

Outcomes of Kidney Transplantation Among Undocumented Immigrants in the United States

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Abstract

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BACKGROUND: Kidney transplantation is the optimal treatment for end-stage kidney disease (ESKD), but undocumented immigrants in the United States are often excluded from health insurance coverage necessary to undergo kidney transplantation. Arguments in favor of such policies are based on concern that undocumented immigrants face increased risk for graft loss, but transplant outcomes in this population are unknown. **METHODS:** We conducted an analysis of all first single-organ kidney transplant recipients between April 2012 and June 2021 using the UNOS dataset. Recipients were categorized as US citizen/residents or undocumented immigrants. The primary outcome was all-cause graft loss. All-cause mortality and death-censored graft loss were examined as secondary outcomes. Kaplan-Meier curves were constructed to compare the unadjusted graft and patient survival. The unadjusted and adjusted hazard ratios (HRs) for the primary and secondary outcomes were estimated using the Cox proportional hazards models. **RESULTS:** Of 122,732 kidney transplant recipients, 121,298 (98.8%) were citizen/residents and 1,434 (1.2%) were undocumented immigrants. Undocumented immigrants were younger (39 vs. 54 years) and predominantly Hispanic (78.5 vs.

17.3%) with lower prevalence of diabetic nephropathy (12.6 vs.28.4%). Pre-emptive (5.4 vs 19.2%) and living donor transplants (25.4 vs. 35.5%) were less common among undocumented immigrants. Undocumented immigrants had a lower hazard for all-cause graft loss (HR 0.57; 95% CI 0.48-0.69), all-cause mortality (HR 0.38; 95% CI 0.28-0.50) and death-censored graft loss (HR 0.74; 95% CI 0.59-0.93). These associations remained after adjustment for demographic, dialysis and transplant confounders. **CONCLUSIONS:** Kidney transplant recipients who are undocumented immigrants have favorable early graft and patient survival compared to US citizen/residents.

INTRODUCTION

In 2019, there were an estimated 11 million undocumented immigrants residing in the United States, accounting for about 3% of the total US population (1). Although the true prevalence is unknown, an estimated 5000-9000 of these individuals have End Stage Kidney Disease (ESKD) (2). The optimal form of renal replacement therapy (RRT) for adults and children with ESKD is kidney transplantation, which offers better survival and quality of life along with considerable healthcare cost savings compared to chronic dialysis (3–7). While the National Organ Transplant Act (NOTA) specifies that only medical criteria be considered for equitable organ allocation and therefore does not prohibit the inclusion of undocumented immigrants as transplant candidates, legislative and financial barriers remain (8). In the US, Medicare guarantees coverage for costs associated with chronic dialysis and kidney transplantation for individuals with ESKD regardless of age (9), but explicitly excludes undocumented immigrants. While some states such as California and Illinois have expanded their state-funded programs to cover transplantation for undocumented immigrants (10), the majority of the states have not. As a result, many undocumented immigrants are denied access to any form of health insurance necessary to pay for a kidney transplant. Arguments in favor of such policies are based on considerations of nationalism and reciprocity, but also concern that this population could have extremely poor outcomes following transplant (11). Lack of insurance, social support, and access to care has been associated with poorer outcomes in other populations of transplant recipients (9,12–14).

Contrary to these concerns, single-center studies have found comparable or superior transplant outcomes among adult and pediatric kidney transplant recipients who are undocumented (15,16). Another study using national data demonstrated similar findings, but limited its study population to Medicaid-insured patients (17). In March 2012, to assess the magnitude of and better

understand the emerging topic of “transplant tourism,” the United Network for Organ Sharing (UNOS) and Organ Procurement and Transplantation Network (OPTN) modified its categorization of citizenship status of transplant candidates and donors to achieve improved differentiation among citizens, lawful residents, undocumented immigrants and transplant tourists (18). No study has studied outcome differences among kidney transplant recipients of different citizenship statuses using national data since this change has been implemented.

The aim of this study is to describe the prevalence and outcomes of kidney transplant recipients who are undocumented immigrants and to compare them to citizen and resident recipients.

METHODS

Data source and study population

We used the Standard Transplant Analysis and Research (STAR) Dataset derived from the UNOS registry, which contains de-identified patient-level information on transplant recipients and deceased and living donors dating back to 1987 (19). We performed an analysis of a cohort of all individuals who were on the waiting list and received their first kidney transplant between April 1, 2012 and June 30, 2021. Restricting inclusion to kidney transplant recipients listed after April 1, 2012 ensured that their recorded citizenship classification reflected the modified categories of this variable. We excluded individuals with missing or unknown citizenship status and transplant tourists, or those categorized as “non-US citizen/non-US resident who traveled to the US for transplant.” Recipients of multiple organ transplants were excluded.

Exposure Variable

The primary exposure of interest was recipient citizenship status. Under the modified categorization, individuals were classified as 1. US citizen, 2. non-US citizen/US resident, 3. non-US citizen/non-US resident who traveled to the US for reason other than transplant, and 4. non-US citizen/non-US resident who traveled to the US for transplant. In this study, groups 1 and 2 were classified as citizen/residents and group 3 were presumed to be and categorized as undocumented immigrants. Group 4 was excluded.

Recipient, donor and transplant characteristics

Baseline recipient characteristics including age, gender, race/ethnicity, etiology of ESKD, blood type, dialysis vintage and insurance were examined from the registry. As data on participant sex was not available within the registry, gender was used. Donor characteristics of interest were donor type (deceased vs living), Kidney Donor Profile Index (KDPI), donation after circulatory death (DCD), and citizenship status. The following transplant characteristics were also examined: preemptive transplant, HLA mismatch, cold ischemia time ≥ 24 hours and delayed graft function (DGF). Categories of covariates used in the adjusted model are as exhibited in Table 1.

Graft and patient survival

The primary outcome of interest was all-cause graft loss. This was defined as graft failure, indicated on the registry as graft failure, return to dialysis or need for second transplant, or death. Death-censored graft failure and all-cause mortality were examined individually as secondary end points.

Statistical Analysis

Kaplan-Meier curves were constructed to visualize the unadjusted patient and graft survival stratified by citizenship status. The log-rank test was used to test the null hypothesis of no difference in all-cause graft loss and patient and graft survival between citizen/residents and undocumented immigrants. The Cox proportional hazards model was used to estimate unadjusted and adjusted hazard ratios for all-cause graft failure and patient and graft survival comparing citizen/residents to undocumented immigrants. We used sequential models of adjustment for various covariates, modeled after those developed by Shen, et al. in their study (17). In addition to the 1. unadjusted model, the following models were used for analysis: (2) adjusted for patient factors including age, gender, ESKD etiology and BMI, (3) model 2 plus dialysis factors including pre-transplant dialysis and dialysis vintage, (4) model 3 plus transplant factors including HLA zero mismatch, living donor, KDPI and cold ischemia time. Insurance was not included in these models as a confounder because we hypothesized that this was in the causal pathway in the relationship of interest.

RESULTS

A total of 123,121 individuals received a first single-organ kidney transplant within the study period. Of these individuals, 122,732 kidney transplant recipients met inclusion criteria. 366 individuals were categorized as ‘non-US citizen/non-US resident who traveled to the US for transplant’ and were excluded. Of the included individuals, 121,298 (98.8%) were US citizen/residents and 1,434 (1.2%) were non-US citizen/non-US residents presumed to be undocumented immigrants (Table 1). Undocumented immigrant recipients within our study cohort were younger (39 vs. 54 years) and more frequently Hispanic (78.5 vs. 17.3%) compared

to citizen/residents. Hypertension was the most common etiology of ESKD among undocumented immigrants (30.8%), whereas ESKD due to diabetes was most common among citizen/residents (28.4%). More undocumented immigrants had other/unknown ESKD etiology compared to citizen/residents (21.7 vs 16.1%). Undocumented immigrants more often relied on private insurance (43.2 vs 34.4%) or Medicaid (39.5 vs 6.3%) as primary payer over Medicare (12.6 vs 57.2 %). Preemptive (5.4 vs 19.2%) and living donor (25.4 vs 35.5%) transplants were less common among undocumented immigrants and they tended to experience longer dialysis duration prior to transplant. Transplant characteristics, including panel-reactive antibody (PRA) profile and prevalence of HLA zero mismatch and long cold ischemia time, were similar between the two groups. Transplant recipients who were undocumented immigrants were more likely to have received an organ from a donor with undocumented status compared to citizen/resident transplant recipients (3.3 vs 0.4%). The proportion of undocumented immigrants among all kidney transplant recipients was highest in California (35.1%), Illinois (9.6%) and New York (9.4%).

A total of 115 undocumented immigrants and 18,276 citizen/residents experienced all-cause graft loss during a median follow-up time of 2.69 [1.0, 4.5] and 2.07 [1.0, 4.0] years respectively. Among the undocumented immigrants, 76 incidents of these cases were attributed to death-censored graft loss and there were 48 deaths. 9,335 citizen/residents experienced death-censored graft loss and 11,721 died during the study period. The Kaplan-Meier survival curves (Figure 1) demonstrate superior unadjusted composite graft ($p < 0.0001$, log-rank test), patient ($p < 0.0001$) and death-censored graft survival ($p = 0.008$) among undocumented immigrants. In the unadjusted Cox regression model, undocumented status was associated with a reduced hazard of all-cause graft loss, all-cause mortality and death-censored graft loss, with respective HRs

(95% CI) of 0.57 (0.48-0.69), 0.38 (0.28-0.50) and 0.74 (0.59-0.93) (Table 2). When adjusted for demographic, dialysis and transplant factors, the associations between undocumented status and all-cause graft loss and all-cause mortality were only slightly attenuated. Adjustment for these factors did not alter the association with death-censored graft loss.

DISCUSSION

This study is the first study to describe the national landscape of kidney transplant recipients among undocumented immigrants in the United States since OPTN's mandatory reporting of citizenship status went into effect in 2012. 1.17% of first single-organ kidney transplant recipients between 2012 and 2021 were presumed to have undocumented status. Undocumented immigrants had superior early patient and graft survival compared to US citizen/residents.

We found that recipients who are undocumented immigrants differed from citizen/residents in many demographic and pre-transplant characteristics. Undocumented immigrants in our cohort were younger with a lower proportion of diabetic nephropathy and obesity, which is consistent with findings from previous analysis of different cohorts of adult kidney transplant recipients who are undocumented immigrants (15,17). The higher prevalence of unknown or 'other' ESKD etiology among undocumented immigrants suggests late presentation to care due to barriers to healthcare access among this population (16). Given the current national policy barring undocumented immigrants from federal health insurance programs, it is not surprising that a disproportionate number of recipients with undocumented status relied on private or state-sponsored (Medicaid) insurance. Undocumented immigrants had longer dialysis duration and were less likely to receive pre-emptive and living donor transplantation, highlighting the disparity in care even among those who reach transplantation.

Our study contributes to the growing body of evidence that kidney transplant recipients who are undocumented immigrants do not have inferior outcomes than their counterparts who are US citizens and residents (15–17,20). In our study, undocumented immigrants had superior survival free of all-cause graft loss, as well all-cause mortality and death-censored graft loss when examined individually. The association between citizenship status and all-cause graft loss and all-cause mortality was strongest in the unadjusted model, presumably due to differences in baseline health status and risk factors such as age, BMI and ESKD etiology. However, this association remained when adjusted for potential confounders. Nonetheless, it could be speculated that this population of kidney transplant recipients likely represents a select subset with higher education level or secure employment, and equipped with financial and social resources needed to reach transplantation. Our findings support the argument that undocumented status is not associated with poorer outcome, and therefore it in itself should not be used as criteria of exclusion for health coverage needed for transplantation.

Our study has a number of limitations. First, because citizenship status is sensitive information and has implications for potential life-changing consequences such as deportation, there is likely a number of undocumented immigrants who were misclassified as citizen/residents. The way citizenship information is collected varies across transplant centers, leading to varying levels of inaccuracy. However, the most recent citizenship categorizations under UNOS have been validated by Lee et al. to have a 93% positive predictive value based on patient-level chart review at two transplant centers in California (21). Regardless, this type of differential misclassification of exposure status most likely leads to attenuation of the association but unlikely to have affected the directionality of the association. Secondly, our analysis only included kidney transplant recipients and excluded undocumented immigrants with ESKD who

have not undergone transplantation. This exclusion comprises individuals who were: not referred for transplant evaluation or were denied transplant listing by a transplant center on basis of their immigration status; or were listed but have not yet received a transplant. Examining this population of potential kidney transplant candidates is an important next step in further quantifying the degree of disparity and characterizing the barriers along the transplant process for undocumented immigrants. Lastly, the median follow-up among our study population was short. Analysis of outcomes over a longer follow-up period may be needed for a more comprehensive understanding of outcomes, given that median kidney allograft survival typically ranges from 9.7 to 12.9 years (22). This is particularly important when considering this population as an earlier study highlighted later loss of insurance coverage as a major cause of later graft loss (16).

CONCLUSION

Undocumented immigrants in the US who underwent a kidney transplant had favorable short-term graft and patient survival compared to their citizen/resident counterparts. While there were considerable baseline differences between undocumented immigrants and citizen/residents, we observed that undocumented status was not associated with poorer outcomes after adjustment for potential confounding by these differences. While further research is needed to identify the impact of pre-transplant barriers among undocumented immigrants, these results refute the notion that they should be excluded as transplant candidates due their higher risk of poor outcomes.

Table 1– Baseline demographic and transplant characteristics of first single-organ kidney transplant recipients between April 2012 and June 2021, stratified by citizenship status

	US Citizen/residents (n=121,298)	Undocumented Immigrants (n=1,434)
Age, years *	54 [41, 63]	39 [31, 49]
Age, years		
≤5	1,167 (1.0)	3 (0.2)
6-11	1,292 (1.1)	11 (0.8)
12-17	2,510 (2.1)	27 (1.9)
18-34	13,908 (11.5)	411 (28.7)
35-49	27,869 (23.0)	620 (43.2)
50-64	45,473 (37.5)	297 (20.7)
≥65	29,079 (24.0)	65 (4.5)
Male sex, n (%)	74,176 (61.2)	917 (63.9)
Race/ethnicity, n (%)		
White	57,546 (47.4)	78 (5.4)
Black	32,039 (26.4)	85 (5.9)
Hispanic	20,963 (17.3)	1,126 (78.5)
Asian	8,009 (6.6)	137 (9.6)
Amer Indian/Alaska Native	1,013 (0.8)	0 (0)
Native Hawaiian/other Pacific Islander	533 (0.4)	4 (0.3)
Multiracial	1,195 (1.0)	4 (0.3)
Etiology of ESKD, n (%)		
Hypertension (HTN)	25,421 (21.0)	442 (30.8)
Diabetes (DM)	34,414 (28.4)	180 (12.6)
Congenital/Hereditary	4,633 (3.8)	55 (3.8)
Glomerulonephritis (GN)	17,518 (14.4)	278 (19.4)
Focal segmental glomerulosclerosis (FSGS)	8,308 (6.8)	103 (7.2)
Polycystic kidney disease (PKD)	11,501 (9.5)	65 (4.5)
Other/Unknown	19,503 (16.1)	311 (21.7)
Insurance, n (%)		
Private	41,617 (34.3)	619 (43.2)
Medicare	69,336 (57.2)	181 (12.6)
Medicaid	7,645 (6.3)	566 (39.5)
Other or unknown	2,700 (2.2)	68 (4.7)
BMI, n (%)		
<18.5	4,945 (4.1)	79 (5.6)
18.5-24.9	30,308 (25.4)	655 (46.2)
25-29.9	38,311 (32.0)	461 (32.5)
30-39.9	43,500 (36.4)	217 (15.3)
≥40	2,472 (2.1)	7 (0.5)
Preemptive transplant, n (%)	23,294 (19.2)	78 (5.4)

Dialysis duration, n (%)		
≥1 year	80,742 (66.6)	1,224 (85.4)
<1 year	16,886 (13.9)	127 (8.9)
Unknown or no dialysis	23,670 (19.5)	83 (5.8)
Blood type, n (%)		
A	45,512 (37.5)	417 (29.1)
AB	6,431 (5.3)	47 (3.3)
B	16,370 (13.5)	153 (10.7)
O	52,985 (43.7)	817 (57.0)
Wait time, n (%)		
<1 year	6,6372 (54.7)	809 (56.4)
1-2 years	22,465 (18.5)	240 (16.7)
>2 years	32,461 (26.8)	385 (26.8)
Living donor, n (%)	43,048 (35.5)	364(25.4)
PRA, n (%)		
<1%	82,577 (68.6)	981 (68.5)
1-20%	11,303 (9.4)	129 (9.0)
21-80%	17,422 (14.5)	217 (15.2)
>80%	9,148 (7.6)	105 (7.3)
Unknown	848 (0.7)	2 (0.1)
HLA 0 mismatch, n(%)	6,099 (5.1)	66 (4.6)
Cold ischemia time ≥24 hours	16,786 (14.0)	206 (14.5)
KDPI, n (%)		
<20%	18,538 (15.3)	376 (26.2)
20-34%	14,343 (11.8)	221 (15.4)
35-85%	39,585 (32.6)	433 (30.2)
>85%	5,783 (4.8)	40 (2.8)
Unknown	43,049 (35.5)	364 (25.4)
Donation after circulatory death (DCD), n (%)	18,983 (24.3)	230 (21.5)
Delayed graft function (DGF), n (%)	22,684 (18.7)	313 (21.8)
Undocumented donor, n (%)	445 (0.4)	48 (3.3)
Follow-up years*	2.69 [1.0, 4.5]	2.07 [1.0, 4.0]

*Median [IQR]

Figure 1- Kaplan-Meier Curves for All-Cause Graft Loss, All-Cause Mortality and Death-Censored Graft Loss

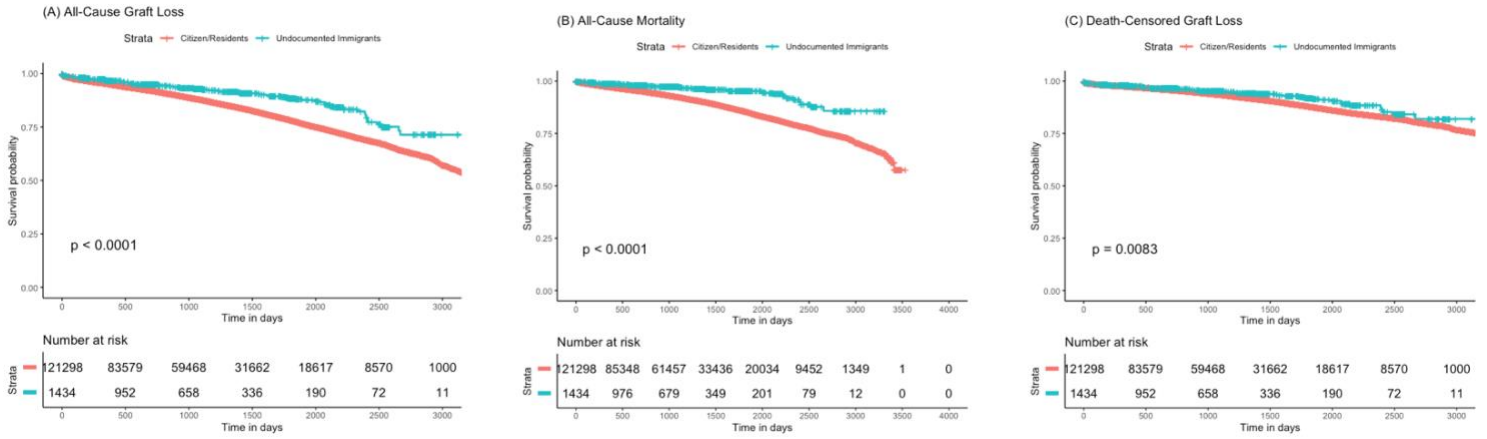


Table 2 – Hazard Ratios for All-Cause Graft Loss, All-Cause Mortality and Death-Censored Graft Loss in Undocumented Immigrants vs. US Citizen/Residents

Cox Proportional Hazards Model	All-Cause Graft Loss			All-Cause Mortality			Death-Censored Graft Loss		
	HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Unadjusted	0.57	0.48–0.69	<0.001	0.38	0.28–0.50	<0.001	0.74	0.59–0.93	0.009
Adjusted for demographic factors*	0.73	0.61–0.88	<0.001	0.71	0.54–0.95	0.019	0.71	0.56–0.89	0.003
Adjusted for demographic and dialysis factors †	0.64	0.53–0.77	<0.001	0.62	0.47–0.82	0.001	0.62	0.49–0.78	<0.001
Adjusted for demographic, dialysis and transplant factors	0.67	0.55–0.82	<0.001	0.67	0.50–0.90	0.009	0.62	0.48–0.81	<0.001

*demographic factors: age category (<5, 6-11, 12-17, 18-34, 35-49, 50-64, ≥65), gender, ESKD category (HTN, DM, congenital/hereditary, GN, FSGS, PKD, unknown/other), BMI category (<18.5, 18.5-24.9, 25-29.9, 30-39.9, ≥40)

† dialysis factors: pre-transplant dialysis, dialysis vintage (≥1 year, <1 year, no dialysis/unknown)

‡ transplant factors: HLA zero mismatch, living donor, KDPI category (<20, 20-34, 35-85, >85%), cold ischemia time ≥24 hours

References

1. Profile of the Unauthorized Population - US [Internet]. migrationpolicy.org. [cited 2023 May 22]. Available from: <https://www.migrationpolicy.org/data/unauthorized-immigrant-population/state/US>
2. Rodriguez R, Cervantes L, Raghavan R. Estimating the prevalence of undocumented immigrants with end-stage renal disease in the United States. *Clin Nephrol*. 2020 Jan 1;93(1):108–12.
3. Tonelli M, Wiebe N, Knoll G, Bello A, Browne S, Jadhav D, et al. Systematic review: kidney transplantation compared with dialysis in clinically relevant outcomes. *Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg*. 2011 Oct;11(10):2093–109.
4. Wyld M, Morton RL, Hayen A, Howard K, Webster AC. A Systematic Review and Meta-Analysis of Utility-Based Quality of Life in Chronic Kidney Disease Treatments. *PLoS Med*. 2012 Sep 11;9(9):e1001307.
5. Axelrod DA, Schnitzler MA, Xiao H, Irish W, Tuttle-Newhall E, Chang SH, et al. An economic assessment of contemporary kidney transplant practice. *Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg*. 2018 May;18(5):1168–76.
6. Saran R, Robinson B, Abbott KC, Agodoa LYC, Bhave N, Bragg-Gresham J, et al. US Renal Data System 2017 Annual Data Report: Epidemiology of Kidney Disease in the United States. *Am J Kidney Dis Off J Natl Kidney Found*. 2018 Mar;71(3 Suppl 1):A7.
7. 2022 USRDS Annual Data Report [Internet]. USRDS. [cited 2023 May 22]. Available from: <https://adr.usrds.org/>
8. Ethics - Ethical Principles in the Allocation of Human Organs - OPTN [Internet]. [cited 2023 May 22]. Available from: <https://optn.transplant.hrsa.gov/professionals/by-topic/ethical-considerations/ethical-principles-in-the-allocation-of-human-organs/>
9. Hart A, Gustafson SK, Wey A, Salkowski N, Snyder JJ, Kasiske BL, et al. The association between loss of Medicare, immunosuppressive medication use, and kidney transplant outcomes. *Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg*. 2019 Jul;19(7):1964–71.
10. Charnaya O, Verghese P, Goldberg A, Ladin K, Porteny T, Lantos JD. Access to Transplantation for Undocumented Pediatric Patients. *Pediatrics*. 2020 Jul 1;146(1):e20193692.
11. Yu E, Wightman A. Pediatric kidney transplant in undocumented immigrants: An American perspectives. *Pediatr Transplant* [Internet]. 2021 Feb [cited 2023 May 22];25(1). Available from: <https://onlinelibrary.wiley.com/doi/10.1111/petr.13788>
12. Bruschein H, Chen G, Yost J. Social support and transplantation. *Curr Opin Organ Transplant*. 2022 Dec;27(6):508–13.

13. Ladin K, Daniels A, Osani M, Bannuru RR. Is social support associated with post-transplant medication adherence and outcomes? A systematic review and meta-analysis. *Transplant Rev Orlando Fla.* 2018 Jan;32(1):16–28.
14. Whelan AM, Johansen KL, Brar S, McCulloch CE, Adey DB, Roll GR, et al. Association between Longer Travel Distance for Transplant Care and Access to Kidney Transplantation and Graft Survival in the United States. *J Am Soc Nephrol.* 2021 May;32(5):1151–61.
15. Eguchi N, Tantisattamo E, Chung D, Reddy UG, Ferrey A, Dafoe D, et al. Outcomes Among Undocumented Immigrant Kidney Transplant Recipients in California. *JAMA Netw Open.* 2023 Feb 13;6(2):e2254660.
16. McEnhill ME, Brennan JL, Winnicki E, Lee MM, Tavakol M, Posselt AM, et al. Effect of Immigration Status on Outcomes in Pediatric Kidney Transplant Recipients. *Am J Transplant.* 2016 Jun;16(6):1827–33.
17. Shen JI, Hercz D, Barba LM, Wilhalme H, Lum EL, Huang E, et al. Association of Citizenship Status With Kidney Transplantation in Medicaid Patients. *Am J Kidney Dis.* 2018 Feb;71(2):182–90.
18. policy-notice_ahirc_guidance-document.pdf [Internet]. [cited 2023 May 22]. Available from: https://optn.transplant.hrsa.gov/media/1syaohhl/policy-notice_ahirc_guidance-document.pdf
19. Data request instructions - OPTN [Internet]. [cited 2023 May 25]. Available from: <https://optn.transplant.hrsa.gov/data/view-data-reports/request-data/data-request-instructions/>
20. Luce MS, Kleber KT, Abdallah AC, Basmaci UN, Perez RV, Troppmann C. Outcomes of Kidney Transplant in Undocumented Immigrants. *JAMA Surg.* 2021 Nov 1;156(11):1063–4.
21. Lee BP, Terrault NA. Liver Transplantation in Unauthorized Immigrants in the United States. *Hepatology.* 2020 May;71(5):1802–12.
22. Poggio ED, Augustine JJ, Arrigain S, Brennan DC, Schold JD. Long-term kidney transplant graft survival-Making progress when most needed. *Am J Transplant Off J Am Soc Transplant Am Soc Transpl Surg.* 2021 Aug;21(8):2824–32.