Health Services Research

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RESEARCH ARTICLE

The Impact of Transplant Waitlisting Measures on Dialysis Facilities' Star Ratings

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Received: 21 May 2025 | **Revised:** 28 August 2025 | **Accepted:** 27 October 2025

Keywords: access to transplant | ESKD | percentage of prevalent patients waitlisted | quality reporting | Standardized First Kidney Transplant Waitlist Ratio for Incident Dialysis Patients

ABSTRACT

Objective: To evaluate how adding kidney transplantation waitlisting measures—the Standardized First Kidney Transplant Waitlist Ratio for Incident Dialysis Patients (SWR) and Percentage of Prevalent Patients Waitlisted (PPPW)—affects Dialysis Facility Care Compare Star Ratings.

Study Setting and Design: In this observational, cross-sectional study, we calculated the difference between facilities' published (with waitlisting measures) and counterfactual (without waitlisting measures) Star Ratings. We used multinomial regression to examine associations between Star Rating changes after waitlisting measure inclusion and facility characteristics and calculated corresponding average risk differences.

Data Sources and Analytic Sample: We used comprehensive clinical and administrative data from the Centers for Medicare/Medicaid Services from 2021 to investigate the impact of waitlisting measure addition on Star Ratings. Facility characteristics included demographic and patient mix, area deprivation index (ADI), dialysis organization affiliation, and urbanicity.

Principal Findings: 36.5% of facilities' ratings changed after waitlisting measures were added. Facility characteristics associated with a higher average risk of Star increase included location in low-ADI (0.091; 95% CI: 0.072, 0.109) or urban areas (0.061; 95% CI: 0.034, 0.087), independent/small dialysis organization affiliation (0.062; 95% CI: 0.041, 0.083), and having more PD patients (0.115; 95% CI: 0.093, 0.138). Characteristics associated with a higher average risk of Star decrease included high-ADI (0.075; 95% CI: 0.054, 0.095) or rural (0.056; 95% CI: 0.028, 0.083) location, large dialysis organization affiliation (0.058; 95% CI: 0.039, 0.078), having more patients with dual Medicare/Medicaid eligibility (0.052; 95% CI: 0.032, 0.071), and having fewer peritoneal dialysis patients (0.100; 95% CI: 0.081, 0.120).

Conclusions: Including waitlisting measures significantly impacts the Star Ratings and captures a new dimension of care quality. Worse socioeconomic status-related facility characteristics were strongly associated with worse Star Rating outcomes. These findings can inform future discussions about risk adjustment among the developers of the SWR and PPPW measures.

Callout Box

- What is known on this topic
  - Transplant waitlisting, a crucial step in the kidney transplantation process, is a shared responsibility between dialysis facilities, transplant centers, and nephrologists.
  - The Dialysis Facility Care Compare (DFCC) Star Rating system summarizes dialysis facility care quality based on a comprehensive set of quality metrics, rating facilities from one to five stars.
  - In October 2023, the Star Rating system added two waitlisting measures (Standardized First Kidney Transplant Waitlist Ratio for Incident Dialysis Patients, Percentage of Prevalent Patients Waitlisted) to its measure set.
- What this study adds
  - After the addition of waitlisting measures, 36.5% of facilities experienced a one-star shift in their Star Ratings, suggesting that the new measures contribute additional information that further differentiates facility performance.
  - Worse socioeconomic status-related facility characteristics (high area deprivation index and rural locations, more dual-eligible patients, and fewer peritoneal dialysis patients) were associated with Star Rating decreases after waitlisting measure addition.
  - Our findings on characteristics associated with Star Rating changes due to inclusion of waitlisting measures may inform future discussion among measure developers about risk adjustment decisions for these measures.

1 | Introduction

Kidney transplantation is widely considered the ideal treatment for patients with end-stage kidney disease (ESKD), but access to transplantation is limited [1–3]. Before transplantation can occur, patients must be referred to a transplant center, undergo an evaluation to determine whether they are eligible to receive either a living or deceased donor kidney transplant, and, if eligible for a deceased donor kidney, ultimately be placed on a waitlist [2]. A complex set of factors at the patient, provider, and systemic levels can influence each stage of the transplantation process [2, 3]. Improving waitlisting rates is crucial for improving access to transplantation and, more broadly, the quality of care for patients with ESKD. In recent years, the Centers for Medicare and Medicaid Services (CMS) have promoted shared accountability models, such as the ESRD (a government term for ESKD) Treatment Choices (ETC) Model [4, 5] the Kidney Care Choices (KCC) Model [5, 6], and most recently, the Increasing Organ Transplant Access (IOTA) Model [7], to foster collaboration among dialysis facilities, nephrologists, and transplant centers in getting patients added to the transplant waitlist. These initiatives align with CMS's broader efforts to enhance transparency and improve the quality of care provided by dialysis facilities.

The CMS public reporting program, Dialysis Facility Care Compare (DFCC), serves as a consumer-facing resource that provides information to patients and other consumers on the quality of care at dialysis facilities. A central feature of DFCC is the Quality of Patient Care Star Rating system, which was developed in collaboration with dialysis community members, including patients and providers. It was implemented by CMS in 2015. The system highlights aspects of care that CMS and patients consider important to patients receiving chronic dialysis. Since 2015, CMS has publicly reported the Star Ratings on the DFCC website with the goal of improving transparency of the quality of care provided by dialysis facilities and providing patients with a tool to make informed care choices [8]. This system assigns each US dialysis facility a rating between one star (representing performance much below the national average) and five stars (representing performance much above the national average) based on their composite performance on a variety of care quality metrics. The Star Rating system is periodically evaluated for enhancements and updates, such as adding new measures, to maintain or improve the validity and usability of the ratings.

Beginning in October 2023, several updates were made to the Star Rating methodology, including the addition of two kidney transplantation waitlisting measures, the Standardized First Kidney Transplant Waitlist Ratio for Incident Dialysis Patients (SWR) and Percentage of Prevalent Patients Waitlisted (PPPW) [9]. The SWR represents the ratio of the observed number of incident patients on the kidney/kidney–pancreas waitlists compared to the expected number of waitlisted incident patients within a facility [9]. Meanwhile, the PPPW measures the percentage of prevalent patients at the facility who are on the kidney transplant waitlist [9]. Including SWR and PPPW in the Star Rating measure set was intended to expand the domains of care quality encompassed by the Star Rating system [9]. The addition of this new domain into the measure set is also likely to result in Star Rating changes across facilities.

This study addresses two key issues. First, we aim to evaluate how the addition of SWR and PPPW to the Star Rating measure set affects facilities' Star Ratings. Second, we investigate how this impact is mediated by select facility-level characteristics. In particular, we test the hypothesis that economic factors, such as the location of facilities in rural or socioeconomically deprived areas, may be associated with changes in ratings following the addition of these two measures. We use comprehensive CMS clinical and administrative data to examine both aims. To our knowledge, this is the first study to systematically evaluate the impact of adding new clinical measures to the Star Rating system.

2 | Methods

2.1 | Data and Variables

Comprehensive CMS clinical and administrative data from eligible Medicare-certified dialysis facilities collected in 2021 was used for this analysis.

To assess the impact of adding the transplant waitlisting measures to facilities' Star Ratings, we calculated two versions of the Star Ratings using the publicly reported facility-level quality measures from DFCC for the 7330 facilities that were eligible to receive a Star Rating corresponding to the October 2023 release (which used calendar year 2021 data), following CMS methodology. Details on this methodology can be found in Supporting Information Part 1 and in the Star Rating technical notes [10]. One version was calculated with the addition of the waitlisting measures, reflecting the Star Ratings published on DFCC in October 2023, and the other was calculated without the waitlisting measures, representing a counterfactual version of the Star Ratings if the waitlisting measures had not been added. All other methodological updates applied to the October 2023 Star Ratings release, as detailed in the Star Rating technical notes [10], were included in both versions to isolate the effect of transplant measure addition, and the same data were used to calculate both versions of the Star Ratings.

We calculated the difference in Star Rating, defined as the publicly released Star Rating (with waitlisting measures) minus the counterfactual Star Rating (without waitlisting measures), for each facility. We then categorized facilities into those with a Star Rating increase, a Star Rating decrease, or no change in Star Rating based on the direction of change of their rating after adding the waitlisting measures.

Facility characteristics of urban/rural location, dialysis organization affiliation, and patient mix were obtained from a number of data sources. Facility location was classified as rural or urban based on the Office of Management and Budget's definition of core-based statistical areas [11]. Dialysis organization affiliation—large organization (LDO) versus smaller organization or independent (non-LDO)—was determined based on whether a facility belonged to a large dialysis organization (1000+ affiliated facilities) using the End Stage Renal Disease Quality Reporting System (EQRS) and Quality Improvement and Evaluation System (QIES) data. Facility size (small—10–61 patients, medium—62–100 patients, or large—more than 100 patients) was categorized using tertiles of reported number of patients within facilities. The percentage of patients on peritoneal dialysis (PD) within a facility, obtained from EQRS data and Medicare claims, was classified as lower or higher than the national median percentage of 14.7%. The average number of comorbidities at ESKD incidence among patients within each facility, and years of ESKD among patients within each facility were obtained from the ESRD Medical Evidence Form for Medicare Entitlement or New Patient Registration (CMS Form 2728). The percentages (lower or higher than median; see Table 1 for cutoff values) of female patients, Black patients, Hispanic patients, and patients with diabetes as the cause of ESKD were also derived from Form 2728. Race and ethnicity variables were included to account for race/ethnicity-related disparities in transplant access that are widely reported in existing literature [12–15].

Facilities were classified as having lower or higher percentages of patients with short-term (1–89 days) and long-term (> 90 days) nursing home stays within the last year and dual Medicare and Medicaid eligible patients relative to the median across facilities using data from the Medicare Enrollment Database and the Medicare Minimum Dataset, respectively (refer to Table 1 for cutoffs) [16]. An area deprivation index (ADI) percentile rank between 1 and 100 was assigned to each facility based on zip code. The ADI is a measure created by the University of Wisconsin-Madison Neighborhood Atlas group that ranks the level of socioeconomic deprivation of neighborhoods (census block groups), with higher ranks assigned to areas with higher levels of socioeconomic deprivation [17]. For this analysis, the ADI of each facility's zip code was categorized into low or high area deprivation based on the median of rank values across facilities (see Table 1). Note that categorical versions of these patient mix variables and the ADI variable were used to improve the interpretability of model results and to account for potential nonlinearity of associations between patient mix variables and Star Rating change; furthermore, using medians and tertiles as the cut-points for these variables ensured balanced groups for valid model fitting. As complete facility characteristic information was needed for statistical modeling, we omitted 92 facilities with missing facility characteristic information (~1.3% of total facilities), leaving 7238 facilities for complete case analysis.

2.2 | Statistical Methods

We fit a multinomial logistic regression model to examine the associations between the categorized Star Rating change and facility characteristics using data from the 7238 facilities that had complete facility characteristic information in addition to being eligible to receive a Star Rating under both versions of the Star Rating calculation. The "no change" group of the outcome was treated as the reference group, and the model estimates odds ratios for a Star increase versus no change, and for a Star decrease versus no change by varying the covariates of interest. The odds ratios obtained from the multinomial model represent the odds of having an increase in Star Rating versus no change, and the odds of having a decrease in Star Rating versus no change. After fitting our multinomial model, we calculated average marginal effects (i.e., average risk differences) for each Star Rating change category (increase, decrease, no change) corresponding to each facility characteristic. Correlations between facility characteristics and variance inflation factors (VIFs) were checked to avoid multicollinearity; facility profit status (for-profit versus not-for-profit) was found to be highly correlated with dialysis organization affiliation and thus was omitted as a variable in our models. A Hosmer–Lemeshow goodness-of-fit test ensured that our model had good fit. See Supporting Information Part 2 for details on model diagnostics; VIF values are reported in Table S1.

A proportional odds cumulative logit model, which would be a natural choice because of the ordinal nature of the outcome (i.e., Star decrease being worse than no change being worse than Star increase), failed due to violation of the proportional odds assumption (Table S2, Supporting Information Part 2). Thus, the multinomial model was chosen as the final model. Models with alternative categorizations (i.e., scaled continuous, quartile-based categories) of key facility characteristics were also considered, but model results remained consistent across categorization methods. We report the model with dichotomized variables to enhance the interpretability of the results. See Tables S3 and S4 in Supporting Information Part 2 for details.

TABLE 1 | Facility characteristics by star change category based on calendar year 2021 data.

Characteristic	Overall, $N=7330$[a]	Any star decrease, $N=1396$[a]	No star rating change, $N=4658$[a]	Any star increase, $N=1276$[a]	p[b]
Dialysis organization affiliation					< 0.001
LDO	5587 (76%)	1137 (81%)	3555 (76%)	895 (70%)	
Non-LDO	1743 (24%)	259 (19%)	1103 (24%)	381 (30%)	
Location					< 0.001
Urban	6100 (83%)	1039 (74%)	3868 (83%)	1193 (93%)	
Rural	1217 (17%)	350 (25%)	784 (17%)	83 (6.5%)	
unknown	13 (0.2%)	7 (0.5%)	6 (0.1%)	0 (0%)	
Facility size					< 0.001
Small (1–61 patients)	2506 (34%)	531 (38%)	1647 (35%)	328 (26%)	
Medium (62–100 patients)	2423 (33%)	480 (34%)	1579 (34%)	364 (29%)	
Large (> 100 patients)	2401 (33%)	385 (28%)	1432 (31%)	584 (46%)	
Proportion PD patients					< 0.001
Low (< 14.7%)	5327 (73%)	1179 (85%)	3461 (75%)	687 (54%)	
High (≥ 14.7%)	1935 (27%)	205 (15%)	1153 (25%)	577 (46%)	
Unknown	68	12	44	12	
ADI					< 0.001
Low (≤ 63.8)	4288 (59%)	610 (44%)	2660 (57%)	1018 (80%)	
High (> 63.8)	3025 (41%)	779 (56%)	1988 (43%)	258 (20%)	
Unknown	17	7	10	0	
Proportion female patients					0.001
Low (≤ 42.1%)	3639 (50%)	639 (46%)	2328 (50%)	672 (53%)	
High (> 42.1%)	3669 (50%)	753 (54%)	2317 (50%)	599 (47%)	
Unknown	22	4	13	5	
Proportion Black patients					0.007
Low (≤ 26.2%)	3659 (50%)	735 (53%)	2261 (49%)	663 (52%)	
High (> 26.2%)	3649 (50%)	657 (47%)	2384 (51%)	608 (48%)	
Unknown	22	4	13	5	
Proportion Hispanic patients					< 0.001
Low (≤ 6.9%)	3663 (50%)	751 (54%)	2392 (51%)	520 (41%)	
High (> 6.9%)	3645 (50%)	641 (46%)	2253 (49%)	751 (59%)	
Unknown	22	4	13	5	
Proportion dual eligible patients					< 0.001
Low (≤ 36.4%)	3681 (50%)	546 (39%)	2292 (49%)	843 (66%)	
High (> 36.4%)	3627 (50%)	846 (61%)	2353 (51%)	428 (34%)	
Unknown	22	4	13	5	

(Continues)

Characteristic	Overall, $N=7330$[a]	Any star decrease, $N=1396$[a]	No star rating change, $N=4658$[a]	Any star increase, $N=1276$[a]	p[b]
Average number of incident comorbidities	1.81 (1.53, 2.12)	1.87 (1.61, 2.18)	1.84 (1.56, 2.14)	1.65 (1.39, 1.92)	< 0.001
Unknown	22	4	13	5	
Proportion of patients > 65 years old					< 0.001
Low (≤ 50%)	3879 (53%)	789 (57%)	2462 (53%)	628 (49%)	
High (> 50%)	3429 (47%)	603 (43%)	2183 (47%)	643 (51%)	
Unknown	22	4	13	5	
Proportion of patients with short-term nursing home stays					< 0.001
Low (≤ 5.8%)	3664 (50%)	683 (49%)	2277 (49%)	704 (55%)	
High (> 5.8%)	3644 (50%)	709 (51%)	2368 (51%)	567 (45%)	
Unknown	22	4	13	5	
Proportion of patients with long-term nursing home stays					< 0.001
Low (≤ 7.69%)	3612 (49%)	661 (47%)	2219 (48%)	732 (58%)	
High (> 7.69%)	3696 (51%)	731 (53%)	2426 (52%)	539 (42%)	
Unknown	22	4	13	5	
Average number of years of ESKD	4.00 (3.00, 5.00)	4.00 (4.00, 5.00)	4.00 (3.00, 5.00)	4.00 (3.00, 5.00)	< 0.001
Unknown	22	4	13	5	
Proportion of patients with diabetes as cause of ESKD					< 0.001
Low (≤ 45%)	3658 (50%)	589 (42%)	2354 (51%)	715 (56%)	
High (> 45%)	3650 (50%)	803 (58%)	2291 (49%)	556 (44%)	
Unknown	22	4	13	5	

Abbreviations: ADI = area deprivation index; ESKD = end-stage kidney disease; LDO = large dialysis organization; PD = peritoneal dialysis.
[a]n (%); median (IQR).
[b]Pearson's χ^2 test; one-way ANOVA.

As a sensitivity analysis, we explored whether adding transplant waitlisting measures influenced facilities' Star Ratings differently based on their "initial" Star Rating in the counterfactual version (i.e., their Star Rating with no waitlisting measures included). Facilities initially rated 1 Star could only experience an increase or no change, while those rated 5 Stars could only experience a decrease or no change. To address these "floor" and "ceiling" constraints, we modeled the odds of Star increase versus no change and odds of Star decrease versus no change separately by initial (i.e., counterfactual with no waitlisting measures included) rating. Specifically, we modeled the odds of a Star increase vs. no change for 1-Star facilities and the odds of a Star decrease versus no change for 5-Star facilities. For facilities rated 2–4 Stars, separate logistic regression models were developed for Star increase and Star decrease versus no change, following an approach similar to a case–control design. We then compared the results for 1-Star facilities with those for 2–4 Star facilities to determine whether facility characteristics associated with the odds of Star increase were consistent across these groups and similarly compared the results for 5-Star versus 2–4 Star facilities on the odds of Star decrease. Average risk differences corresponding to these models were also calculated. See Supporting Information Part 3 for details.

3 | Results

3.1 | Descriptive Analysis

The addition of the transplant waitlisting measures changed the Star Rating in 36.5% (2672) of the 7330 dialysis facilities that were eligible to receive a Star Rating under both versions of the Star Rating calculations (Figure 1). A large majority of those changes were by one star, with only 2.1% (155) of facilities experiencing changes of two or more stars in their rating. The differences seen in the distributions of the Star Ratings were roughly symmetric, with 63.5% (4658) facilities experiencing no change, 19.0% (1396) experiencing a Star decrease, and 17.5% (1276) experiencing a Star increase after the waitlisting measures were added to the measure set (Figure 1).

3.2 | Model Results

A multinomial logistic regression model was used to identify associations between changes in Star Ratings with versus without the waitlisting measures and facility characteristics based on data from the 7238 facilities with complete facility characteristic information. We report the average marginal effects (i.e., average risk differences) corresponding to each facility characteristic for changes in Star Rating calculated from our model.

Figure 2 and Table 2 show that facilities in areas with ADI higher than the national median of 57.5 (i.e., areas of higher deprivation) had a significantly lower average probability of having a Star increase than facilities in areas with ADI lower than the national median (i.e., less deprived areas) with an average risk difference of −0.09 (95% CI: −0.11, −0.07), holding other facility characteristics at their observed values. High ADI facilities also had a significantly higher average risk of a Star decrease than low ADI facilities (average risk difference: 0.08; 95% CI: 0.05, 0.10), adjusting for other characteristics. Rural facilities had a significantly lower average risk of a Star increase (average risk difference: −0.06; 95% CI: −0.09, −0.03) and a significantly higher average risk of a Star decrease (average risk difference: 0.06; 95% CI: 0.03, 0.08) compared to urban facilities, adjusting for all other facility characteristics. Non-LDO facilities had a 6% higher average risk (95% CI: 0.04, 0.08) of an increase in their Star Rating and a 6% lower risk of a Star decrease (95% CI: −0.08, −0.04) compared to facilities affiliated with an LDO, holding all other facility characteristics at their observed values.

Counterfactual Star Rating without Waitlisting Measures	Published Star Rating with Waitlisting Measures					
	★	★★	★★★	★★★★	★★★★★	Total
★	553 (7.54)	144 (1.96)	32 (0.44)	4 (0.05)	0	733 (10)
★★	180 (2.46)	910 (12.41)	355 (4.84)	16 (0.22)	5 (0.07)	1,466 (20)
★★★	0	412 (5.62)	2,034 (27.75)	410 (5.59)	76 (1.04)	2,932 (40)
★★★★	0	0	489 (6.67)	743 (10.14)	234 (3.19)	1,466 (20)
★★★★★	0	0	22 (0.30)	293 (4.00)	418 (5.70)	733 (10)
Total	733 (10)	1,466 (20)	2,932 (40)	1,466 (20)	733 (10)	7,330 (100)

Any Star Decrease
No Star Rating Change
Any Star Increase

FIGURE 1 | Star rating agreement with and without addition of transplant waitlisting measures based on calendar year 2021 data. Each cell represents the number and percentage of facilities with a given Star Rating calculated with the transplant waitlisting measures (columns) and a given Star Rating calculated without the transplant waitlisting measures (rows). Diagonal cells (in yellow) correspond to facilities with perfect agreement between the two versions of the Star Ratings, bottom left off-diagonal cells (teal) represent facilities whose Star Ratings decreased after the addition of the new measures, and top right off-diagonal cells (green) represent those whose Star Ratings improved after the addition of the new measures. Note that calendar year 2021 data were used to generate both versions of these Star Ratings.

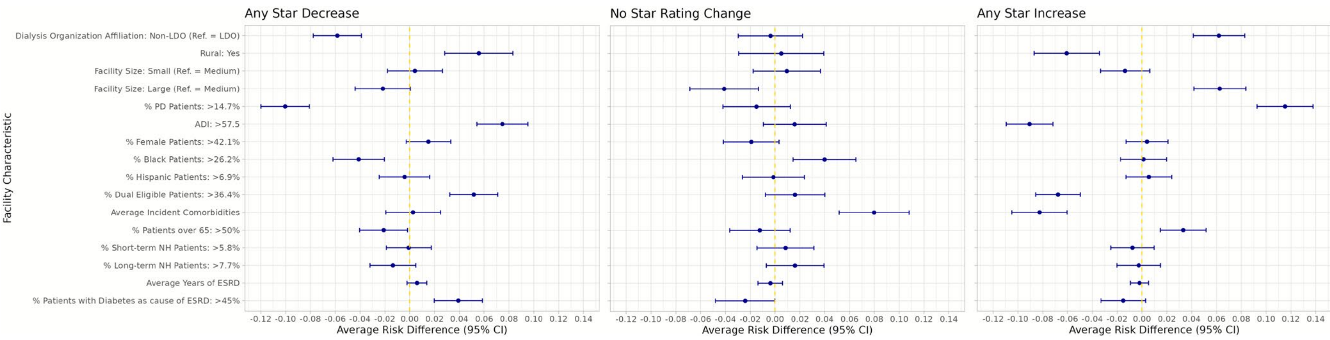

FIGURE 2 | Forest plot of average risk differences and 95% CIs of star change outcomes by facility characteristics based on calendar year 2021 data. Average risk differences and 95% confidence intervals for Star Rating Change outcomes calculated from multinomial regression model results are presented here in a graphical view. The leftmost plot represents average risk differences of a Star decrease, the middle plot represents average risk differences of no Star Rating change, and the rightmost plot represents average risk differences of a Star increase corresponding to each facility characteristic. The yellow vertical dashed line in each plot marks the position of an average risk difference of 0 (representing no difference in risk). Overlaps between the bars for each facility characteristic and this yellow line indicate nonsignificance of results at the $p = 0.05$ significance threshold.

TABLE 2 | Average risk differences of star change outcomes by facility characteristics based on calendar year 2021 data.

Facility characteristics	Any star decrease			No star rating change			Any star increase		
	Average risk difference	95% CI	p[a]	Average risk difference	95% CI	p[a]	Average risk difference	95% CI	p[a]
Non-LDO dialysis organization affiliation	−0.058	(−0.078, −0.039)	**< 0.001**	−0.004	(−0.03, 0.022)	0.777	0.062	(0.041, 0.083)	**< 0.001**
Rural location	0.056	(0.028, 0.083)	**< 0.001**	0.005	(−0.029, 0.039)	0.775	−0.061	(−0.087, −0.034)	**< 0.001**
Small facility size: < 62 patients (Ref = medium; 62–100 patients)	0.004	(−0.018, 0.026)	0.710	0.009	(−0.018, 0.037)	0.497	−0.014	(−0.034, 0.006)	0.179
Large facility size: > 100 patients (Ref = medium; 62–100 patients)	−0.022	(−0.044, 0.001)	0.056	−0.041	(−0.069, −0.013)	**0.004**	0.063	(0.042, 0.084)	**< 0.001**
Proportion PD patients > median (14.7%)	−0.100	(−0.12, −0.081)	**< 0.001**	−0.015	(−0.042, 0.012)	0.282	0.115	(0.093, 0.138)	**< 0.001**
ADI > median (57.5)	0.075	(0.054, 0.095)	**< 0.001**	0.016	(−0.009, 0.041)	0.219	−0.091	(−0.109, −0.072)	**< 0.001**
Proportion of female patients > median (42.1%)	0.015	(−0.003, 0.033)	0.099	−0.019	(−0.042, 0.003)	0.094	0.004	(−0.013, 0.021)	0.637
Proportion of Black patients > median (26.2%)	−0.041	(−0.062, −0.021)	**< 0.001**	0.040	(0.015, 0.065)	**0.002**	0.001	(−0.017, 0.02)	0.896
Proportion of Hispanic patients > median (6.9%)	−0.004	(−0.025, 0.016)	0.687	−0.001	(−0.026, 0.024)	0.917	0.006	(−0.013, 0.024)	0.556
Proportion of dual eligible patients > median (36.4%)	0.052	(0.032, 0.071)	**< 0.001**	0.016	(−0.008, 0.04)	0.186	−0.068	(−0.086, −0.05)	**< 0.001**
Average number of incident comorbidities	0.003	(−0.019, 0.025)	0.809	0.080	(0.052, 0.108)	**< 0.001**	−0.083	(−0.105, −0.06)	**< 0.001**
Proportion of patients over age 65 > median (50%)	−0.021	(−0.04, −0.002)	**0.034**	−0.012	(−0.037, 0.012)	0.323	0.033	(0.015, 0.052)	**< 0.001**
Proportion of patients with short-term nursing home stays > median (5.8%)	−0.001	(−0.019, 0.017)	0.937	0.008	(−0.014, 0.031)	0.470	−0.008	(−0.025, 0.01)	0.385
Proportion of patients with long-term nursing home stays > median (7.7%)	−0.013	(−0.032, 0.005)	0.151	0.016	(−0.007, 0.039)	0.174	−0.003	(−0.02, 0.015)	0.769

(Continues)

TABLE 2 | (Continued)

Facility characteristics	Any star decrease			No star rating change			Any star increase		
	Average risk difference	95% CI	p[a]	Average risk difference	95% CI	p[a]	Average risk difference	95% CI	p[a]
Average years with ESRD among patients	0.006	(−0.002, 0.014)	0.146	−0.004	(−0.014, 0.006)	0.443	−0.002	(−0.009, 0.005)	0.581
Proportion of patients with diabetes as cause of ESRD > median (>45%)	0.039	(0.02, 0.058)	**<0.001**	−0.024	(−0.048, 0)	**0.050**	−0.015	(−0.033, 0.003)	0.102

Abbreviations: ADI = area deprivation index; ESKD = end-stage kidney disease; LDO = large dialysis organization; PD = peritoneal dialysis.
[a]Bolded p-values indicate significance at the $p = 0.05$ significance threshold.

A number of patient-mix related variables were also found to have significantly different average risks of Star changes in both directions. Facilities with a high proportion of patients with dual eligibility for Medicare and Medicaid (defined as > 36.4%, the national median) had both a significantly lower average risk of having a Star increase (average risk difference: −0.07; 95% CI: −0.09, −0.05), and a significantly higher average risk of having a Star decrease (average risk difference: 0.05; 95% CI: 0.03, 0.07) compared to facilities with fewer dual eligible patients, adjusting for other characteristics. Additionally, facilities with a high proportion of patients on PD (defined as > 14.7%, the national median) had a 12% higher average risk of a Star increase (95% CI: 0.09, 0.14) and a 10% lower average risk of a Star decrease (95% CI: −0.12, −0.08) compared to facilities with a low proportion of PD patients, adjusting for other facility characteristics. Finally, facilities with a high proportion of patients over age 65 (defined as > 50%, the national median) also had a modest but significantly higher average risk of Star increase and lower average risk of Star decrease compared to facilities with fewer patients over age 65, adjusting for other facility characteristics.

Some facility characteristics were associated with a significantly different average risk of Star Rating change only in one direction. Large facility size was associated with a significantly higher average risk of a Star increase and a lower average risk of a Star decrease that was not statistically significant. Conversely, having more patients with diabetes as the cause of their ESKD was associated with a significantly higher average risk of a Star decrease (but nonsignificantly associated with a lower average risk of a Star increase).

Additionally, facilities with certain characteristics seemed to be more likely to experience no change in their Star Ratings versus a shift in either direction. Having more Black patients was significantly associated with a lower average risk of a Star decrease but was not significantly associated with a higher average risk of a Star increase; in fact, facilities with a high proportion of Black patients also had a significantly higher average risk of no change in their rating than facilities with a lower proportion of Black patients, adjusting for other characteristics. Having higher average numbers of incident comorbidities among patient populations was similarly associated with a significantly lower average probability of a Star increase as well as a significantly higher average probability of no Star Rating change, adjusting for other characteristics.

Finally, from sensitivity analyses addressing floor/ceiling effects, similar directionality and significance of coefficients were found between the main model and sensitivity models, suggesting consistent findings for the risk of Star increase for facilities initially rated 1 Star and those rated 2–4 Stars (details in Supporting Information Part 3). Comparable results were also found for ceiling impacts when the model outcomes from the 5-Star logistic regression and the 2–4 Star case–control logistic regression (for the risk of Star decrease) were compared. Ultimately, ceiling and floor constraints from initial Star Ratings did not substantially affect our findings.

4 | Discussion

The primary goal of the Star Rating program is to provide a summary indicator of dialysis facility quality to guide patient decision-making. Incorporating additional quality measures, such as the transplant waitlisting measures, enhances the system by offering a more comprehensive representation of facility quality [18, 19].

With the addition of the waitlisting measures to the Star Rating measure set, we found more than one third of facilities experienced a shift in their Star Rating, suggesting that the waitlisting measures contribute new information to the composite that further differentiates dialysis facility performance. However, among facilities that experienced Star Rating changes, the majority of changes were not extreme, with a roughly equal number of facilities experiencing a one-star shift upwards or downwards and few facilities experiencing changes of more than one star. This suggests that the use of factor analysis to group related measures into domains within the Star Rating methodology, as explained in Supporting Information Part 1, and weighting domains accordingly achieves its intended purpose of preventing any one domain from dominating the overall facility ratings [10].

A key takeaway from our work is that the observed impact of the waitlisting measures on the Star Ratings is associated with several facility characteristics, especially those related to socioeconomic status (SES). As shown in Figure 2, the most notable factors associated with changes in Star Ratings include ADI, the proportion of patients with dual eligibility, LDO affiliation, rural location, and the proportion of PD patients. Our findings are consistent with what is reported in the existing literature describing facility characteristics associated with less access to transplantation [3, 12, 13, 15, 20–35]. We observed that several SES-related characteristics, particularly higher facility-level ADI and a larger proportion of dual-eligible patients, were associated with changes in Star Ratings following the addition of the transplant waitlisting measure. These findings are consistent with prior research linking low SES with reduced access to kidney transplantation, such as Adler et al. and Harding et al. [20, 30]. Facilities in areas with high ADI and those serving a larger dual-eligible population may care for more patients who face greater barriers to meeting transplant waitlist criteria due to factors such as limited access to specialty care, transportation challenges, and higher burdens of comorbidity [28, 30].

Our result that facilities affiliated with LDOs were more likely to experience negative changes in Star Ratings following the addition of the transplant waitlisting measures, compared to independent facilities or those affiliated with small dialysis organizations, aligns with prior research demonstrating associations between for-profit status—a characteristic closely tied to LDO affiliation—and lower rates of access to kidney transplantation [20–22, p. 20; 24]. Several factors may influence the lower transplant waitlisting rates observed in LDO-affiliated facilities. One possibility is the financial incentive structure of investor-driven, for-profit dialysis organizations. As noted by Zhang et al., such facilities may have reduced motivation to refer patients for transplantation, since transplanted patients no longer generate revenue for the dialysis provider [22]. Alternatively, the observed differences in transplant waitlisting between LDO and non-LDO facilities may reflect underlying differences in the populations served by facilities of different dialysis organization affiliations. Almachraki et al. suggest that LDO-affiliated and for-profit facilities are more frequently located in socioeconomically disadvantaged areas [34]. This may be due to operational efficiencies and economies of scale that allow large organizations to operate profitably in such settings. As a result, the poorer performance of LDO-affiliated facilities on transplant-related Star Rating measures may be at least partially attributable to the lower SES of their patient populations. Although our model controlled for several measures related to SES, it is possible that some residual aspects of SES correlated with ownership remain.

Geographic location emerged as another key characteristic associated with changes in Star Ratings following the addition of the transplant waitlisting measures. Our analysis found that rural facilities were less likely to experience an increase and more likely to experience a decrease in their Star Rating compared to urban facilities. This aligns with findings from Adler et al., who reported that patients treated in rural facilities were less likely to be waitlisted, and Axelrod et al., who found that rural patients had lower rates of both kidney waitlist registration and transplant [20, 23]. Factors like longer travel times to transplant centers and higher poverty levels in rural areas may contribute to these differences and help explain our findings [26, 30]. This could be explored in future work as the scope of our analyses used the existing CMS-developed measures as implemented which do not adjust for geographic or area level characteristics.

Additionally, the proportion of PD patients at a facility was also associated with Star Rating changes. PD patients are generally younger and healthier, which may increase their likelihood of being referred for and placed on the transplant waitlist [35, 36]. Thus, facilities with a higher proportion of PD patients may reflect a patient population more amenable to transplantation [36]. The proportion of PD patients a facility has may also relate to a facility's flexibility in offering treatment modalities or resource availability [35, 36]. However, the use of PD is only a rough proxy for a healthier patient population or better resource availability, as PD uptake may also reflect regional practice patterns, sociodemographic differences, and patient preferences [35–39]. Further research would be needed to disentangle whether higher PD use reflects facility-driven factors or underlying differences in patient populations.

The strong associations between SES-related facility characteristics and changes in Star Ratings following the addition of waitlisting measures highlight the issue of whether risk adjustment should be incorporated into these measures. Promoting access to transplantation is a central policy goal [5, 20, 40], supported by initiatives such as the ETC and KCC Models. However, the degree to which dialysis facilities can influence access to transplantation remains a matter of debate, though referral and waitlisting are arguably the steps most directly tied to facilities [30, 41–43]. Thus, some in the dialysis community may feel that including waitlisting measures without risk adjustment may disadvantage facilities serving low-income populations for value-based purchasing and public reporting programs, potentially impacting their business survival and resource availability. However, others may want to use the Star Ratings to directly identify facilities with the best transplant waitlisting rates, making risk adjusting the transplant waitlisting measures counterproductive. Risk adjustment may also obscure the underlying problem of SES-related disparities in waitlisting while failing to incentivize efforts to improve waitlisting access. Ultimately, for all quality measures, including SWR and PPPW, risk adjustment decisions are made (and periodically revisited) by the developers of the quality measures, with decisions being highly individualized for each measure in the Partnership for Quality Forum's measure submission process [44]. Our findings may help inform future discussion among measure developers regarding risk adjustment of the waitlisting measures by demonstrating how these decisions may ultimately influence Star Ratings.

This study has several limitations. First, this was a cross-sectional study, as the transplant waitlisting measures were only recently introduced in the October 2023 public Star Rating release. It is not yet clear to what extent facilities' clinical performance may change in response to this change in the Star Rating system. Additionally, we used calendar year 2021 data, which coincided with COVID-19 pandemic-related disruptions that affected many aspects of the dialysis community. This potentially introduced unmeasured confounding and limits the generalizability of our results. Moreover, we focus solely on kidney transplant waitlisting, a shared outcome between dialysis facilities and transplant centers. Further exploration of how dialysis facilities' affiliation or geographic proximity to transplant centers may relate to dialysis facility outcomes may be informative. We also note that waitlisting is a necessary intermediate step, but not the only step in successful access to deceased donor kidney transplantation. Federal agencies have discussed plans for collecting transplant referral and evaluation data in the near future; should these data become available and undergo validation, CMS could choose to develop a facility-level referral measure that could augment the current transplant waitlisting measures in the Star Ratings [45]. Furthermore, many factors influence a patient's access to transplantation, including the availability of donor kidneys, psychological evaluations, presence and severity of comorbidities, ability to maintain health to remain active on the waitlist, and the ability of a patient to maintain a certain standard of post-transplant care, among others [3, 30]. As our data was primarily at the dialysis facility level, it did not directly measure these factors.

This study also has several strengths. We use national-level administrative and clinical data, making our results generalizable to US dialysis facilities. Furthermore, our approach to calculating the Star Ratings with and without transplant waitlisting measure addition utilizes data from the same year and holds all other aspects of the Star Rating calculation constant for both versions, allowing us to evaluate the impact of the new measures on the Star Ratings without confounding from other components of the methodology. Finally, to our knowledge, while there are previous studies examining patient, provider and system level factors associated with transplant waitlisting, ours is the first study that examines these associations with transplant waitlisting in the context of a composite measure of dialysis facility quality.

Our results based on the national data suggest that the addition of the transplant waitlisting measures to the Star Rating measure set differentiates facility performance with respect to a new dimension of care quality. Furthermore, we found that the changes in Star Ratings that facilities experienced due to the addition of the new measures were primarily associated with socioeconomic factors (ADI and dual eligibility), facility location and organization affiliation, and PD patient mix, associations that have been observed to be related to transplant waitlisting. Each of these associations has a number of potential explanations; however, it is interesting to note that many of the significant factors identified in our model have some connection to SES. The mechanisms behind these associations warrant further exploration. We believe this work will help to inform the ongoing discussion about the roles of various healthcare providers in the achievement of quality outcomes that are important to both patients and federal entities providing oversight of the Medicare ESRD Program, as well as contribute to future discussion on the appropriateness of risk adjustment for transplant waitlisting measures within the Star Ratings.

Acknowledgments

This manuscript was supported through contracts from the CMS: ESRD Quality Measure Development, Maintenance, and Support contract (HHSM-500-2013-13017I, task order number HHSM-500-T001), and the Kidney Disease Quality Measure Development, Maintenance, and Support contract (75FCMC18D0041, task order number 75FCMC18F0001). Data were obtained from CMS under the contract and associated Data Use Agreements.

Funding

This work was supported by Centers for Medicare and Medicaid Services, 75FCMC18D0041-75FCMC18F0001, HHSM-500-2013-13017I-HHSM-500-T001.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The research data are not publicly shared but may be available through a Data Use Agreement (DUA) with the Centers for Medicare & Medicaid Services (CMS).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** hesr70071-sup-0001-Supinfo.docx.