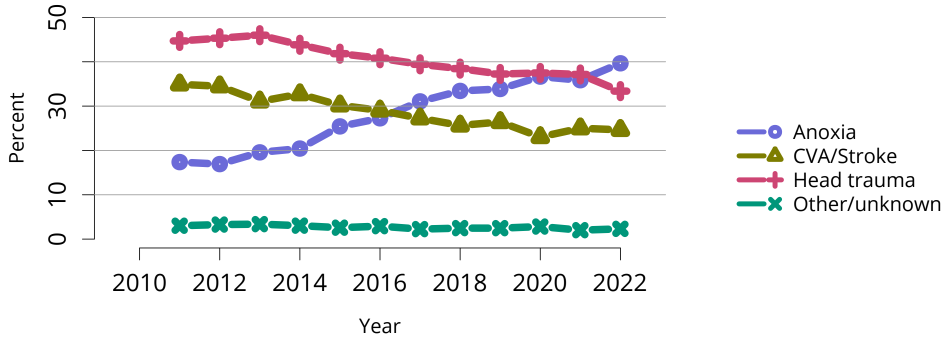
OPTN/SRTR 2022 Annual Data Report

Figure LU 41: Percent of lungs recovered for transplant and not transplanted by donor cause of death. Percentages of lungs not transplanted out of all lungs recovered for transplant. CVA, cerebrovascular accident.



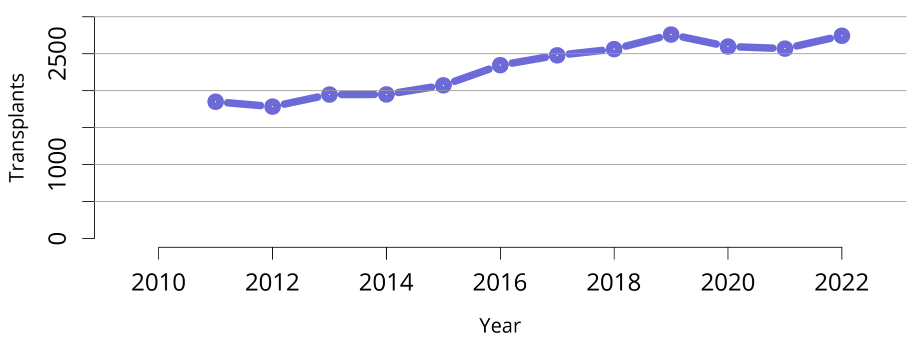
OPTN/SRTR 2022 Annual Data Report

Figure LU 42: Percent of lungs recovered for transplant and not transplanted, by donor risk of disease transmission. Percentages of lungs not transplanted out of all lungs recovered for transplant. "Increased risk" is defined by criteria from the US Public Health Service Guidelines for increased risk for HIV, hepatitis B, and hepatitis C transmission.



OPTN/SRTR 2022 Annual Data Report

Figure LU 43: Cause of death among deceased lung donors. Deceased donors with a lung recovered for the purposes of transplant. CVA, cerebrovascular accident.



OPTN/SRTR 2022 Annual Data Report

Figure LU 44: Overall lung transplants. All lung transplant recipients, including adult and pediatric, re-transplant, and multiorgan recipients.

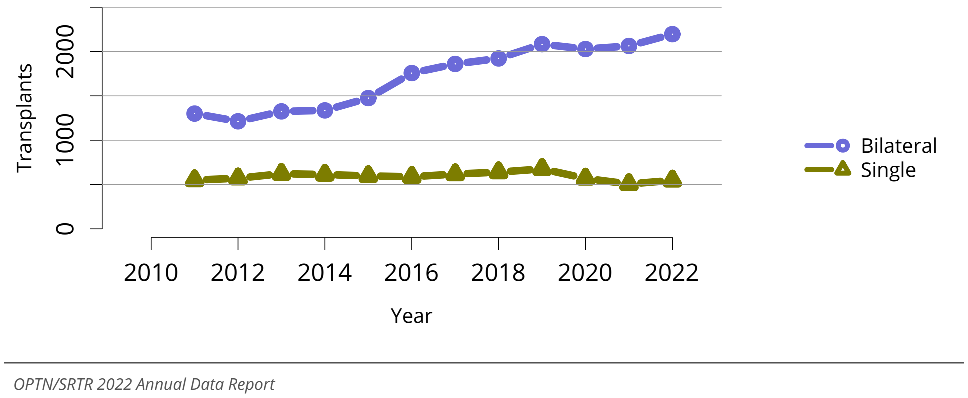


Figure LU 45: Total lung transplants by procedure type. All lung transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

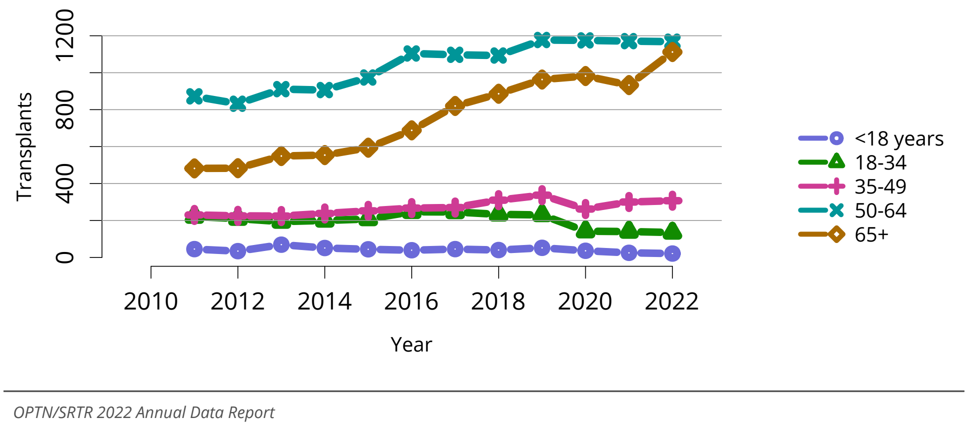
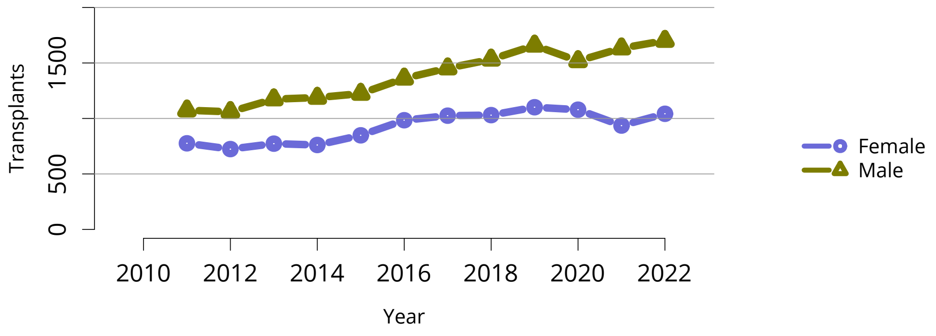
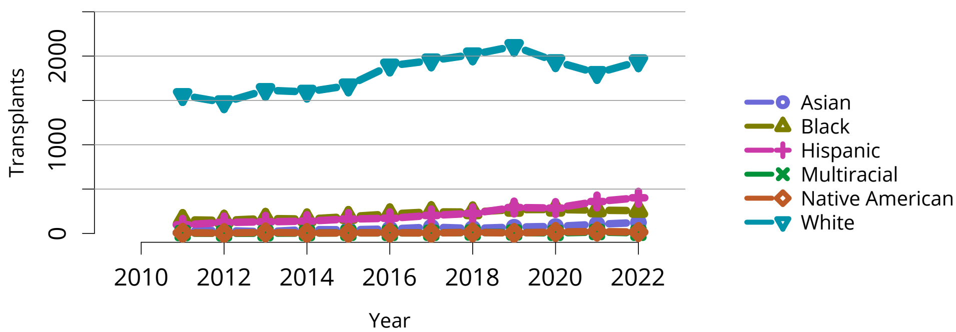


Figure LU 46: Total lung transplants by age. All lung transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LU 47: Total lung transplants by sex. All lung transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LU 48: Total lung transplants by race and ethnicity. All lung transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients.

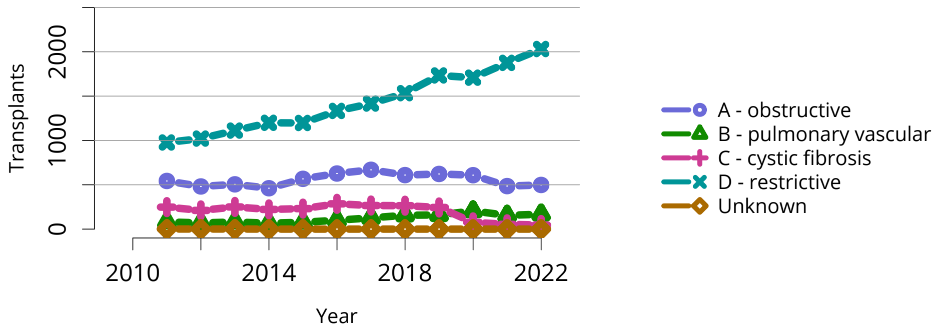


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Figure LU 49: Total lung transplants by diagnosis. All lung transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. The unknown group includes a small number of heart-lung recipients prior to 2015 who did not have an A/B/C/D diagnosis group specified.

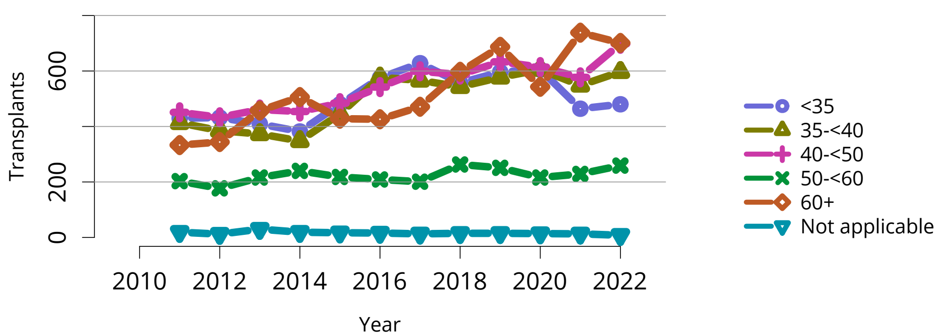

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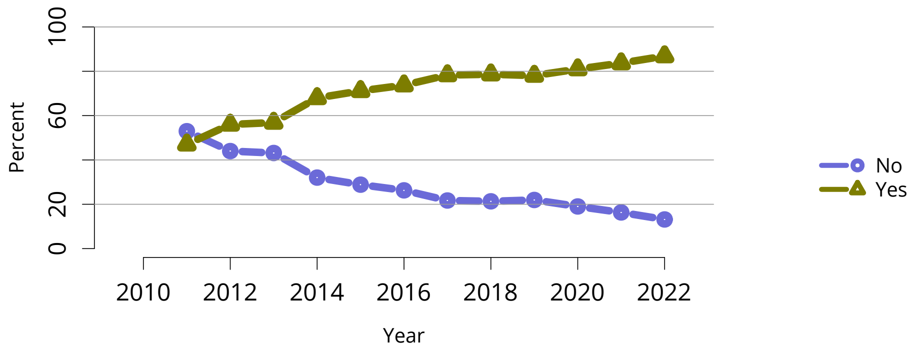
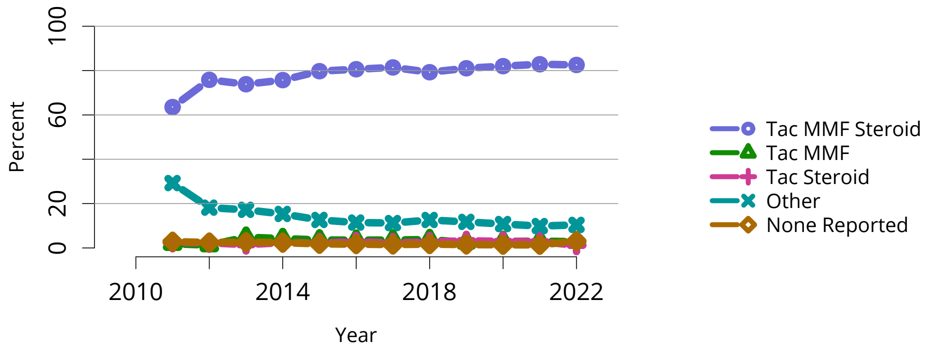
Figure LU 50: Total lung transplants by LAS. All lung transplant recipients, including adult and pediatric, retransplant, and multiorgan recipients. LAS, lung allocation score.



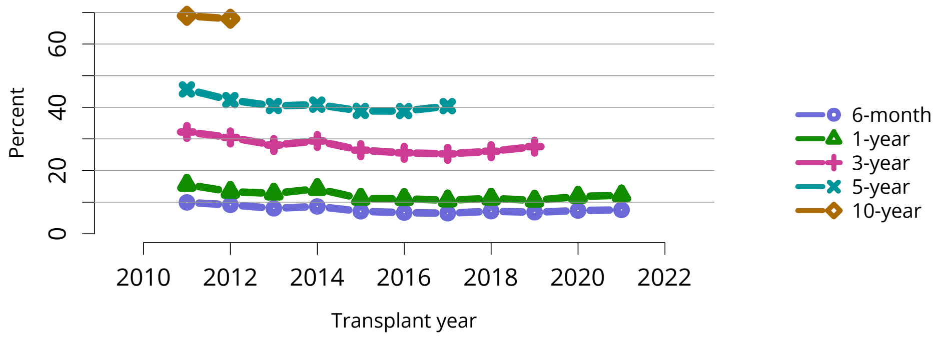
OPTN/SRTR 2022 Annual Data Report

Figure LU 51: Induction agent use in adult lung transplant recipients. Immunosuppression at transplant reported to the OPTN.



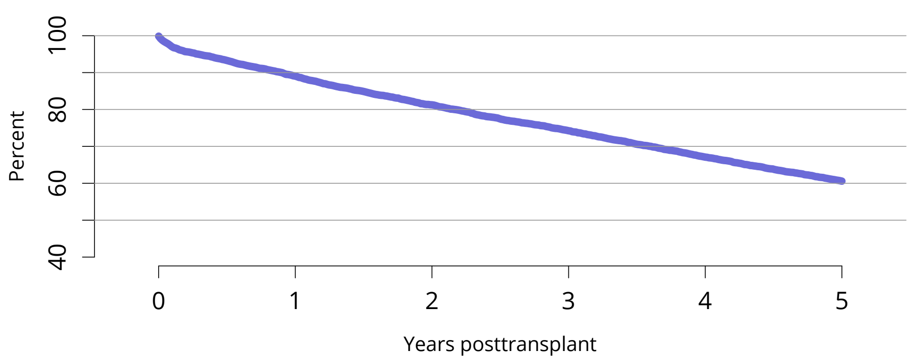
OPTN/SRTR 2022 Annual Data Report

Figure LU 52: Immunosuppression regimen use in adult lung transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.



OPTN/SRTR 2022 Annual Data Report

Figure LU 53: Patient death among adult lung transplant recipients. All adult recipients of deceased donor lungs, including multiorgan transplant recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LU 54: Patient survival among adult lung transplant recipients, 2015-2017. Patient survival estimated using unadjusted Kaplan-Meier methods.

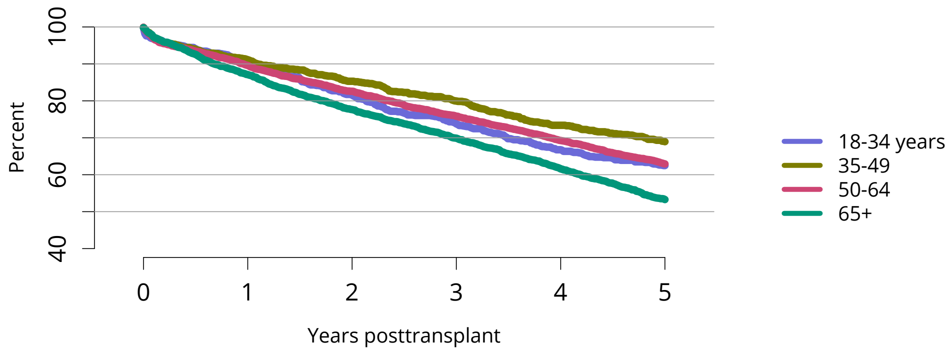


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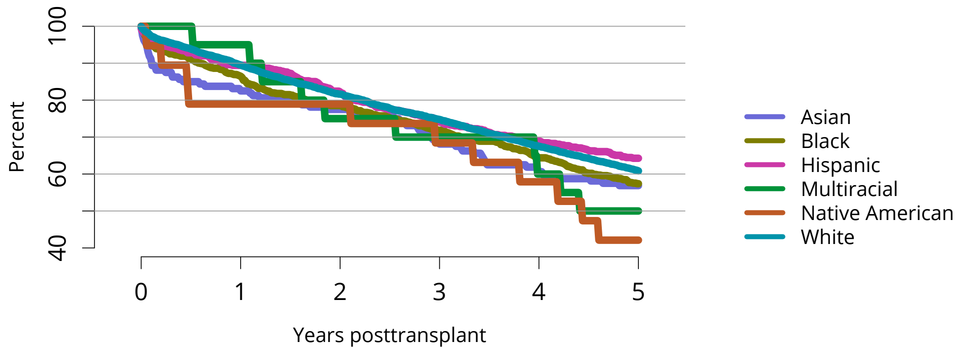
Figure LU 55: Patient survival among adult lung transplant recipients, 2015-2017, by age. Patient survival estimated using unadjusted Kaplan-Meier methods.



OPTN/SRTR 2022 Annual Data Report

Figure LU 56: Patient survival among adult lung transplant recipients, 2015-2017, by race and ethnicity. Patient survival estimated using unadjusted Kaplan-Meier methods.

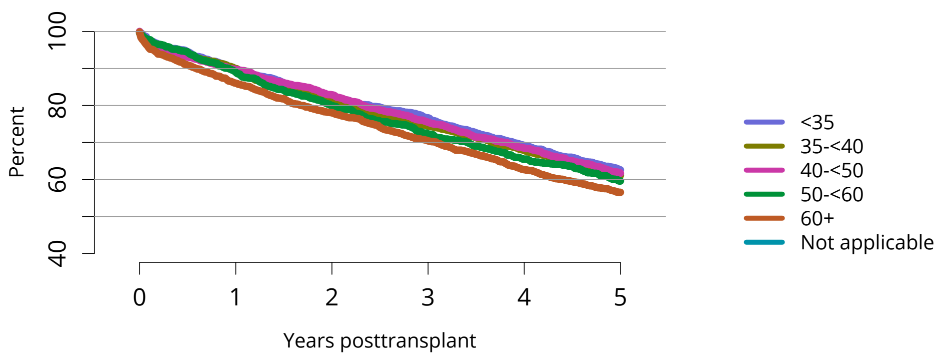


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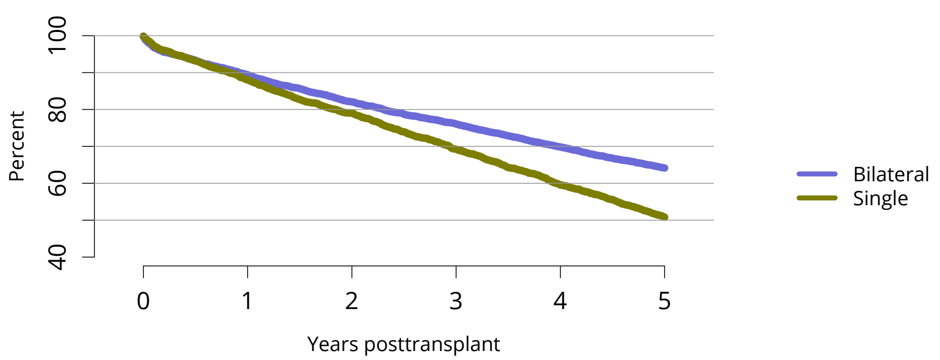
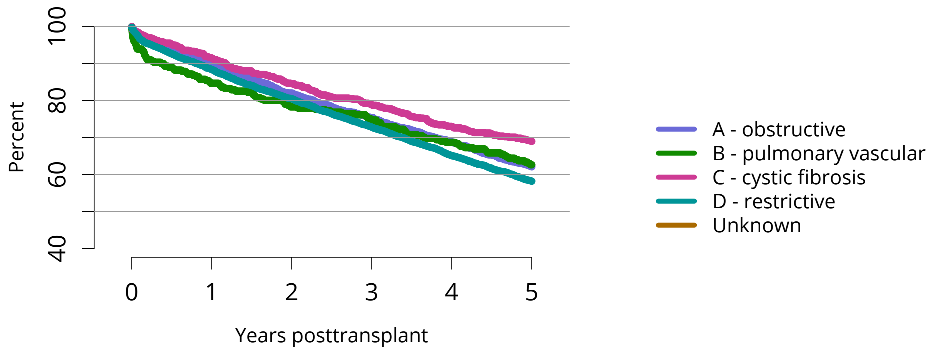
Figure LU 57: Patient survival among adult lung transplant recipients, 2015-2017, by LAS. Patient survival estimated using unadjusted Kaplan-Meier methods. LAS, lung allocation score.



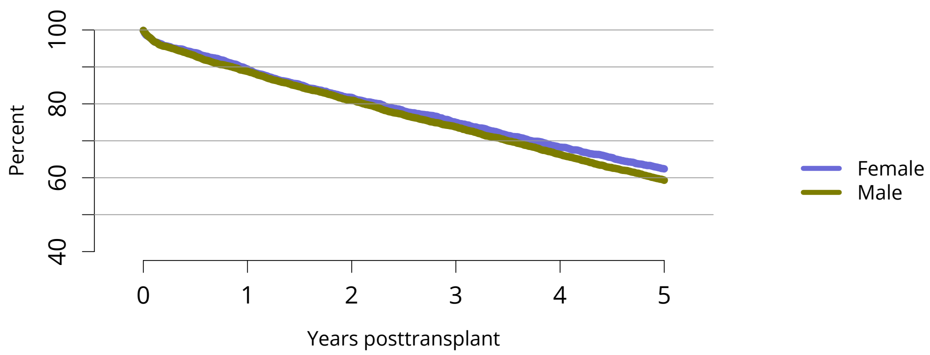
OPTN/SRTR 2022 Annual Data Report

Figure LU 58: Patient survival among adult lung transplant recipients, 2015-2017, by transplant type. Patient survival estimated using unadjusted Kaplan-Meier methods.



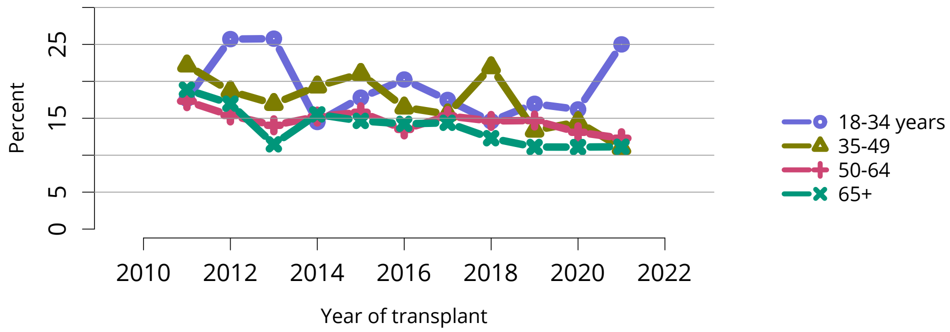
OPTN/SRTR 2022 Annual Data Report

Figure LU 59: Patient survival among adult lung transplant recipients, 2015-2017, by diagnosis group. Patient survival estimated using unadjusted Kaplan-Meier methods. The unknown group includes a small number of heart-lung recipients prior to 2015 who did not have an A/B/C/D diagnosis group specified.



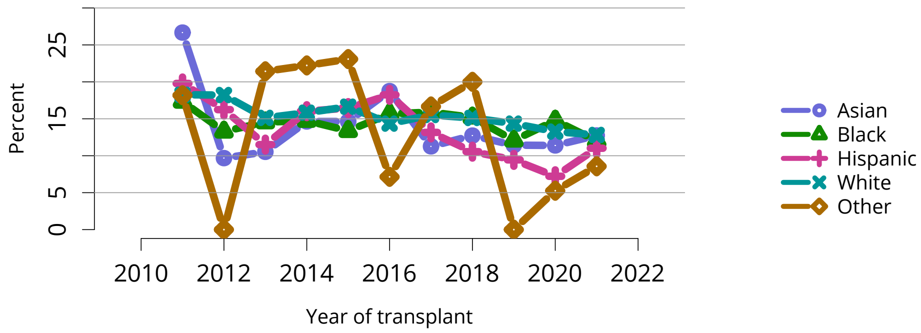
OPTN/SRTR 2022 Annual Data Report

Figure LU 60: Patient survival among adult lung transplant recipients, 2015-2017, by sex. Patient survival estimated using unadjusted Kaplan-Meier methods.



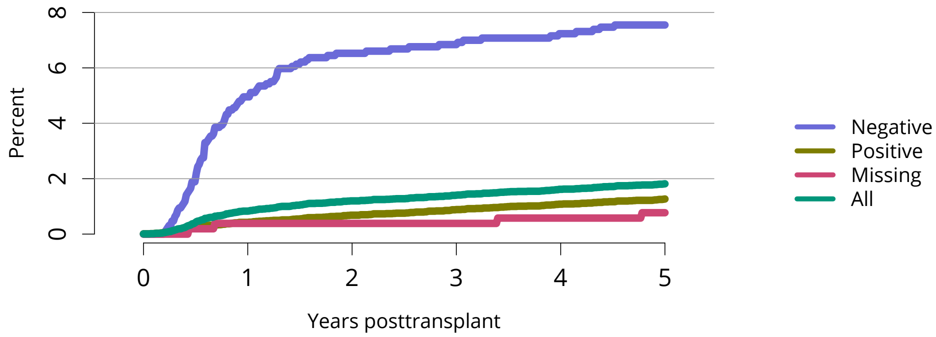
OPTN/SRTR 2022 Annual Data Report

Figure LU 61: Incidence of acute rejection by 1 year posttransplant among adult lung transplant recipients by age. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method.



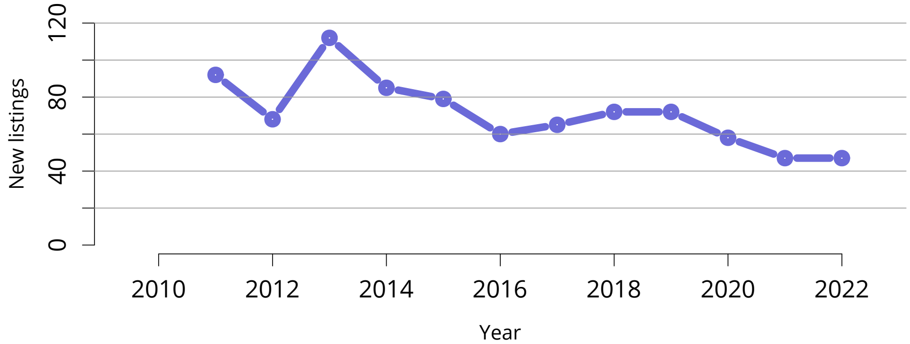
OPTN/SRTR 2022 Annual Data Report

Figure LU 62: Incidence of acute rejection by 1 year posttransplant among adult lung transplant recipients by race and ethnicity. Only the first reported rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier method. The Other race category is composed of Native American and Multiracial categories.



OPTN/SRTR 2022 Annual Data Report

Figure LU 63: Incidence of PTLD among adult lung transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.



OPTN/SRTR 2022 Annual Data Report

Figure LU 64: New pediatric candidates added to the lung transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.

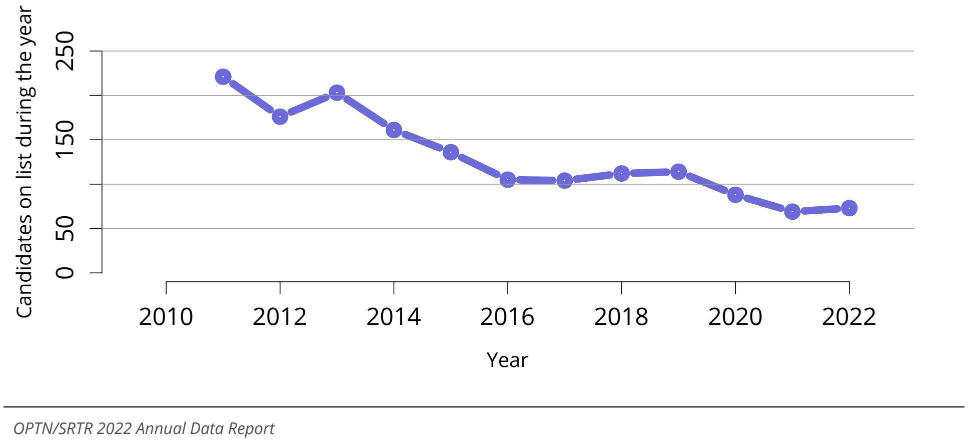


Figure LU 65: All pediatric candidates on the lung transplant waiting list. Pediatric candidates listed at any time during the year. Candidates listed at more than one center are counted once per listing.

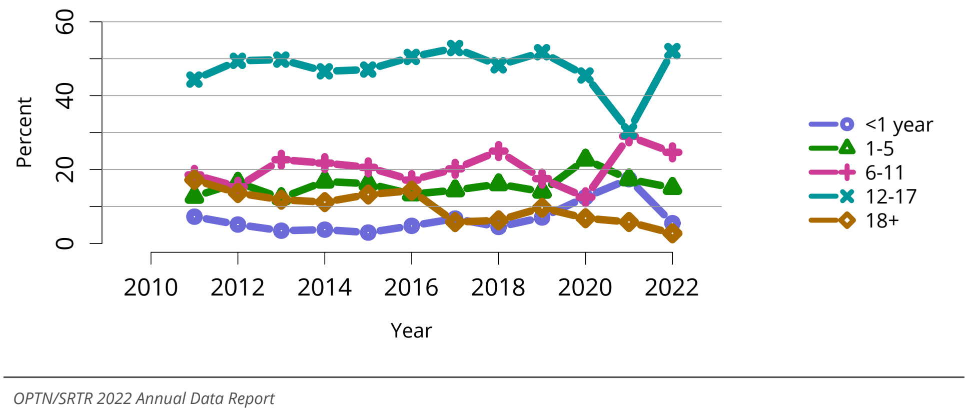
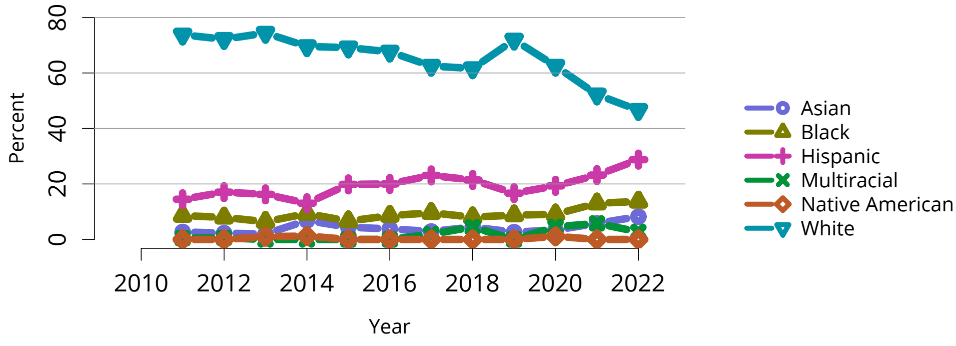
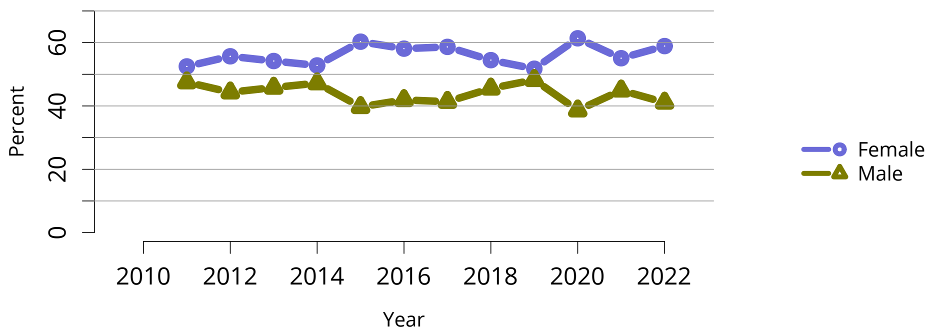


Figure LU 66: Distribution of pediatric candidates waiting for lung transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included. Age is determined at the earliest of transplant, death, removal, or December 31 of the year.



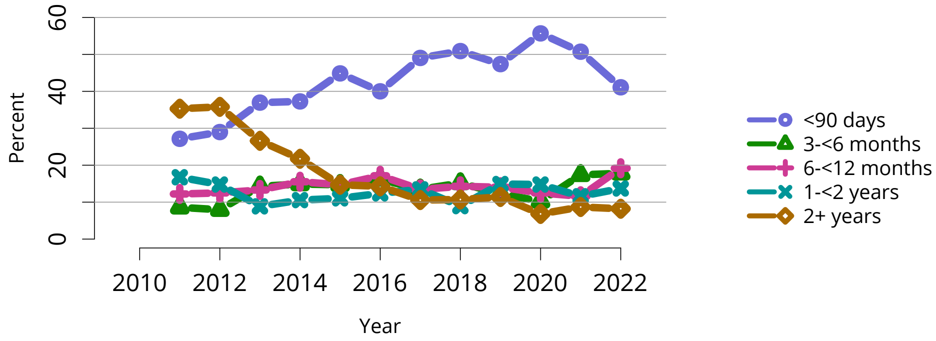
OPTN/SRTR 2022 Annual Data Report

Figure LU 67: Distribution of pediatric candidates waiting for lung transplant by race and ethnicity. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive candidates are included.



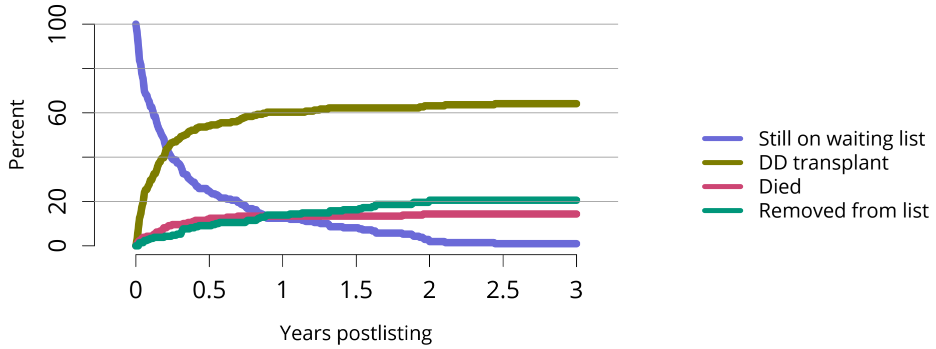
OPTN/SRTR 2022 Annual Data Report

Figure LU 68: Distribution of pediatric candidates waiting for lung transplant by sex. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Active and inactive patients are included.



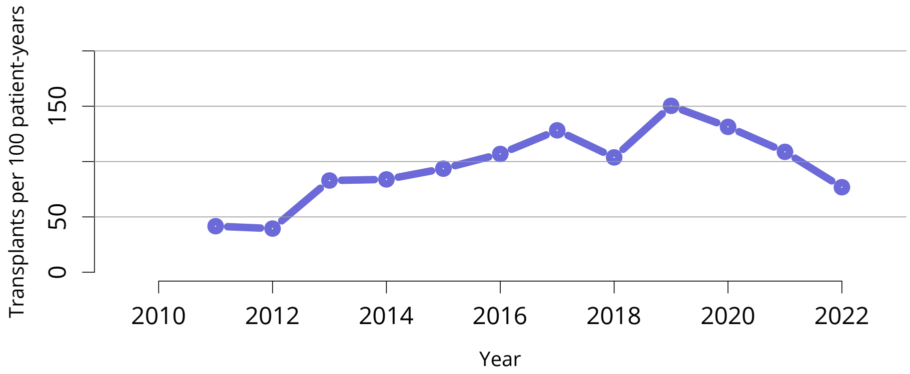
OPTN/SRTR 2022 Annual Data Report

Figure LU 69: Distribution of pediatric candidates waiting for lung transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed at more than one center are counted once per listing. Time on the waiting list is determined at the earliest of transplant, death, removal, or December 31 of the year. Active and inactive candidates are included.



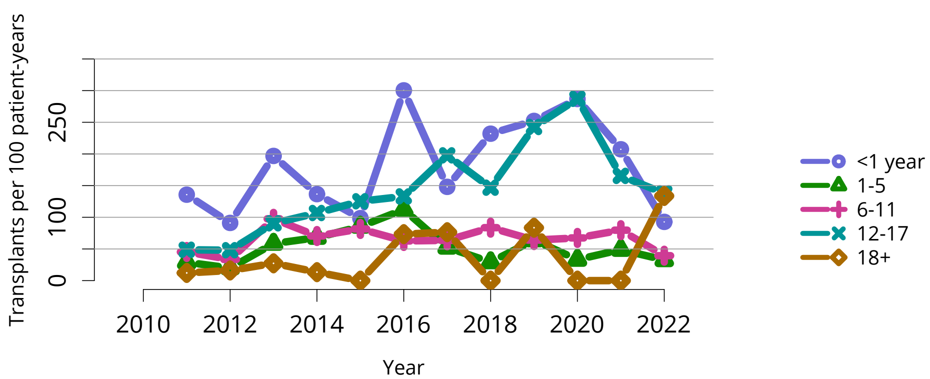
OPTN/SRTR 2022 Annual Data Report

Figure LU 70: Three-year outcomes for newly listed pediatric candidates waiting for lung transplant, 2017-2019. Pediatric candidates who joined the waiting list in 2017-2019. Pediatric candidates listed at more than one center are counted once per listing. Removed from list includes all reasons except transplant and death. DD, deceased donor.



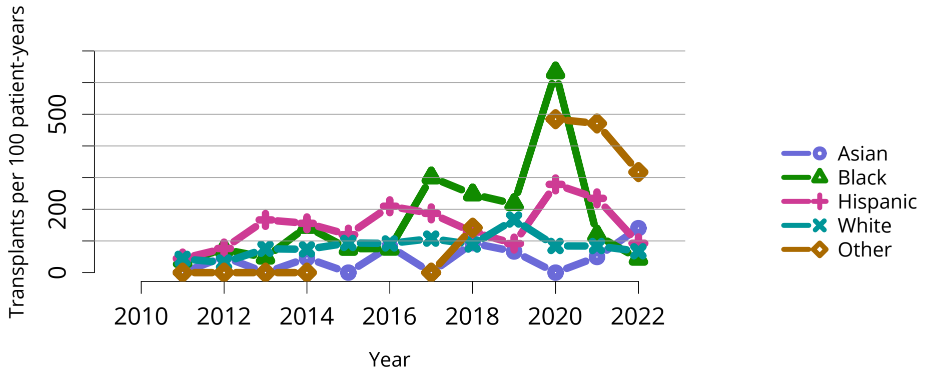
OPTN/SRTR 2022 Annual Data Report

Figure LU 71: Overall deceased donor lung transplant rates among pediatric waitlist candidates. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately.



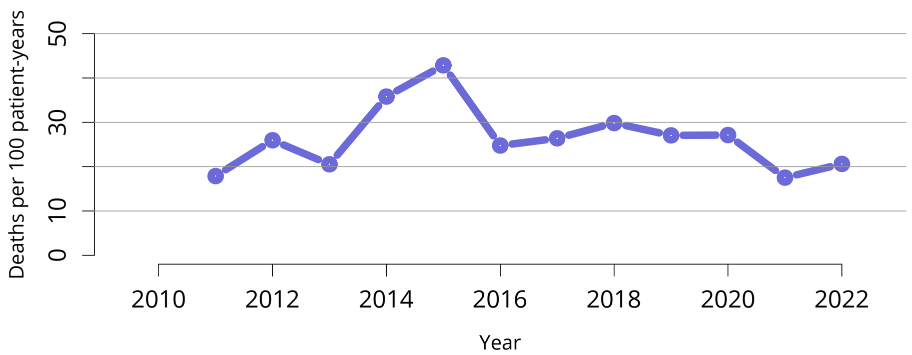
OPTN/SRTR 2022 Annual Data Report

Figure LU 72: Deceased donor lung transplant rates among pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



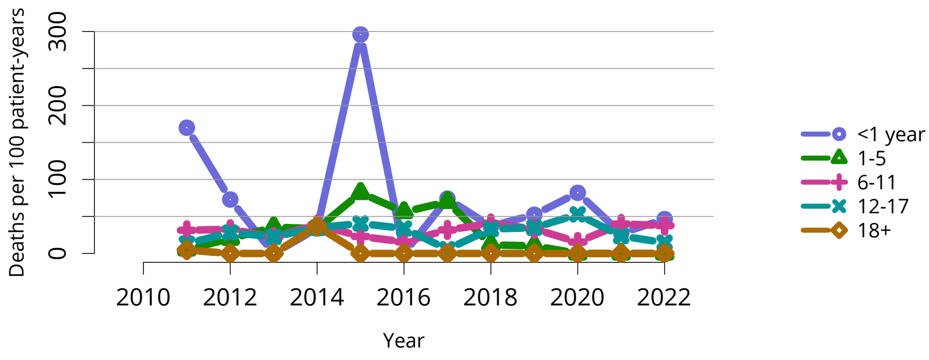
OPTN/SRTR 2022 Annual Data Report

Figure LU 73: Deceased donor lung transplant rates among pediatric waitlist candidates by race and ethnicity. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given year. Individual listings are counted separately. The Other race category is composed of Native American and Multiracial categories.



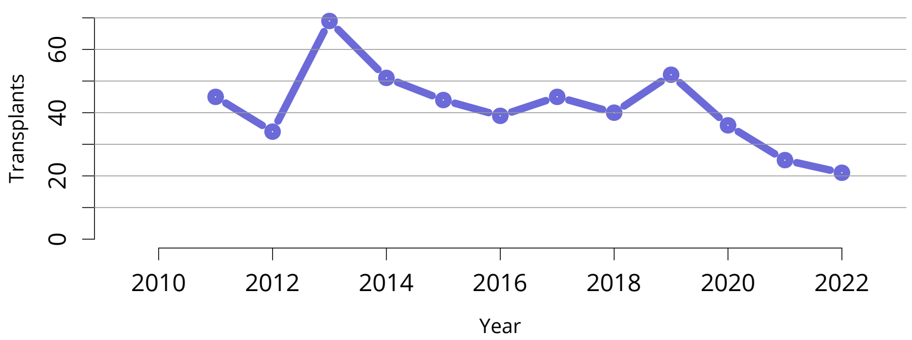
OPTN/SRTR 2022 Annual Data Report

Figure LU 74: Overall pretransplant mortality rates among pediatric candidates waitlisted for lung. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



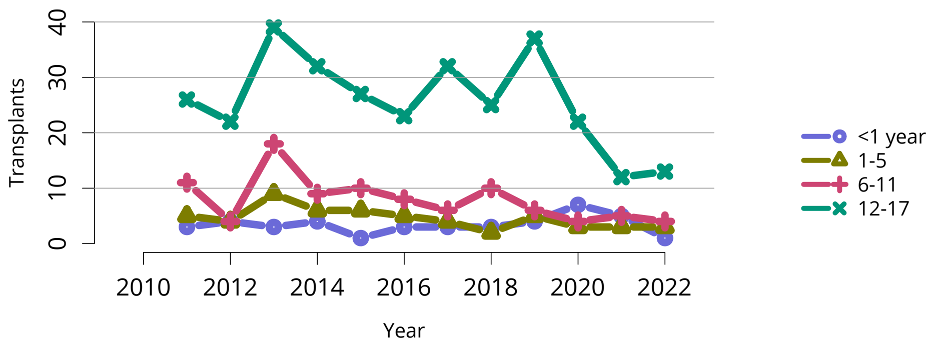
OPTN/SRTR 2022 Annual Data Report

Figure LU 75: Pretransplant mortality rates among pediatric candidates waitlisted for lung transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year.



OPTN/SRTR 2022 Annual Data Report

Figure LU 76: Overall pediatric lung transplants. All pediatric lung transplant recipients, including re-transplant and multiorgan recipients.



OPTN/SRTR 2022 Annual Data Report

Figure LU 77: Pediatric lung transplants by recipient age. All pediatric lung transplant recipients, including retransplant and multiorgan recipients.

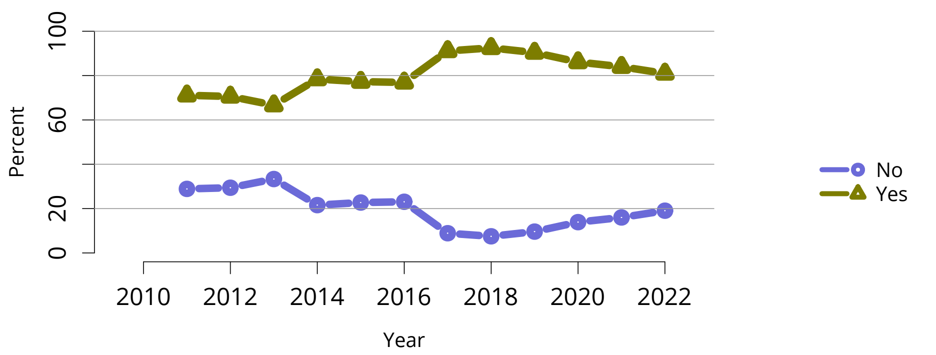


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Figure LU 78: Induction agent use in pediatric lung transplant recipients. Immunosuppression at transplant reported to the OPTN.

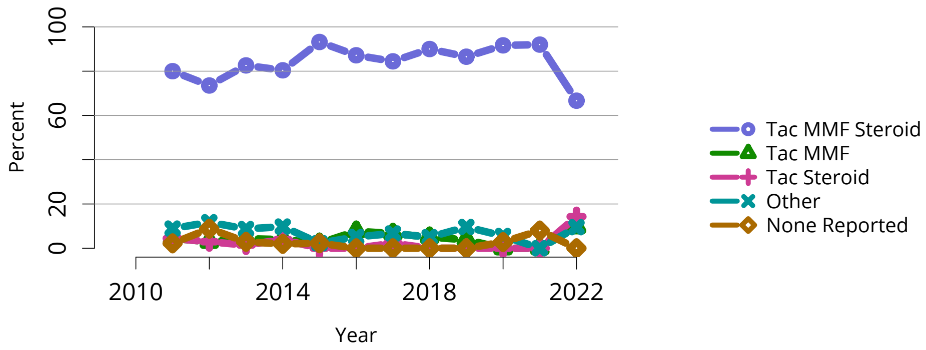

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Figure LU 79: Immunosuppression regimen use in pediatric lung transplant recipients. Immunosuppression regimen at transplant reported to the OPTN. MMF, all mycophenolate agents; Tac, tacrolimus.

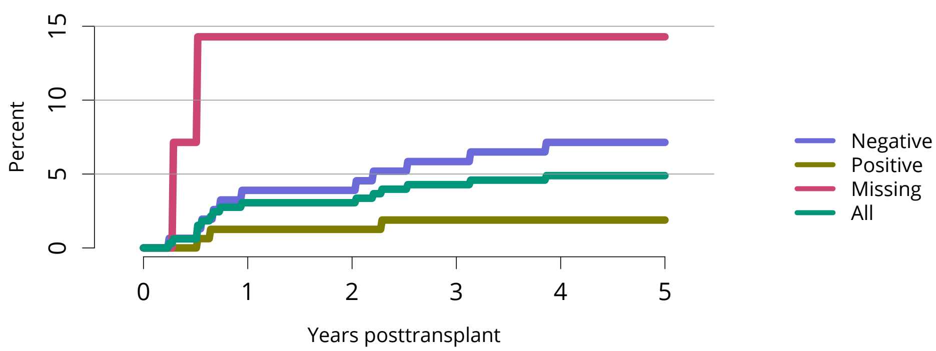

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Figure LU 80: Incidence of PTLD among pediatric lung transplant recipients by recipient EBV status at transplant, 2011-2017. Cumulative incidence is estimated using the Kaplan-Meier method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin's disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

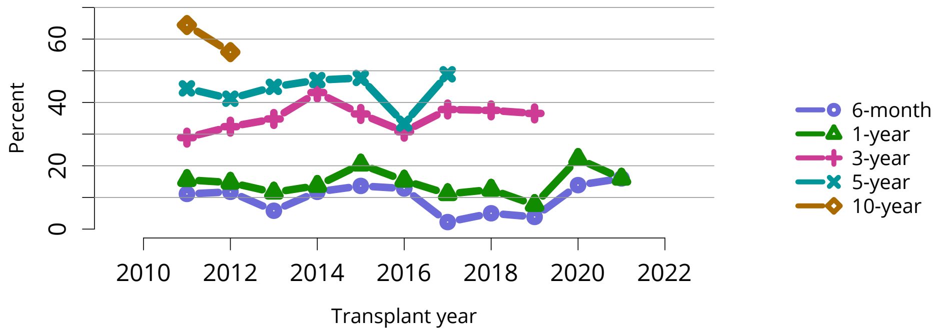

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Figure LU 81: Patient death among pediatric lung transplant recipients. All pediatric recipients of deceased donor lungs, including multiorgan transplant recipients. Estimates are unadjusted, computed using unadjusted Kaplan-Meier methods.

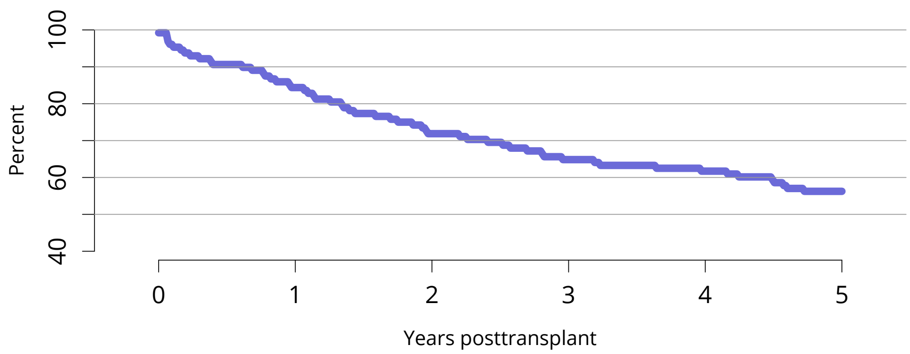

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Figure LU 82: Overall patient survival among pediatric deceased donor lung transplant recipients, 2015-2017. Recipient survival estimated using unadjusted Kaplan-Meier methods.

Table LU 1: Demographic characteristics of adults on the lung transplant waiting list on December 31, 2017, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. Distance is computed from candidate's home zip code to the transplant center. Age is determined on December 31 of the year.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
18-34 years	128	9.2	71	7.2
35-49	202	14.5	130	13.3
50-64	661	47.5	489	49.9
65+	400	28.8	290	29.6
Sex				
Female	825	59.3	590	60.2
Male	566	40.7	390	39.8
Race and ethnicity				
Asian	43	3.1	47	4.8
Black	176	12.7	141	14.4
Hispanic	132	9.5	139	14.2
Multiracial	6	0.4	3	0.3
Native American	6	0.4	2	0.2
White	1028	73.9	648	66.1
Geography				
Metropolitan	1156	83.1	842	85.9
Nonmetropolitan	226	16.2	127	13
Missing	9	0.6	11	1.1
Miles between candidate and center				
<50 miles	702	50.5	521	53.2
50-<100	240	17.3	178	18.2
100-<150	137	9.8	92	9.4
150-<250	160	11.5	113	11.5
250+	143	10.3	66	6.7
Missing	9	0.6	10	1
Height at listing (cm)				
<150 cm	52	3.7	53	5.4
150-<160	319	22.9	261	26.6
160-<170	492	35.4	327	33.4
170-<180	358	25.7	233	23.8
180+	169	12.1	104	10.6
Missing	1	0.1	2	0.2
All candidates				
All candidates	1391	100	980	100

Table LU 2: Clinical characteristics of adults on the lung transplant waiting list on December 31, 2017, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date. LAS, lung allocation score.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis group				
A - obstructive	539	38.7	268	27.3
B - pulmonary vascular	143	10.3	106	10.8
C - cystic fibrosis	111	8	27	2.8
D - restrictive	598	43	579	59.1
LAS at waiting				
<35	649	46.7	359	36.6
35-<40	370	26.6	309	31.5
40-<50	246	17.7	219	22.3
50-<60	59	4.2	45	4.6
60+	67	4.8	48	4.9
Blood type				
A	441	31.7	331	33.8
AB	42	3	25	2.6
B	165	11.9	91	9.3
O	743	53.4	533	54.4
All candidates				
All candidates	1391	100	980	100

Table LU 3: Listing characteristics of adults on the lung transplant waiting list on December 31, 2017, and December 31, 2022. Candidates waiting for transplant on December 31 of the given year, regardless of first listing date.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Previous transplant				
No prior transplant	1362	97.9	950	96.9
Prior transplant	29	2.1	30	3.1
Waiting time				
<90 days	454	32.6	371	37.9
3-<6 months	230	16.5	174	17.8
6-<12 months	244	17.5	190	19.4
1-<2 years	232	16.7	136	13.9
2+ years	231	16.6	109	11.1
All candidates				
All candidates	1391	100	980	100

Table LU 4: Lung transplant waitlist activity among adults. Candidates listed at more than one center are counted once per listing. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	1424	1006	1067
Patients added during year	2696	3111	3161
Patients removed during year	3114	3050	3248
Patients at end of year	1006	1067	980

Table LU 5: Removal reason among adult lung transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	2560	2542	2721
Patient died	151	132	142
Patient refused transplant	14	5	10
Improved, transplant not needed	65	52	44
Too sick for transplant	131	154	151
Other	193	165	180

Table LU 6: Demographic characteristics of adult lung transplant recipients, 2017 and 2022. Lung transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
18-34 years	246	10.1	135	5
35-49	270	11.1	307	11.3
50-64	1097	45.1	1168	42.9
65+	820	33.7	1112	40.9
Sex				
Female	997	41	1027	37.7
Male	1436	59	1695	62.3
Race and ethnicity				
Asian	71	2.9	121	4.4
Black	239	9.8	255	9.4
Hispanic	190	7.8	395	14.5
Multiracial	7	0.3	6	0.2
Native American	5	0.2	15	0.6
White	1921	79	1930	70.9
Height at transplant (cm)				
<150 cm	66	2.7	68	2.5
150-<160	362	14.9	344	12.6
160-<170	722	29.7	787	28.9
170-<180	844	34.7	975	35.8
180+	439	18	535	19.7
Missing	0	0	13	0.5
Insurance				
Private	1077	44.3	1098	40.3
Medicare	1088	44.7	1285	47.2
Medicaid	190	7.8	231	8.5
Other/unknown	78	3.2	108	4
Geography				
Metropolitan	2036	83.7	2268	83.3
Nonmetropolitan	379	15.6	394	14.5
Missing	18	0.7	60	2.2
Miles between recipient and center				
<50 miles	1191	49	1399	51.4
50-<100	483	19.9	461	16.9
100-<150	269	11.1	267	9.8
150-<250	249	10.2	264	9.7
250+	223	9.2	271	10
Missing	18	0.7	60	2.2
All recipients				
All recipients	2433	100	2722	100

Table LU 7: Clinical characteristics of adult lung transplant recipients, 2017 and 2022. Lung transplant recipients, including retransplant recipients. ECMO, extracorporeal membrane oxygenation; LAS, lung allocation score; vent, ventilation.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis group				
A - obstructive	669	27.5	498	18.3
B - pulmonary vascular	123	5.1	157	5.8
C - cystic fibrosis	241	9.9	42	1.5
D - restrictive	1400	57.5	2025	74.4
Blood type				
A	985	40.5	1038	38.1
AB	99	4.1	87	3.2
B	277	11.4	320	11.8
O	1072	44.1	1277	46.9
LAS at transplant				
<35	619	25.4	474	17.4
35-<40	558	22.9	596	21.9
40-<50	589	24.2	697	25.6
50-<60	201	8.3	258	9.5
60+	466	19.2	697	25.6
Vent/ECMO at transplant				
Vent+ECMO	75	3.1	107	3.9
Vent only	70	2.9	50	1.8
ECMO only	51	2.1	130	4.8
Neither	2237	91.9	2435	89.5
All recipients				
All recipients	2433	100	2722	100

Table LU 8: Transplant characteristics of adult lung transplant recipients, 2017 and 2022. Lung transplant recipients, including retransplant recipients. DBD, donation after brain death; DCD, donation after circulatory death.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
None	76	3.1	79	2.9
<90 days	1460	60	1892	69.5
3-<6 months	382	15.7	343	12.6
6-<12 months	268	11	245	9
1-<2 years	156	6.4	101	3.7
2+ years	91	3.7	62	2.3
Bilateral versus single lung transplant				
Bilateral	1815	74.6	2175	79.9
Single	618	25.4	547	20.1
Donation after circulatory death				
DBD	2344	96.3	2520	92.6
DCD	89	3.7	202	7.4
Previous transplant for recipients				
No prior transplant	2356	96.8	2644	97.1
Prior transplant	77	3.2	78	2.9
All recipients				
All recipients	2433	100	2722	100

Table LU 9: Demographic characteristics of pediatric candidates on the lung transplant waiting list on December 31, 2017, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date. Age is determined on December 31 of the year. Distance is computed from candidate's home zip code to the transplant center.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Age (years)				
<1 year	2	5	2	6.5
1-5	6	15	8	25.8
6-11	12	30	9	29
12-17	18	45	12	38.7
18+	2	5	0	0
Sex				
Female	22	55	16	51.6
Male	18	45	15	48.4
Race and ethnicity				
Asian	1	2.5	1	3.2
Black	2	5	5	16.1
Hispanic	9	22.5	6	19.4
Multiracial	2	5	0	0
White	26	65	19	61.3
Geography				
Metropolitan	32	80	27	87.1
Nonmetropolitan	7	17.5	2	6.5
Missing	1	2.5	2	6.5
Miles between candidate and center				
<50 miles	15	37.5	5	16.1
50-<100	3	7.5	6	19.4
100-<150	2	5	6	19.4
150-<250	8	20	4	12.9
250+	11	27.5	8	25.8
Missing	1	2.5	2	6.5
Height at listing (cm)				
<70 cm	6	15	3	9.7
70-<90	1	2.5	6	19.4
90-<110	4	10	2	6.5
110-<130	11	27.5	8	25.8
130+	18	45	12	38.7
All candidates				
All candidates	40	100	31	100

Table LU 10: Clinical characteristics of pediatric candidates on the lung transplant waiting list on December 31, 2017, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis group				
Cystic fibrosis	16	40	3	9.7
Pulmonary hypertension	11	27.5	13	41.9
Pulmonary fibrosis	1	2.5	2	6.5
Other vascular	1	2.5	3	9.7
Other/unknown	11	27.5	10	32.3
Blood type				
A	11	27.5	13	41.9
AB	2	5	1	3.2
B	2	5	6	19.4
O	25	62.5	11	35.5
All candidates				
All candidates	40	100	31	100

Table LU 11: Listing characteristics of pediatric candidates on the lung transplant waiting list on December 31, 2017, and December 31, 2022. Candidates younger than 18 years at listing waiting for transplant on December 31 of the given year, regardless of first listing date.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Previous transplant				
No prior transplant	40	100	31	100
Waiting time				
<90 days	14	35	10	32.3
3-<6 months	7	17.5	5	16.1
6-<12 months	5	12.5	6	19.4
1-<2 years	7	17.5	5	16.1
2+ years	7	17.5	5	16.1
All candidates				
All candidates	40	100	31	100

Table LU 12: Lung transplant waitlist activity among pediatric candidates. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multiorgan transplants are included.

Waiting list state	2020	2021	2022
Waiting list state			
Patients at start of year	30	22	26
Patients added during year	58	47	47
Patients removed during year	66	43	42
Patients at end of year	22	26	31

Table LU 13: Removal reason among pediatric lung transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Removal reason	2020	2021	2022
Removal reason			
Deceased donor transplant	36	25	22
Patient died	7	3	7
Patient refused transplant	0	0	1
Improved, transplant not needed	8	5	0
Too sick for transplant	4	6	2
Other	11	4	10

Table LU 14: Demographic characteristics of pediatric lung transplant recipients, 2017 and 2022. Pediatric lung transplant recipients, including retransplant recipients. Distance is computed from recipient's home zip code to the transplant center.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Recipient age (years)				
<1 year	3	6.7	1	4.8
1-5	4	8.9	3	14.3
6-11	6	13.3	4	19
12-17	32	71.1	13	61.9
Sex				
Female	28	62.2	15	71.4
Male	17	37.8	6	28.6
Race and ethnicity				
Asian	0	0	2	9.5
Black	4	8.9	2	9.5
Hispanic	13	28.9	7	33.3
Multiracial	0	0	1	4.8
White	28	62.2	9	42.9
Height at transplant (cm)				
<70 cm	4	8.9	2	9.5
70-<90	2	4.4	1	4.8
90-<110	1	2.2	1	4.8
110-<130	5	11.1	0	0
130+	33	73.3	17	81
Insurance				
Private	20	44.4	10	47.6
Medicaid	24	53.3	9	42.9
Other/unknown	1	2.2	2	9.5
Geography				
Metropolitan	38	84.4	20	95.2
Nonmetropolitan	6	13.3	1	4.8
Missing	1	2.2	0	0
Miles between recipient and center				
<50 miles	8	17.8	8	38.1
50-<100	9	20	1	4.8
100-<150	3	6.7	0	0
150-<250	4	8.9	2	9.5
250+	20	44.4	10	47.6
Missing	1	2.2	0	0
All recipients				
All recipients	45	100	21	100

Table LU 15: Clinical characteristics of pediatric lung transplant recipients, 2017 and 2022. Pediatric lung transplant recipients, including retransplant recipients. Pediatric priority was reported in 2010 and later. ECMO, extracorporeal membrane oxygenation; LAS, lung allocation score; vent, ventilation.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Diagnosis group				
Cystic fibrosis	25	55.6	4	19
Pulmonary hypertension	3	6.7	5	23.8
Pulmonary fibrosis	3	6.7	2	9.5
Other vascular	1	2.2	1	4.8
Other/unknown	13	28.9	9	42.9
Blood type				
A	18	40	10	47.6
AB	1	2.2	1	4.8
B	6	13.3	1	4.8
O	20	44.4	9	42.9
LAS at transplant				
<35	9	20	6	28.6
35-<40	8	17.8	1	4.8
40-<50	10	22.2	1	4.8
50-<60	0	0	1	4.8
60+	5	11.1	4	19
Not applicable	13	28.9	8	38.1
Vent/ECMO at transplant				
Vent+ECMO	1	2.2	4	19
Vent only	8	17.8	3	14.3
ECMO only	2	4.4	1	4.8
Neither	34	75.6	13	61.9
All recipients				
All recipients	45	100	21	100

Table LU 16: Transplant characteristics of pediatric lung transplant recipients, 2017 and 2022. Pediatric lung transplant recipients, including retransplant recipients.

	2017		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Waiting time				
None	2	4.4	0	0
<90 days	27	60	12	57.1
3-<6 months	6	13.3	3	14.3
6-<12 months	5	11.1	5	23.8
1-<2 years	4	8.9	1	4.8
2+ years	1	2.2	0	0
Bilateral versus single lung transplant				
Bilateral	45	100	21	100
Previous transplant for recipients				
No prior transplant	44	97.8	21	100
Prior transplant	1	2.2	0	0
All recipients				
All recipients	45	100	21	100

OPTN/SRTR 2022 Annual Data Report: Deceased Organ Donation

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Abstract

The Scientific Registry of Transplant Recipients uses data collected by the Organ Procurement and Transplantation Network to calculate metrics such as organs recovered per donor, organs transplanted per donor, and organs recovered for transplant but not transplanted (ie, nonuse). In 2022, there were 14,905 deceased donors, a 7.5% increase from 13,863 in 2021, and this number has been increasing since 2010. The number of deceased donor organs used for transplant increased to 37,334 in 2022, a 4.6% increase from 35,687 in 2021; this number has been increasing since 2012. The increase may be due in part to the rising number of deaths of young people amid the ongoing opioid epidemic. The number of organs transplanted included 10,130 left kidneys, 10,039 right kidneys, 298 en bloc kidneys, 922 pancreata, 8,847 livers, 83 intestines, 4,169 hearts, and 2,633 lungs. Compared with 2021, transplants of all organs except pancreata and intestines increased in 2022. In 2022, 3,563 left kidneys, 3,673 right kidneys, 156 en bloc kidneys, 366 pancreata, 965 livers, 4 intestines, 54 hearts, and 219 lungs were not used. These data suggest an opportunity to increase the number of transplants by reducing the number of unused organs. Despite the COVID-19 pandemic, there was no dramatic increase in the number of unused organs and there was an increase in the total numbers of donors and transplants.

Keywords: Donation rate, organ nonuse

1 Introduction

This chapter reports data collected by the Organ Procurement and Transplantation Network (OPTN) to describe changes in deceased donor characteristics over the past decade and deceased organ donor metrics such as donation rate and rate of organs recovered for transplant but not transplanted (ie, nonuse). These metrics are currently produced by the Scientific Registry of Transplant Recipients (SRTR), and some are used for organ procurement organization (OPO) quality assessment by OPTN. Some data described in this chapter are also used by the Centers for Medicare & Medicaid Services (CMS) to develop its own quality assessment of OPOs. The chapter also describes the Centers for Disease Control and Prevention's national data on deaths that will be used by CMS as part of its metrics to assess OPO quality. In 2019, the federal government ordered the revision of OPO quality metrics "to establish more transparent, reliable, and enforceable objective metrics for evaluating an OPO's performance."[1] This federal order also aims to reduce organ nonuse nationally. CMS has approved new metrics to assess OPO quality.[2] The new metrics to assess OPO quality became effective on August 1, 2022; their impact will be seen in the future.

Definitions of Terms Related to Deceased Organ Donation

- **Donation service area (DSA):** The geographic area designated by CMS that is served by one OPO.
- **DBD:** Donation after brain death.
- **DCD:** Donation after circulatory death.
- **Donor:** A person from whom at least one organ was recovered for transplant, regardless of whether the organ was transplanted.
- **Nonuse:** Organs recovered for transplant but not transplanted.
- **Nonuse rate:** Number of organs not used divided by number of organs recovered for transplant.
- **Organs authorized for recovery:** Authorization requested and given for recovery of specific organs from a donor. Recovery of organs for transplant must be authorized by the individual(s) authorizing the donation (donor or surrogate decision maker), consistent with applicable state law.
- **Organs recovered per donor (ORPD):** Total number of organs recovered for transplant, divided by the number of donors, not limited to eligible deaths.
- **Organs transplanted per donor (OTPD):** Total number of organs transplanted, divided by the number of donors, not limited to eligible deaths (eg, OTPD for kid-

neys is the total number of kidneys transplanted, divided by the total number of all donors).

- **Referrals:** All deaths and imminent deaths reported to an OPO.

2 Donors and Organs

In 2022, there were 14,905 deceased donors, a 7.5% increase from 13,863 in 2021. Over the past decade, the number of deceased donors has increased annually (from 8,126 in 2011) (Figure DD 1).

In 2022, there were 10,127 donation after brain death (DBD) and 4,778 donation after circulatory death (DCD) donors, which represent increases of 4.6% and 1.4%, respectively, compared with 2021. Since 2012, the numbers of both DBD and DCD donors have increased annually (Figure DD 2). There have also been similar annual increases in the numbers of organs authorized, organs recovered, and organs transplanted since 2012.

In 2022, there were 107,639 organs authorized for donation, a 7.9% increase from 99,708 in 2021, and this number has increased annually over the past decade. Likewise, the numbers of organs recovered and organs transplanted have increased annually since 2012. In 2022, there were 53,709 organs recovered, an increase of 9.4% from 49,091 in 2021.

In 2022, there were 37,334 organs used for transplant, an increase of 4.6% from 35,687 in 2021 (Figure DD 3). The characteristics of deceased organ donors in 2022 differ from those of donors in 2012. In 2022, there were more donors with the following characteristics: kidney donor profile index (KDPI) of 35%-85%, KDPI of greater than 85%, HIV positive, hepatitis C virus (HCV) positive, anoxia as cause of death, male, age 35 years and older, Latino ethnicity, White race, Other or unknown race, and DCD (Table DD 1).

3 Organs Recovered Per Donor

In 2022, there were 49,187 organs recovered for transplant, a 6.4% increase from 46,219 in 2021. The year 2022 saw 3.30 organs recovered per donor (ORPD) for all organs, a decrease of 1.0% from 2021. Over the past decade, this ORPD has ranged from 3.30 to 3.55. Given that each donor can potentially donate two kidneys, the organ-specific ORPD was highest for kidneys at 1.90 in 2022, stable since 2021. Over the past decade, the ORPD for kidneys has ranged from 1.80 to 1.90 (Figure DD 4).

The ORPD for liver was 0.66 in 2022, a decrease of 4.3% from 0.69 in 2021; the value in 2011 was 0.82. The ORPD for pancreas was 0.086 in 2022, a 4.3% decrease from 0.094 in 2021; the value was 0.18 in 2011 and has decreased annually over the past decade. The ORPD for intestine was 0.0058 in 2022, a decrease of 16.5% from 0.0069 in 2021; the value in 2011 was 0.016. Thus, ORPD values for liver, pancreas, and intestine have declined over the past decade (Figure DD 5).

In contrast, heart and lung did not have ORPD declines. The ORPD for heart was 0.28 in 2022, showing a slight increase from 2021. Over the past decade, the ORPD for heart has fluctuated between 0.28 and 0.32. The ORPD for lung was 0.36 in 2022, an increase of 0.4% from 2021. Over the past decade, the ORPD for lung has fluctuated from 0.37 to 0.45 (Figure DD 5).

In 2022, the ORPD for all organs varied by donation service area (DSA), ranging from 2.52 to 3.70 (Figure DD 6). The ORPD is an unadjusted number representing a mix of donor types, including young, old, DBD, and DCD, which explains some differences observed.

4 Organs Transplanted Per Donor

In 2022, there were 39,833 organs transplanted, a 4.6% increase from 38,080 in 2021. In 2022, there were 2.67 organs transplanted per donor (OTPD) for all organs, a decrease of 2.9% from 2.75 in 2021. Organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant; thus, this number will be higher than deceased donor organs used for transplant. This OTPD has generally been decreasing, from 3.07 in 2011. Given that each donor can potentially donate two kidneys, the organ-specific OTPD was highest for kidneys at 1.39 in 2022, a 2.8% decline from 1.43 in 2021. Over the past decade, the OTPD for kidneys has fluctuated between 1.39 and 1.50 (Figure DD 4). In 2022, from 14,411 donors, 10,130 left kidney transplants and 10,039 right kidney transplants were performed (Figure DD 21 and Figure DD 22). In 2022, from 494 donors, 298 en bloc kidney transplants were done (Figure DD 23).

The OTPD for liver was 0.59 in 2022, a decrease of 5.0% from 0.62 in 2021. Over the past decade, the OTPD for liver has typically decreased every year and was 0.74 in 2011 (Figure DD 8). In 2022, from the 14,905 total deceased organ donors, 8,847 livers were transplanted (Figure DD 25). The OTPD for pancreas was 0.062 in 2022, a 11.5% decrease from 0.070 in 2021. Over the past decade, the OTPD for pancreas has decreased annually and was 0.13 in 2011. In 2022, from the 14,905 donors, there were 922 pancreata transplanted and this includes five pancreata that were transplanted as islet cells (Figure DD 24). The OTPD for intestine was 0.0056 in 2022, a decrease of 19.5% from

0.0069 in 2021. Over the past decade, the OTPD for intestine has largely decreased year to year and was 0.015 in 2011. In 2022, from the 14,905 donors, there were 83 intestines transplanted (Figure DD 26). Thus, liver, pancreas, and intestine have seen a fairly steady decline in OTPD over the past decade (Figure DD 8).

The OTPD for heart was 0.28 in 2022, showing a slight increase from 2021. Since 2011, the OTPD for heart has fluctuated between 0.28 and 0.32. In 2022, from the 14,905 donors, there were 4,169 hearts transplanted (Figure DD 27). The OTPD for lung was 0.33 in 2022, showing a slight decrease from 2021. Over the past decade, the OTPD for lung has fluctuated between 0.33 and 0.42 (Figure DD 8). In 2022, from the 14,905 donors, there were 2,633 lung transplants done.

In 2022, the OTPD for all organs varied by DSA, ranging from 2.09 to 3.12 (Figure DD 9). The OTPD is an unadjusted number representing a mix of donor types, including young, old, DBD, and DCD, which explains some differences observed. The OTPD for all organs was 3.14 for DBD in 2022, a 1.2% decrease from 3.18 in 2021. This OTPD for DBD has varied from 3.14 to 3.34 over the past decade. The OTPD for all organs was 1.67 for DCD in 2022, a 4.6% decrease from 1.75 in 2021. The OTPD for DCD has decreased over the past decade and was 2.00 in 2011 (Figure DD 10). The percentage of DCD donors varies across DSAs on the mainland in the United States, ranging from 0% to 51.4% (Figure DD 19).

In 2022, the OTPD for kidneys was 1.44 for DBD donors and 1.30 for DCD donors. The OTPD for kidneys has been lower for DCD compared with DBD since 2021. In 2011 through 2020, the OTPD for kidneys for DCD was higher than that for DBD (Figure DD 11). In 2022, the OTPD for pancreas was 0.09 for DBD donors and 0.005 for DCD donors (Figure DD 12). In 2022, the OTPD for liver was 0.77 for DBD donors and 0.21 for DCD donors (Figure DD 13). No intestines were transplanted from DCD donors in 2022 or in the past decade (Figure DD 14). A few DCD hearts have been transplanted since 2019 (Figure DD 15). The OTPD for lung was 0.45 for DBD donors and 0.081 for DCD donors (Figure DD 16).

The OTPD for kidneys varied by KDPI in 2022, from 1.92 for KDPI of 20% or less to 0.56 for KDPI of greater than 85%. This trend was relatively stable over the past decade (Figure DD 17). The percentage of kidney donors with KDPI of greater than 85% also varied across DSAs, ranging from 2.4% to 14.4% (Figure DD 20).

5 Organs Recovered for Transplant but Not Transplanted

In 2022, there were 9,354 organs recovered for transplant but not transplanted (ie, nonuse), a 14.9% increase from 8,139 in 2021. These unused organs represented 19.0% of all organs recovered combined in 2022, an increase from 17.6% in 2021. The percentage of nonuse has increased annually since 2018. In 2022, the nonuse percentage varied by organs. Pancreas had the highest percentage of nonuse in 2022 at 28.6%, followed by kidneys, liver, lung, intestine, and heart in sequential order with 26.7%, 9.8%, 9.0%, 4.6%, and 1.3%, respectively (Figure DD 18); by their number values, 366 pancreata, 3,563 left kidneys, 3,673 right kidneys, 156 en bloc kidneys, 965 livers, 219 lungs, 4 intestines, and 54 hearts were not used. Given the high nonuse rates of kidney and pancreas, the OPTN Board of Directors has asked the Kidney and Pancreas Committees to focus on increasing the efficiency in use of such organs prior to changing their allocation systems.

6 Change in Characteristics of Donors Over the Past Decade

In 2022, 20.9% of donors had a KDPI of greater than 85%, an increase from 17.9% in 2012. In contrast, in 2022, there was a decline in percentage of donors with a KDPI of less than 20% compared with 2012. In 2022, the use of HIV-positive and HCV-positive donors increased compared with 2012. Given the increase in deceased donors over the past decade, there is controversy regarding an explanation (Table DD 1). Some have argued that deaths from the opioid epidemic have fueled this increase in donors. In 2022, 16.7% of donors died from drug intoxication, an increase from 5.4% in 2012. However, in 2022, 20.5% of donors died from cardiovascular causes, an increase from 15.7% in 2012. This stagnation in improvement of deaths from cardiovascular causes has been well described in the medical literature. In contrast, there was an increase in deaths from gunshot wound, blunt injury, and stroke in 2022 compared with 2012, but they all represent a lower percent of the total deaths. Others have argued that the improvement in performance of OPOs is responsible for the increase in deceased donors. The unadjusted analysis presented herein is unlikely to resolve the issue.

For circumstances of death, in 2022, 19.3% of the donors died from non–motor vehicle accidents (non-MVAs), an increase from 9.9% in 2012. Natural causes was the category with the largest percentages in both years, at 47.6% and 45.0% of deaths in 2022 and 2012, respectively. In 2022, anoxia was the cause of death in 48.0% of donors, an increase from 29.9% in 2012. All other causes of death decreased in relative percentage in 2022 from 2012. The increases in deaths related to non-MVAs and anoxia are consistent with increases in deaths from opioid overdose (Table DD 2).

7 New Metrics From the Centers for Medicare & Medicaid Services

The CMS has finalized and published new metrics in December 2021 for the OPO public performance report cards. These new metrics were used in 2022. The new metrics determine the CMS potential donors, which is the denominator for both the donation rate and transplant rate metrics. In Figure DD 29, the CMS potential donors were identified using data obtained from the National Center for Health Statistics Detailed Multiple Cause of Death (MCOD) file as provided by the Centers for Disease Control and Prevention. The potential donor deaths were identified using the codes from the *International Classification of Diseases*, Tenth Revision, for ischemic heart disease (120-125), cerebrovascular disease (160-169), and external causes of morbidity and mortality, which includes blunt trauma, gunshot wound, suicide, drowning, and asphyxiation (V-1-Y89). The definition of potential donors is based on the cause of death, age younger than 75 years, and the location of death being consistent with organ donation, mainly inpatient deaths. The numerator is the number of donors for the donation rate metric and is defined as the number of deceased individuals from whom at least one organ, such as heart, liver, lung, kidney, pancreas, or intestine, was transplanted. The number of donors also includes donors with pancreata or islet cells that were either recovered for research or recovered for transplant but submitted for research. In 2021, the donation rate metric varied across DSAs from 6.9 to 19.2 (Figure DD 29 and Table DD 3).

The transplant rate metric, the second CMS metric, uses the number of organs transplanted from deceased donors as shown in Figure DD 30. In 2021, the CMS transplant rate varied across DSAs from 15.0 to 57.5. The CMS transplant rate was lowest for the Hawaii DSA, and the metric for this DSA only includes transplanted kidneys in its numerator. For the US mainland, the lowest transplant rate metric was 20.8 (Figure DD 30 and Table DD 3).

This numerator for the transplant metric also includes pancreata and islet cells that were either recovered for research or recovered for transplant but submitted for research. In 2022, there were 2,737 pancreata either recovered for research or recovered for transplant but submitted for research, a 134% increase from 1,165 in 2021 (Figure DD 31). In 2022, there were 254 donors who had only a pancreas recovered for research or recovered for transplant but submitted for research, a 230% increase from 107 in 2021.

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[2] US Department of Health and Human Services. Centers for Medicare and Medicaid Services. 42 CFR Part 486 [CMS-3380-F], RIN 0938-AU02. Medicare and Medicaid Programs; Organ Procurement Organizations Conditions for Coverage: Revisions to the Outcome Measure Requirements for Organ Procurement Organizations; Final rule. 2020. Accessed October 27, 2023. https://www.govinfo.gov/content/pkg/FR-2020-12-02/pdf/2020-26329.pdf

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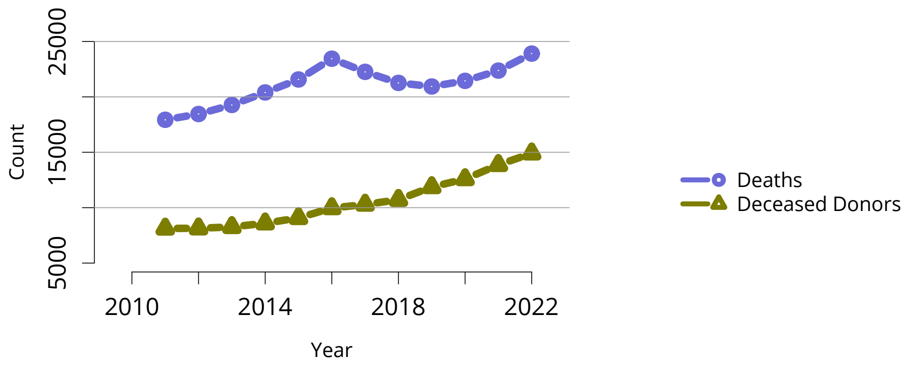

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Figure DD 1: Overall counts of deaths and donors, 2011-2022. The number and source of donors.

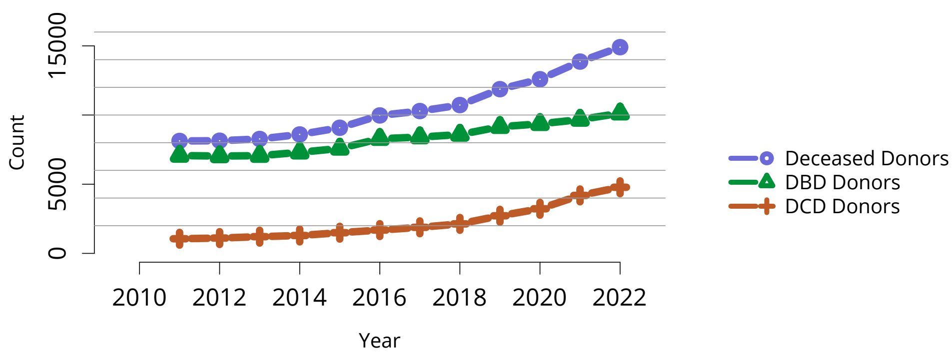

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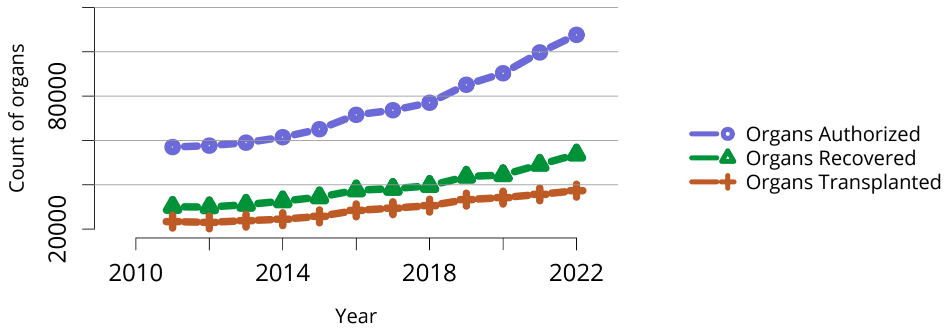
Figure DD 2: Overall counts of deceased donors, DBD donors, and DCD donors, 2011-2022. The number of deceased donors, DBD donors, and DCD donors. Deceased donor counts include all donors for whom at least one organ was recovered for transplant. DBD, donation after brain death; DCD, donation after circulatory death.



OPTN/SRTR 2022 Annual Data Report

Figure DD 3: Overall counts of authorized, recovered, and transplanted organs, 2011-2022. The number of authorized , recovered, and transplanted organs.

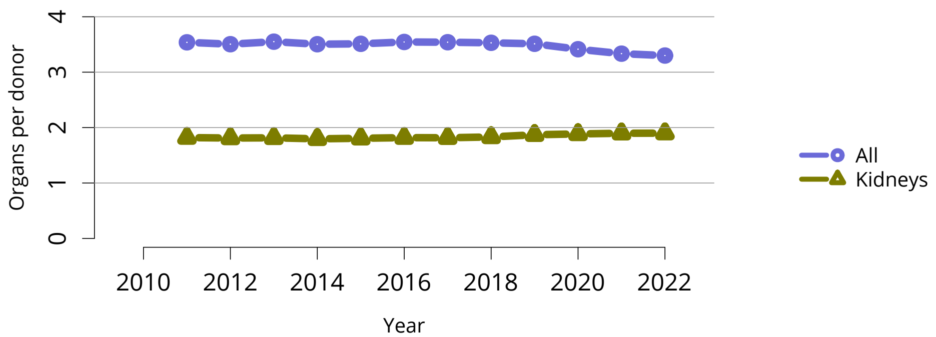


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Figure DD 4: Organs recovered per donor, all organs and kidney. Average number of overall organs and kidneys recovered per donor, calculated as the sum of recovered organs and by organ type; e.g., up to two kidneys can be recovered from each donor, but only one heart.

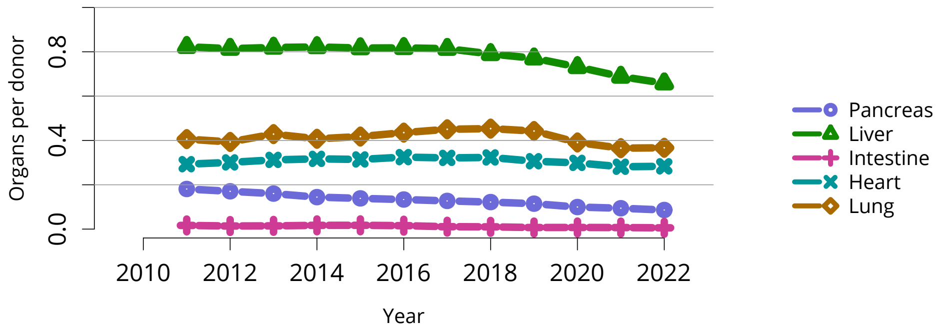

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Figure DD 5: Organs recovered per donor, pancreas, liver, intestine, heart, and lung. Average number of organs other than kidneys recovered per donor, calculated as the sum of recovered organs and by organ type. Pancreata recovered for islet transplant are excluded.

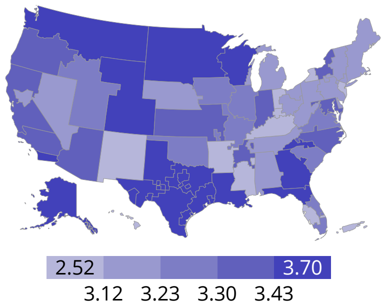

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Figure DD 6: Organs recovered per donor by DSA, 2022. Average number of organs recovered per donor, calculated as the sum of recovered organs and by organ type; e.g., up to two kidneys can be recovered from each donor, but only one heart. Pancreata recovered for islet transplant are excluded. DSA, donation service area.

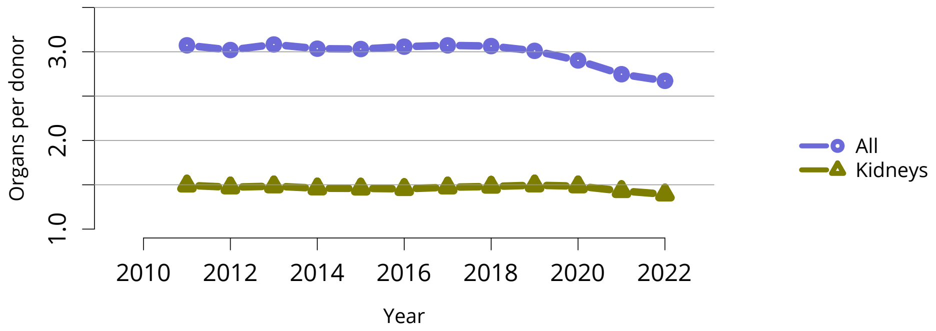

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Figure DD 7: Organs transplanted per donor, all organs and kidney. Average number of overall organs and kidneys transplanted per donor. As organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, the number or organs transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from number of transplant operations. Pancreata recovered for islet transplant are excluded.

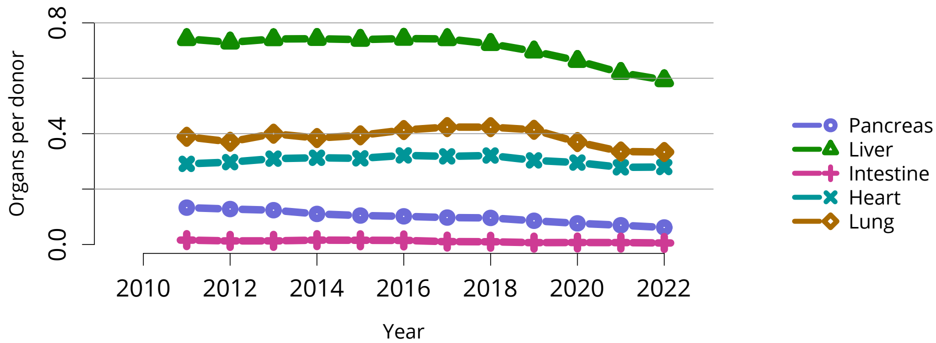

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Figure DD 8: Organs transplanted per donor, pancreas, liver, intestine, heart, and lung. Average number of organs other than kidneys transplanted per donor. As organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, the number or organs transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from number of transplant operations. Pancreata recovered for islet transplant are excluded.

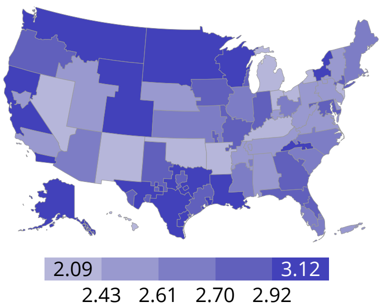

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Figure DD 9: Organs transplanted per donor, by DSA, 2022. Average number of organs transplanted per donor. As organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, the number or organs transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from number of transplant operations. DSA-level means are shown. Pancreata recovered for islet transplant are excluded. DSA, donation service area.

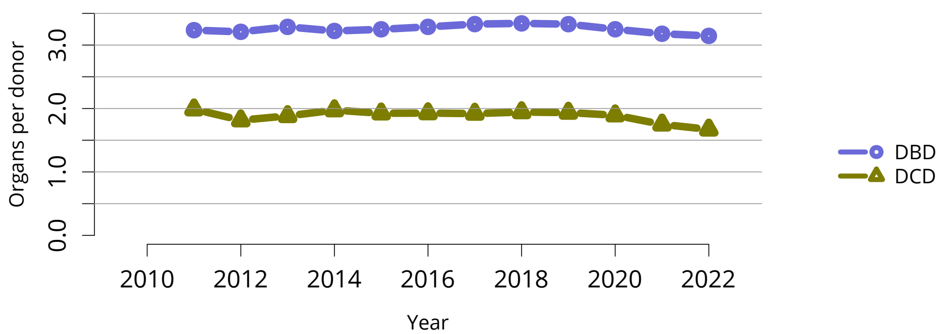

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Figure DD 10: Organs transplanted per donor, by DBD and DCD status. Average number of organs transplanted per donor. As organs divided into segments (liver, lung, pancreas, intestine) may account for more than one transplant, the number of organs transplanted may exceed the number recovered. Based on a count of recovered organs that are transplanted, which differs from number of transplant operations. Pancreata recovered for islet transplant are excluded. DBD, donation after brain death; DCD, donation after circulatory death.

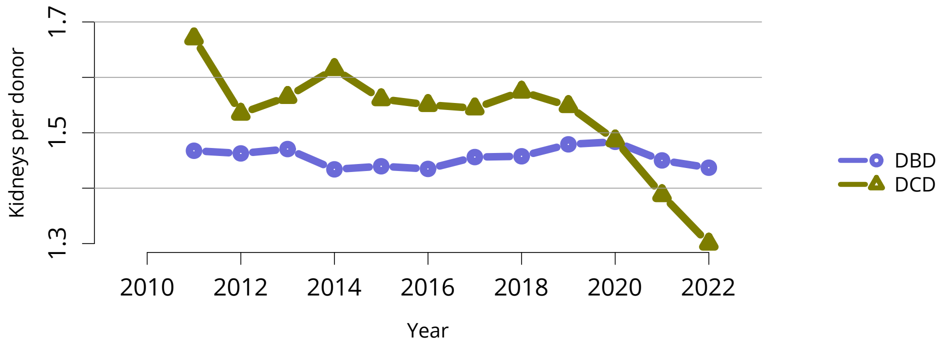

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Figure DD 11: Kidneys transplanted per donor, by DBD and DCD status. Average number of kidneys transplanted per donor. Based on a count of recovered kidneys that are transplanted, which differs from number of transplant operations. DBD, donation after brain death; DCD, donation after circulatory death.

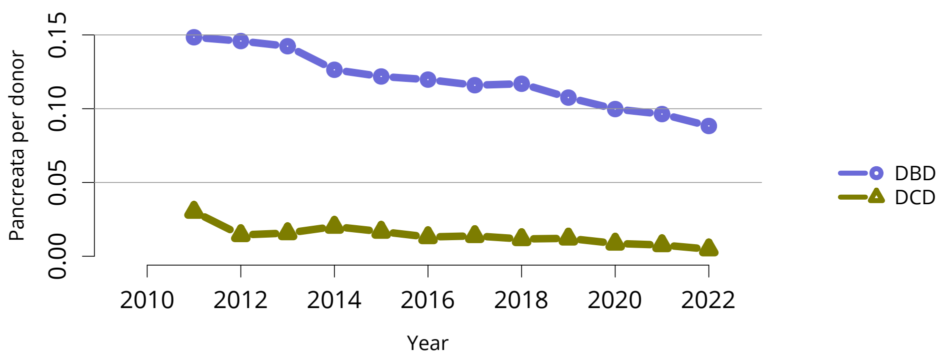

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Figure DD 12: Pancreata transplanted per donor, by DBD and DCD status. Average number of pancreata transplanted per donor. Pancreata divided into segments may account for more than one transplant, thus the number of pancreata transplanted may exceed the number recovered. Based on a count of recovered pancreata that are transplanted, which differs from number of transplant operations. Pancreata recovered for islet transplant are excluded. DBD, donation after brain death; DCD, donation after circulatory death.

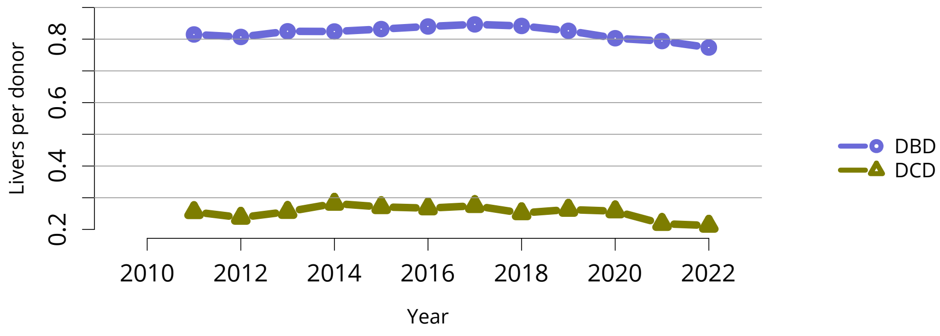

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Figure DD 13: Livers transplanted per donor, by DBD and DCD status. Average number of livers transplanted per donor. Livers divided into segments may account for more than one transplant, thus the number of livers transplanted may exceed the number recovered. Based on a count of recovered livers that are transplanted, which differs from number of transplant operations. DBD, donation after brain death; DCD, donation after circulatory death.

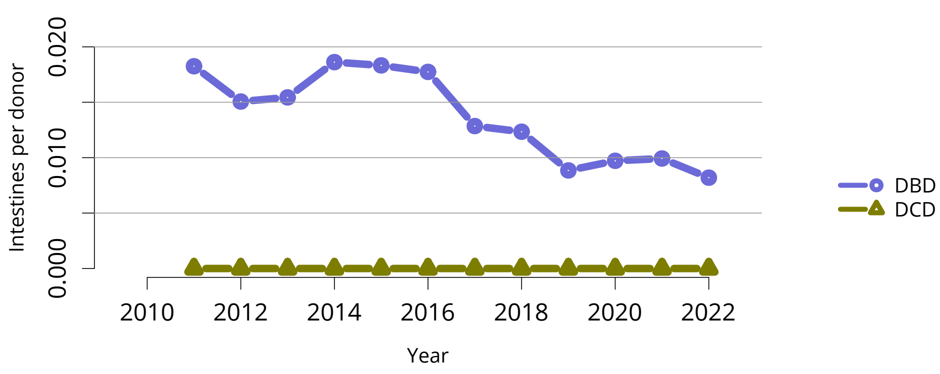

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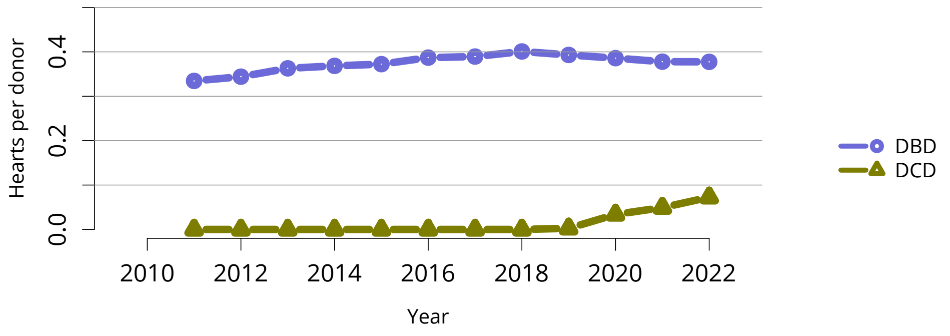
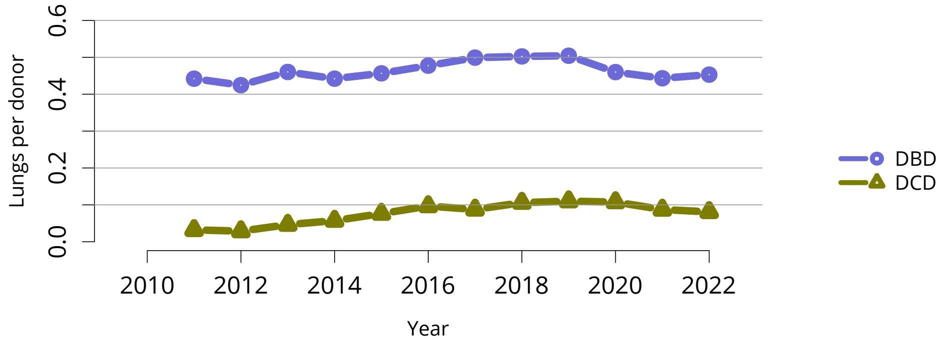
Figure DD 14: Intestines transplanted per donor, by DBD and DCD status. Average number of intestines transplanted per donor. Intestines divided into segments may account for more than one transplant, thus the number of intestines transplanted may exceed the number recovered. Based on a count of recovered intestines that are transplanted, which differs from number of transplant operations. DBD, donation after brain death; DCD, donation after circulatory death.



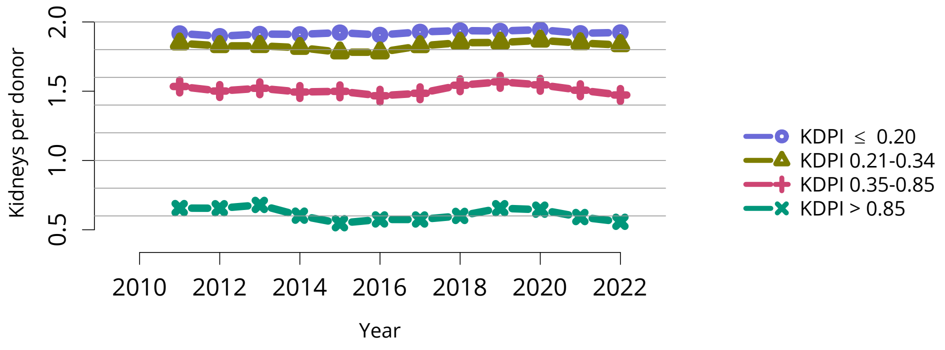
OPTN/SRTR 2022 Annual Data Report

Figure DD 15: Hearts transplanted per donor, by DBD and DCD status. Average number of hearts transplanted per donor. Based on a count of recovered hearts that are transplanted, which differs from number of transplant operations. DBD, donation after brain death; DCD, donation after circulatory death.



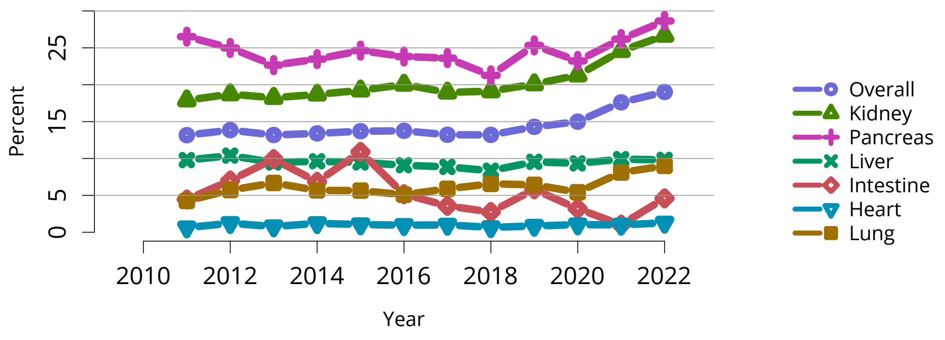
OPTN/SRTR 2022 Annual Data Report

Figure DD 16: Lungs transplanted per donor, by DBD and DCD status. Average number of lungs transplanted per donor. Lungs divided into segments may account for more than one transplant, thus the number of lungs transplanted may exceed the number recovered. Based on a count of recovered lungs that are transplanted, which differs from number of transplant operations. DBD, donation after brain death; DCD, donation after circulatory death.



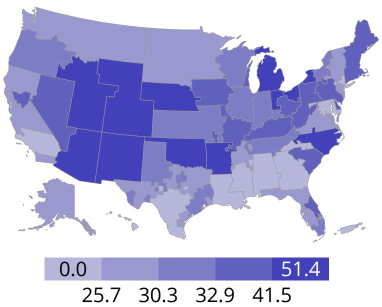
OPTN/SRTR 2022 Annual Data Report

Figure DD 17: Kidneys transplanted per donor, by KDPI. Average number of kidneys transplanted per donor. Based on a count of recovered kidneys that are transplanted, which differs from number of transplant operations. KDPI, kidney donor profile index.



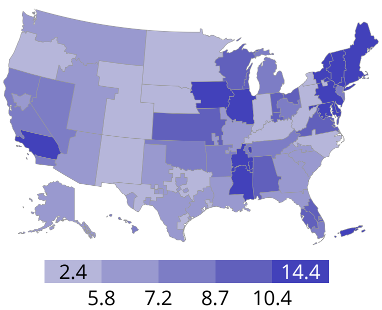
OPTN/SRTR 2022 Annual Data Report

Figure DD 18: Organs recovered for transplant and not transplanted. Percents are calculated as the difference between the number of organs recovered and the number of organs transplanted, divided by the number of organs recovered. Pancreata recovered for islet transplant are excluded.



OPTN/SRTR 2022 Annual Data Report

Figure DD 19: The percentage of DCD donors across DSAs from all donors, 2022. Percentage of DCD donors within a DSA. DCD, donation after circulatory death; DSA, donation service area.



OPTN/SRTR 2022 Annual Data Report

Figure DD 20: The percentage of kidney donors with KDPI greater than 85% among deceased donor kidney transplant recipients across DSAs, 2022. Percentage of kidney donors within a DSA with a donor KDPI greater than 85%. DSA, donation service area; KDPI, kidney donor profile index.

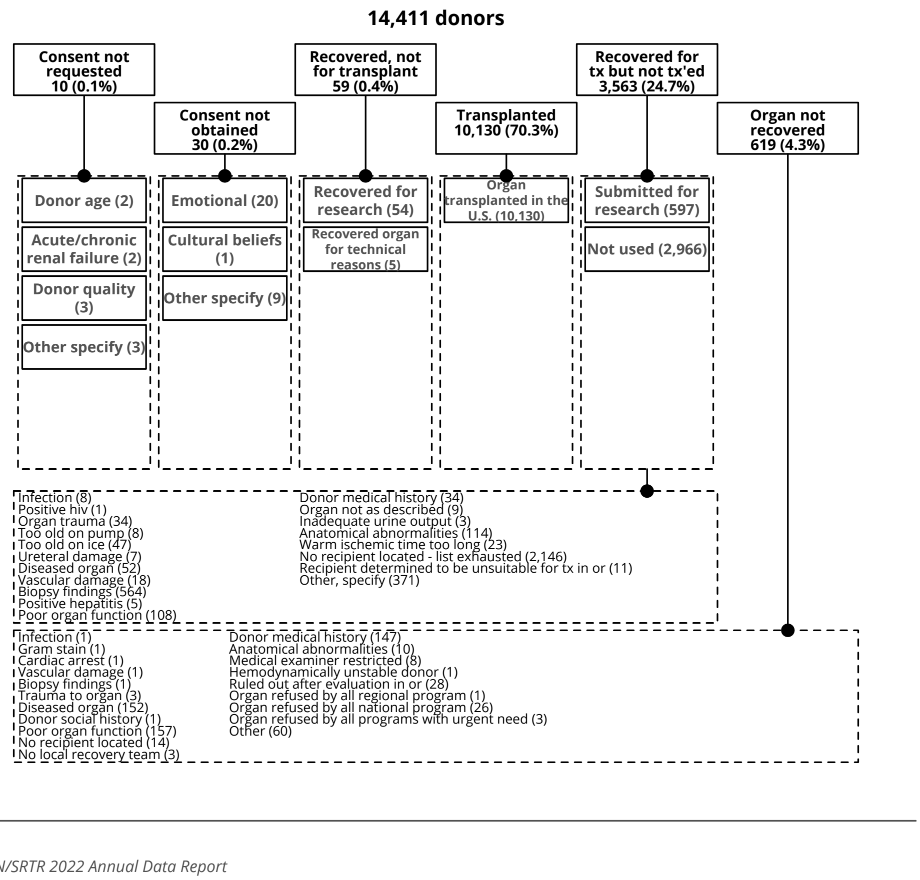
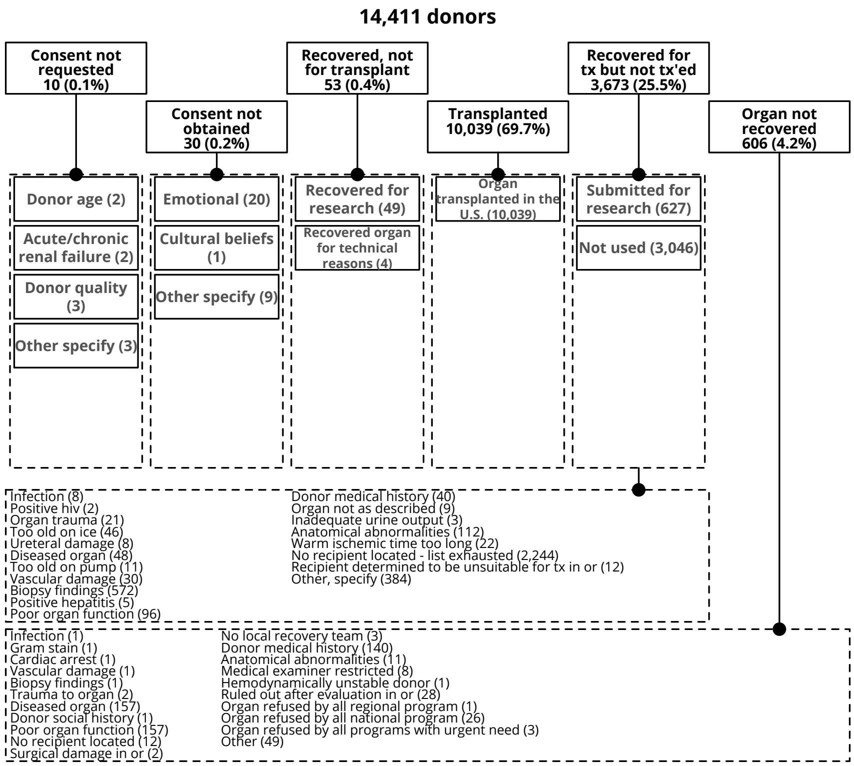
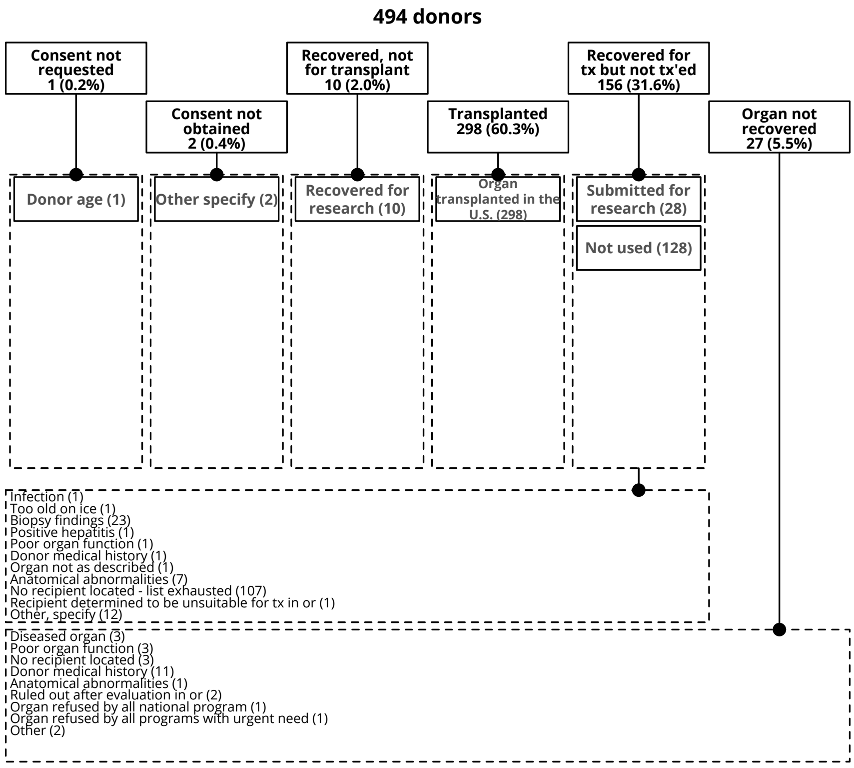


Figure DD 21: Organ use chart for reported left kidneys, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated left kidneys. The number of left and right kidneys may not equal the total number of donors. "Local" transplant or nonuse occurred within the donation service area of the donor organ, and "shared" occurred outside the donation service area. Tx, transplant.



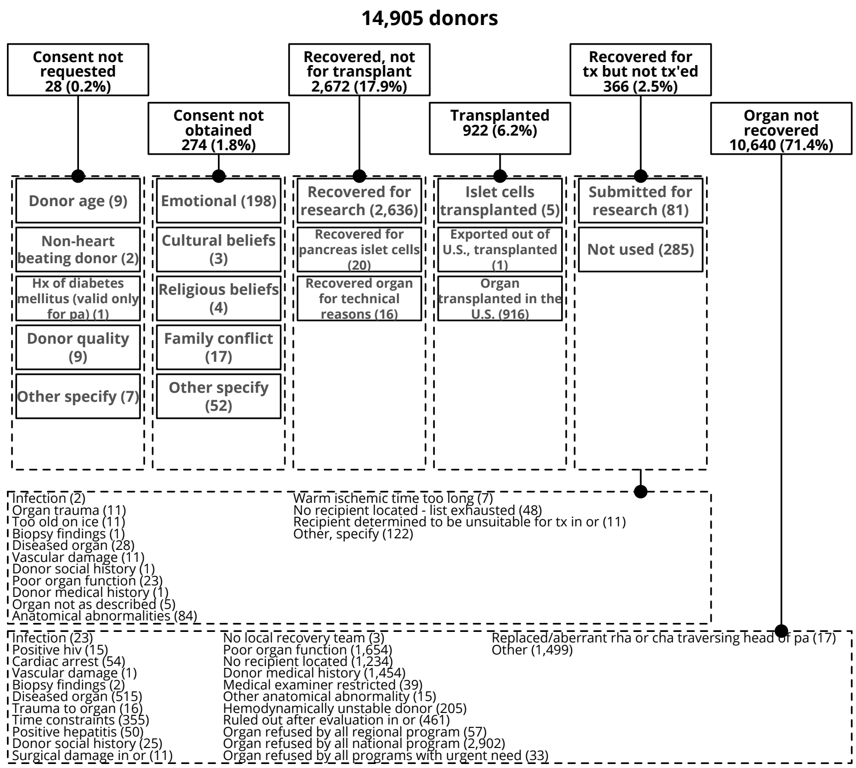
OPTN/SRTR 2022 Annual Data Report

Figure DD 22: Organ use chart for reported right kidneys, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated right kidneys. The number of left and right kidneys may not equal the total number of donors. "Local" transplant or nonuse occurred within the donation service area of the donor organ, and "shared" occurred outside the donation service area. Tx, transplant.



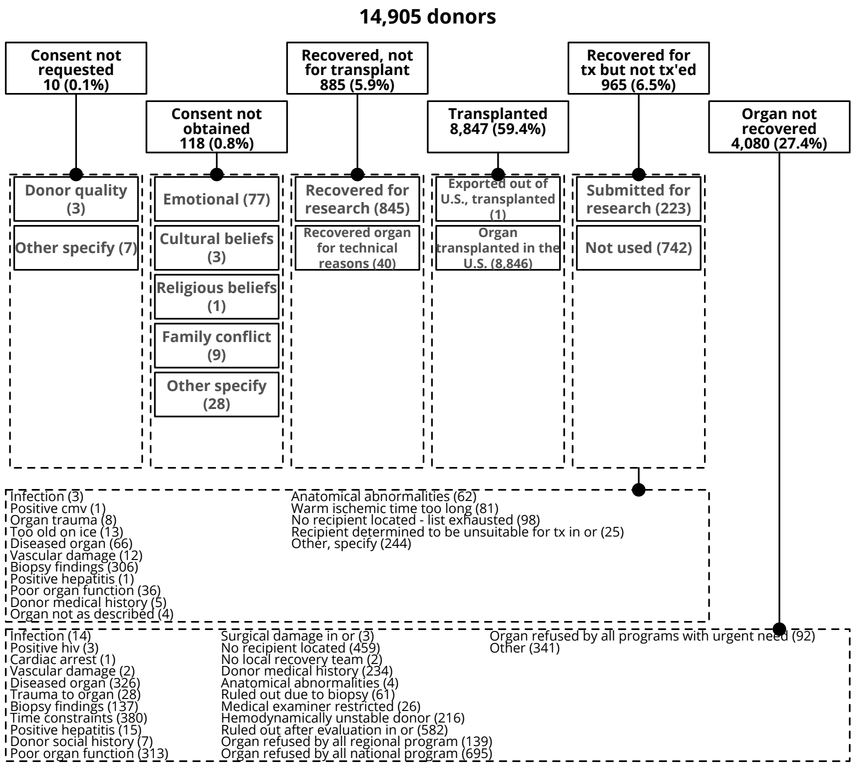
OPTN/SRTR 2022 Annual Data Report

Figure DD 23: Organ use chart for reported en bloc kidneys, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated en bloc kidneys. The number of en bloc kidneys may not equal the total number of donors. “Local” transplant or nonuse occurred within the donation service area of the donor organ, and “shared” occurred outside the donation service area. Tx, transplant.



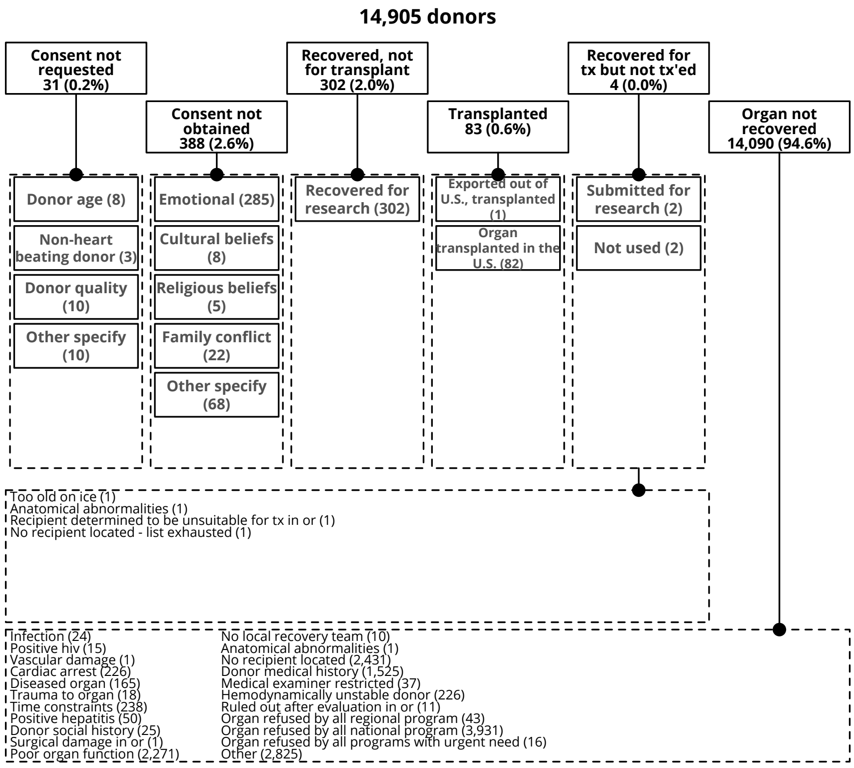
OPTN/SRTR 2022 Annual Data Report

Figure DD 24: Organ use chart for pancreas, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated pancreas. "Local" transplant or nonuse occurred within the donation service area of the donor organ, and "shared" occurred outside the donation service area. cha, common hepatic artery; hx, history; ipda-sma, inferior pancreaticoduodenal artery-superior mesenteric artery; pa, pancreas; rha, right hepatic artery; tx, transplant.



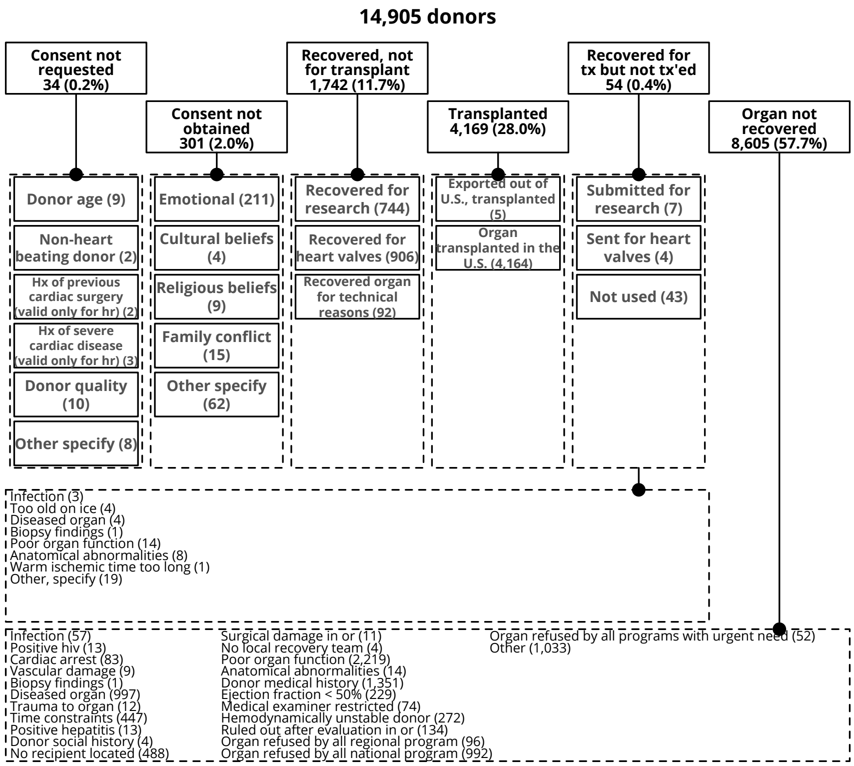
OPTN/SRTR 2022 Annual Data Report

Figure DD 25: Organ use chart for liver, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated livers. "Local" transplant or nonuse occurred within the donation service area of the donor organ, and "shared" occurred outside the donation service area. Tx, transplant.



OPTN/SRTR 2022 Annual Data Report

Figure DD 26: Organ use chart for intestine, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated intestines. “Local” transplant or nonuse occurred within the donation service area of the donor organ, and “shared” occurred outside the donation service area. Tx, transplant.



OPTN/SRTR 2022 Annual Data Report

Figure DD 27: Organ use chart for heart, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated hearts. “Local” transplant or nonuse occurred within the donation service area of the donor organ, and “shared” occurred outside the donation service area. Hx, history; tx, transplant.

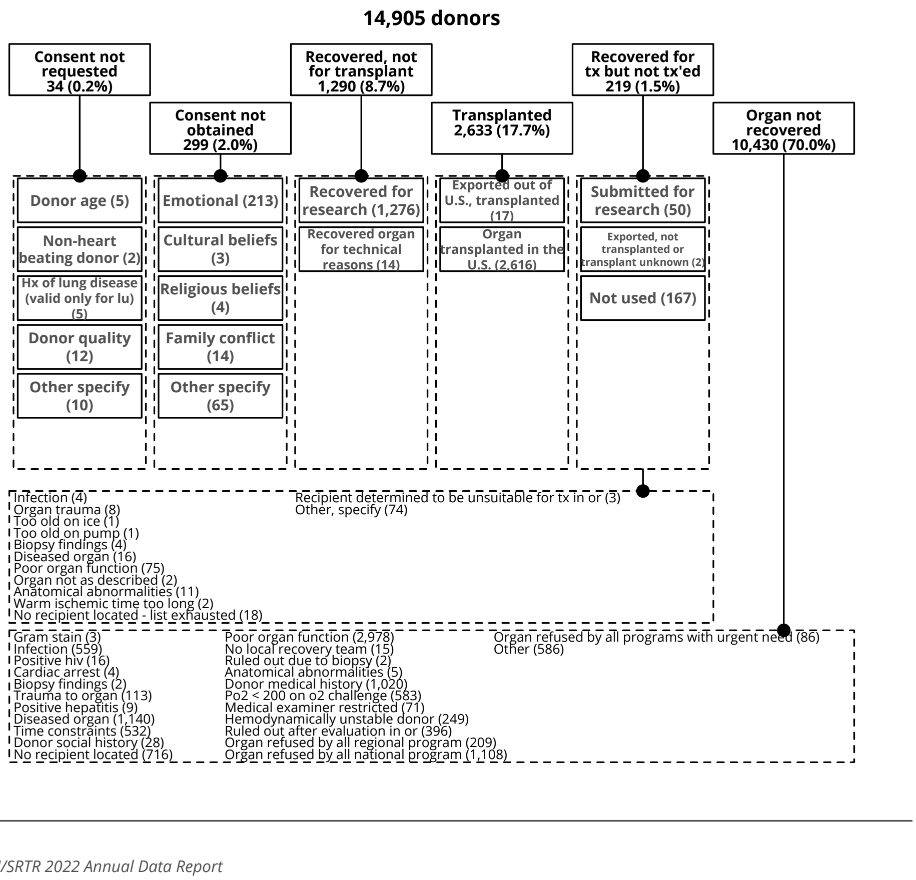


Figure DD 28: Organ use chart for lung, 2022. A summary of the consent, recovered, transplanted, or nonuse status for donated lungs. “Local” transplant or nonuse occurred within the donation service area of the donor organ, and “shared” occurred outside the donation service area. Hx, history; tx, transplant.

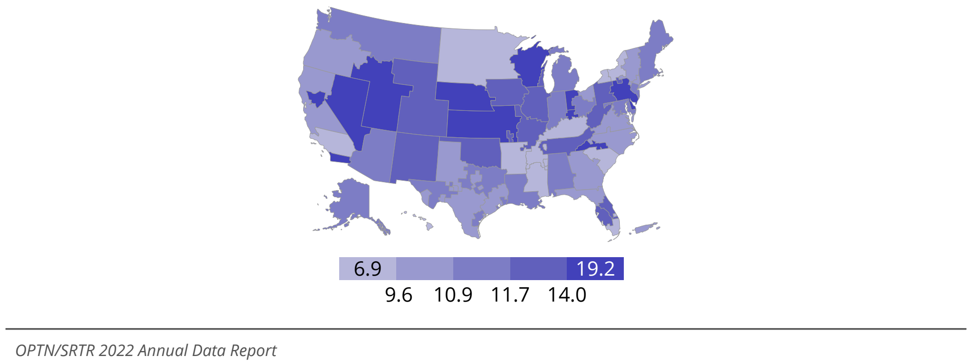


Figure DD 29: CMS Defined Donation Rate across DSAs, 2021. Donation rate as defined by new CMS criteria. CMS, Centers for Medicare & Medicaid Services; DSA, donation service area.

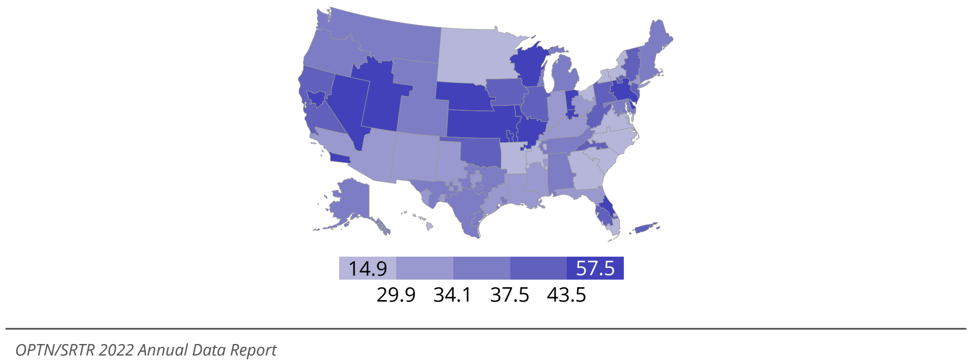
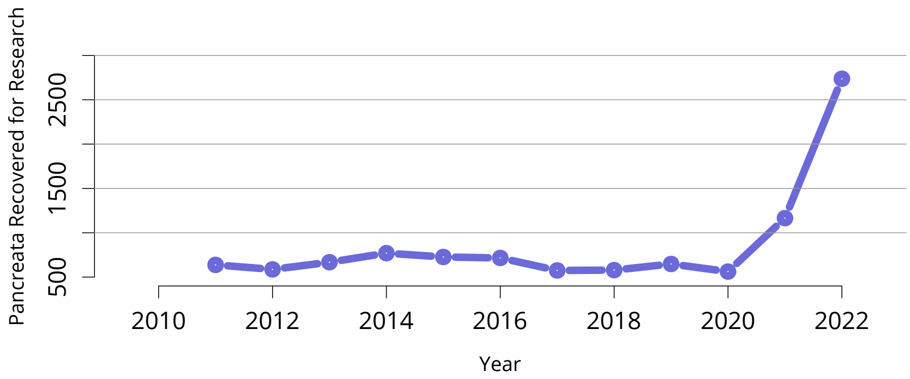
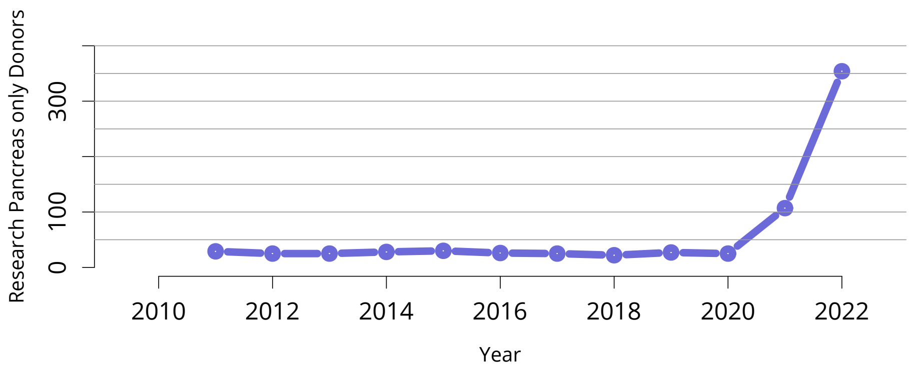


Figure DD 30: CMS Defined Transplant Rate across DSAs, 2021. Transplant rate as defined by new CMS criteria. CMS, Centers for Medicare & Medicaid Services; DSA, donation service area.



OPTN/SRTR 2022 Annual Data Report

Figure DD 31: Count of pancreata recovered for research by year. Pancreas recovered for research are defined as pancreas recovered not for the purpose of transplant but sent for research.



OPTN/SRTR 2022 Annual Data Report

Figure DD 32: Count of donors with only a pancreas recovered for research by year. Research pancreas only donors are defined as donors from whom only a pancreas was recovered for the purpose of research and no organs were transplanted, though other organs may have been recovered for the purpose of transplant but not transplanted.

Table DD 1: Characteristics of deceased donors, 2012 and 2022. Note: The way citizenship data are collected changed in 2012, so differences may be misleading. DBD, donation after brain death; DCD, donation after circulatory death; HCV, hepatitis C virus; KDPI, kidney donor profile index.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
KDPI				
<20%	1677	20.6	2218	14.9
21-34%	1035	12.7	1846	12.4
35-85%	3972	48.8	7724	51.8
>85%	1459	17.9	3117	20.9
HIV				
Not Positive	0	0	14880	99.8
Positive	0	0	25	0.2
HCV				
Not Positive	7808	95.9	14072	94.4
Positive	335	4.1	833	5.6
Citizenship				
US	7864	96.6	13660	91.6
Non-US	274	3.4	380	2.5
Other/unknown	5	0.1	865	5.8
Sex				
Female	3323	40.8	5603	37.6
Male	4820	59.2	9302	62.4
Age				
<18 years	852	10.5	947	6.4
18-34 years	2335	28.7	3718	24.9
35-49 years	2132	26.2	4448	29.8
50-64 years	2250	27.6	4652	31.2
>=65 years	574	7	1140	7.6
Ethnicity				
Non-Latino/unknown	7032	86.4	12692	85.2
Latino	1111	13.6	2213	14.8
Race				
Asian	219	2.7	388	2.6
Black	1445	17.7	2400	16.1
White	6415	78.8	11891	79.8
Other/unknown	64	0.8	226	1.5
DCD status				
DBD	7036	86.4	10127	67.9
DCD	1107	13.6	4778	32.1

Table DD 2: Characteristics of deceased donors, 2012 and 2022. Note: CNS, central nervous system; MVA, motor vehicle accident; SIDS, sudden infant death syndrome.

	2012		2022	
Characteristic	**N**	**Percent**	**N**	**Percent**
Mechanism of Death				
Drowning	99	1.2	141	0.9
Seizure	86	1.1	160	1.1
Drug Intoxication	440	5.4	2485	16.7
Asphyxiation	366	4.5	683	4.6
Cardiovascular	1275	15.7	3055	20.5
Electrical	4	0	5	0
Gunshot Wound	766	9.4	961	6.4
Stab	19	0.2	24	0.2
Blunt Injury	1781	21.9	2369	15.9
SIDS	7	0.1	9	0.1
Stroke	2912	35.8	3774	25.3
Natural Causes	195	2.4	903	6.1
Other/unknown	193	2.4	336	2.3
Circumstance of Death				
MVA	1266	15.5	1629	10.9
Suicide	753	9.2	1100	7.4
Homicide	456	5.6	483	3.2
Child-Abuse	90	1.1	49	0.3
Non-MVA	806	9.9	2880	19.3
Natural Causes	3668	45	7096	47.6
Other/unknown	1104	13.6	1668	11.2
Cause of Death				
Anoxia	2436	29.9	7157	48
Stroke	2833	34.8	3688	24.7
Head Trauma	2628	32.3	3332	22.4
CNS Tumor	41	0.5	49	0.3
Other/unknown	205	2.5	679	4.6

Table DD 3: CMS Eligible Donor Funnel. Patient deaths determined from CDC county-level mortality datafiles used to determine eligible donors. CDC, Centers for Disease Control and Prevention; CMS, Centers for Medicare & Medicaid Services; OPO, organ procurement organization. Organ procurement organization abbreviation expansions can be found online here: https://www.srtr.org/reports/opo-specific-reports/

OPO	CDC Total Deaths	Total Referrals	CDC Inpatient Deaths <= 75 years	CMS Potential Donors	CMS Donors	CMS Donation Rate	CMS Transplant Rate
OPO							
ALOB	67347	30014	15522	1924	213	11.07068607	36.46310727
AROR	34913	14358	7456	1082	101	9.317343173	28.66670287
AZOB	82488	29465	16691	2469	288	11.66464156	32.57055442
CADN	112578	43135	21282	3343	364	10.88842357	37.84983629
CAGS	29971	11497	5086	898	142	15.79532814	45.4387134
CAOP	171330	73018	38719	5667	527	9.299452973	32.41487355
CASD	28854	11994	5166	863	128	14.83198146	43.51303002
CORS	54473	16524	9434	1497	209	13.96125585	35.10253706
FLFH	51901	21317	9473	1637	219	13.37813073	44.45747709
FLMP	73408	31571	14058	2466	169	6.853203569	20.82010464
FLUF	57946	25253	12374	2043	213	10.42584435	33.4910518
FLWC	81572	32277	14900	2437	308	12.63848995	39.2391213
GALL	114251	50368	25714	3404	343	10.07638073	28.95453755
HIOP	12880	4936	2171	495	42	8.484848485	14.94949495
IAOP	33619	12002	5135	972	128	13.14168378	42.12082425
ILIP	114505	48160	21361	3676	438	11.92485707	39.33623618
INOP	68694	30666	13377	2435	276	11.33470226	34.08850542
KYDA	62789	29913	14521	2039	189	9.264705882	33.30466871
LAOP	57499	22660	12155	2054	233	11.34371957	31.03850365
MAOB	143817	59760	23112	3712	405	10.91056035	34.95178963
MDPC	42421	14708	6835	1222	140	11.45662848	34.10020006
MIOP	114337	58539	21517	3307	366	11.06074343	36.87614126
MNOP	69977	24090	11557	2002	183	9.145427286	29.51701048
MOMA	59708	24573	11764	1821	246	13.51648352	47.20830927
MSOP	32790	14089	7353	1163	101	8.684436801	32.62249044
MWOB	63371	24053	11268	1815	316	17.41046832	53.55123137
NCCM	32343	13941	6905	1059	153	14.44759207	43.47310574
NCNC	87860	35534	17197	2664	265	9.947447447	29.7525653
NEOR	19480	7139	3456	574	94	16.37630662	56.1357844
NJTO	64962	35379	12702	1811	211	11.56798246	41.83678701
NMOP	24604	8677	4890	620	83	13.38709677	31.58061753
NVLV	25554	10197	5854	1003	160	15.95214357	51.07003375
NYAP	30861	11255	4656	727	71	9.793103448	38.04823455
NYFL	27022	11839	4769	774	64	8.258064516	25.56566134
NYRT	107727	56461	24194	3523	339	9.617021277	33.70901221
NYWN	18561	7792	3317	504	43	8.531746032	24.05381685
OHLB	57469	21541	10456	1678	163	9.713945173	29.89451806
OHLC	28798	10720	4926	779	149	19.20103093	57.48170533
OHLP	41916	17145	9014	1466	162	11.02040816	30.77808904
OHOV	25565	8677	4527	660	99	15	47.20414419
OKOP	49150	21367	10492	1646	200	12.15066829	38.89072031
ORUO	59868	19713	9711	1715	182	10.6122449	37.33562973
PADV	129219	48605	23021	3765	632	16.84434968	47.05333621
PATF	78541	30937	14814	2233	285	12.75167785	41.13386845
PRLL	34027	17876	6964	974	103	10.57494867	38.58187017
SCOP	62079	24061	13471	2151	189	8.786610879	22.79165061
TNDS	83527	39374	18611	3277	386	11.77547285	37.49183375
TNMS	25005	12439	5941	941	77	8.182784272	24.62966264
TXGC	101439	48678	26473	4031	391	9.699826346	30.28089281
TXSA	66784	28946	16853	2321	238	10.24096386	36.37655833
TXSB	103628	35785	25289	3503	398	11.36818052	36.41994798
UTOP	30591	8353	5159	878	169	19.24829157	43.93058674
VATB	67358	28251	13653	2170	209	9.631336406	29.16432903
WALC	84949	33232	15958	2747	307	11.17989803	34.92815881
WIDN	25406	9108	4271	810	100	12.37623762	36.18487154
WIUW	37113	12264	5429	1054	155	14.63644948	53.06355878

OPTN/SRTR 2022 Annual Data Report: COVID-19

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Abstract

This chapter updates the COVID-19 chapter from the 2021 Annual Data Report with trends through November 12, 2022, and introduces trends in recovery and use of organs from donors with a positive COVID-19 test. Posttransplant mortality and graft failure, which remained a concern in all organs at the last report due to the Omicron variant wave, have returned to lower levels in the most recent available data through November 2022. Use of organs from donors with a positive COVID-19 test has grown, particularly after the first year of the pandemic. Mortality due to COVID-19 should continue to be monitored, but most other measures have sustained their recovery and may now be responding more to changes in policy than to ongoing concerns with COVID-19.

Keywords: COVID-19, solid organ transplant, transplant outcomes, waitlist mortality

1 Introduction

The COVID-19 pandemic has now continued for more than 3 years. While the most dramatic disruptions to transplant activity happened in the first months of the pandemic,[1,2,3,4] the effects of COVID-19 on the US transplantation system are ongoing. This chapter updates the COVID-19 chapter from the *OPTN/SRTR 2021 Annual Data Report*[5] with trends through November 12, 2022 (the most recently available complete data). SRTR continues to maintain an online app that is now updated quarterly and tracks these metrics, as well as more detailed subgroup and adjusted analyses, at https://www.srtr.org/tools/covid-19-evaluation.

The previous (2021) Annual Data Report presented monthly trends before and after the March 13, 2020, declaration of a national emergency through February 12, 2022. The previous report detailed the trends under the Delta variant (months 17 and 18 after the national emergency declaration: August 13, 2021, through October 12, 2021) and Omicron variant (months 21 and 22 after the national emergency declaration: December 13, 2021, through February 12, 2022). This current report describes trends after the subsidence of the Omicron variant wave, during the summer and fall months of 2022 when vaccines became available for every age group, including children younger than 5 years. This current report adds trends in use of organs from donors with a positive COVID-19 test that have not been reported previously.

2 Kidney

2.1 Waiting List

The number of prevalent kidney listings, which decreased by almost 5,000 in the first year of the pandemic, remained low. There were 104,647 candidates listed for kidney transplant in the month before the onset of the pandemic (February 13, 2021, through March 12, 2021), and there were 99,637 candidates listed for kidney transplant in the most recent month for which data are available (October 13, 2022, through November 12, 2022) (Figure COV 1). The numbers of new adult kidney candidates added to the waiting list each month for the most recent available year of data (November 13, 2021, through November 12, 2022) were similar (average 3,665 adult candidates added per month) to the numbers added each month in the 12 months before the pandemic (average 3,608 adult candidates added per month) (Figure COV 2).

Adult waitlist mortality rates, including active and inactive candidates, from March 13, 2022, through November 12, 2022, did not show any spike like those that correlated to the Delta variant wave and Omicron variant wave (Figure COV 8). However, average monthly adult waitlist mortality rates for the most recent year of available data are higher (6.8 deaths per 100 patient-years) than in the year prior to the pandemic (4.8 deaths per 100 patient-years). Monthly COVID-19–specific cause of death rates from March 13, 2022, through November 12, 2022, reached some of the lowest levels since the onset of the pandemic, dropping as low as 0.01 COVID-19 deaths per 100 patient-years (Figure COV 9). Following an increase in overall waitlist mortality rates for pediatric candidates during the Delta variant wave, pediatric waitlist mortality rates from March 13, 2022, through November 12, 2022, were not noticeably different from rates during the year prior to the pandemic (Figure COV 8).

Geographically, all regions of the US experienced higher kidney waitlist mortality from COVID-19 during waves of the pandemic. Notably, though, the Northeast US experienced a higher waitlist mortality rate during the first months of the pandemic than other regions, and the Southwest US experienced a higher waitlist mortality rate during the winter 2020-2021 wave of the pandemic than other regions (Figure COV 10).

2.2 Transplant Rates

Living donor transplant rates decreased from an average monthly rate of 6.5 transplants per 100 patient-years for adults (17.0 for pediatric) in the 12 months prior to the pandemic to 4.8 transplants per 100 patient-years for adults (14.4 for pediatric) in the 12 months following the onset of the pandemic. For the most recent year of data available (November 13, 2021, through November 12, 2022), average monthly transplant rates for adults (5.9 transplants per 100 patient-years) were only slightly lower than average rates in the 12 months prior to the pandemic (6.5 transplants per 100 patient-years), while transplant rates for pediatrics (13.7 transplants per 100 patient-years) remained lower than the 12 months prior to the pandemic (17.0 transplants per 100 patient-years) (Figure COV 4).

Deceased donor transplant rates for adult candidates, which did not decrease notably in the 12 months following the onset of the pandemic compared with the 12 months prior to the pandemic, were higher from November 13, 2021, through November 12, 2022 (average rate 20.3 transplants per 100 patient-years) than for the year prior to the pandemic (average rate 18.0 transplants per 100 patient-years), while average monthly pediatric transplant rates were slightly lower for the most recent year (36.1 transplants per 100 patient-years) than in the year prior to the pandemic (38.4 transplants per 100 patient-years) (Figure COV 3).

Geographically, while transplant rates in all US regions were lower in the first months of the pandemic than in the following months, after the first months of the pandemic, transplant rates rose in all regions and did not change notably through the following months (Figure COV 5).

2.3 Offers

The number of kidney offers made remained substantially higher compared with the year before the start of the pandemic (Figure COV 6) and the unadjusted offer acceptance rate remained substantially lower (Figure COV 7) in the most recent year of data. However, as noted in the previous (2021) Annual Data Report, these changes correspond with the implementation of the 250–nautical-mile circle kidney allocation policy on March 15, 2021, which replaced OPO DSA with a 250–nautical-mile circle around the donor hospital as the unit for local allocation.

2.4 Graft Failure

Adult all-cause kidney graft failure rates, among patients who underwent transplant in 2000 or later and were alive and at risk for graft failure in a given month, had peaks during the Delta and Omicron waves. However, from March 13, 2022, through November 12, 2022, these rates remained at or lower than levels from the year prior to the pandemic (Figure COV 11), with correspondingly low rates of COVID-19–specific posttransplant mortality, among patients who underwent transplant at any time and were alive and at risk for graft failure in a given month (Figure COV 12).

Geographically, all regions of the US experienced higher COVID-19–specific posttransplant mortality during waves of the pandemic. Notably, though, the Northeast US experienced a higher COVID-19–specific posttransplant mortality rate during the first months of the pandemic than other regions (Figure COV 13).

3 Pancreas

3.1 Waiting List

The number of prevalent pancreas candidates has continued a gradual increase that started before the pandemic (Figure COV 14). The number of new pancreas candidates added each month in the most recent year of data from November 13, 2021, through November 12, 2022 (monthly average 144 adult and 3 pediatric candidates) was similar to levels in the year before the start of the pandemic (monthly average 151 adult and

3 pediatric) (Figure COV 15). Mortality rates on the pancreas waiting list, including active and inactive candidates, remained similar in the most recent year of data (monthly average 5.5 adult deaths per 100 patient-years) compared with the year prior to the pandemic (monthly average 5.4 adult deaths per 100 patient-years) (Figure COV 18). Only one recorded COVID-19–specific cause of death has occurred among pancreas waitlist candidates, during month 22 after the national emergency declaration.

3.2 Transplant Rates

The pancreas deceased donor transplant rate remained lower in the most recent year of data (monthly average 36.7 adult transplants per 100 patient-years) than in the year before the pandemic (monthly average 44.7 adult transplants per 100 patient-years) (Figure COV 16). Geographically, there were no notable trends in pancreas transplant rates across US regions throughout the months of the pandemic (Figure COV 17).

3.3 Graft Failure

In the most recent year of data, adult pancreas all-cause graft failure, among patients who underwent transplant in 2000 or later and were alive and at risk for graft failure in a given month, was slightly higher (monthly average 6.2 graft failures per 100 patient-years) than in the year prior to the pandemic (monthly average 5.3 graft failures per 100 patient-years) (Figure COV 19). Following the peak in COVID-19–specific deaths among pancreas transplant recipients during the Omicron variant wave, COVID-19–specific deaths have remained at a relatively low rate through November 12, 2022 (Figure COV 20). While pancreas transplant volumes are lower and trends in posttransplant mortality should be interpreted cautiously, there seems to have been a higher posttransplant COVID-19–specific mortality rate in the Northwest US during the Delta variant wave (August 13, 2021 – October 12, 2021) (Figure COV 21).

4 Liver

4.1 Waiting List

An ongoing downward trend in prevalent adult liver listings continued from March 2022 through November 2022 (Figure COV 22). The monthly number of new listings in the most recent year of data from November 13, 2021, through November 12, 2022 (monthly average 1,062 new adult and 64 new pediatric listings) remained similar to levels in the year before the start of the pandemic (monthly average 1,075 new adult and 56 new pediatric listings) (Figure COV 23). Liver waitlist mortality, including active and inactive candidates, was no higher in the most recent year of data (monthly average 13.0 adult candidate deaths per 100 patient-years) than levels in the year before the pandemic (monthly average 13.7 adult candidate deaths per 100 patient-years) (Figure COV 29). Reported COVID-19–specific cause of death, which had shown peaks at previous waves of the pandemic, remained quite low from March 13, 2022, through November 12, 2022 (Figure COV 30). Geographically, all regions of the US experienced higher liver waitlist mortality from COVID-19 during waves of the pandemic. Notably, though, the Southwest US experienced a higher waitlist mortality rate during the winter 2020-2021 wave of the pandemic than other regions (Figure COV 31).

4.2 Transplant Rates

Deceased donor transplant rates (Figure COV 24) and living donor transplant rates (Figure COV 25) were higher in the most recent year of data (monthly average 76.2 adult deceased donor and 4.7 adult living donor transplants per 100 patient-years) as compared to the year prior to the start of the pandemic (monthly average 62.9 adult deceased donor and 3.6 adult living donor transplants per 100 patient-years). Numbers of liver offers in the most recent year of data (monthly average 24,426 liver offers to adult candidates) remained higher than levels in the year before the pandemic (monthly average 14,726 liver offers to adult candidates) (Figure COV 27), and unadjusted offer acceptance rates remained lower than levels before the pandemic (Figure COV 28); these trends are likely due to implementation of the liver acuity circle allocation policy in February 2020. Geographically, while liver transplant rates in all US regions were lower in the first months of the pandemic than in the following months, after the first months of the pandemic, transplant rates rose in all regions and did not change notably through the following months (Figure COV 26).

4.3 Graft Failure

Liver all-cause graft failure, among patients who underwent transplant in 2000 or later and were alive and at risk for graft failure in a given month, which reached a high point during the Omicron variant wave, returned to a lower level from March 13, 2022, through November 12, 2022 (Figure COV 32). The COVID-19–specific cause of death rate among liver recipients also reached its lowest levels, with monthly rates as low as 0.03 COVID-19 deaths per 100 patient-years, from March 13, 2022, through November 12, 2022 (Figure COV 33). Geographically, all regions of the US experienced higher COVID-19–specific posttransplant mortality during waves of the pandemic (Figure COV 34).

5 Intestine

Small numbers of patients receiving or waiting for an intestine transplant led to high month-to-month variability in metrics, making it difficult to detect any trends related to the pandemic (Figure COV 35, Figure COV 36, Figure COV 37, Figure COV 38, and Figure COV 39). The decrease in the number of prevalent pediatric candidates and increase in the number of prevalent adult candidates during the pandemic noted in the previous (2021) Annual Data Report continued from March 2022 through November 2022 (Figure COV 35).

6 Lung

6.1 Waiting List

The number of prevalent lung listings in the most recent year of data (monthly average 1,317 adult and 31 pediatric candidates) remained lower than in the year before the start of the pandemic (monthly average 1,700 adult and 42 pediatric candidates) (Figure COV 40). The number of new lung listings per month in the most recent year of data (monthly average 264 adult and 4 pediatric candidates) was similar to the year before the start of the pandemic (monthly average 270 adult and 6 pediatric candidates) (Figure COV 41). There was no noticeable trend in unadjusted offer acceptance rates (Figure COV 45).

Rates of overall lung waitlist mortality, including active and inactive candidates, have not been substantially higher after the start of the pandemic (Figure COV 46), and while there have been deaths due to COVID-19 among lung waitlist candidates, there have been very few COVID-19 deaths in lung candidates since March 13, 2022, following the Omicron variant wave (Figure COV 47). Geographically, most regions of the US experienced higher COVID-19–specific waitlist mortality during waves of the pandemic (Figure COV 48).

6.2 Transplant Rate

The lung transplant rate continued an upward trend in the most recent year of data compared with the year before the start of the pandemic (Figure COV 42). Offer numbers, which lowered notably following the start of the pandemic, returned to and surpassed levels seen in the year before the pandemic in the most recent months of data (Figure COV 44). Geographically, while lung transplant rates in most US regions were lower in the first months of the pandemic than in the following months, after the first months of the pandemic, transplant rates rose in all regions and did not change notably through the following months (Figure COV 43).

6.3 Graft Failure

Following peaks in both all-cause lung graft failure, among patients who underwent transplant in 2000 or later and were alive and at risk for graft failure in a given month, as well as COVID-19–specific cause of posttransplant deaths during the Omicron variant wave, all-cause lung graft failure and COVID-19–specific cause of posttransplant death returned to lower levels from March 13, 2022, through November 12, 2022 (Figure COV 49 and Figure COV 50). Geographically, all regions of the US experienced higher COVID-19–specific posttransplant mortality during waves of the pandemic (Figure COV 51).

7 Heart

7.1 Waiting List

The number of prevalent adult heart listings continued a downward trend that was already apparent in the year before the pandemic, while the prevalent pediatric heart listings continued on an upward trend (Figure COV 52), with a monthly average of 3,747 adult and 466 pediatric candidates waiting in the year before the start of the pandemic and 3,367 adult and 538 pediatric candidates in the most recent year of data (November 13, 2021, through November 12, 2022). The number of new heart listings per month was similar in the most recent year of data (monthly average 363 adult and 60 pediatric candidates) to in the year before the start of the pandemic (monthly average 341 and 58 pediatric candidates) (Figure COV 53). The number of adult heart offer numbers continued an upward trend in the most recent year of data and pediatric offers remained stable (monthly average 4,919 adult and 285 pediatric offers) compared with the year before the pandemic (monthly average 3,833 adult and 299 pediatric offers) (Figure COV 56), with unadjusted adult offer acceptance rates decreasing slightly (Figure COV 57). As with other organs, heart allocation policy was changed recently, with the January 2020 removal of DSA from heart allocation, making it difficult to attribute any changes in listings solely to COVID-19.

There have not been any additional reported heart waitlist COVID-19–specific deaths since the previous report (Figure COV 59), and rates of adult heart waitlist mortality, including active and inactive candidates, have not changed notably after the start of the pandemic; pediatric heart waitlist mortality has continued a downward trend (Figure COV 58). Geographically, most regions of the US experienced higher COVID-19–specific waitlist mortality during waves of the pandemic (Figure COV 60).

7.2 Transplant Rate

The adult heart transplant rate continued an upward trend in the most recent year of data (monthly average 118 transplant per 100 patient-years) compared with the year before the start of the pandemic (monthly average 92 transplants per 100 patient-years), although pediatric transplant rates continued a downward trend (monthly average 103 transplants per 100 patient-years in the most recent year of data; 122 transplants per 100 patient-years in the year before the pandemic) (Figure COV 54). Geographically, heart transplant rates showed notable trends during the months of the pandemic (Figure COV 55).

7.3 Graft Failure

Following high rates of graft failure reported in the months corresponding to the Omicron variant wave noted in the previous report, heart all-cause graft failure rates, among patients who underwent transplant in 2000 or later and were alive and at risk for graft failure in a given month, returned to lower levels from March 13, 2022, through November 12, 2022 (Figure COV 61), and COVID-19–specific cause of death decreased back to lower levels (Figure COV 62). Geographically, all regions of the US experienced higher COVID-19–specific posttransplant mortality during waves of the pandemic (Figure COV 63).

8 Deceased Donor

While organs from donors with a positive COVID-19 test were recovered for transplant as early as the month from May 13 to June 12, 2020, recovery of these organs remained low in the first year of the pandemic. Recovery from donors with a positive COVID-19 test began an upward trend for all organs, but remained low for pancreas and lung, in the second year of the pandemic and showed a distinct peak during the Omicron variant wave, reaching as high as 603 kidneys, 182 livers, and 54 hearts in a month during that wave (Figure COV 64). Nonuse percents were variable, but relatively high for kidneys and livers from donors with a positive COVID-19 test during the early months in which these organs were considered. By the third year of the pandemic, nonuse of organs from donors with a positive COVID-19 test had stabilized and was around 20%-25% for kidneys and 4%-8% for livers (Figure COV 65).

9 Discussion

The previous (2021) Annual Data Report noted that while transplant rates continued to remain at or even slightly above prepandemic levels, deaths due to COVID-19, both pre-transplant and posttransplant, surged at waves of the pandemic.[5] Encouragingly, since the previous report, COVID-19 deaths and overall waitlist mortality and posttransplant all-cause graft failure have returned, for most organs, to levels seen prior to waves of the pandemic. The waves of the pandemic did not hit all parts of the country at exactly the same time, yet limitations in incidence data mean that the scope of the Annual Data Report is restricted to analyzing COVID-19 mortality as reported to the OPTN at relatively large geographic levels.

While it is difficult to disentangle effects of the pandemic from effects related to changes in organ allocation policy, continuing trends in many organs in transplant rates and offer numbers might indicate that the changes in these aspects of the transplant system are continuing to be less influenced by the pandemic and more influenced by recent changes in policy.

Use of organs from donors with a positive COVID-19 test has become more common in the third year of the pandemic, and the nonuse rates for these organs have stabilized from the high rates in the first year of the pandemic.

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This report is available at https://srtr.transplant.hrsa.gov. Individual chapters may be downloaded.

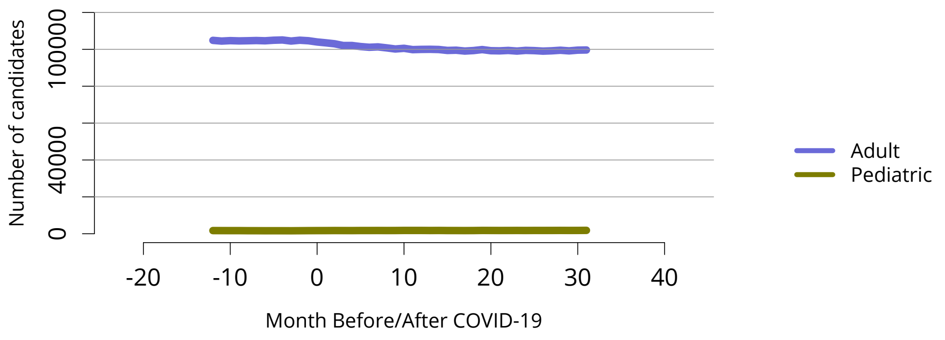

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Figure COV 1: Number of prevalent kidney candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

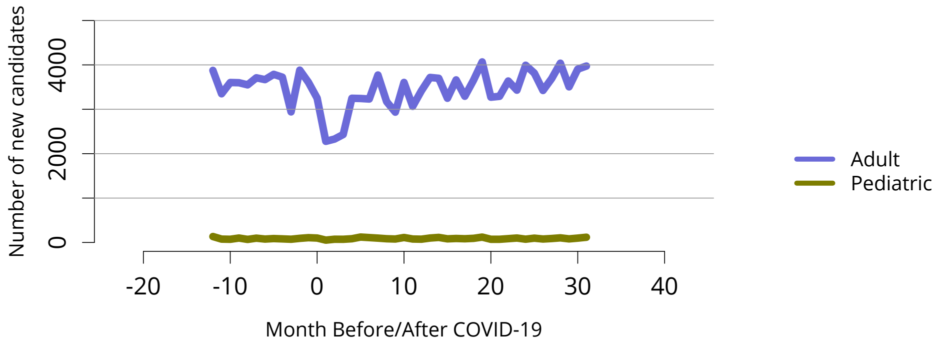

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Figure COV 2: Number of new kidney candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

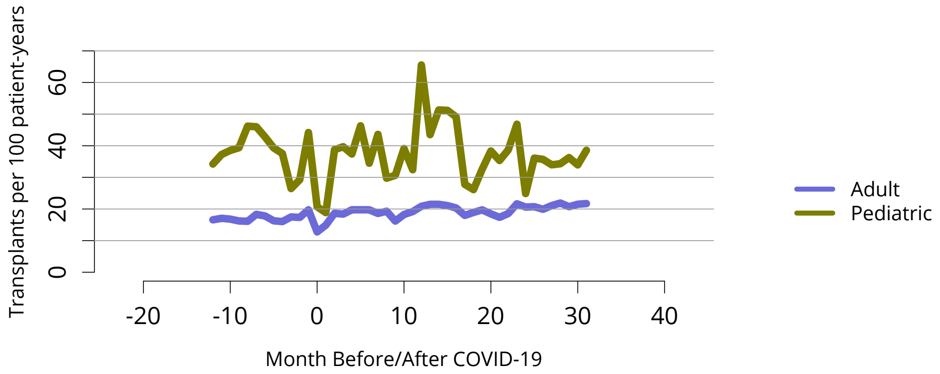

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Figure COV 3: Deceased donor kidney transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.

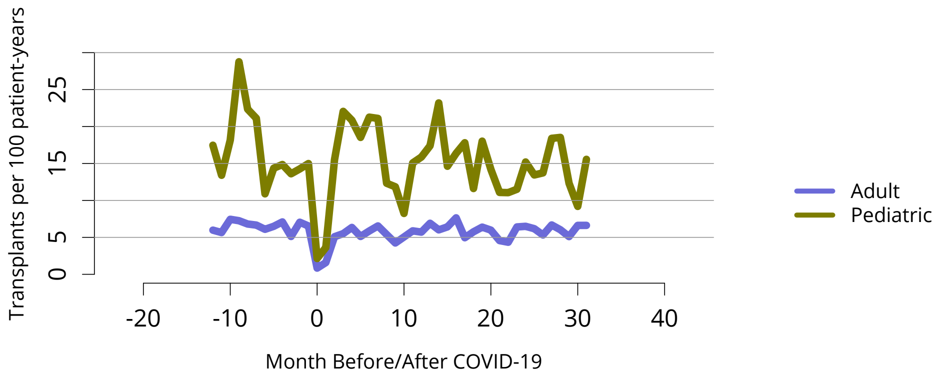

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Figure COV 4: Living donor kidney transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of living donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.

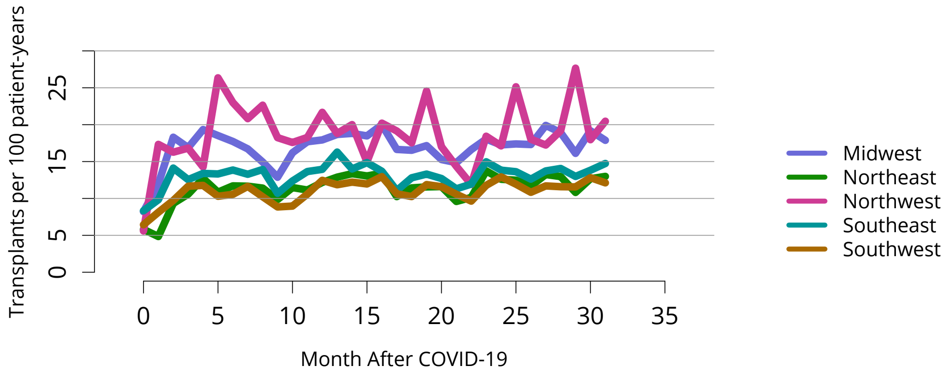

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Figure COV 5: Kidney transplant rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of transplants per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

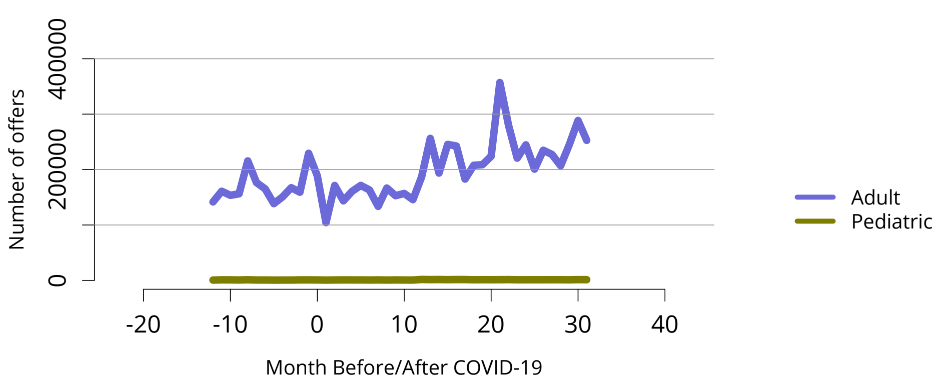

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Figure COV 6: Number of kidney offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

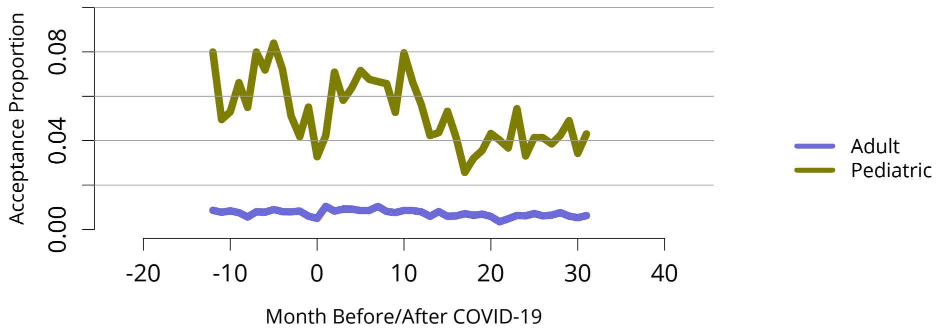

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Figure COV 7: Kidney offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

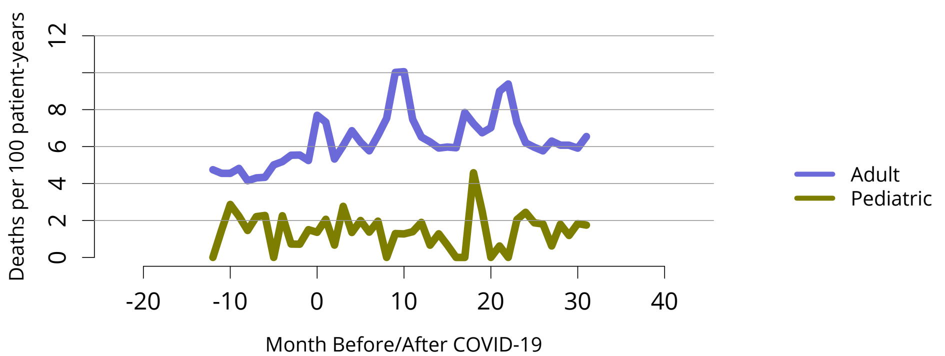

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Figure COV 8: Kidney waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

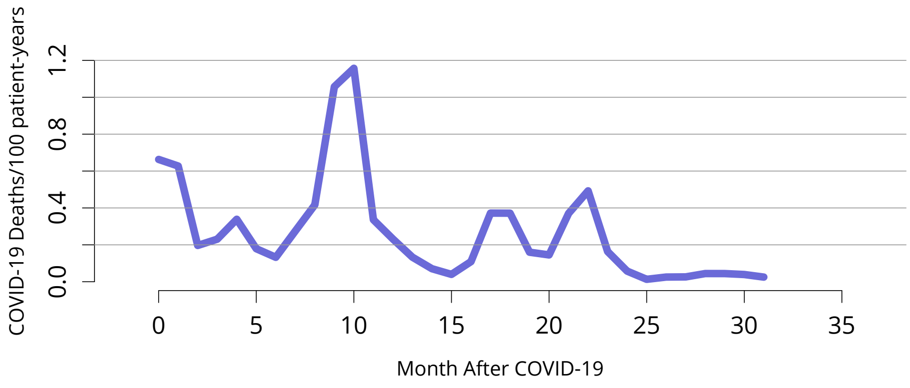

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Figure COV 9: Kidney waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

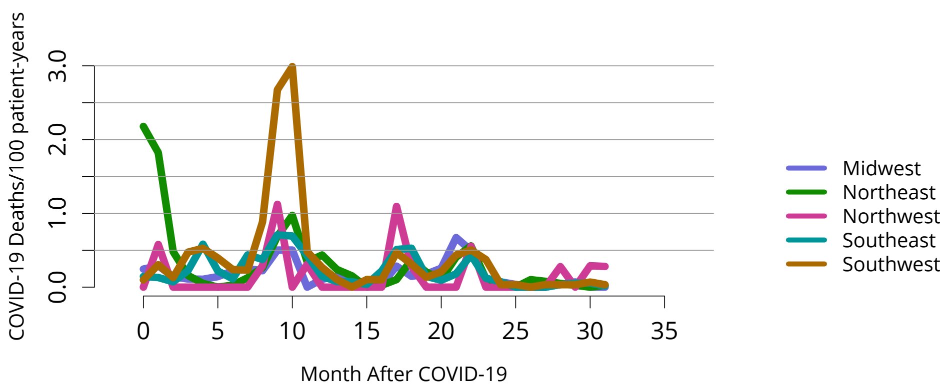

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Figure COV 10: Kidney waitlist COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

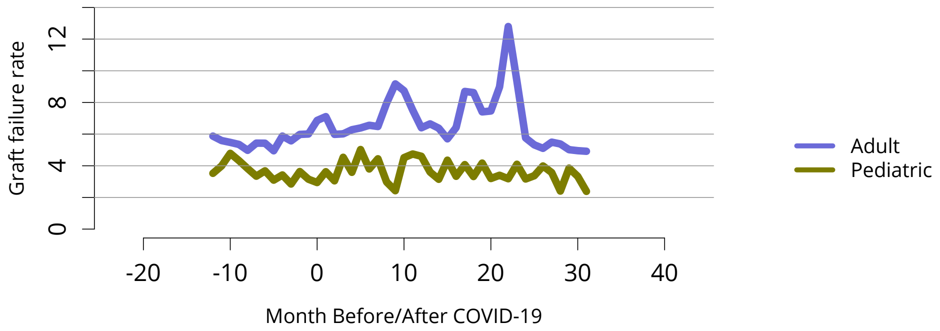

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Figure COV 11: Kidney all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

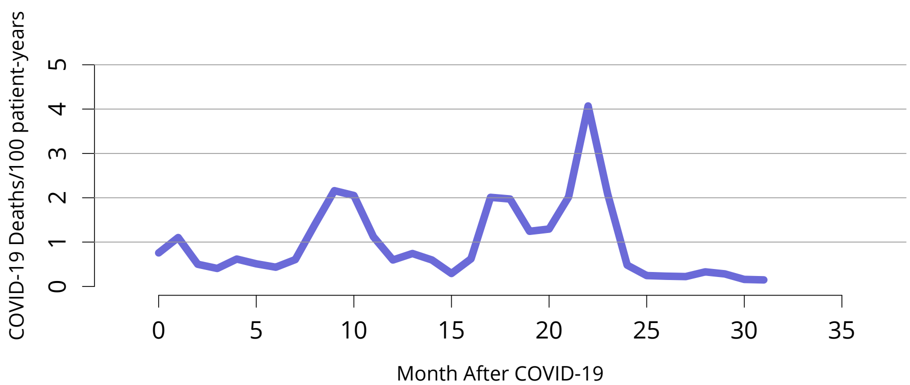

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Figure COV 12: Kidney posttransplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

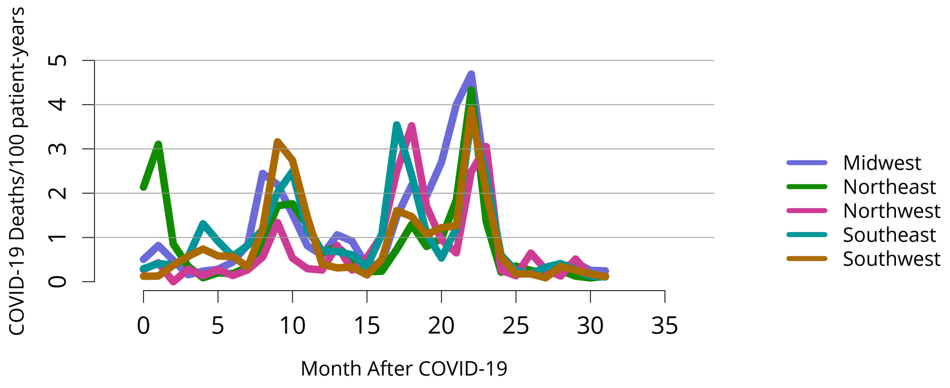

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Figure COV 13: Kidney posttransplant COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

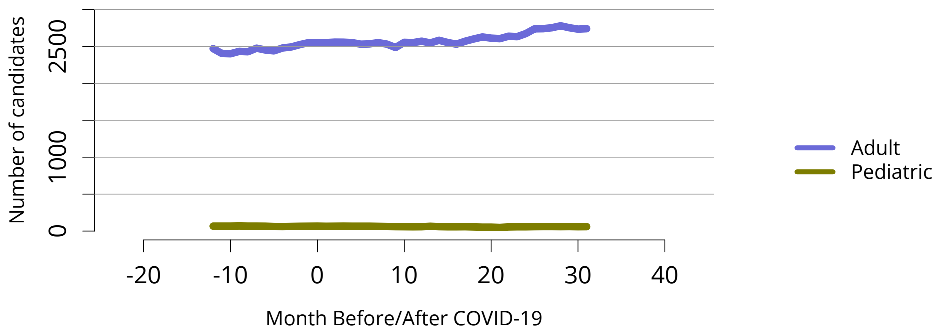

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Figure COV 14: Number of prevalent pancreas candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

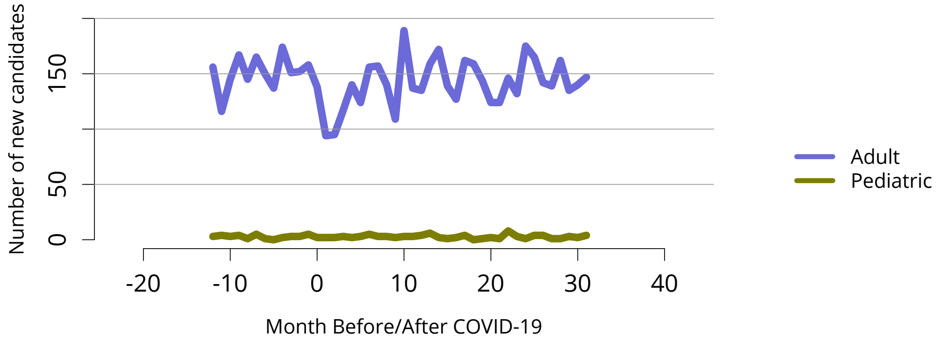

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Figure COV 15: Number of new pancreas candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

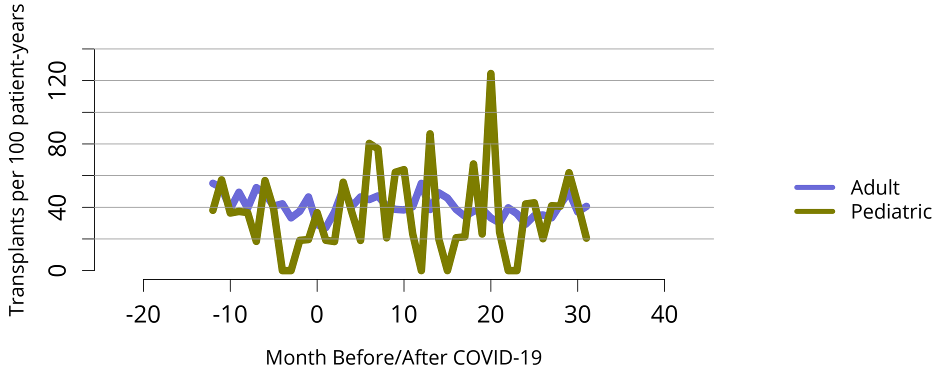

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Figure COV 16: Deceased donor pancreas transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.

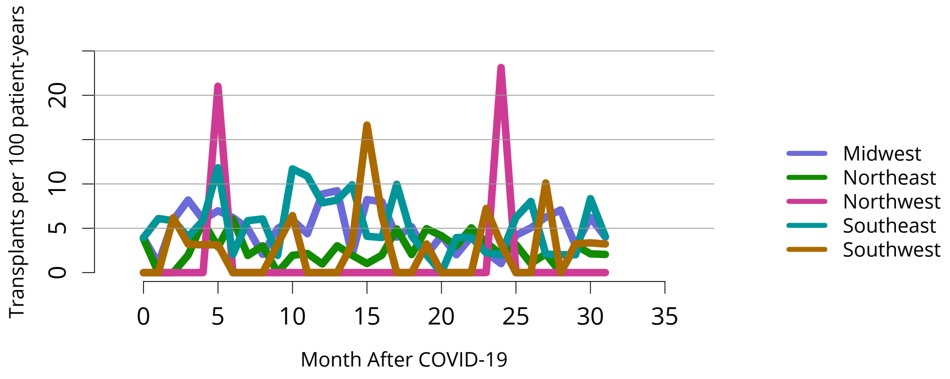

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Figure COV 17: Pancreas transplant rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of transplants per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

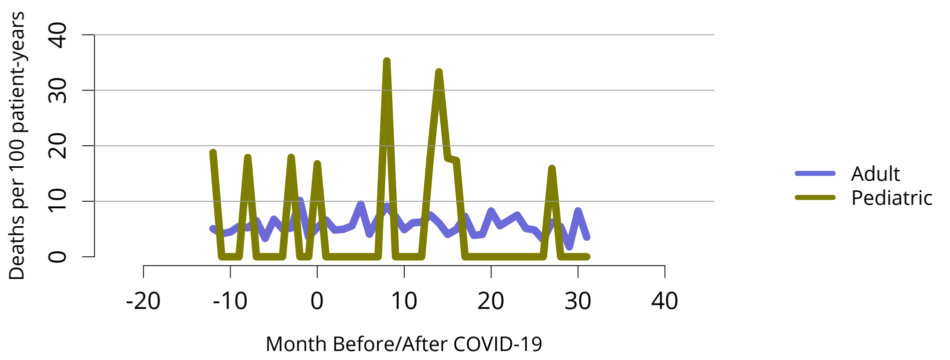

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Figure COV 18: Pancreas waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

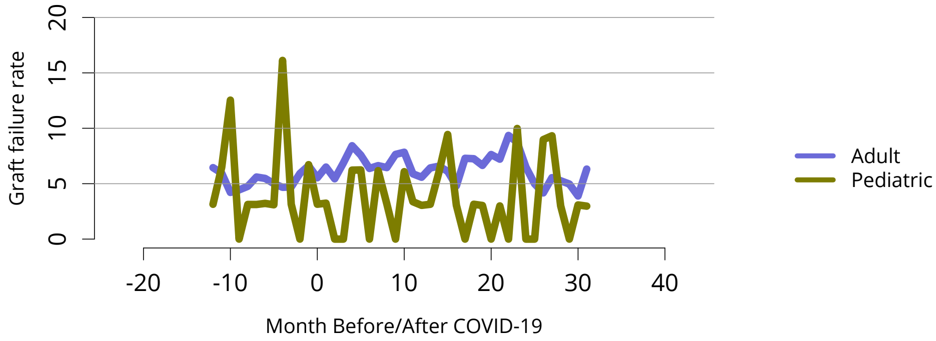

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Figure COV 19: Pancreas all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

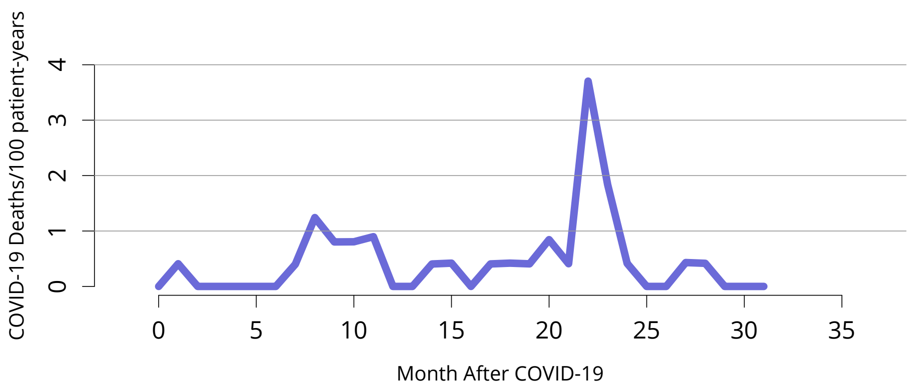

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Figure COV 20: Pancreas posttransplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

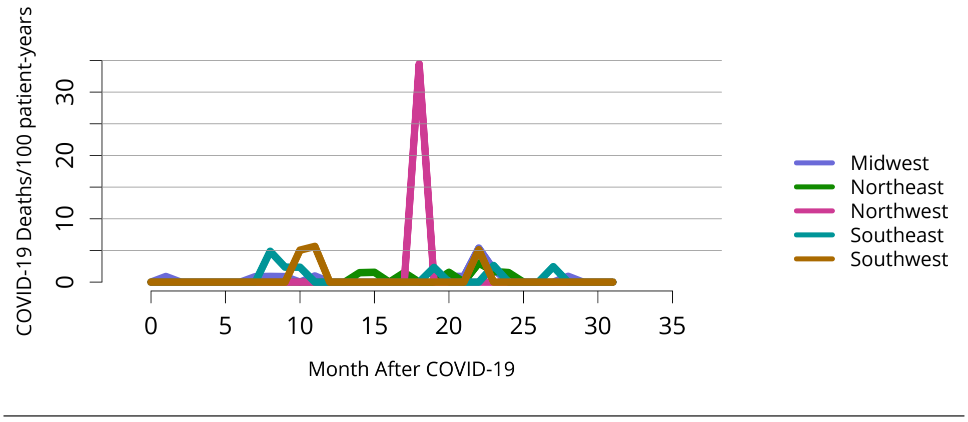


Figure COV 21: Pancreas posttransplant COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

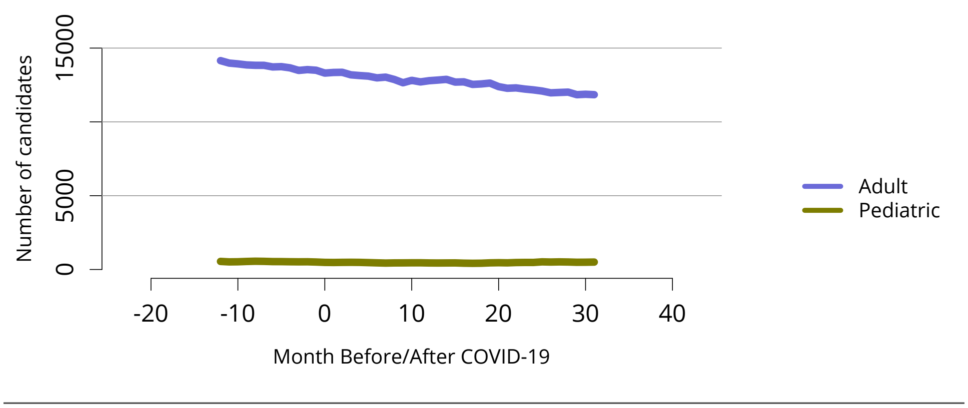
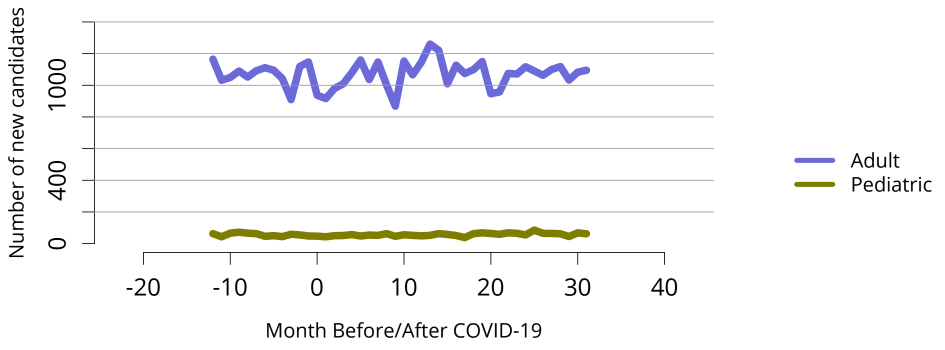
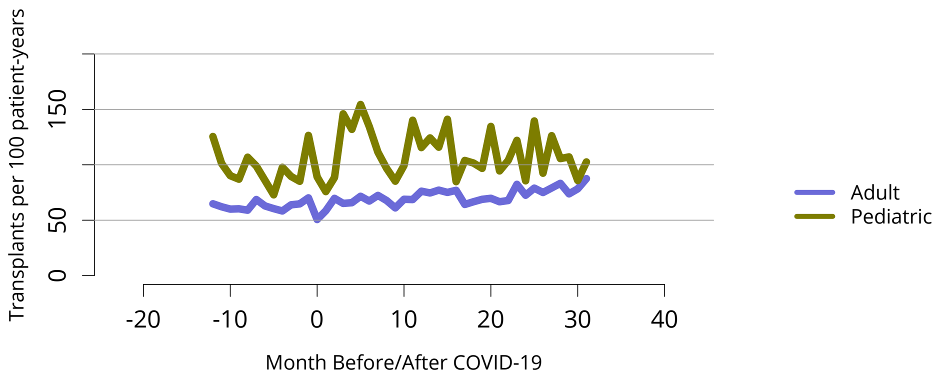


Figure COV 22: Number of prevalent liver candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.



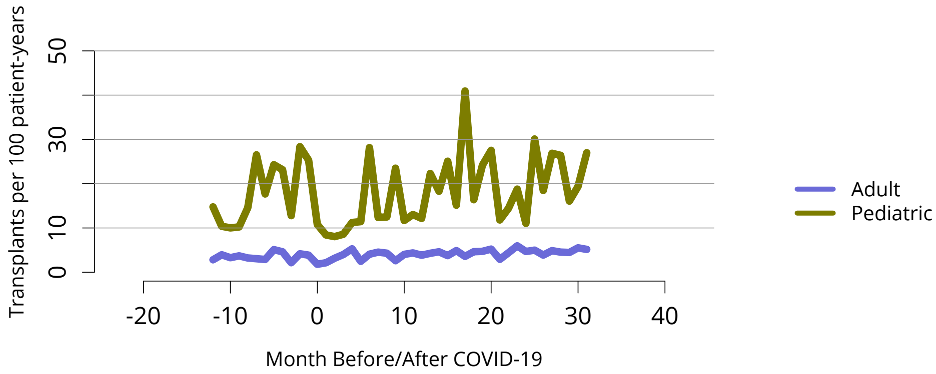
OPTN/SRTR 2022 Annual Data Report

Figure COV 23: Number of new liver candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.



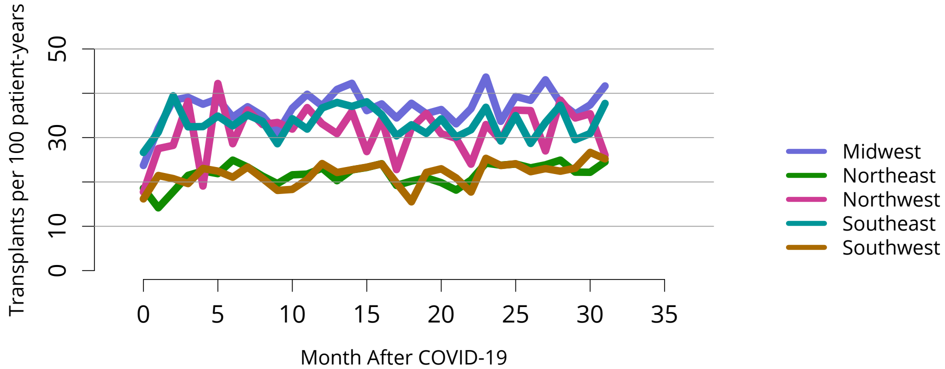
OPTN/SRTR 2022 Annual Data Report

Figure COV 24: Deceased donor liver transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.



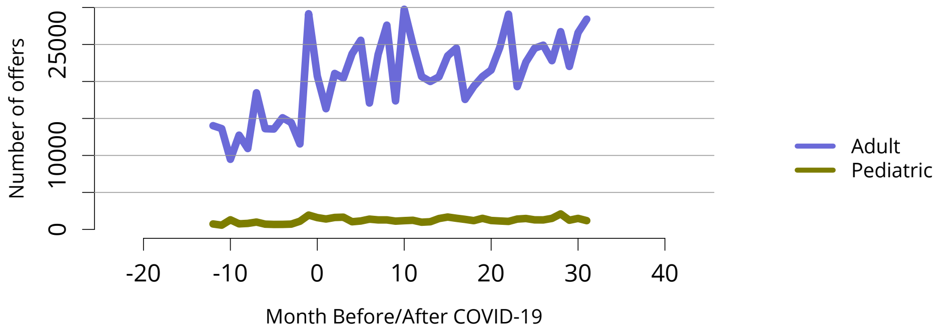
OPTN/SRTR 2022 Annual Data Report

Figure COV 25: Living donor liver transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of living donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.



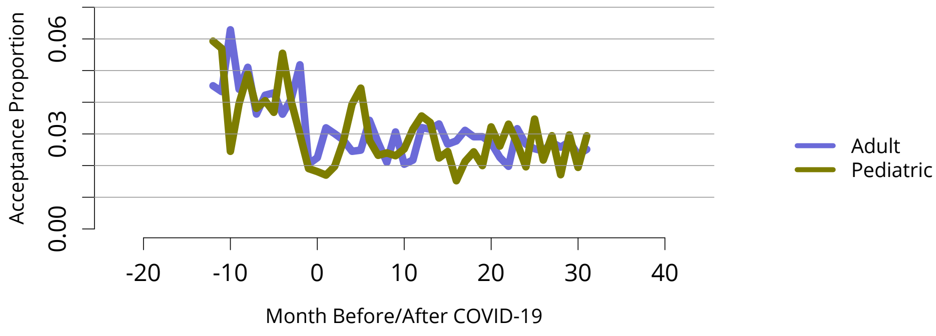
OPTN/SRTR 2022 Annual Data Report

Figure COV 26: Liver transplant rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of transplants per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



OPTN/SRTR 2022 Annual Data Report

Figure COV 27: Number of liver offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



OPTN/SRTR 2022 Annual Data Report

Figure COV 28: Liver offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

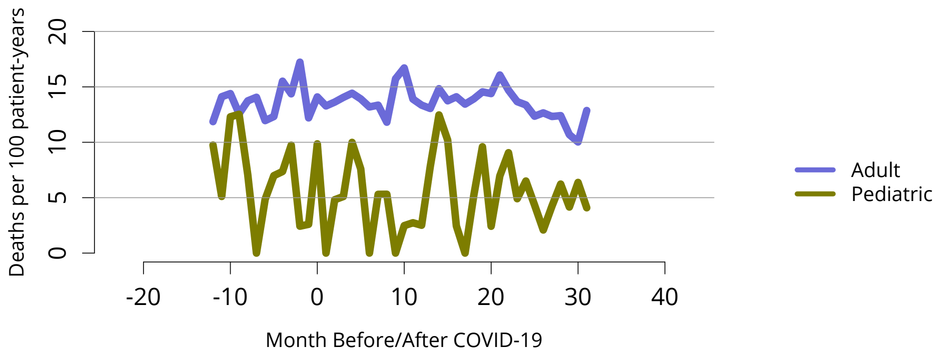


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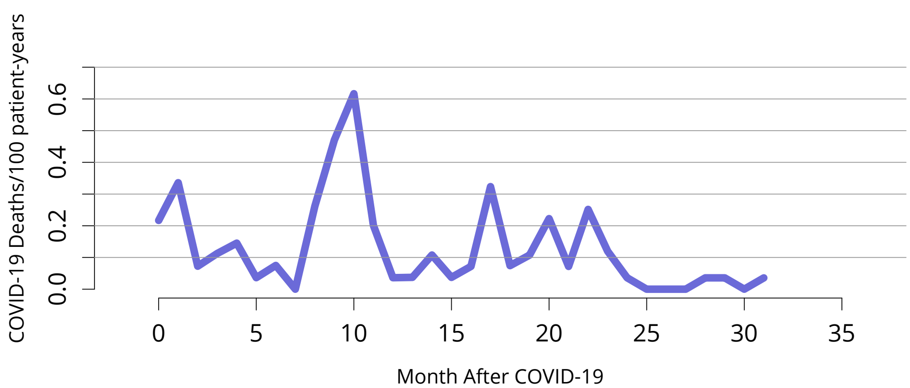
Figure COV 29: Liver waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure COV 30: Liver waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.

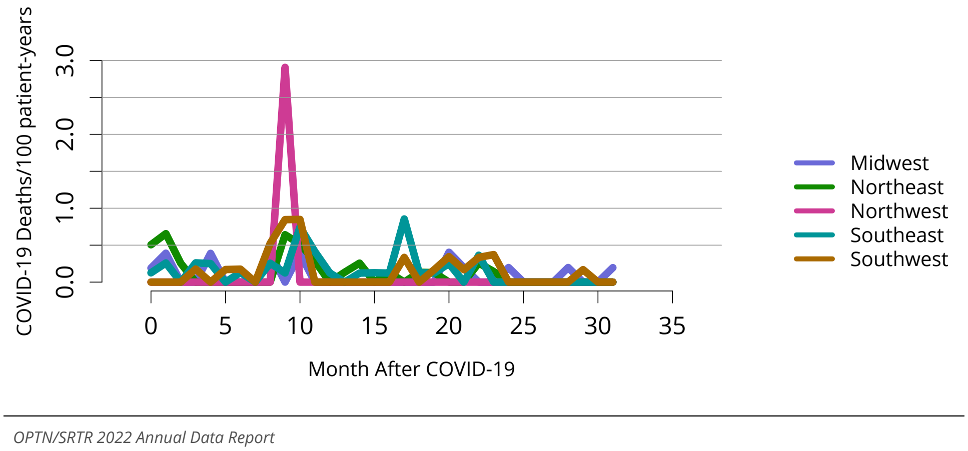


Figure COV 31: Liver waitlist COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

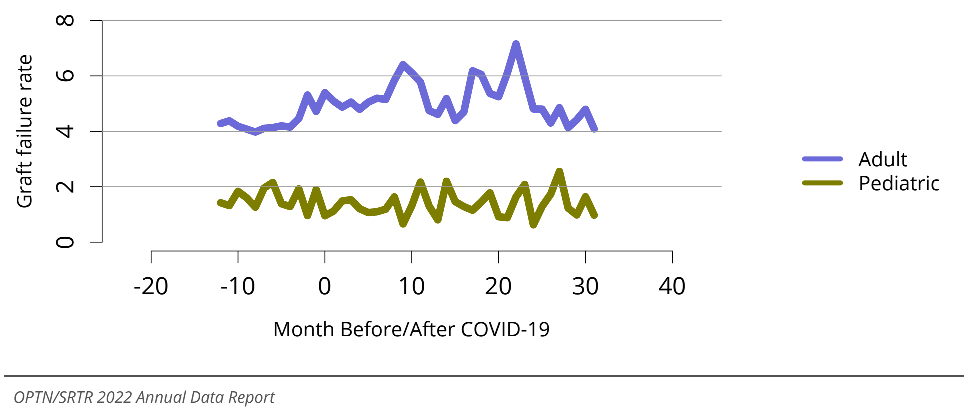
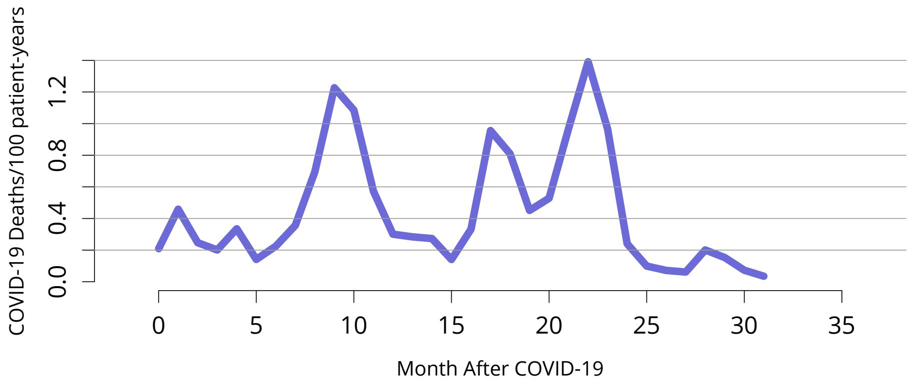
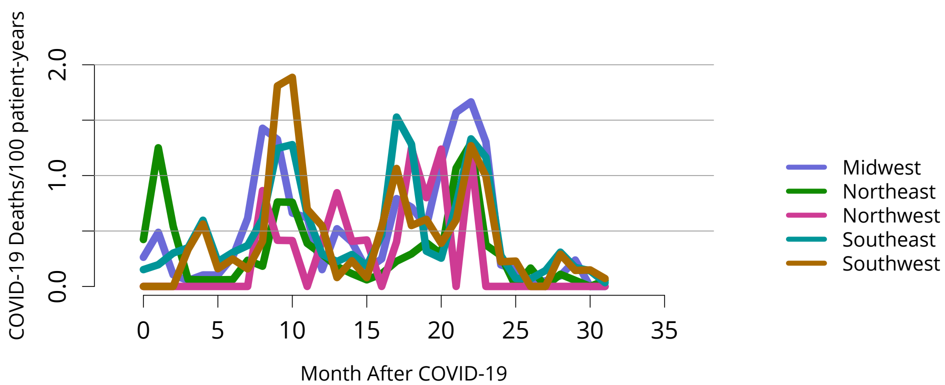


Figure COV 32: Liver all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



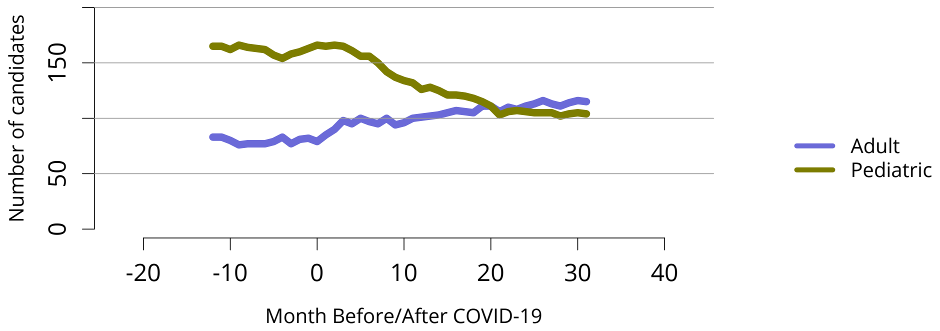
OPTN/SRTR 2022 Annual Data Report

Figure COV 33: Liver posttransplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



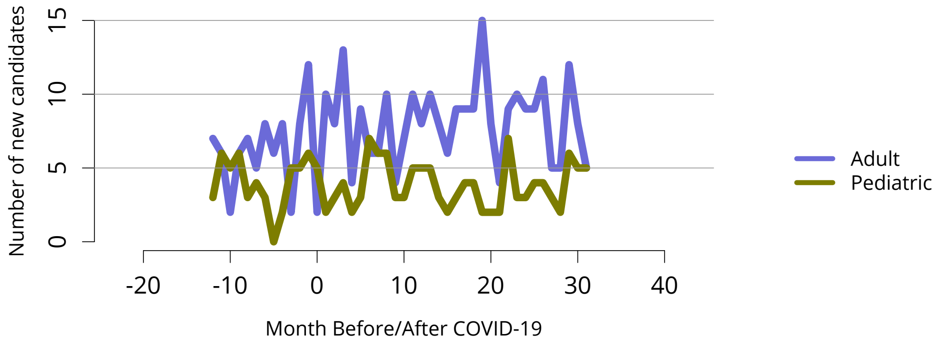
OPTN/SRTR 2022 Annual Data Report

Figure COV 34: Liver posttransplant COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



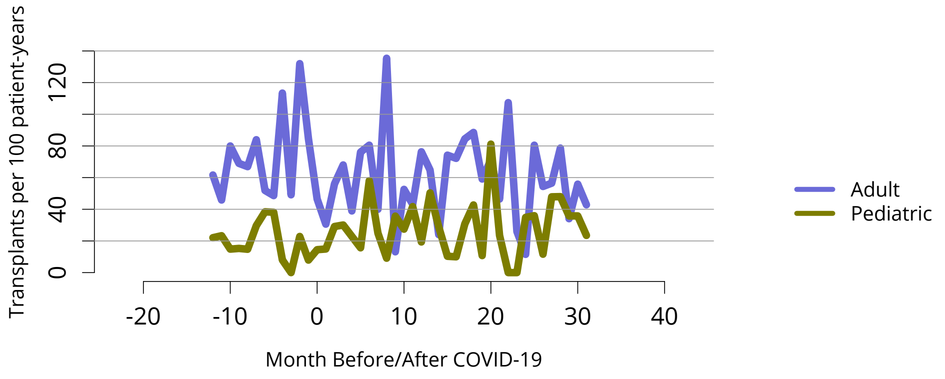
OPTN/SRTR 2022 Annual Data Report

Figure COV 35: Number of prevalent intestine candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.



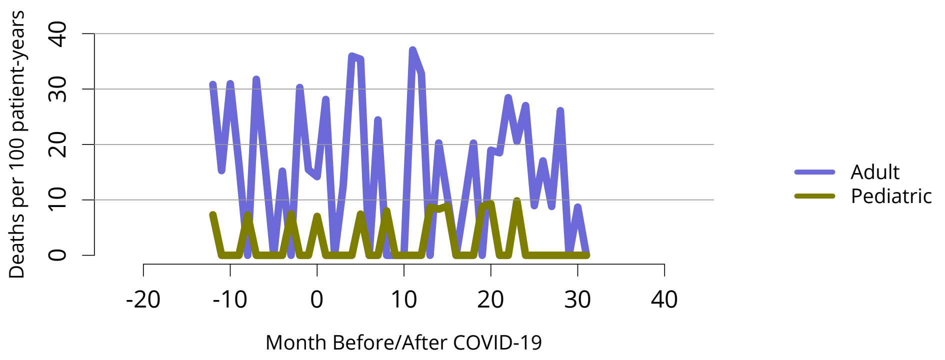
OPTN/SRTR 2022 Annual Data Report

Figure COV 36: Number of new intestine candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.



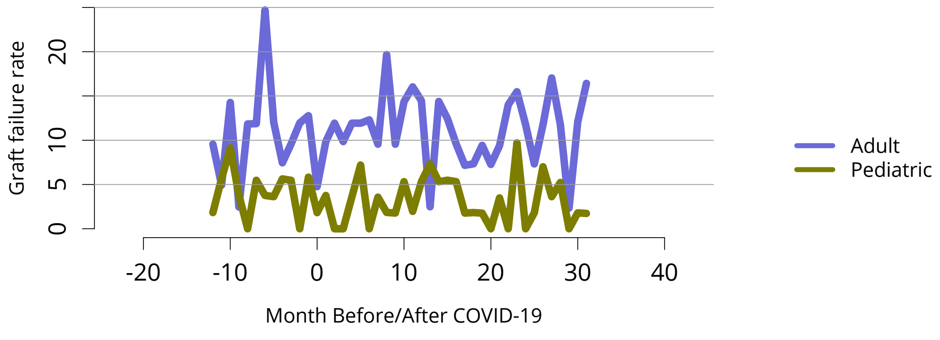
OPTN/SRTR 2022 Annual Data Report

Figure COV 37: Deceased donor intestine transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure COV 38: Intestine waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure COV 39: Intestine all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

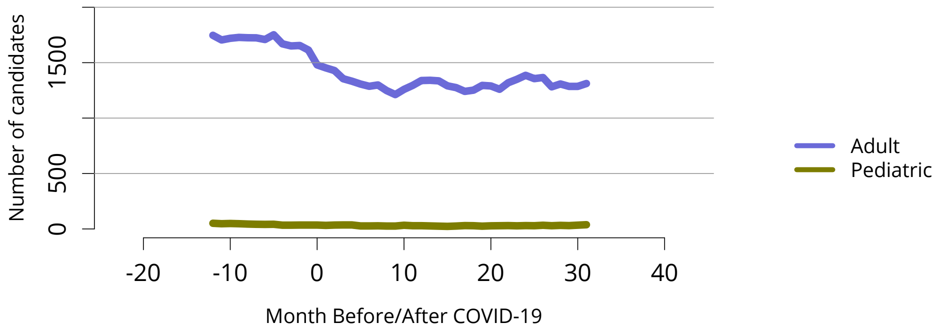


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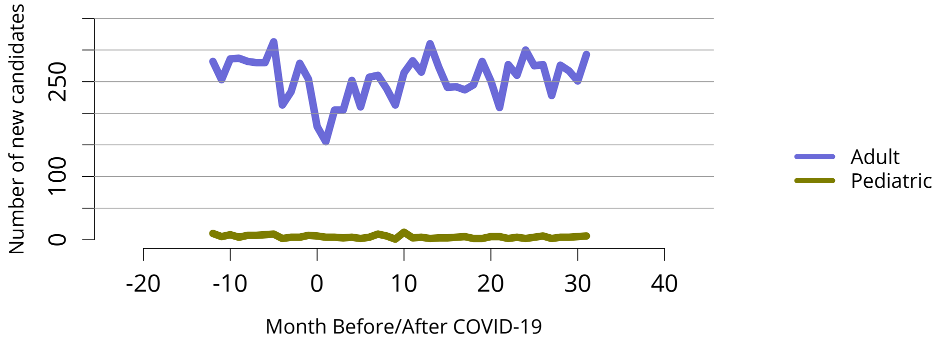
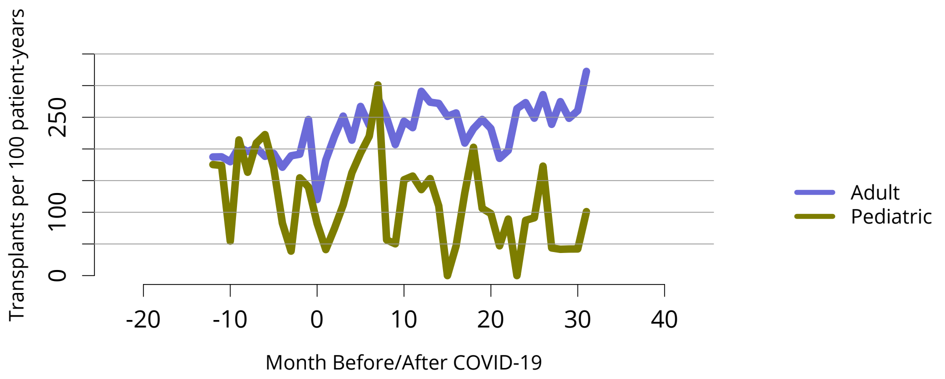
Figure COV 40: Number of prevalent lung candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.



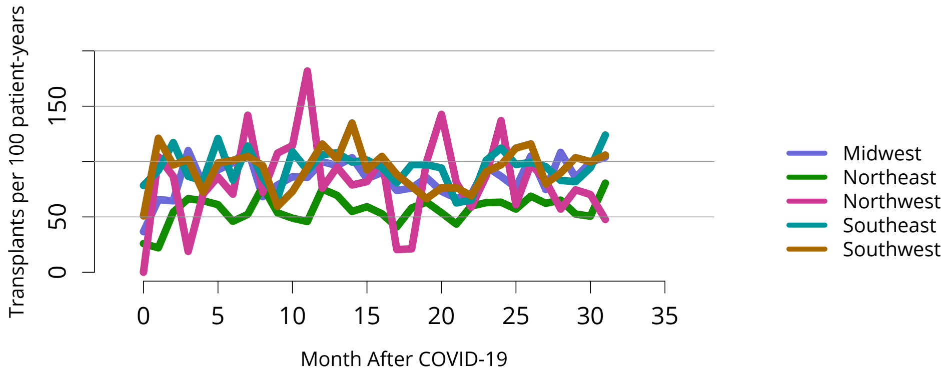
OPTN/SRTR 2022 Annual Data Report

Figure COV 41: Number of new lung candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.



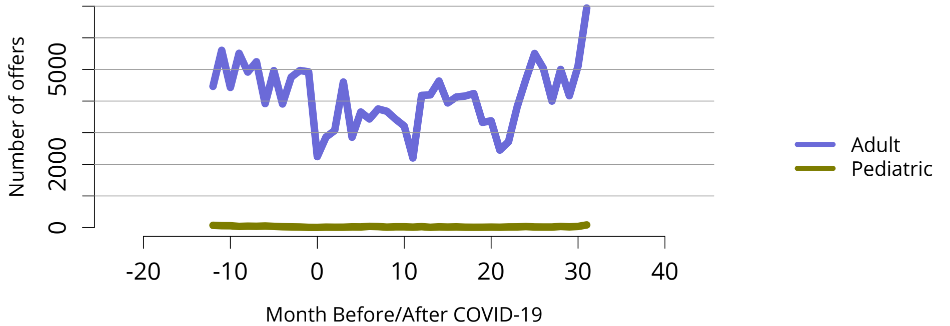
OPTN/SRTR 2022 Annual Data Report

Figure COV 42: Deceased donor lung transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure COV 43: Lung transplant rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of transplants per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



OPTN/SRTR 2022 Annual Data Report

Figure COV 44: Number of lung offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

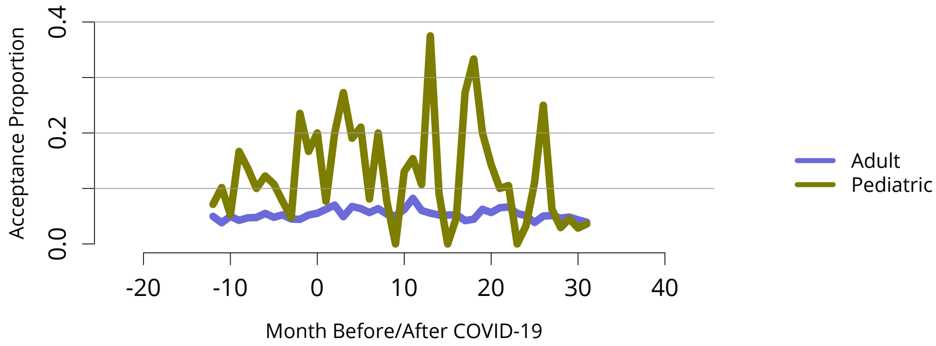


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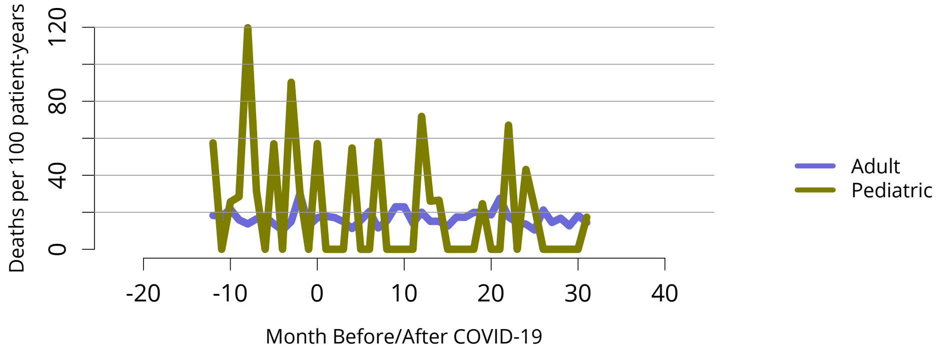
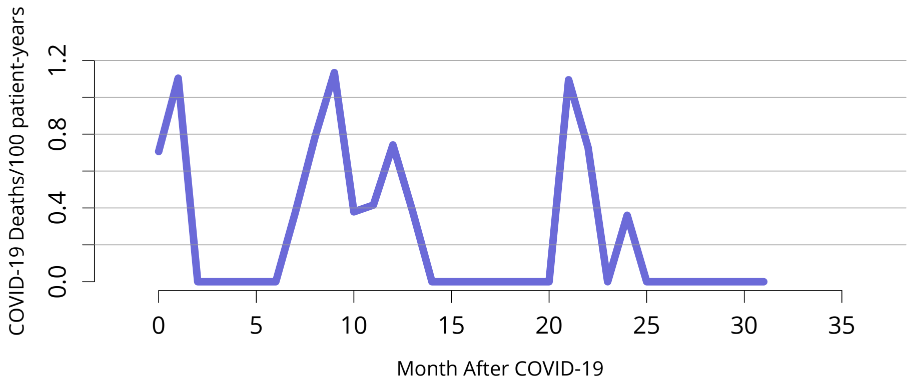
Figure COV 45: Lung offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



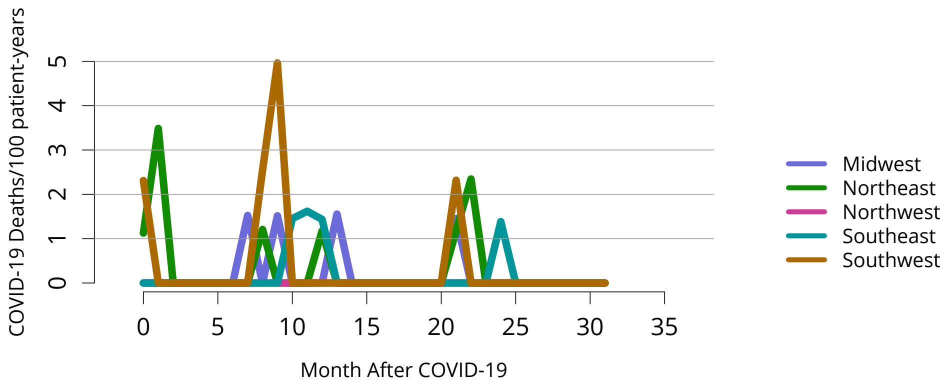
OPTN/SRTR 2022 Annual Data Report

Figure COV 46: Lung waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure COV 47: Lung waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



OPTN/SRTR 2022 Annual Data Report

Figure COV 48: Lung waitlist COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).

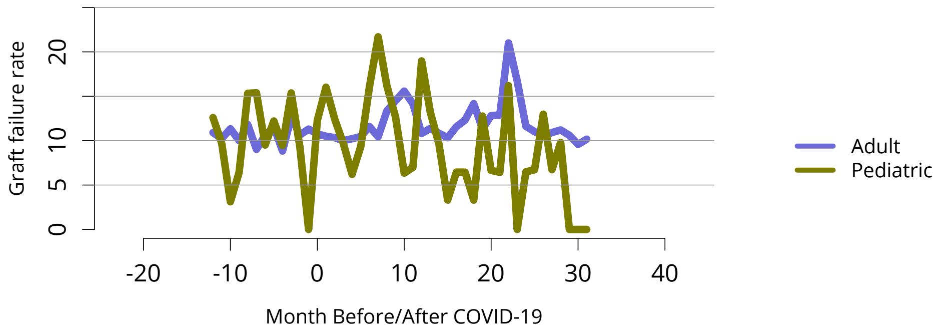


Figure COV 49: Lung all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.

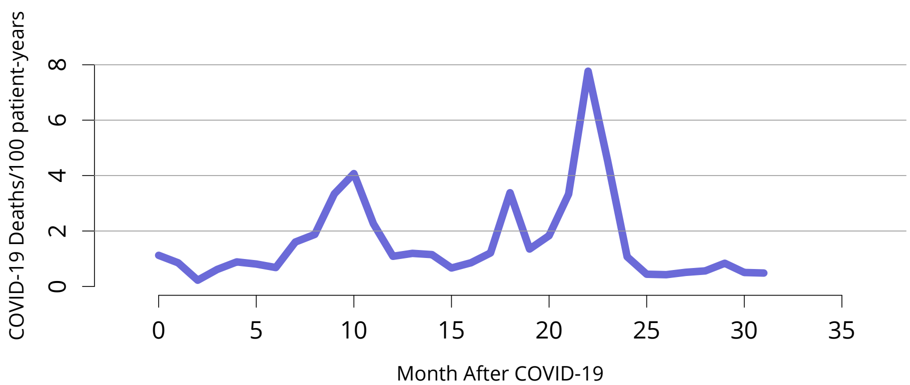
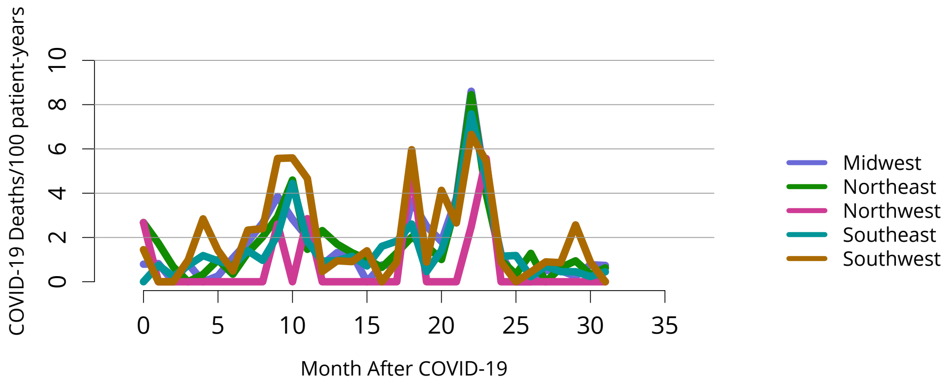
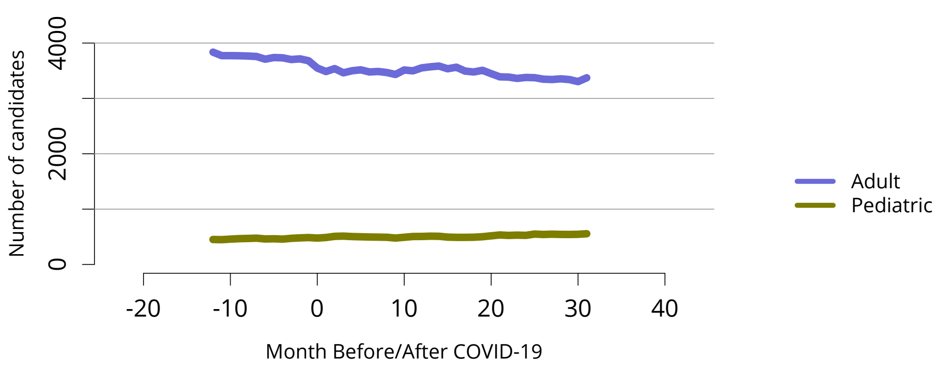


Figure COV 50: Lung posttransplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



OPTN/SRTR 2022 Annual Data Report

Figure COV 51: Lung posttransplant COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



OPTN/SRTR 2022 Annual Data Report

Figure COV 52: Number of prevalent heart candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the month.

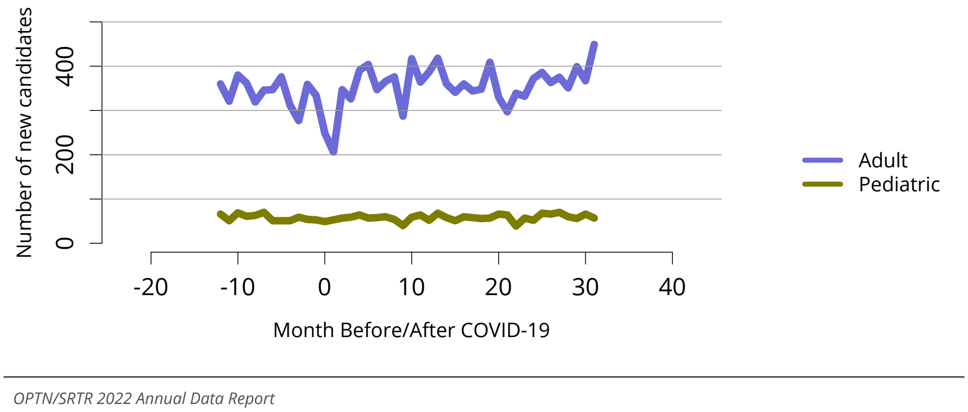


Figure COV 53: Number of new heart candidates. Month 0 begins March 13, 2020, the date of declaration of the national emergency. A new candidate is one who first joined the list during the given month, without having been listed in a previous month.

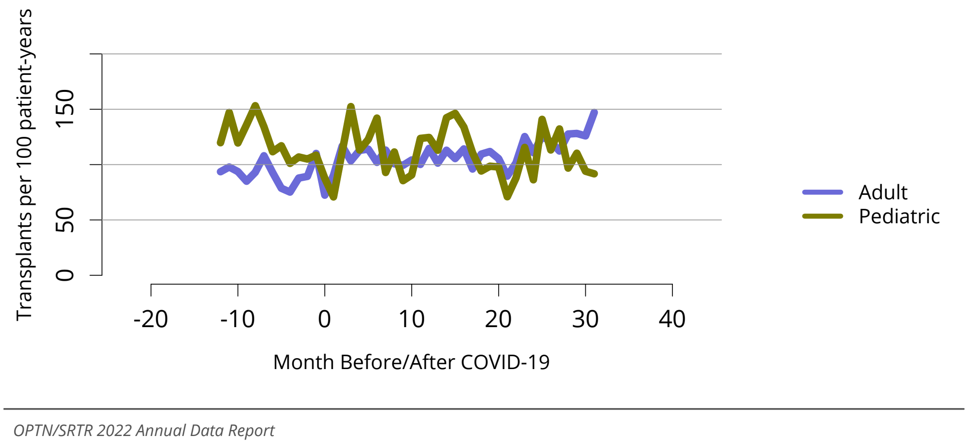
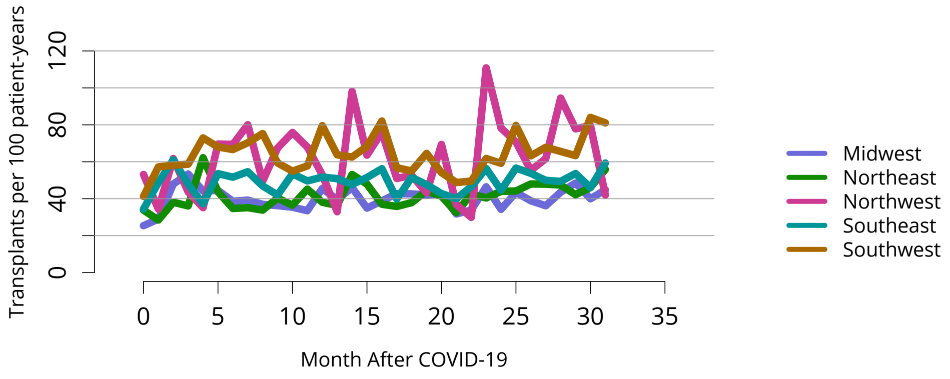
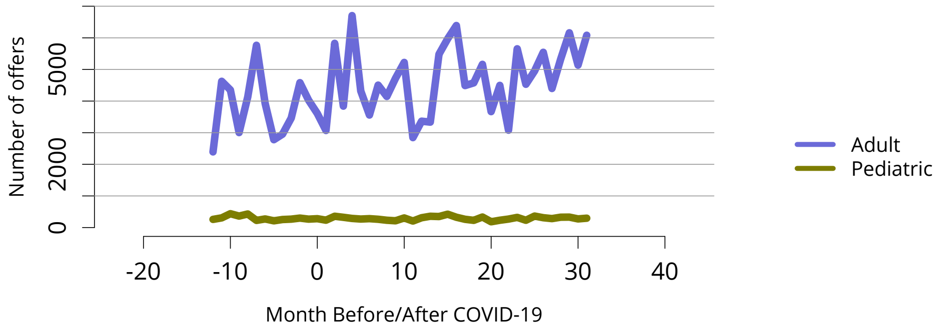


Figure COV 54: Deceased donor heart transplant rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of waiting time in a given month. Individual listings are counted separately.



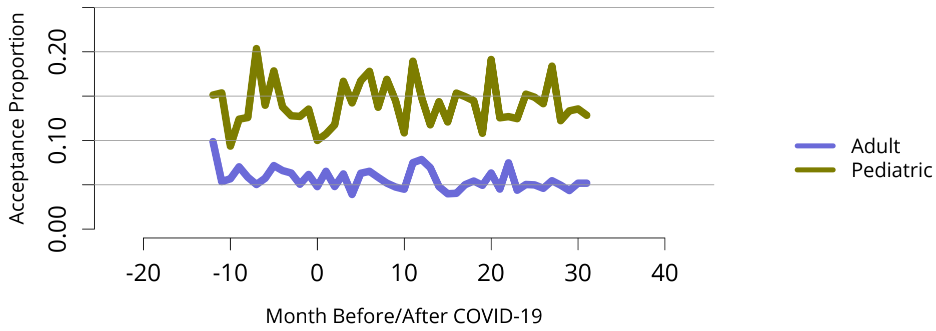
OPTN/SRTR 2022 Annual Data Report

Figure COV 55: Heart transplant rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Transplant rates are computed as the number of transplants per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



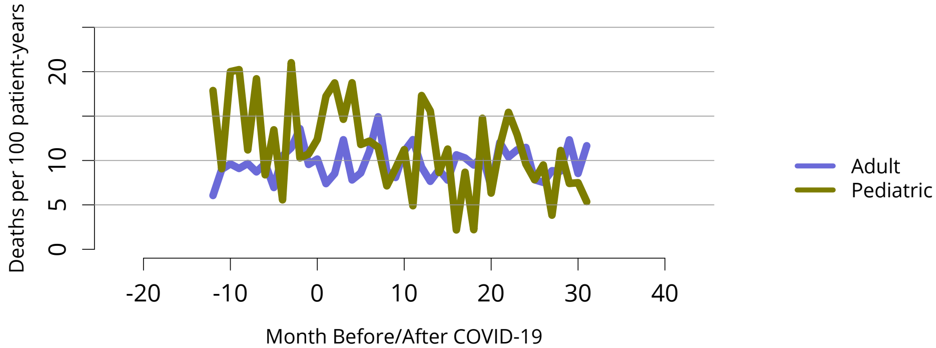
OPTN/SRTR 2022 Annual Data Report

Figure COV 56: Number of heart offers. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



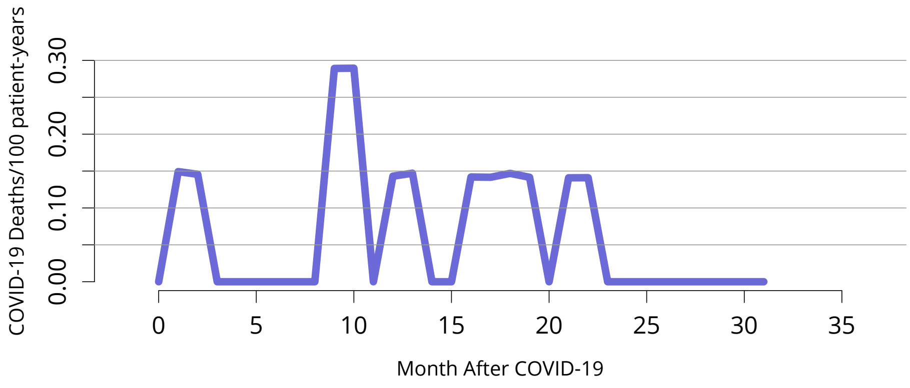
OPTN/SRTR 2022 Annual Data Report

Figure COV 57: Heart offer acceptance rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



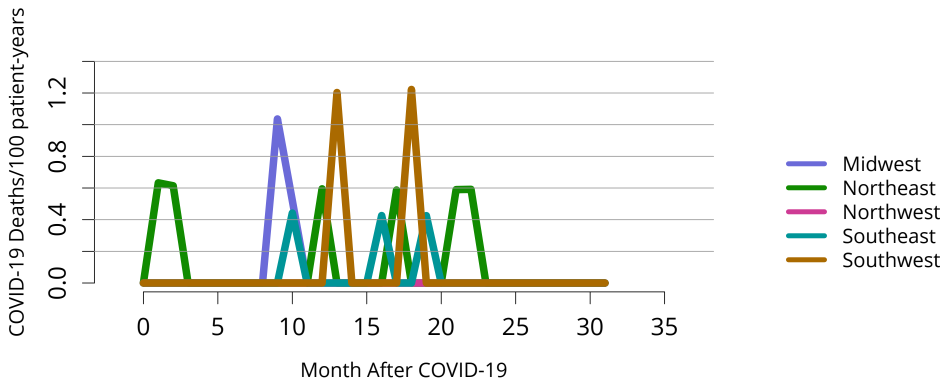
OPTN/SRTR 2022 Annual Data Report

Figure COV 58: Heart waitlist mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



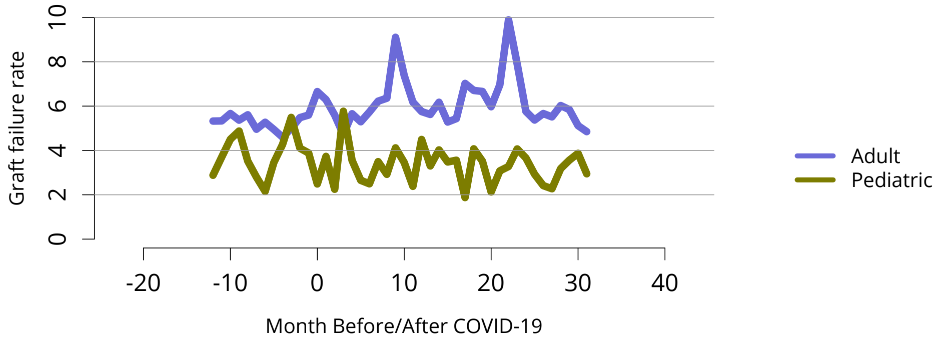
OPTN/SRTR 2022 Annual Data Report

Figure COV 59: Heart waitlist COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given year. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately.



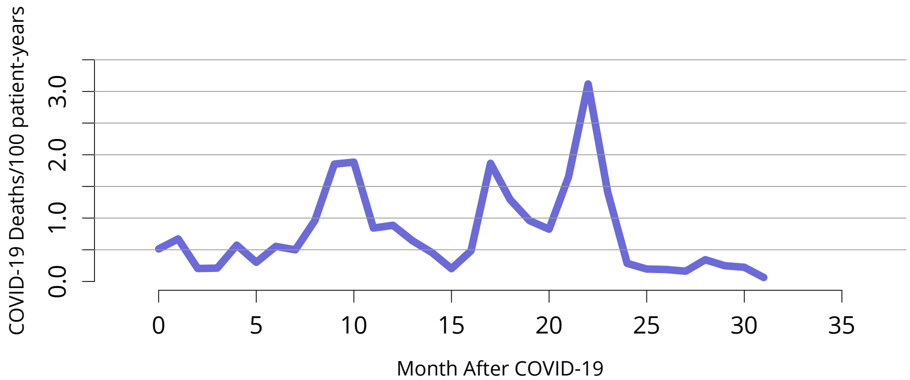
OPTN/SRTR 2022 Annual Data Report

Figure COV 60: Heart waitlist COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting time in the given month. Waiting time is censored at transplant, death, transfer to another program, removal because of improved condition, or end of cohort. Individual listings are counted separately. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



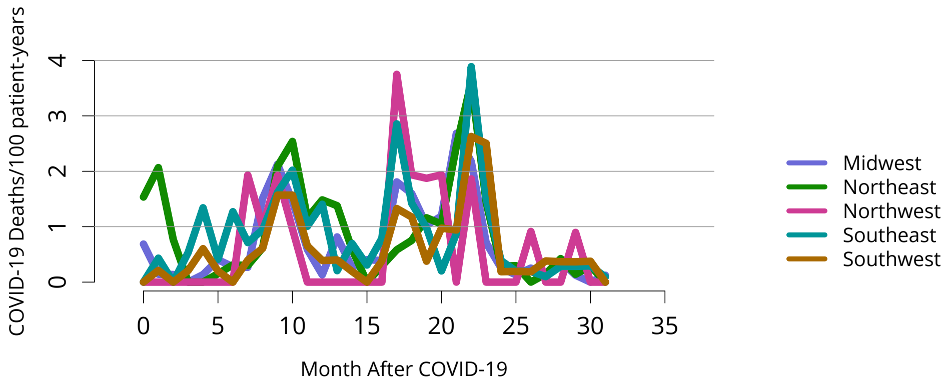
OPTN/SRTR 2022 Annual Data Report

Figure COV 61: Heart all-cause graft failure. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



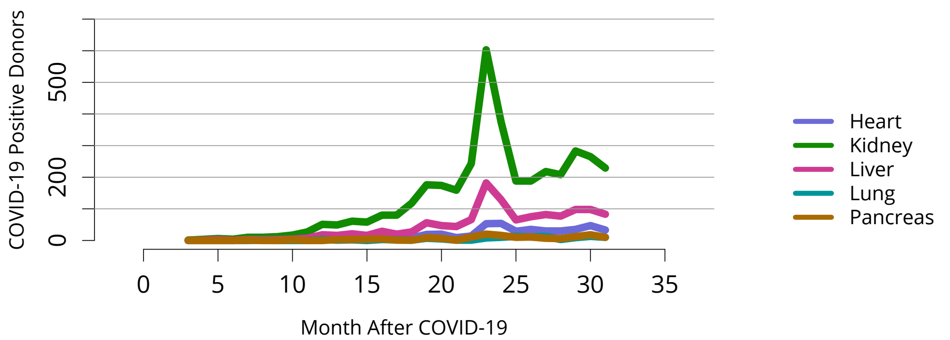
OPTN/SRTR 2022 Annual Data Report

Figure COV 62: Heart posttransplant COVID-19 mortality rate. Month 0 begins March 13, 2020, the date of declaration of the national emergency.



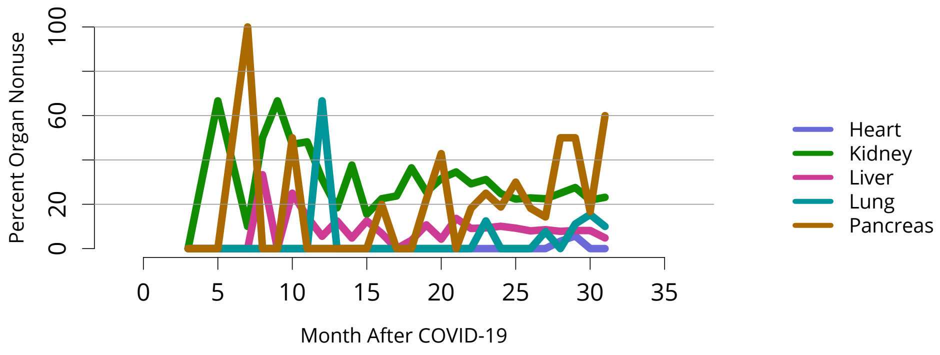
OPTN/SRTR 2022 Annual Data Report

Figure COV 63: Heart posttransplant COVID-19 mortality rate by US geographic region. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Geographic regions are defined as: Northeast (OPTN Regions 1, 2, and 9); Southeast (OPTN Regions 3, 4, and 11); Midwest (OPTN Regions 7, 8, and 10); Northwest (OPTN Region 6); Southwest (OPTN Region 5).



OPTN/SRTR 2022 Annual Data Report

Figure COV 64: COVID-19-Positive Deceased Donor Organs Recovered for Transplant by Organ. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Organs included are organs recovered for transplant from donors who tested positive for COVID-19, whether or not the organ was eventually transplanted.



OPTN/SRTR 2022 Annual Data Report

Figure COV 65: Nonuse Percent by COVID-19-Positive Deceased Donor Organs. Month 0 begins March 13, 2020, the date of declaration of the national emergency. Nonuse is the percent of organs 'recovered for transplant but not transplanted' out of the total number of COVID-19-positive organs recovered for transplant.

OPTN/SRTR 2022 Annual Data Report: Vascularized Composite Allograft

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Abstract

This year's chapter on vascularized composite allograft (VCA) encompasses reviews of data collected from 2014 (when VCA was included in the Final Rule) through 2022. The present Annual Data Report shows that the number of VCA recipients in the United States continues to be small and has remained consistent from the prior report. The data continue to be limited by sample size, with trends persistently demonstrating a predominance of White males in the young/middle-aged population as both donors and recipients for nonuterus VCA transplants, and White women younger than 35 years as the predominant recipients of uterus transplant. Similar to the 2021 report, there were only eight failed uterus grafts and one failed nonuterus VCA graft reported from 2014 through 2022. Standardization of definitions of success and failure as well as outcome measures for the different VCA types remain unmet needs in VCA transplantation.

Keywords: Abdominal wall transplant, face transplant, multiorgan transplant, upper limb transplant, vascularized composite allograft (VCA)

1 Introduction

In 2014, vascularized composite allograft (VCA) was included within the Final Rule, which established regulatory oversight by the Organ Procurement and Transplantation Network (OPTN).[1,2] The Final Rule defined VCA transplantation as the transplant of any body part that meets the following nine criteria:

1. Vascularized and requires blood flow by surgical connection of blood vessels to function after transplant
2. Contains multiple tissue types
3. Recovered from a human donor as an anatomical/structural unit
4. Transplanted into a human recipient as an anatomical/structural unit
5. Minimally manipulated (ie, processing that does not alter the original relevant characteristics of the organ relating to the organ's utility for reconstruction, repair, or replacement)
6. For homologous use (the replacement or supplementation of a recipient's organ with an organ that performs the same basic function or functions in the recipient as in the donor)
7. Not combined with another article such as a device
8. Susceptible to ischemia and, therefore, only stored temporarily and not cryopreserved
9. Susceptible to allograft rejection[3]

This chapter on VCA in the *OPTN/SRTR 2022 Annual Data Report* encompasses reviews of data collected since 2014, with a particular emphasis on the year 2022, with the aim being to depict and examine trends within VCA transplantation. In this chapter, Hispanic is defined as Hispanic/Latino ethnicity with no race reported. White, Black, Asian, Native Hawaiian, and Native American categories are all defined as non-Hispanic. Multiracial includes persons reported to be multiple races or Hispanic/Latino with at least one reported race (eg, White Hispanic). When the Non-White category is shown, Non-White is defined as Black, Asian, Hispanic, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial. When the Other race category is shown, Other is defined as

Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial. The Other/multiple category of organ for nonuterus VCA transplant includes larynx transplant or transplants that involve multiple VCA organs. Detailed information on VCA candidates, donors, and recipients, as well as VCA access and patient outcomes, in the United States from 2014 through 2022 is presented below.

2 Uterus Transplant

2.1 Candidates

Twelve candidates were on the waiting list for uterus transplant in 2022 (Figure VCA 1). Since 2016 (the year of the first uterus transplant in the United States), most uterus transplant candidates were younger than 35 years (81.1%; Figure VCA 2) and White (86.8%; Figure VCA 3), with blood types A (56.6%) or O (34.0%; Figure VCA 4).

2.2 Transplants

As of December 2022, 37 uterus transplants were performed in the United States (Figure VCA 5). Most uterus transplants were performed in White (33 of 37 recipients; Figure VCA 7) women younger than 35 years (31 of 37 recipients; Figure VCA 6). Uterus transplant recipients predominantly had blood type A (21 of 37 recipients) or O (12 of 37 recipients; Figure VCA 8). Primary diagnosis of absolute uterine factor infertility due to congenital absence of the uterus was present in 28 of 37 recipients (Figure VCA 9).

2.3 Donors

Unlike transplants for other VCA organs that use only deceased donor organs, living donor uterus transplants are performed: 21 of 37 uterus transplants (56.8%) since 2016 used living donors (Figure VCA 10). Only one living uterus donor was older than 50 years; all other donors, living or deceased, were younger than 50 years, with most aged 18-34 years (Figure VCA 11).

2.4 Posttransplant Outcomes

Unlike other organ transplants, uterus grafts are always removed after the recipient has finished having children. Data reported to the OPTN show 25 functioning uterus grafts and 8 failed uterus grafts of 37 transplants (67.6% and 21.6%, respectively; Figure VCA

12). However, uterus transplantation is a small and growing field, and the authors are aware of 17 uterus grafts that have, in fact, been removed after successful child delivery. The essential outcome variable for a uterus transplant is a live birth. Although number of births is not yet captured in the data, as of December 2022, the authors are aware of 21 children who were born to 19 uterus transplant recipients.

2.5 Access

Uterus transplants through 2022 were performed at centers in four states: Alabama, Ohio, Pennsylvania, and Texas. Of these, most transplants were performed in Texas (22 of 37 [59.5%]; Table VCA 1).

3 VCA Transplant Other Than Uterus

3.1 Candidates

Since the implementation of the Final Rule and OPTN guidance in 2014, there has been an increase in the number of candidates for VCA transplant other than uterus (referred to as nonuterus VCA transplant herein). However, despite this growth, the overall number of listed candidates remained stable compared with the previous year, with a total of 17 candidates reported in 2022 (Figure VCA 13). An examination of candidate listings by organ type since 2014 reveals that the most common category is upper limb (23 of 56 [41.1%]), while the least common is scalp (1 of 56 [1.8%]). Note that due to the limited sample size, evaluating annual data remains challenging. Nevertheless, as of the end of 2022, there were nine patients listed for abdominal wall transplant, two for face transplant, four for upper limb transplant, and one for Other/multiple transplant (Figure VCA 13 and Figure VCA 14).

Despite the challenges posed by a limited sample size, the demographic data of candidates undergoing nonuterus VCA transplant are presented. Candidates were primarily aged 18-34 years (33.9%) and 50-64 years (30.4%), with a substantial portion listed in the 35-49 years age group (25.0%; Figure VCA 15). In terms of race and ethnicity, White candidates constituted the majority (71.4%), while candidates in the Black, Hispanic, and Other categories represented 10.7%, 16.1%, and 1.8%, respectively (Figure VCA 16). Since 2014, male candidates have consistently outnumbered female candidates among nonuterus VCA recipients (39 of 56 [69.6%] and 17 of 56 [30.4%], respectively) (Figure VCA 17). The distribution of blood types among nonuterus VCA candidates since 2014 reveals most having blood type O (46.4%), followed by type A (33.9%), type B (16.1%), and type AB

(3.6%) (Figure VCA 18). The median waiting time for organ-specific transplant among patients who had undergone transplant since 2014 was notably the longest for scalp transplant (355 days), followed by face (342 days), penis (262 days), Other/multiple (238 days), upper limb (186 days), and abdominal wall (102 days) (Figure VCA 19).

3.2 Donors

Since the regulation of VCA transplant in 2014, donor data for nonuterus VCA transplant have been limited. Similar to in previous years,[4] most donors in 2014-2022 were aged 18-34 years (50.0%), with the remainder 35-49 years (35.2%), younger than 18 years (11.8%), and 50-64 years (2.9%) (Figure VCA 27).

3.3 Recipients

Of the total 56 listed nonuterus VCA candidates, 34 individuals (60.7%) underwent transplant in 2014-2022. There has been no substantial change in the number of nonuterus VCA transplants performed. Upper limb transplant was the most frequently performed (44.1%), followed by face (32.4%), abdominal wall (11.8%), penis (5.9%), scalp (2.9%), and Other/multiple (2.9%) (Figure VCA 21).

The demographic profile of the 34 patients who underwent nonuterus VCA transplant in 2014-2022 can be summarized as follows: the primary causes leading to transplant were trauma (41.2%), infection (23.5%), and burn/explosion (5.9%). However, a portion of etiologic data was missing (17.6%) (Figure VCA 26), which is consistent with the findings of the previous year's report.[4] The age distribution of nonuterus VCA transplant recipients during this period was as follows: the most prevalent age group was 18-34 years (41.1%), followed by 50-64 years (26.5%), 35-49 years (20.6%), 65 years or older (8.8%), and younger than 18 years (2.9%) (Figure VCA 22). These recipients were stratified into two distinct categories for race and ethnicity data collection: White (27 of 34 [79.4%]) and non-White (7 of 34 [20.6%]) (Figure VCA 23). Among nonuterus VCA recipients during this period, males continued to make up the largest portion, accounting for 70.6% (24 of 34), while females were the remaining 29.4% (10 of 34) (Figure VCA 24). When analyzing the distribution of blood types among nonuterus VCA transplant recipients since 2014, it is evident that type O blood is the most prevalent (50.0%), followed by type A (29.4%) and type B (20.6%). Note that no transplants were performed in individuals with type AB blood (Figure VCA 25).

3.4 Access and Outcomes

Currently, 21 programs in 11 states have performed nonuterus VCA transplant (Figure VCA 28, Table VCA 3). When assessing the distribution of programs according to organ type, upper limb transplant emerges as the most prevalent procedure, with nine programs having performed it from 2014 through 2022. Face transplant has been carried out at five programs, and abdominal wall transplant has been done at three programs. Transplants in the Other/multiple category were performed at one program; penis and scalp transplant were conducted at two programs and one program, respectively (Figure VCA 28). Compared with the previous year's report,[4] there was an increase in the number of programs providing abdominal wall transplant from two to three.

The examination of patient outcomes in nonuterus VCA transplant involved the classification of results into "functioning graft" and "failed graft." Over the recorded timeframe of 2014-2022, there was one occurrence of upper limb VCA failure reported (1 of 15 [6.7%]), while abdominal wall, face, Other/multiple, penis, and scalp VCA transplants were reported with a 100% functioning graft rate, similar to earlier observations (Table VCA 2).

4 Observations

The number of VCA recipients in the United States did not significantly increase in the past year. It is important to note that missing data entries continue to improve compared with prior annual reports. Like in previous years, factors such as limited funding availability, as well as the cost of and limited dedicated resources available for these low-volume, complex cases, may be contributing to the number of VCA transplants not increasing at a faster rate. The VCA transplant community continues to actively work to address unmet needs, such as unstandardized definitions and nonvalidated outcome tools specific to VCA transplant. Continuing education, data sharing, training, and collaborations continue to be adopted; these will provide insights and contribute to the advancement of the field.

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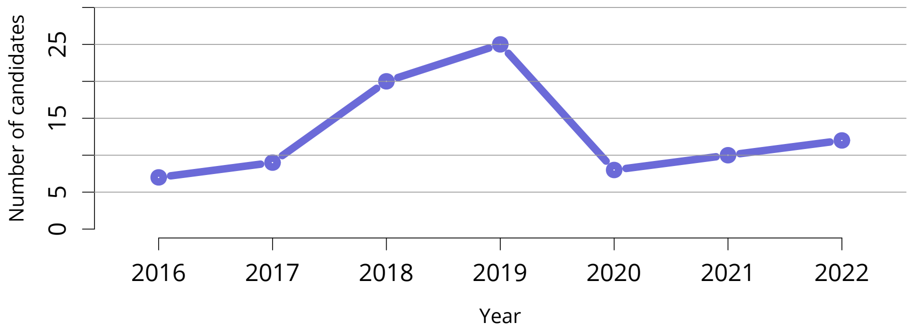

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Figure VCA 1: Number of prevalent uterus candidates. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the year.

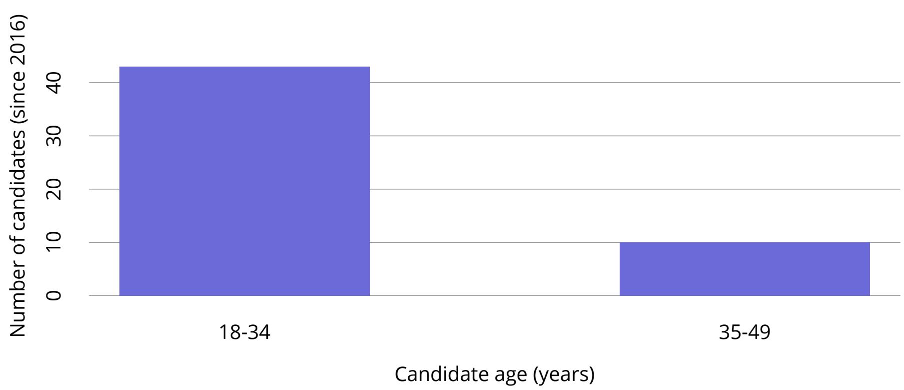

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Figure VCA 2: Number of uterus candidates by age, 2016-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time.

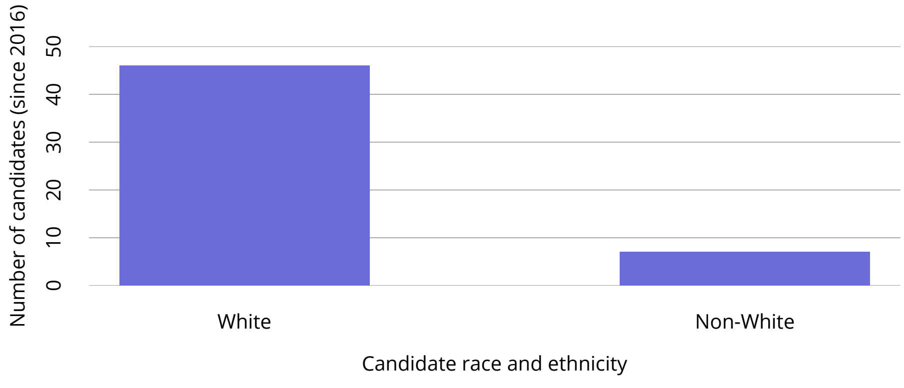

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Figure VCA 3: Number of uterus candidates by race and ethnicity, 2016-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time. Non-White race and ethnicity includes Black, Asian, Hispanic, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial.

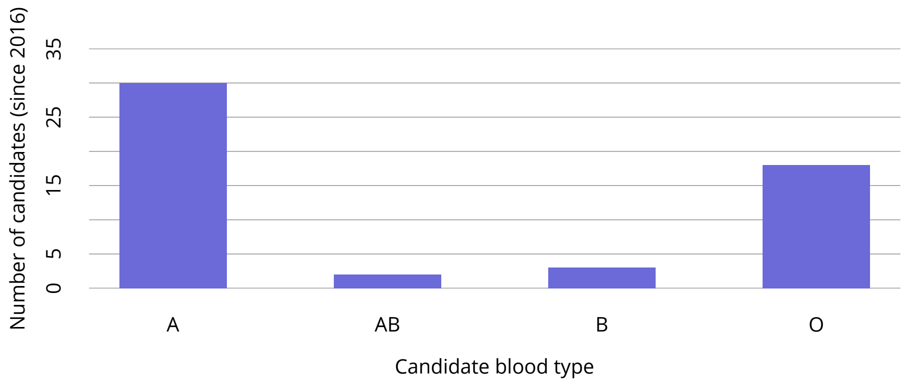

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Figure VCA 4: Number of uterus candidates by blood type, 2016-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time.

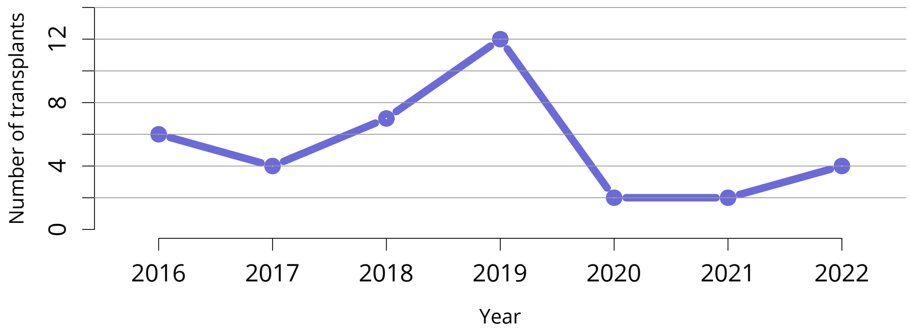

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Figure VCA 5: Number of uterus transplants, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

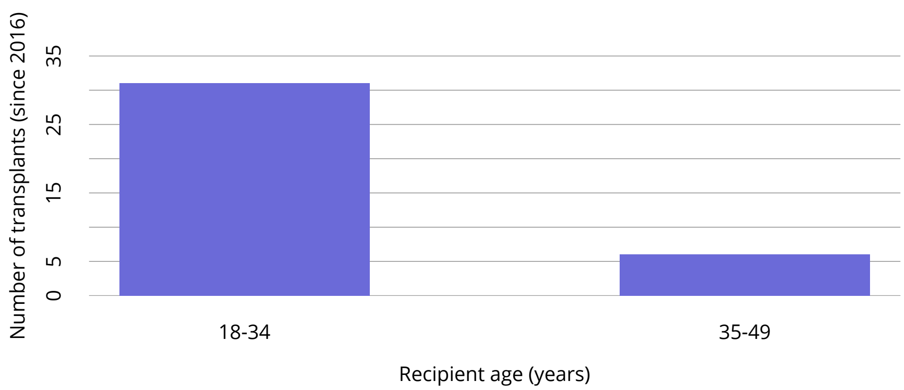

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Figure VCA 6: Number of uterus transplants by age, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

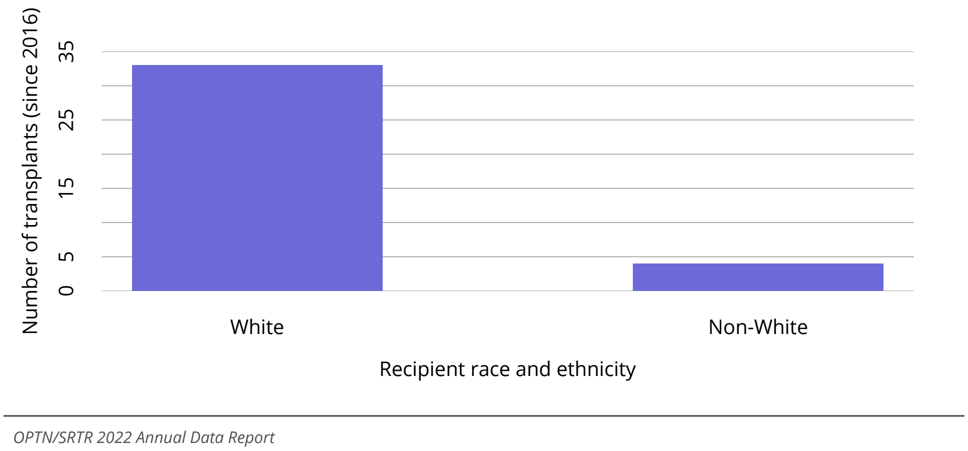

Figure VCA 7: Number of uterus transplants by race and ethnicity, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients. Non-White race and ethnicity includes Black, Asian, Hispanic, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial.

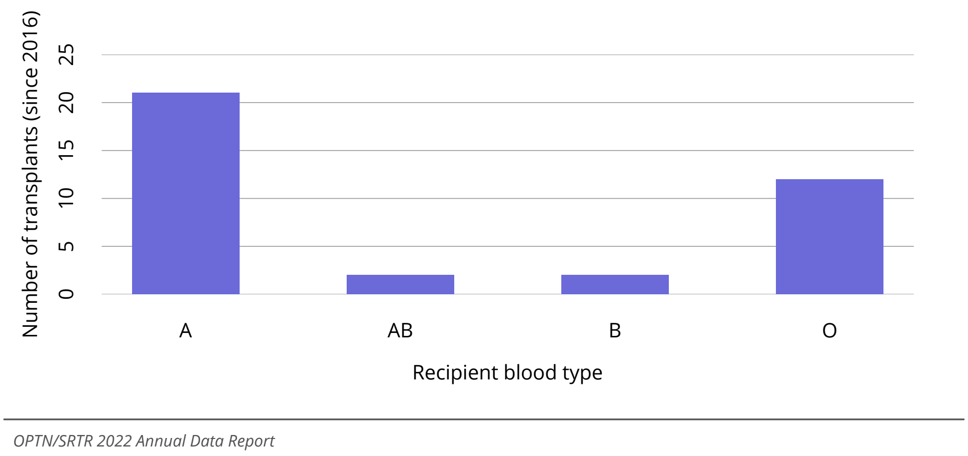

Figure VCA 8: Number of uterus transplants by blood type, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

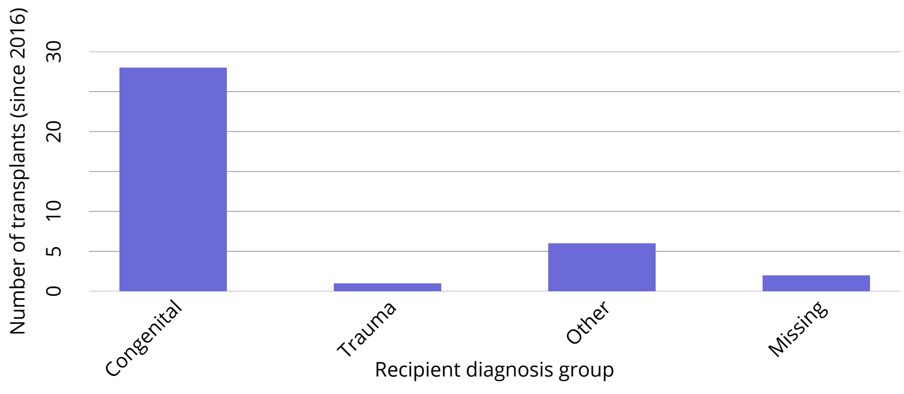

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Figure VCA 9: Number of uterus transplants by diagnosis, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

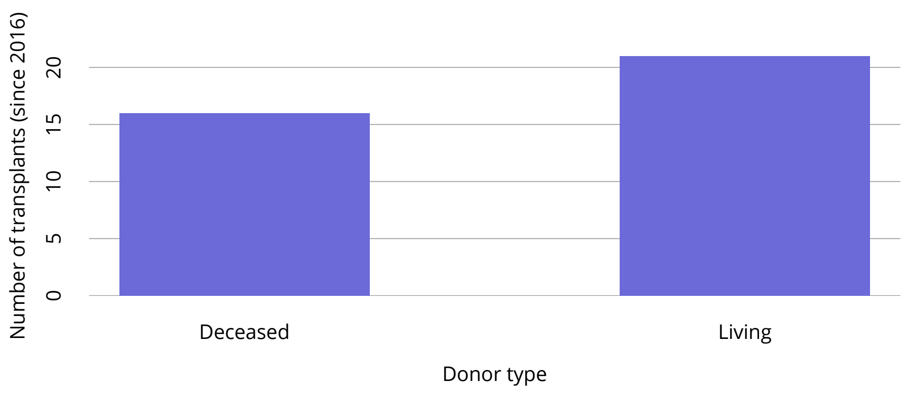

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Figure VCA 10: Number of uterus transplants by donor type, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

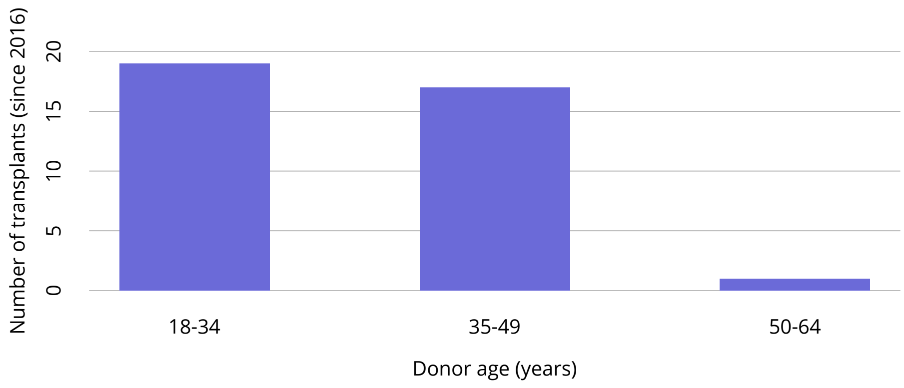

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Figure VCA 11: Number of uterus transplants by donor age, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

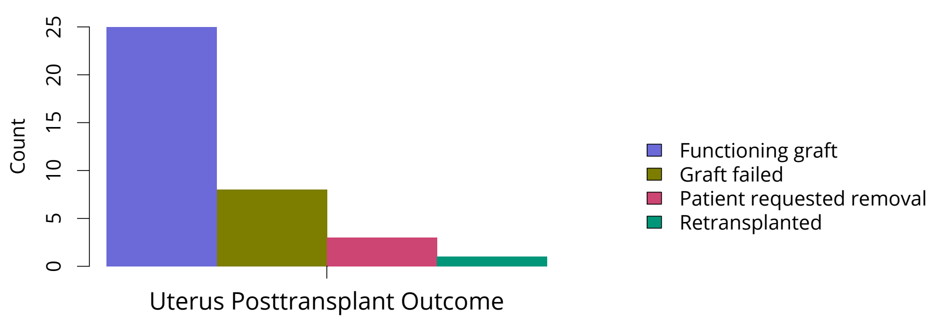

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Figure VCA 12: Posttransplant outcome counts among uterus transplant recipients, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

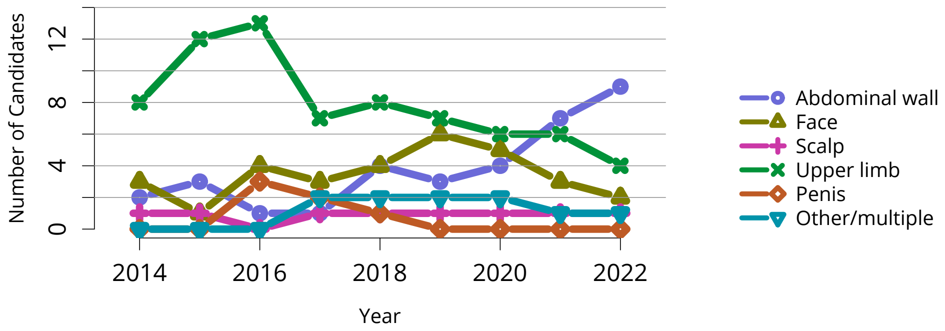

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Figure VCA 13: Number of prevalent nonuterus VCA candidates by organ. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time during the year. The other/multiple category includes larynx transplant or transplants that involve multiple VCA organs.

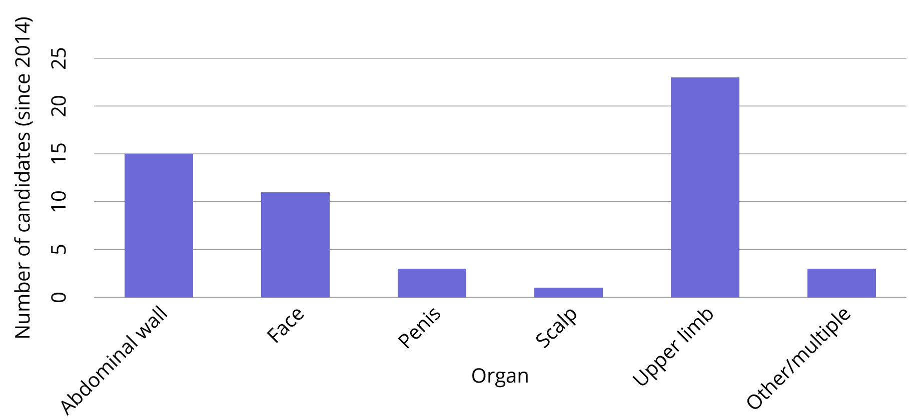

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Figure VCA 14: Number of nonuterus VCA candidates by organ type, 2014-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time. The other/multiple category includes larynx transplant or transplants that involve multiple VCA organs.

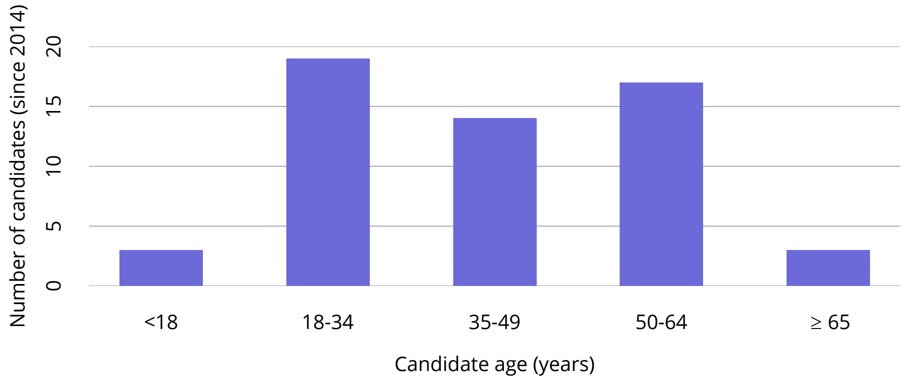

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Figure VCA 15: Number of nonuterus VCA candidates by age, 2014-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time.

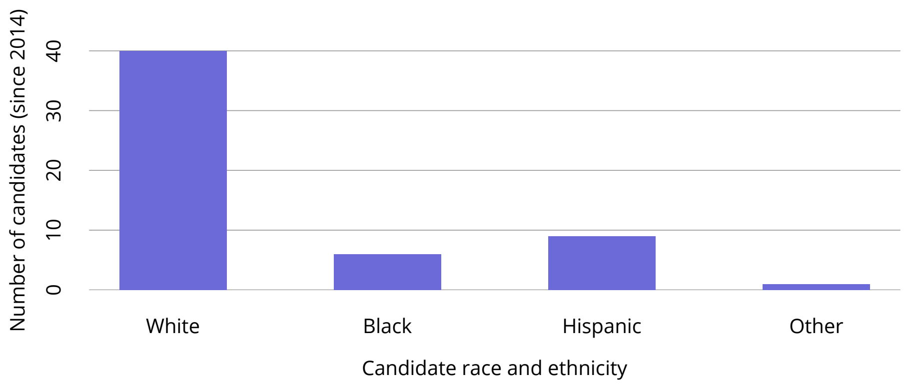

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Figure VCA 16: Number of nonuterus VCA candidates by race and ethnicity, 2014-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time. Other race and ethnicity includes Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial.

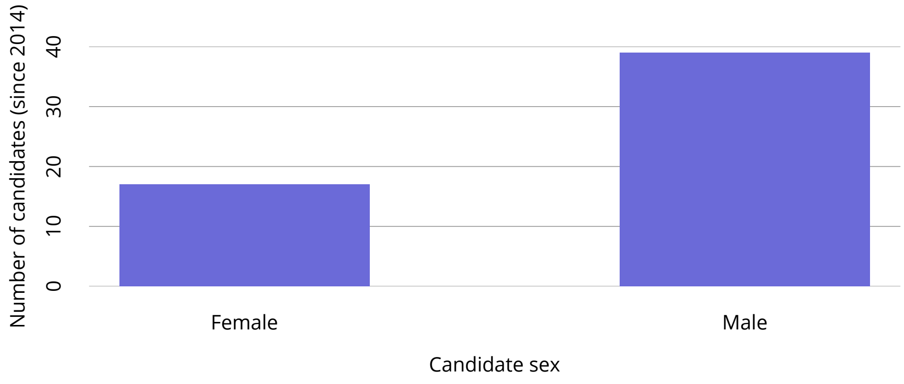

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Figure VCA 17: Number of nonuterus VCA candidates by sex, 2014-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time.

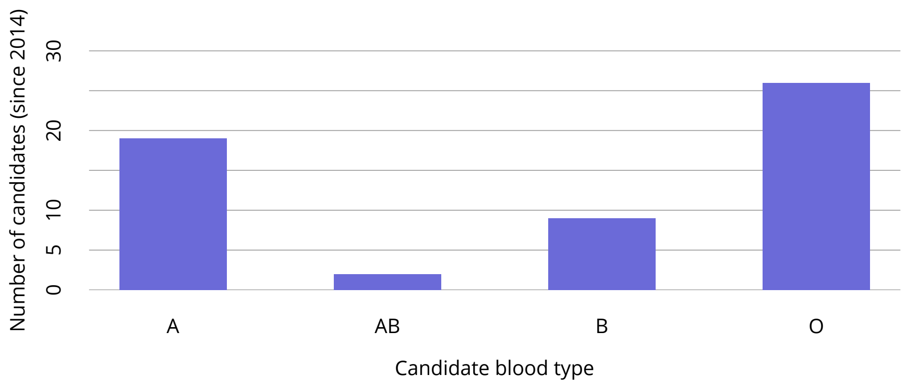

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Figure VCA 18: Number of nonuterus VCA candidates by blood type, 2014-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time.

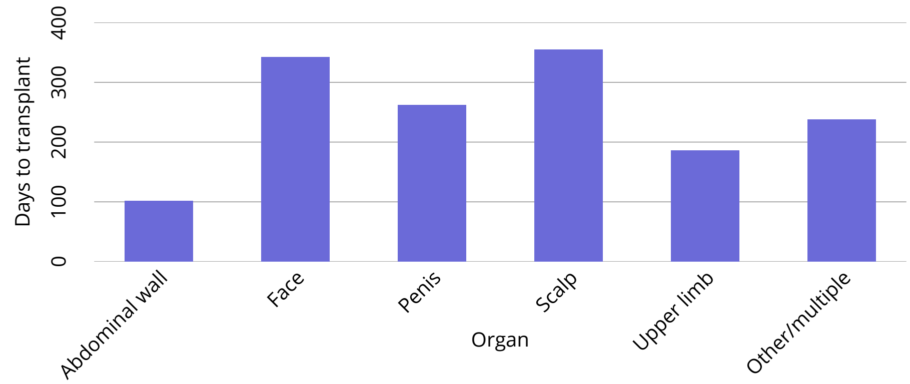

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Figure VCA 19: Median days to transplant among nonuterus VCA candidates by organ, 2014-2022. Candidates listed at multiple centers are counted once per listing. Includes active and inactive candidates on the list any time. Organs with no visible bar in the graph have a median days to transplant of 0, meaning that more than 50% of candidates are added to the list on the same day that they undergo transplant or do not have a recorded listing date, in which case their listing date is assumed to be their transplant date. The other/multiple category includes larynx transplant or transplants that involve multiple VCA organs.

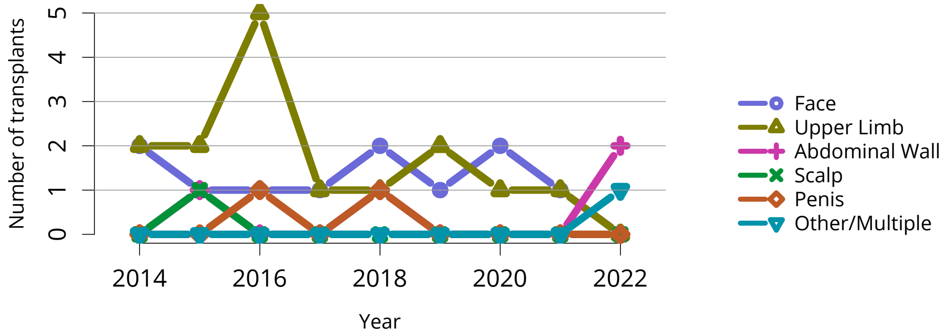

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Figure VCA 20: Number of nonuterus VCA transplants by organ. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

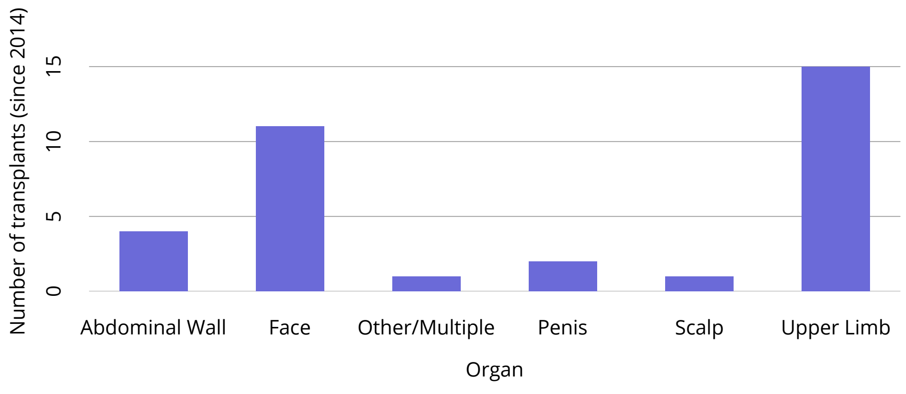

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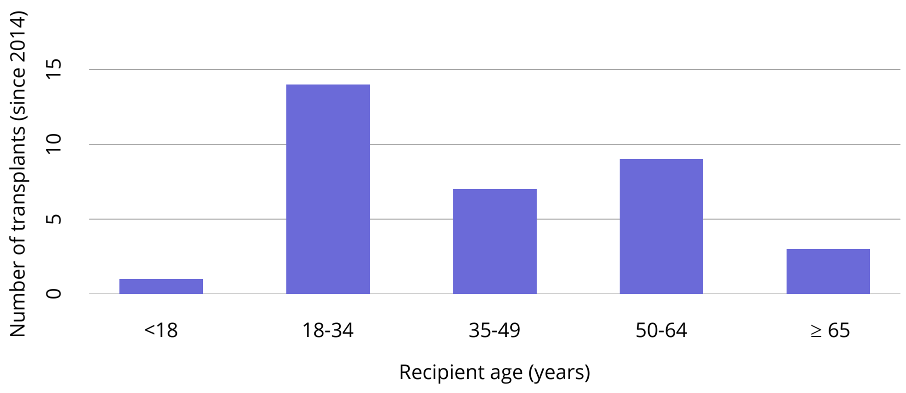
Figure VCA 21: Number of nonuterus VCA transplants by organ type, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients. The other/multiple category includes larynx transplant or transplants that involve multiple VCA organs.



OPTN/SRTR 2022 Annual Data Report

Figure VCA 22: Number of nonuterus VCA transplants by age, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

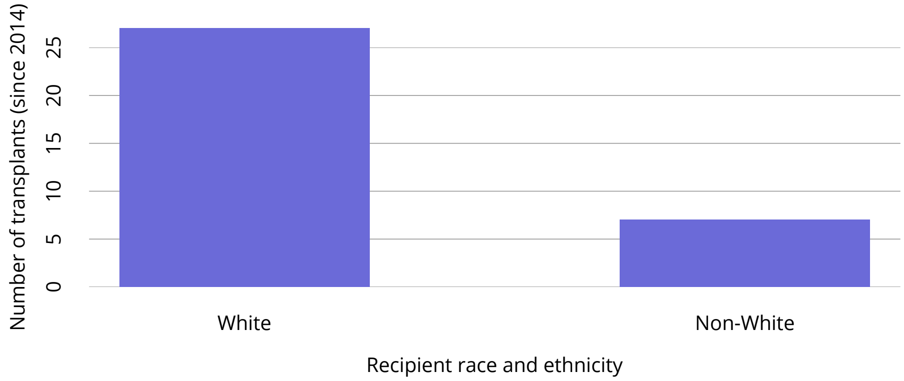


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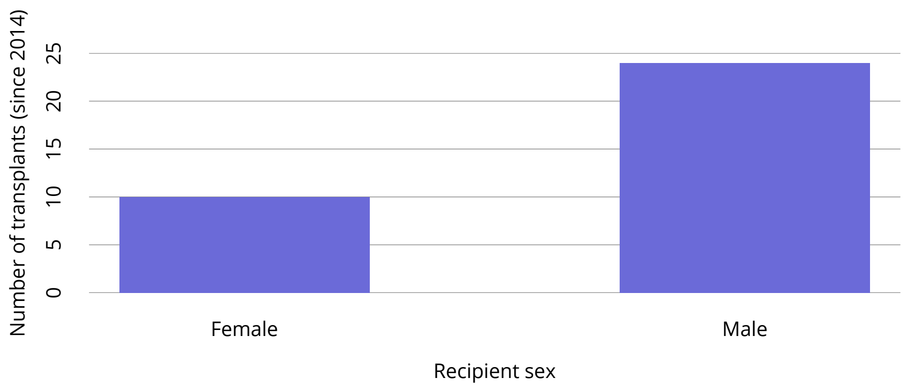
Figure VCA 23: Number of nonuterus VCA transplants by race and ethnicity, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients. Non-White race and ethnicity includes Black, Asian, Hispanic, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Multiracial.



OPTN/SRTR 2022 Annual Data Report

Figure VCA 24: Number of nonuterus VCA transplants by sex, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

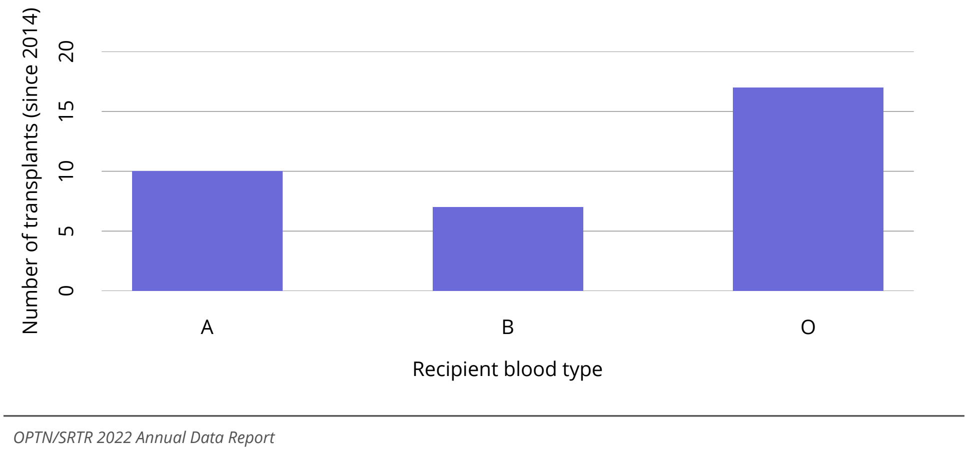


Figure VCA 25: Number of nonuterus VCA transplants by blood type, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

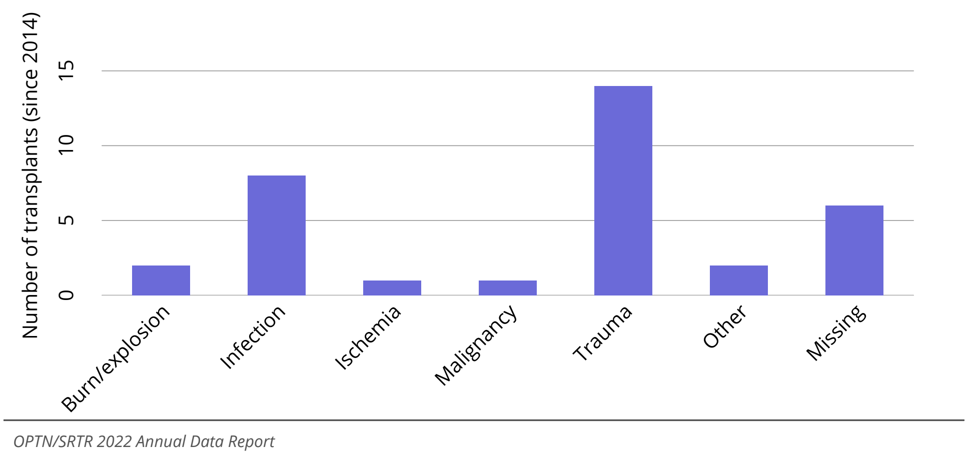


Figure VCA 26: Number of nonuterus VCA transplants by diagnosis, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

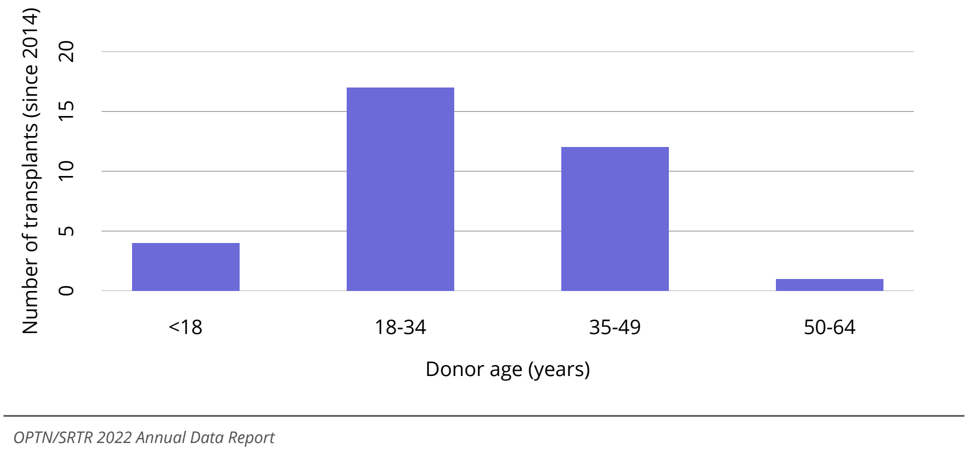


Figure VCA 27: Number of nonuterus VCA transplants by donor age, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

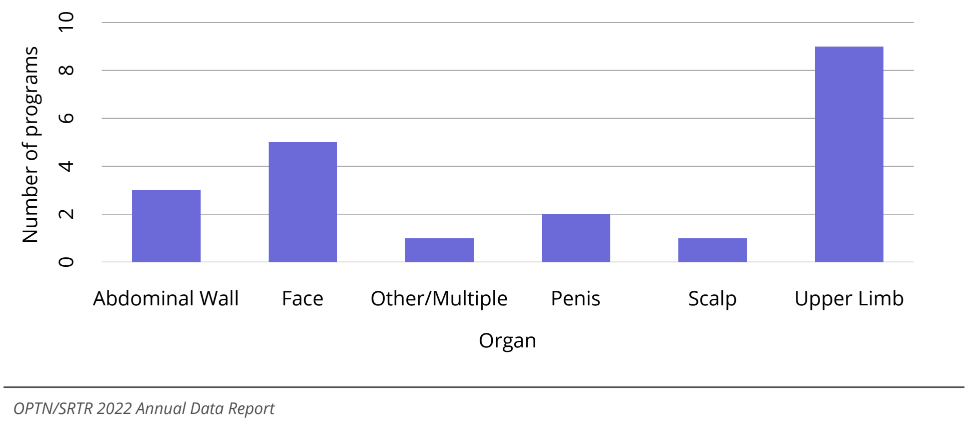


Figure VCA 28: Number of transplant programs performing VCA transplants by nonuterus organ, 2014-2022. All unique transplant programs performing nonuterus VCA transplants by organ type. The other/multiple category includes larynx transplant or transplants that involve multiple VCA organs.

Table VCA 1: Number of uterus transplants by state where transplant program is located, 2016-2022. All uterus transplants, including retransplant and multiorgan recipients.

State	Transplant Count
State	
Alabama	4
Ohio	8
Pennsylvania	3
Texas	22

Table VCA 2: Posttransplant outcome counts by nonuterus VCA organ type, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients. The other/multiple category includes larynx transplant or transplants that involve multiple VCA organs.

Organ	Functioning graft	Graft failed
Organ		
Abdominal Wall	4	0
Face	11	0
Other/Multiple	1	0
Penis	2	0
Scalp	1	0
Upper Limb	14	1

Table VCA 3: Number of nonuterus VCA transplants by state where transplant program is located, 2014-2022. Nonuterus VCA transplants, including adult and pediatric, retransplant, and multiorgan recipients.

State	Transplant Count
State	
California	2
Florida	2
Kentucky	2
Massachusetts	7
Maryland	3
Minnesota	2
North Carolina	4
New York	5
Ohio	2
Pennsylvania	3
Texas	2