

Socioeconomic Disparities in Pediatric and Adult DDLT Rates: Impact of the Acuity Circle Policy Implementation

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Background

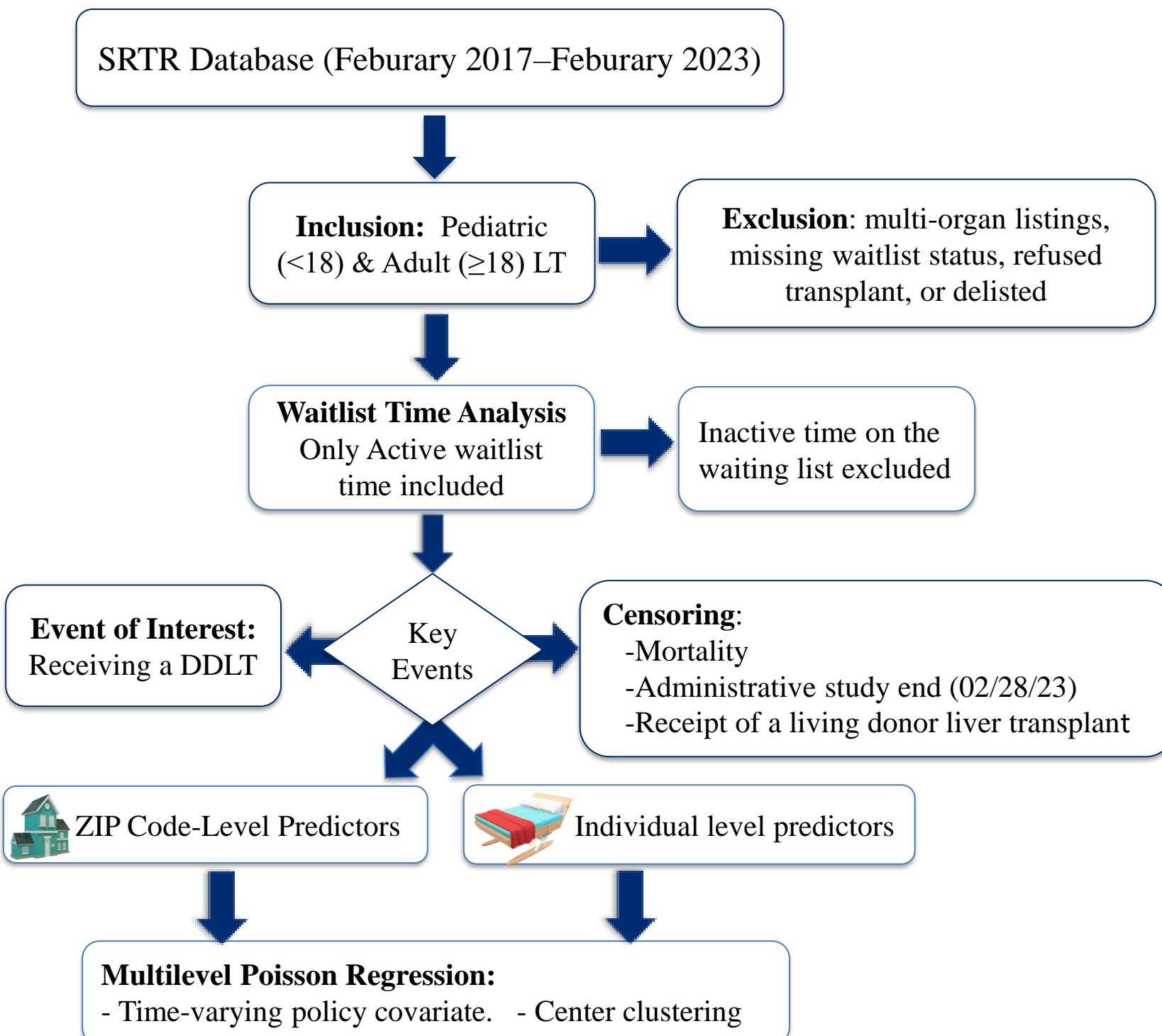
Access to deceased donor liver transplants (DDLT) is inequitable, with patients from lower-income backgrounds or on public insurance facing higher waitlist mortality. The Acuity Circle (AC) policy, implemented in February 2020, aimed to prioritize the sickest patients and reduce geographic disparities, but its impact on socioeconomic disparities remains understudied.

Objectives

- Compare pre-policy (before Feb. 4, 2020) vs. post-policy (after Feb. 4, 2020) DDLT rates among pediatric (<18 years) and adult (≥18 years) candidates.
- Examine the impact of individual (race, insurance, MELD*) and neighborhood factors (income, employment, poverty rate) on transplant access.

Methods

Study Design and Analysis Flowchart



* Abbreviation: MELD(Model of End Stage Liver Disease)

Results

Table 1A: Pediatric Candidates' Characteristics (Pre- vs. Post-Policy)

Variable, Mean (SD) or n (%)	On and before Feb 04,2020 (N=2,156)	After Feb 04,2020 (N=2,384)	p-value
Individual Level Characteristics			
Age Categories			
<1	703 (32.6%)	740 (31.0%)	0.002
(1-5)	607 (28.2%)	614 (25.8%)	
(5-11)	343 (15.9%)	353 (14.8%)	
(11-18)	503 (23.3%)	677 (28.4%)	
Male	1,092 (51%)	1,165 (49%)	0.23
Race & Ethnicity			
Black	346 (16.0%)	429 (18.0%)	0.068
Caucasian	1,072 (49.7%)	1,112 (46.6%)	
Hispanic	495 (23.0%)	593 (24.9%)	
Other/Multiracial	243 (11.3%)	250 (10.5%)	
Public Insurance	1,235 (57.3%)	1,336 (56.0%)	0.63
Time-Varying MELD			
<15	884 (41.0%)	876 (36.7%)	<0.001
15 - 24	394 (18.3%)	389 (16.3%)	1
25 - 34	263 (12.2%)	190 (8.0%)	
>=35	100 (4.6%)	226 (9.5%)	
Status I	448 (20.8%)	504 (21.1%)	0.025
Indication for liver transplant			
Biliary Atresia	638 (29.6%)	656 (27.5%)	
Acute Hepatic Necrosis	225 (10.4%)	281 (11.8%)	
Metabolic	290 (13.5%)	271 (11.4%)	
Liver Malignancy	170 (7.9%)	175 (7.3%)	
Other	833 (38.6%)	1,001 (42.0%)	
Zip code Level Characteristics			
% Below Poverty Level	13.9 (8.2)	13.5 (8.6)	0.087
Education			
Less than High School	558 (25.9%)	596 (25.0%)	0.002
High School Graduate	259 (12.0%)	375 (15.7%)	
Some College	1 (0.0%)	5 (0.2%)	
Unknown	1,338 (62.1%)	1,407 (59.0%)	
Neighborhood Poverty Classification			
<20% Below Poverty Line	1,662 (77.1%)	1,892 (79.4%)	0.18
≥20% Below Poverty Line	448 (20.8%)	446 (18.7%)	
% with Private Insurance	64.8 (15.2)	65.3 (15.5)	0.30
Unemployment Rate (%)	5.7 (2.9)	5.7 (3.0)	0.95
Household Income Quartile			
Low Income (<\$55K)	459 (21.3%)	466 (19.5%)	0.068
Lower-Middle Income (\$55K-\$71K)	465 (21.6%)	464 (19.5%)	
Upper-Middle Income (\$71K-\$92K)	521 (24.2%)	602 (25.3%)	
High Income (>\$92K)	660 (30.6%)	804 (33.7%)	

Table 2A. Mixed-Effects Poisson Regression Results for Pediatric DDLT Rates

Variable	IRR	95% CI: lower-upper	P-value
Age 1-5 (Ref: <1)	0.77	0.65 - 0.91	0.002
Age 5-11 (Ref: <1)	0.61	0.46 - 0.81	<0.001
Age 11-18 (Ref: <1)	0.51	0.33 - 0.78	0.002
Male (Ref: Female)	1.03	0.92 - 1.15	0.657
Black (Ref: Caucasian)	0.94	0.82 - 1.07	0.342
Hispanic (Ref: Caucasian)	0.92	0.81 - 1.03	0.159
Other/Multiracial (Ref: Caucasian)	1.03	0.89 - 1.20	0.683
Public Insurance (Ref: Private Insurance)	1.00	0.89 - 1.13	0.978
Other/Missing Insurance (Ref: Private Insurance)	1.07	0.73 - 1.55	0.734
Lower-Middle Income (\$55K-\$71K) (Ref: Low Income)	0.91	0.76 - 1.09	0.324
Upper-Middle Income (\$71K-\$92K) (Ref: Low Income)	1.00	0.83 - 1.20	0.992
High Income (>\$92K) (Ref: Low Income)	1.04	0.88 - 1.22	0.680
MELD 15-24 (Ref: MELD <15)	1.50	1.12 - 2.00	0.006
MELD 25-34 (Ref: MELD <15)	2.77	2.08 - 3.69	<0.001
MELD ≥35 (Ref: MELD <15)	6.74	4.98 - 9.13	<0.001
Status 1 (Ref: MELD <15)	24.22	17.19 - 34.13	<0.001
Acute Hepatic Necrosis (Ref: Biliary Atresia)	1.83	1.39 - 2.39	<0.001
Metabolic (Ref: Biliary Atresia)	0.38	0.30 - 0.47	<0.001
Liver Malignancy (Ref: Biliary Atresia)	0.58	0.44 - 0.77	<0.001
Other Diagnosis (Ref: Biliary Atresia)	0.75	0.63 - 0.90	0.002
Weight in kg	1.02	1.01 - 1.03	<0.001
Accept HCV+ Liver (Ref: No)	1.03	0.78 - 1.35	0.835
After Feb 04, 2020 (Ref: On and before Feb 04, 2020)	1.28	1.08 - 1.51	0.004

Table 1B: Adult Candidates' Characteristics (Pre- vs. Post-Policy)

Variable, Mean (SD) or n (%)	On and Before Feb 4, 2020 (N=37,377)	After Feb 4, 2020 (N=48,006)	p-value
Individual-Level Characteristics			
Candidate Age at Listing (years)			
56 (11)	56 (11)	55 (12)	<0.001
Male			
23,424 (63%)	23,424 (63%)	29,665 (62%)	0.009
Race & Ethnicity			
Black	2,838 (7.6%)	3,191 (6.6%)	<0.001
Caucasian	26,088 (69.8%)	33,351 (69.5%)	
Hispanic	6,164 (16.5%)	8,540 (17.8%)	
Other/Multiracial	2,270 (6.1%)	2,896 (6.0%)	
Private Insurance	19,013 (50.9%)	24,614 (51.3%)	0.49
Education			
College Graduate or Higher	7,449 (19.9%)	10,402 (21.7%)	<0.001
Less than High School	2,243 (6.0%)	2,732 (5.7%)	
High School Graduate	14,577 (39.0%)	17,308 (36.1%)	
Some College	9,382 (25.1%)	12,018 (25.0%)	
Time-Varying MELD			
<15	12,644 (33.8%)	14,696 (30.6%)	<0.001
15 - 24	12,985 (34.7%)	15,769 (32.8%)	
25 - 34	6,198 (16.6%)	8,754 (18.2%)	
≥35	3,250 (8.7%)	4,436 (9.2%)	
Status I	1,913 (0.53%)	1,766 (0.40%)	<0.001
Indication for Liver Transplant			
ALD	11,489 (30.7%)	15,258 (31.8%)	<0.001
Viral Hepatitis	5,041 (13.5%)	4,109 (8.6%)	
NAFLD/NASH	8,647 (23.1%)	11,309 (23.6%)	
Cholestatic/Autoimmune	3,598 (9.6%)	4,424 (9.2%)	
HCC/Malignancy	4,740 (12.7%)	5,595 (11.7%)	
Other	3,862 (10.3%)	7,311 (15.2%)	
Zip Code Level Characteristics			
% Below Poverty Level	12.6 (7.9)	12.3 (7.8)	<0.001
Neighborhood Poverty Classification			
Low-Poverty Area (<20%)	31,392 (84.0%)	40,871 (85.1%)	<0.001
High-Poverty Area (≥20%)	5,485 (14.7%)	6,619 (13.8%)	
% with Private Insurance	67.0 (14.3)	67.3 (14.3)	0.001
Unemployment Rate (%)	5.5 (3.0)	5.4 (2.9)	<0.001
Median Household Income Quartile			
Low Income (<\$53K)	6,238 (16.7%)	7,549 (15.7%)	<0.001
Lower-Middle Income (\$53K-\$67K)	7,793 (20.8%)	10,019 (20.9%)	
Upper-Middle Income (\$67K-\$85K)	9,442 (25.3%)	12,227 (25.5%)	
High Income (>\$85K)	13,304 (35.6%)	17,556 (36.6%)	

Table 2B. Mixed-Effects Poisson Regression Results for Adult DDLT Rates

Variable	IRR	95% CI: lower-upper	P-value
Age at Listing	1.00	1.00 - 1.00	0.035
Male (Ref: Female)	1.21	1.15 - 1.27	<0.001
Black (Ref: Caucasian)	1.02	0.97 - 1.07	0.422
Hispanic (Ref: Caucasian)	0.95	0.90 - 1.00	0.046
Other/Multiracial (Ref: Caucasian)	0.92	0.86 - 0.99	0.021
Public Insurance (Ref: Private Insurance)	0.94	0.92 - 0.97	<0.001
Other/Missing Insurance (Ref: Private Insurance)	0.94	0.75 - 1.16	0.545
Lower-Middle Income (\$53K-\$67K) (Ref: Low Income)	1.00	0.94 - 1.05	0.911
Upper-Middle Income (\$67K-\$85K) (Ref: Low Income)	1.01	0.96 - 1.06	0.650
High Income (>\$85K) (Ref: Low Income)	1.03	0.97 - 1.10	0.355
MELD 15-24 (Ref: MELD <15)	5.90	5.13 - 6.79	<0.001
MELD 25-34 (Ref: MELD <15)	46.62	38.10 - 57.05	<0.001
MELD ≥35 (Ref: MELD <15)	473.24	378.66 - 591.45	<0.001
Status 1 (Ref: MELD <15)	1006.06	787.92 - 1284.59	<0.001
Viral Hepatitis (Ref: ALD)	0.71	0.67 - 0.76	<0.001
NAFLD/NASH (Ref: ALD)	0.83	0.79 - 0.86	<0.001
Cholestatic/Autoimmune (Ref: ALD)	0.72	0.68 - 0.76	<0.001
HCC/Malignancy (Ref: ALD)	0.59	0.53 - 0.65	<0.001
Other (Ref: ALD)	0.64	0.57 - 0.72	<0.001
Accept HCV+ Liver (Ref: No)	1.10	1.01 - 1.20	0.037
After Feb 04, 2020 (Ref: On and before Feb 04, 2020)	1.35	1.21 - 1.51	<0.001

Figure 1. Liver Transplant Wait Times (Days): Acuity Circle Policy Highlighted

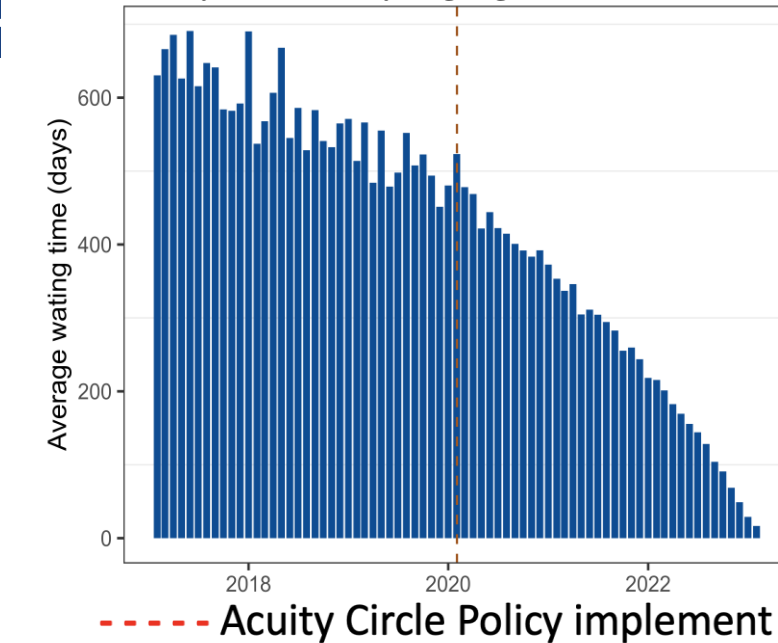
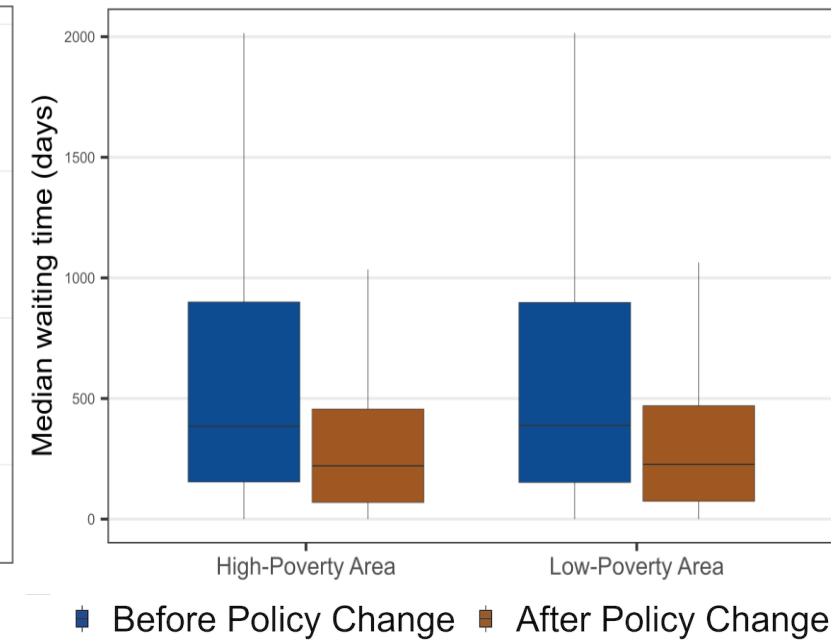


Figure 2: Policy Impact on Median Wait Times in High vs. Low-Poverty Areas



--- Acuity Circle Policy implement

■ Before Policy Change ■ After Policy Change

Conclusion

- **DDLT rates increased post-policy** ($IRR: 1.35, p < 0.001$), improving organ allocation efficiency.
- **Socioeconomic disparities persist**—Publicly insured candidates had lower transplant rates ($IRR: 0.94, p < 0.001$) despite policy changes.
- **Medical urgency was prioritized**—Higher MELD scores and Status 1 candidates had significantly higher transplant rates ($IRR: 24.22, p < 0.001$).
- **Pediatric disparities were minimal**—No significant race/ethnicity effects; insurance was not a strong predictor.
- **Adult disparities remain**—Transplant access still varies by insurance coverage, highlighting inequities in healthcare access.
- **Policy alone didn't eliminate disparities**—Further interventions are needed to address socioeconomic barriers to transplant access.

Future Steps

Investigate persistent socioeconomic disparities in liver transplant access by interviewing key stakeholders and analyzing post-DDLT outcomes (graft survival, mortality, quality of life) across groups

Acknowledgments

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[Link to Stratified Poisson Regression & Acuity Circle Policy](#)

