Racial Disparity in Liver Transplantation Listing

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Brief title: Disparity in Liver Transplantation

Background: Previous studies have demonstrated disparities in transplantation for women, non-Caucasians, the uninsured or publicly insured, and rural populations. We sought to correlate transplant center characteristics with patient access to the waiting list and liver transplantation.

Hypothesis: Liver transplant centers vary greatly in providing equitable access to the waiting list and liver transplantation.

Study Design: Center-specific adult deceased donor liver transplant and waitlist data for the years 2013 to 2018 were obtained from the Scientific Registry of Transplant Recipients. Waitlist race/ethnicity distributions from liver transplant centers performing ≥250 transplants over this period (n=109) were compared with those of their Donor Service Area, as calculated from 5-year US Census Bureau estimates of 2017. Center-specific characteristics correlated with disparities were analyzed using a linear regression model with a log transformed outcome.

Results: Non-Hispanic Blacks (NHBs) are *underrepresented* in liver transplant listing compared to center Donation Service Area (88/109, 81%), whereas non-Hispanic Whites are *overrepresented* (65/109, 58%) ($p<0.0001$). Hispanics were also underrepresented on the waitlist at the majority of transplant centers (68/109, 62%) ($p=0.02$). While the racial/ethnic distribution of transplantation is more reflective of the waitlist, there is a higher than expected rate of transplantation for NHBs compared to the waitlist. Predictors of disparity in listing include percentage of transplant recipients at the center who had private insurance, racial composition of the Donation Service Area, and the distance recipients had to travel for transplant.

Conclusions: Non-Hispanic Blacks are listed for liver transplantation less than would be expected. Once listed, however, racial disparities in transplantation are greatly diminished. Improvements in access to adequate health insurance appears to be essential to diminishing disparities in access to this life-saving care.

Keywords: race, disparities, racial disparity, liver transplantation, transplant listing, access to care, transplant center, transplant waitlist

Introduction

In 2020, the Organ Procurement and Transplantation Network (OPTN) implemented a new allocation system for liver transplantation based on concentric circles of geographic proximity rather than somewhat arbitrarily delineated Donor Service Areas (DSAs) (1). Although this was a step towards improving and equalizing access to life saving organs for those on the liver transplant waitlist, the listing process determining which patients will be considered for transplantation has continued to be a significant hurdle.

The process in which patients with liver disease are considered for organ transplantation is rife with impediments to equal access to listing. At present, a patient with hepatic dysfunction must first obtain physician referral to a transplant center; once evaluated and deemed appropriate by the center's medical review board, the patient is then registered with the United Network for Organ Sharing (UNOS) and placed on the national waitlist (2). The process, while intended to safeguard a precious resource, potentiates inequity in liver transplant listing: access to primary care is necessary for patients to be diagnosed, much less to be considered by transplant centers, and transplant centers may deem patients as appropriate or inappropriate for transplantation based on often subjective criteria. These sources of potential disparity necessitate investigation.

Access to liver transplant listing has been investigated by groups such as Mathur et al., who showed that older patients and African Americans have lower access to the waitlist in comparison to younger patients and Whites in the United States (3). Similarly, Bryce et al. found that candidates who were female, black, or uninsured were less likely to undergo evaluation and waitlisting for liver transplantation than their male, white, or commercially insured counterparts (4). These are only a few examples of studies that have demonstrated disparity in listing,

highlighting the need for scrutiny of the process. Whether individual centers or types of centers provide more or less equitable access, however, has not been investigated.

Herein, we aim to investigate transplant centers involved in listing patients for liver allocation. We examine the characteristics of liver transplant centers and correlate these characteristics with trends in waitlisting and subsequent liver transplantation disparities. We hypothesize that liver transplant centers vary greatly in providing equitable access to the liver transplant waiting list. We propose that awareness of this phenomenon may serve to improve transplant center practices and assist in ameliorating disparity in the liver transplant waitlisting process.

Methods

To address access to the liver transplant waiting list amongst various centers, center-specific adult deceased donor liver transplant and waitlist data were obtained from the Scientific Registry of Transplant Recipient (SRTR) files for cases between January 2013 and December 2018. Liver transplant centers performing > 250 transplants over this period were analyzed. Veteran Affairs hospitals were excluded as access to those waitlists are limited by affiliation. Auxilio Mutuo Hospital was also excluded because its nearly 100% Hispanic population DSA made it an extreme outlier relative to the rest of the US hospitals.

Waitlist race/ethnicity, poverty, education level, and insurance coverage were the primary variables compared with those of the center's DSA, as calculated from US Census Bureau American Community Survey 5-year estimates published in 2017. DSA counties were taken from UNOS Organ Procurement Organization (OPO) fact sheets. Center waitlist and transplant recipient

data were received from UNOS SRTR files. The SRTR files based on OPTN data as of March 15, 2019 were used.

Center-specific characteristics correlated with disparities were analyzed using multiple logistic regression models. Specifically, a random-effects model was used to derive empirical Bayes shrinkage estimates for rates in each race/ethnicity and transplant center. Observed/Expected (O/E) ratios were determined, where O = adjusted rate from the empirical Bayes estimator and E = expected rate of the race/ethnicity in question from the population DSA. Univariate and multivariate analyses were conducted to identify significant predictors. For multivariable modeling, the natural log of the O/E ratio was chosen as outcome to meet model assumptions of homoscedastic and normally distributed residuals. Model covariates included OPO status (single-center versus multiple centers), center type (Academic-State, Academic-Private, Non-academic), mean MELD and age at listing and transplant, percent waitlist with hepatocellular carcinoma (HCC), private insurance, percent public insurance, percent DSA in poverty, education level, and mean distance traveled. Mean MELD at transplant (correlated with mean MELD at listing), center percent of transplant recipients on government insurance (correlated with private insurance), and mean age at transplant (correlated with age at listing) were excluded due to lack of independence. The socioeconomic indicators of poverty, insurance, and education were also highly covariate, complicating their separate introduction into a multivariate analysis. To combat this, a single Socioeconomic Status (SES) variable that is the sum of the normalized values of %poverty+%no college degree+%public/no insurance was utilized for analysis. This created a variable centered at 0 and varying from -6 to about 4 that roughly ranked the donor service area from least to most disadvantaged. Statistical analysis was conducted in SAS version 9.4 software.

Results

One-hundred and nine transplant centers were included in the analysis, with 30,353 patients listed at these centers. Of the patients on the waitlist for liver transplantation during this time, 20,941 (69%) were Non-Hispanic White, 2408 (7.9%) were Non-Hispanic Black, 5161 (17%) were Hispanic, and 1843 (6.1%) were in other racial/ethnic categories. For comparison, the overall national racial/ethnic distribution from the 2017 Census is 61.5% Non-Hispanic White, 12.3% Non-Hispanic Black, 17.6% Hispanic, and 8.6% in other racial/ethnic categories. The primary and secondary outcome variables studied among the waitlisted patients are listed in Table 1. During the study period, there were 34,359 liver transplant operations: 24,360 (70.9 %) were in Non-Hispanic Whites, 3,229 (9.4 %) were in Non-Hispanic Black, 4,810 (14.0 %) were in Hispanic, and 1,960 (5.7 %) were in other racial/ethnic categories.

Of the centers, 41 were academic institutions with a state affiliation, 30 were academic institutions with no state affiliation, and 38 were transplant programs with no primary academic/university affiliation. Twenty-one (19%) centers were in single-center DSAs and 88 (81%) were in multicenter DSAs. Other overall characteristics of the centers' waitlist population such as illness acuity, demographics, and socioeconomic status are listed in Table 1.

As depicted in Figures 1 and 2, the Non-Hispanic Black (NHB) were underrepresented on the waitlist when compared to the population of the DSA at large. The O/E ratio of NHBs on the waitlist was less than 1 across the vast majority of centers (88/109, 81%); conversely, the O/E ratio of NHBs on the waitlist was greater than 1 in 21/109 (19%) of centers ($p < 0.0001$). Though the differences were not as large as in NHBs, Hispanics were also underrepresented on the waitlist when compared to the population of the DSA (Figure 3). The O/E ratio of Hispanics on the waitlist was less than 1 at the majority of transplant centers (68/109, 62%); conversely, the O/E ratio of

Hispanics on the waitlist was greater than 1 in 41/109 (38%) of center ($p = 0.022$). This is compared to Non-Hispanic Whites (NHW), for whom the O/E ratio for listing was less than 1 in a minority of centers (49/109, 45%), whereas the O/E ratio of NHWs on the waitlist was greater than 1 in 60/109 (55%) of centers ($p = 0.152$).

On univariate analysis, DSA characteristics associated with NHB waitlist disparities were percent population with private insurance (more private insurance associated with increase in O/E), the NHB percentage of the DSA population, and percent poverty (lower poverty associated with increase in O/E). Center-specific variables with statistically significant correlation with waitlist O/E included mean miles traveled for transplant (fewer miles traveled associated with increase in O/E) and percent of transplant recipients with private insurance. (Table 2)

With respect to waitlist disparities for Hispanics, on univariate analysis, DSA characteristics associated with greater disparity included percent population with private insurance (more private insurance associated with decrease in O/E) and education levels (percent with no high school diploma was associated with increase O/E, whereas high school diploma was associated with decrease in O/E). Center-specific variables with statistically significant correlation with waitlist O/E included the type of DSA (being the only center in the DSA is associated with lower O/E), mean MELD at transplant (higher MELD associated with higher O/E), and percent of transplant recipients with government or private insurance (Table 3).

Building the multivariate model resulted in the suggestion that the NHB O/E ratio i) decreases with increasing percentage of the center's transplant recipients who are privately insured, ii) with an increasing distance the recipients must travel for transplantation, and iii) with an increasing percentage of the NHB population in the DSA (Table 4). For the Hispanic population, O/E ratio decreases with increasing percentage of the center's transplant recipients

who are privately insured. There did not appear to be any correlation with the SES score, DSA type, mean MELD or age at transplant, or the percentage of cancer patients transplanted at that center (Table 5).

In examining the disparities in transplantation once patients were listed, we found a much more equitable distribution (Figure 1D-F). Looking at univariate or multivariate predictors of O/E, we found no statistically significant variables in either the NHB or the Hispanic populations. Consistent with the hypothesis that NHBs are underrepresented on the waitlist is the finding that NHBs are overrepresented with regard to being transplanted as compared to the waitlist. Across all hospitals, 9.8% were NHBs, compared to 7.9% on the waitlist ($p < 0.0001$). In the same vein, the number of hospitals where the transplanted percentage of NHBs exceeds the waitlisted percentage in 71/109 (65%, $p = 0.002$). In comparison, the number of hospitals where the transplanted percentage exceeds the waitlisted percentage for NHWs is 40/109 (37%, $p = 0.007$).

Non-Hispanic Black underrepresentation on the waitlist is also supported by the finding that mean MELD at listing is significantly different between minority populations and NHW (NHW 18.7 ± 9.5, NHB 20.2 ± 10.7, and Hispanic 19.4 ± 9.9, $p < 0.0001$). While differences in MELD at transplant are also statistically significant, the magnitude of the differences are much smaller (NHW 21.5 ± 11.2, NHB 22.7 ± 12.2, and Hispanic 22.8 ± 12.0, $p < 0.0001$).

Discussion

Access to liver transplantation is, in part, regulated by the transplant waitlist. However, few studies have scrutinized the center and DSA-specific factors that contribute to racial and ethnic disparities in listing transplant candidates. The analysis of the data described in this report confirms that there are significant disparities in listing patients for liver transplantation and in transplanting

patients on the list. Non-Hispanic Blacks are listed for liver transplantation less than would be expected based on the population of their DSA, in contrast to NHWs, who tend to be overrepresented.

The predictors for O/E are slightly different for the groups. The findings suggest that the NHB O/E ratio declines (and disparity grows) with increasing percentage of transplants in which the recipient is privately insured, and with an increasing mean number of miles that recipients must travel for transplant. The same trend exists with Hispanic populations but is reversed in the NHW group. It appears that with increasing frequency of listing those with private insurance at a center, the greater the disparity between minority populations and NHW at that center.

This phenomenon has been observed previously by Emani et al. in investigating survival outcomes while candidates awaited cardiac transplantation. There, Medicaid insurance status was associated with poor survival, particularly in comparison with the privately insured on the waitlist (5). Similar findings were observed by Gutin et al. in 2019, who found that patients with hepatocellular carcinoma who had public insurance had a higher incidence of dropping off the waiting list due to tumor progression in comparison with those who were privately insured (6). This is also true when looking at the risk of being delisted overall due to death or clinical deterioration (7). These disparities in listing and transplantation associated with insurance status are multifactorial but are likely associated with the lower reimbursement that transplant centers face for publicly insured recipients (8).

Another predictor of lower O/E amongst minority groups derived from our data was decreased listing with increased distance from a transplant center. In patients with chronic liver failure who were already listed, Goldberg et al found that increasing distance from transplant centers led to significantly higher mortality compared to those who lived < 150 miles from a center,

and this was attributed to access to gastroenterologist/hepatologist care during episodes of decompensated cirrhosis (9). It appears that those who live further from transplant centers have lower access to complex care and may further be sicker at time of listing and transplantation. This hypothesis is further supported by the higher MELD at listing for NHBs and Hispanics and may be due to late referrals by their local physicians. These data together highlight a need for focused efforts to increase access to care for underserved populations, perhaps by implementing more aggressive outreach to patients in the form of mobile clinics or telemedicine, or educational efforts geared towards primary care and other referring providers. These findings also provide further argument to bolster the smaller liver transplant centers with smaller population bases in order to ameliorate some of the exaggerated hardships caused by the need to travel faced by underrepresented populations.

A potentially alarming finding derived from the data is that disparities in listing NHBs increase with increasing percentage of NHBs in the DSA population. Whether this is due to increasing inequalities in access to care in the larger Black populations around the country, or due to worse functional segregation in these areas independent of poverty or socioeconomic levels, demands closer examination.

Our study is by nature limited by its retrospective nature and the limitations of the data collected by SRTR. One major limitation is the inability to distinguish the types of government insurance, whether Medicare or Medicaid, from the database. Furthermore, the assumption that the transplant centers should serve the patient population of the DSA is limited by some other geographic factors, for example the fact that some DSAs have multiple centers who may serve different populations within that area or the fact that populations from one DSA may find it more convenient to cross to another DSA for easier access to a transplant center. One factor that has not

been incorporated is whether the prevalence of liver disease is evenly distributed among NHWs, NHBs, and Hispanics. In fact, if anything, NAFLD is more prevalent in Hispanics compared with non-Hispanics (10-12). A meta-analysis of 34 studies including 368,569 unique patients in the United States found a significant racial/ethnic disparity in the prevalence and severity NAFLD with the highest burden of NAFLD observed among Hispanics (13). Conversely, HCV disproportionately affects non-Hispanic Blacks (14). This emphasizes the need for increased efforts to reach the underserved.

Conclusions

Data from this study show that the waitlists at many transplant centers in the United States underrepresent minority populations compared with what would be expected based on their service areas. These disparities stem at least in part from the populations being publicly insured and geographically distant from transplant centers. While it is somewhat encouraging that the disparities in access to transplantation greatly diminish after listing, the initial impediments are likely to be more difficult to solve. Future work will need to be devoted to increasing awareness of these trends to promote equitable access to listing for liver transplantation.

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Table 1: Waitlist Characteristics for all Centers

Characteristic	**Data**
Waitlist race/ethnicity, n (%)	
Non-Hispanic white	20,941 (69.0)
Non-Hispanic black	2408 (7.9)
Hispanic	5161 (17.0)
Other	1843 (6.1)
O/E ratio of waitlist race/ethnicity, mean (SD)	
Unadjusted black O/E ratio	0.78 (0.87)
Adjusted black O/E ratio	0.81 (0.82)
Unadjusted Hispanic O/E ratio	0.89 (0.55)
Adjusted Hispanic O/E ratio	0.93 (0.51)
Unadjusted white O/E ratio	1.0 (0.24)
Adjusted white O/E ratio	1.0 (0.24)
DSA type, n (%)	
Single center	21 (19.3)
Multiple centers	88 (80.7)
Center type, n (%)	
Academic state	41 (37.6)
Academic private	30 (27.5)
Private	38 (34.9)
MELD at transplant, mean (SD)	23.8 (2.5)
MELD at listing, mean (SD)	19.0 (1.6)
Waitlist with HCC, % (SD)	26 (8)
Age at transplant, y, mean (SD)	55.4 (1.4)
Age at listing, y, mean (SD)	55.4 (1.1)
Center transplanted patient insurance, % (SD)	
Government (Medicare/Medicaid)	46 (12)
Private	52 (11)
Distance traveled, mi, mean (SD)	144 (75.3)
DSA insurance distribution, % (SD)	
Private	61 (6)
Public	30 (4)
No insurance	9 (4)
DSA poverty, % (SD)	13 (5)
Education level (DSA), % (SD)	
No high school diploma	12 (3)
High school diploma	48 (5)
College degree	40 (5)

N = 109 liver transplant centers, N = 30,353 unique patients listed for liver transplantation.
DSA, donor service area; HCC, hepatocellular carcinoma, MELD, Model for End-Stage Liver Disease; O/E, observed/expected

Table 2: Univariate Correlation between Adjusted Non-Hispanic Black Waitlist Observed/Expected Ratio and Transplant Center/Donor Service Area Characteristics

Center characteristic	**Association with NHB O/E ratio**	**p Value**
DSA type		0.659
Single center		
Mean (SD)	0.81 (0.56)	
Median [IQR]	0.68 [0.40, 0.91]	
Range	0.17, 2.6	
Multi center		
Mean (SD)	0.81 (0.88)	
Median [IQR]	0.63 [0.41, 0.95]	
Range	0.09, 5.7	
Center type		0.617
Academic-State		
n (%)	41 (37.6)	
Mean (SD)	0.77 (0.85)	
Median [IQR]	0.63 [0.40, 0.91]	
Range	0.09, 5.7	
Academic-Private		
n (%)	30 (27.5)	
Mean (SD)	0.77 (0.45)	
Median [IQR]	0.64 [0.47, 0.97]	
Range	0.33, 2.6	
Private		
n (%)	38 (34.9)	
Mean (SD)	0.90 (1.0)	
Median [IQR]	0.65 [0.36, 1.1]	
Range	0.10, 5.2	
Mean MELD at transplant, Spearman correlation	0.03	0.736
Mean MELD at listing, Spearman correlation	0.09	0.357
% NHB population in DSA, Spearman correlation	-0.60	<0.001*
% Waitlist with HCC, Spearman correlation	0.13	0.192
Mean age at transplant, Spearman correlation	- 0.08	0.404
Mean age at listing, Spearman correlation	-0.10	0.279
Center transplanted patient insurance, Spearman correlation		
Government (Medicare/Medicaid)	0.17	0.072*
Private	-0.24	0.014*
Mean miles traveled, Spearman correlation	-0.24	0.012*
DSA insurance distribution %, Spearman correlation		
Private	0.21	0.029
Public	-0.10	0.292

No insurance	-0.18	0.060
DSA % poverty, Spearman correlation	-0.19	0.043*
Education level (% in DSA), Spearman correlation		
No high school diploma	-0.09	0.363
High school diploma	-0.10	0.282
College degree	0.10	0.311

*Statistically significant

DSA, donor service area; HCC, hepatocellular carcinoma; IQR, interquartile range; MELD, Model for End-Stage Liver Disease; NHB, non-Hispanic Black; O/E, observed/expected.

Table 3: Univariate Correlation between Adjusted Hispanic Waitlist Observed/Expected Ratio and transplant center/DSA characteristics.

Center characteristic	**Association with Hispanic O/E ratio**	**p Value**
DSA type		0.041*
Single OPO		
Mean (SD)	0.78 (0.59)	
Median [IQR]	0.73 [0.49, 0.92]	
Range	0.10, 3.0	
Multi-OPO		
Mean (SD)	0.96 (0.49)	
Median [IQR]	0.89 [0.56, 1.3]	
Range	0.16, 2.3	
Center type		0.993
Academic-state		
n (%)	41, (37.6)	
Mean (SD)	0.94 (0.60)	
Median [IQR]	0.82 [0.51, 1.3]	
Range	0.10, 3.0	
Academic-private		
n (%)	30 (27.5)	
Mean (SD)	0.93 (0.50)	
Median [IQR]	0.82 [0.54, 1.2]	
Range	0.28, 2.3	
Private		
n (%)	38 (34.9)	
Mean (SD)	0.91 (0.44)	
Median [IQR]	0.84 [0.64, 1.1]	
Range	0.16, 2.1	
Mean MELD at transplant, Spearman correlation	0.20	0.030*
Mean MELD at listing, Spearman correlation	0.07	0.495
% Hispanic Population in DSA, Spearman correlation	0.17	0.085
% Waitlist with HCC, Spearman correlation	0.10	0.306
Mean age at transplant, Spearman correlation	-0.05	0.611
Mean age at listing, Spearman correlation	0.002	0.978
Center transplanted patient insurance, Spearman correlation		
Government (Medicare/Medicaid)	0.43	<0.0001*
Private	-0.35	0.0002*
Mean miles traveled, Spearman correlation	0.05	0.615

DSA Insurance Distribution, Spearman correlation		
Private	-0.21	0.027*
Public	0.11	0.109*
No insurance	0.11	0.073*
Percent poverty, Spearman correlation	-0.09	0.344
Education level (DSA), Spearman correlation		
No high school diploma	0.19	0.042*
High school diploma	-0.25	0.008*
College degree	0.08	0.395*

*Statistically significant

DSA, donor service area; HCC, hepatocellular carcinoma; IQR, interquartile range; MELD, Model for End-Stage Liver Disease; O/E, observed/expected; OPO, organ procurement organization

Table 4: Multivariate Analysis of Non-Hispanic Black Waitlist vs Donor Service Area Population

Covariate	**Estimated Effect on NHB O/E**	**p Value**
% poverty	Not significantly associated with O/E	0.672
DSA type	Not significantly associated with O/E	0.745
Center type	Not significantly associated with O/E	0.278
% NHB population in DSA	Log (O/E) declines 0.05 for each percentage point increase in black DSA (95% CI [-0.060, -0.034])	<0.0001*
Mean MELD at Transplant	Not significantly associated with O/E	0.269
% of waitlist with HCC	Not significantly associated with O/E	0.476
Mean age at transplant	Not significantly associated with O/E	0.380
Center percent transplanted patient with private insurance	Log (O/E) decreases 0.13 for each 10-percentage point increase (95% CI [-0.230, -0.027])	0.014*
Mean miles traveled	Log(O/E) decreases 0.02 for each 10-mile increase in mean distance (95% CI [-0.036, -0.005])	0.011*

Linear model results, non-Hispanic black (NHB) observed/expected (O/E). p value for overall model <0.0001, Adjusted $R^2 = 0.40$. The results are very similar if % poverty is replaced by % public/no insurance or by the composite socioeconomic status score.
*Statistically significant
DSA, donor service area; HCC, hepatocellular carcinoma; MELD, Model for End-Stage Liver Disease

Table 5: Multivariate Analysis of Hispanic Waitlist vs Donor Service Area Population

Covariate	**Estimated Effect on Hispanic O/E**	**p Value**
% Poverty	Not significantly associated with O/E	0.305
DSA type	Not significantly associated with O/E	0.195
Center type	Not significantly associated with O/E	0.998
% Hispanic population in DSA	Not significantly associated with O/E	0.485
Mean MELD at transplant	Not significantly associated with O/E	0.728
% waitlist with HCC	Not significantly associated with O/E	0.728
Mean age at transplant	Not significantly associated with O/E	0.731
Center percent transplanted patient with private insurance	Log (O/E) declines 0.18 for each 10-percentage point increase (95% CI [-0.281, -0.074])	0.001*
Mean miles traveled	Not significantly associated with O/E	0.210

Linear model results, Hispanic observed/expected (O/E). p Value for overall model = 0.050, adjusted $R^2 = 0.075$. The results are very similar if % poverty is replaced by % public/no insurance or by the composite socioeconomic status score.

*Statistically significant

DSA, donor service area; HCC, hepatocellular carcinoma; MELD, Model for End-Stage Liver Disease

Figure 1: Non-Hispanic blacks (A) and Hispanics (B) are underrepresented in liver transplant listing compared to the population of each center's donor service area (DSA) (A), whereas whites are overrepresented (C). The observed to expected distribution of race in liver transplantation compared to the waitlist population is closer to parity, though the transplantation rate of NHBs is higher than would be expected based on the percent of the waitlist (D, E, F). Tx, transplant.

Figure 2: Adjusted percent non-Hispanic blacks (NHBs) on waitlist (observed) vs NHBs in center donor service area (DSA) population (expected). Observed/expected < 1 at 88/109 (81%) of centers ($p < 0.0001$).

Figure 3: Adjusted percent Hispanic on waitlist (observed) vs Hispanic in center donor service area (DSA) population (expected). Observed/expected < 1 at 68/109 (62%) of centers ($p = 0.022$).

Precis:

The liver transplant waitlist at many US centers underrepresents minority populations compared with what would be expected based on their service area. This disparity stem in part from the patients' insurance type and distance from transplant centers.