Examining Disparities in Quality of Dialysis Facilities in Puerto Rico vs. Five Mainland US States Before and After Hurricane Maria (2015-2023)

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TABLE OF CONTENTS

Introduction.....1

Study Purpose.....3

Method.....3

Results.....4

Discussion.....6

Limitations.....9

Conclusions.....10

Table and Figures.....11

References.....14

Introduction

Individuals living in Puerto Rico experience a multitude of challenges, including poverty, inadequate infrastructure, a fragile healthcare system, and an increased vulnerability to climate change-related disasters.[1] In September 2017, Puerto Rico endured the impact of two major hurricanes in quick succession. First, Hurricane Irma, a Category 5 storm with sustained winds at 58 mph and a maximum rainfall of 10-15 inches in 36 hours, passed close to the mainland of Puerto Rico.[2] Then, within two weeks of Hurricane Irma, Hurricane Maria, a Category 4 storm with sustained winds at 155 mph and rainfall of 38 inches in 48 hours, directly struck Puerto Rico upon its arrival.[2] Hurricanes Irma and Maria are two of the costliest hurricanes in US history. Hurricane Maria's damages exceeded 90 billion dollars, making it the third most expensive hurricane in US history.[3] In comparison, Hurricane Irma's damages exceeded 50 billion dollars, ranking the storm as the fifth costliest hurricane in US history. Hurricane Maria resulted in numerous deaths and significant damage to the power grid, affecting hospitals and other healthcare facilities.[3] As a result, almost the entire island was left without electricity and wireless communication, and about half of households were without water, leading to thousands of homes being destroyed and countless people being displaced.[4]

Healthcare Before Hurricane Maria

Before Hurricane Maria struck Puerto Rico, the island faced significant economic, societal, and health challenges. Puerto Rico's economy has declined significantly following the 2006 Puerto Rico Budget Crisis and the 2008 economic recession leaving a substantial portion of its population below the federal poverty level. Puerto Rico's healthcare system was strained, with limited access to healthcare services and high rates of chronic diseases such as diabetes and HIV.[5] Outbreaks of mosquito-borne illnesses such as Zika posed significant public health threats before the hurricane. Overall rates of chronic disease in Puerto Rico, such as heart disease and diabetes, exceeded US averages. For instance, 17.2% of individuals in Puerto Rico reported being diagnosed with diabetes, compared to 10.5% across all US states, including Washington, D.C. Puerto Rico faced persistent challenges related to water and air pollution, along with waste management.[5]

Healthcare After Hurricane Maria

After Hurricane Maria, Puerto Rico's public health situation worsened causing extensive damage to infrastructure and exacerbating existing health challenges.[6] Immediately following the hurricane, access to essential services such as electricity, clean water, and healthcare was severely disrupted. Hospitals and healthcare facilities faced operational challenges, operating on generators and shortages of crucial supplies. The lack of access to clean water and sanitation raised concerns about the spread of infectious diseases, while limited access to food led to malnutrition among residents.[6] Previous findings suggest that individuals with non-communicable diseases (NCDs), such as chronic kidney disease, diabetes, and mental health disorders, experienced significant impacts following Hurricane Maria in Puerto Rico in 2017.[7] One study estimated that the primary causes of death following the hurricane were complications associated with NCDs such as diabetes, cardiovascular disease, and Alzheimer's.[7] Furthermore, following Hurricane Maria, mental health issues emerged as a pressing concern, with reports of increased anxiety, depression, and suicide rates among Puerto Ricans.[8] The official death toll from Hurricane Maria, initially reported as 55, is highly likely to be an underestimate, with many more deaths linked to the storm.[6]

Dialysis Facilities in Puerto Rico

Given the significant prevalence of diabetes in Puerto Rico, dialysis facilities play a critical role in the healthcare system. In 2020, the prevalence of End-Stage Renal Disease (ESRD) in Puerto Rico was estimated to be approximately 8,038 people, surpassing the national average.[9] Similar to hospitals, dialysis facilities faced challenges such as shortages of fuel for backup generators, access to clean water, and operational telephone and internet services.[6] Consequently, dialysis facilities had to transport essential medical supplies and equipment from the mainland to their clinics in Puerto Rico. This disruption to the healthcare system likely heavily impacted populations reliant on medical care. Approximately 47 dialysis facilities lost power following Hurricane Maria, though many have resumed operations. Due to the inconsistent electrical supply in dialysis facilities, patients were relocated to alternative locations, including some within the mainland US states, for treatment.[6]

Quality of Care of Dialysis Facilities

Nearly 20% of the United States gross domestic product (GDP) is allocated to healthcare, yet other countries with lower expenditures outperform the US in healthcare quality and other health outcomes.[10] As a result, healthcare quality improvement has become a central focus of national policy in the US. Specifically, the End-Stage Renal Disease (ESRD) program is undergoing innovation for quality assessment due to its high cost and limited progress in enhancing survival rates among its targeted population. Previous findings from the Dialysis Facility Compare (DFC) Star Ratings indicate that patient satisfaction is directly linked to the quality of dialysis facilities. Patient satisfaction measures positively correlate with safety outcomes such as pressure ulcers and healthcare-acquired infections, clinical effectiveness measures such as utilization of preventive services, treatment adherence, and decrease in mortality rates. For instance, patients highly satisfied with hospitalizations had a 40% lower 30-day readmission rate than patients with lower satisfaction.[10]

Study Purpose

Although findings suggest a significant increase in the number of people receiving dialysis outside of Puerto Rico after Hurricane Maria, no studies have examined the quality of dialysis facilities in Puerto Rico compared to those in mainland US states.[11] Our study aims to compare the quality of dialysis facilities in Puerto Rico before and after Hurricane Maria to identify key factors driving differences in the quality of dialysis facilities in Puerto Rico compared to the five mainland US states.

Methods

This cross-sectional study examined the quality of patient care rating of dialysis facilities using publicly available data through Dialysis Facility Compare (DFC) maintained and developed from the Centers for Medicare and Medicaid Services (CMS) dataset from October 23, 2015, to October 31, 2023, comparing Puerto Rico to five mainland US states. Data from the Master Beneficiary Summary File (MBSF) were utilized to analyze the migration patterns of Puerto Rican Medicare beneficiaries with ESRD to the US mainland between 2017 and 2018. From this dataset,

150 individuals with ESRD were identified as having migrated from Puerto Rico to various mainland states, with the top five destination states being Florida (FL), Massachusetts (MA), New York (NY), Pennsylvania (PA), and Texas (TX). We examined 4,469 unique dialysis facilities representing 19,507 facility years to assess the quality of care for ESRD patients in these states. Our study relied on DFC data on the quality of patient care ratings for dialysis facilities from the October quarterly dataset for all years (2015-2023), giving us the most recent yearly updates on the quality of dialysis facilities. Ratings were based on various quality measures including preventing hospitalizations and deaths, ensuring effective bloodstream access, and managing the transplant waitlist. The study's main outcome was the mean star rating and identifying the percentage of dialysis facilities with a mean star rating of four or more derived from the publicly available DFC dataset on quality of patient care rating before and after Hurricane Maria (2015-2024). Star ratings range from one to five, with five stars representing “much above care,” four or more stars indicating “care above the national average,” three stars representing “the national average,” and one or two stars indicating “below-average health outcomes.” For our study, each state’s yearly, mean star rating was calculated by averaging dialysis facility ratings from the DFC quality of patient care rating dataset. We defined high-quality dialysis facilities as those with four or more stars and calculated the proportion of high-quality dialysis facilities by state and year. Statistical tests were conducted using the Statistical Analysis System (SAS) programming language. We used chi-square tests to compare facility characteristics between Puerto Rico and the five mainland states while identifying the significance of the percentage of facilities with a mean rating of four or more. ANOVA tests were used to assess the quality of dialysis facilities in Puerto Rico compared to the mainland US states, comparing mean star ratings and facility characteristics across these regions.

Results

Table 1 portrays the characteristics of dialysis facilities by state for 2023, including the number of facilities within the five mainland US states and Puerto Rico categorized by ownership: for-profit, non-profit, and chain-owned, as well as the services offered: in-center hemodialysis, peritoneal dialysis, and home hemodialysis training. In terms of ownership, of the 50 dialysis facilities

in Puerto Rico, (96%) are for-profit, which is the highest compared to other states, except for Texas (96.6%). Puerto Rico (4%) and Texas (3.5%) have the highest percentage of non-profit facilities compared to other states. Puerto Rico (95.6%), Texas (94.8%), and Pennsylvania (95.6%) have the highest percentage of chain-owned facilities compared to other states. Regarding services offered, of the 50 dialysis facilities in Puerto Rico (100%) have the highest percentage of facilities offering in-center hemodialysis compared to other states. Puerto Rico (56%) is approximately average for peritoneal dialysis compared to other states (56.4%). Except for Texas at (18.6%), Puerto Rico has the lowest percentage of facilities offering home hemodialysis training at (20%).

Figure 1 depicts the quality of dialysis facilities measured by the mean star rating (1-5) in Puerto Rico compared to the five mainland US states between 2015 and 2023. Findings suggest between 2015-2023, there was a statistical difference in mean star ratings between Puerto Rico and five states in the US mainland ($p<0.001$). From 2015-2023, Puerto Rico, Massachusetts, New York, and Pennsylvania experienced an increase in mean star rating over time, while Florida and Texas experienced a decrease in mean star rating. In 2015, Puerto Rico had a mean star rating of 1.3 [95% CI: 4.8-9.3], slightly increasing in 2023 to 1.4 stars [95% CI: 1.2-1.6]. In 2017, the same year as Hurricane Maria, Puerto Rico had a mean star rating of 2.2 [95% CI: 2.0-2.4], and in 2018, the mean star rating dropped to 2. The DFC dataset had no dialysis star ratings for 2018, so the average mean star ratings between 2018-2023 were taken for that year. Florida had a mean star rating of 2.6 in 2015 [95% CI: 2.5 -2.7], slightly decreasing to 2.2 stars in 2023 [95% CI: 2.1-2.3], and Texas had a star rating of 3.1 in 2015 [95% CI: 3.0-3.2] and 2.7 in 2023 [95% CI: 2.7-2.8]. Massachusetts experienced an increase in mean star ratings from 2.9 in 2015 [95% CI: 2.7-3.1] to 3.7 in 2023 [95% CI: 3.4-3.9]. New York's mean star rating increased from 2.8 in 2015 [95% CI: 2.7-2.9] to 3.2 in 2023 [95% CI: 3.1-3.4]. Furthermore, Pennsylvania also increased its mean star rating from 2.8 in 2015 [95% CI: 2.6-2.9] to 3.2 in 2023 [95% CI: 3.0-3.3].

Figure 2 shows the percentage of high-quality dialysis facilities in Puerto Rico compared to five mainland US states. High-quality dialysis facilities are defined as those with a mean star rating of 4 or more, surpassing the national average of 3 stars. The findings indicate a significant difference in the percentage of high-quality dialysis facilities between 2015 and 2023 in Puerto Rico compared to

the five mainland US states. Between 2015 and 2023, Puerto Rico, Massachusetts, New York, and Pennsylvania saw a rise in the proportion of dialysis facilities achieving a mean star rating of four or higher. In contrast, Florida and Texas saw a decrease in the percentage of high-quality dialysis facilities during this period. Specifically, in 2015, Puerto Rico had no high-quality dialysis facilities; by 2023, this figure had only increased to 2% [95% CI: 0%-5.8%]. In 2017, the year of Hurricane Maria, Puerto Rico had 2.1% [95% CI: 0%- 6.3%] of high-quality dialysis facilities, while in 2018, Puerto Rico had none. Florida had 12.78% [95% CI: 9.5%- 16%] of high-quality dialysis facilities in 2015, which dropped to 4.5% [95% CI: 2.8%-6.3%] by 2023. Similarly, Texas declined from 29.3% [95% CI: 25.6%-33.2%] in 2015 to 19% [95% CI: 15.8%-21.3%] in 2023. Conversely, Massachusetts experienced a substantial increase from 22% [95% CI: 12.6%-31%] in 2015 to 57% [95% CI: 46.5%-67.4%] in 2023. New York's percentage of high-quality dialysis facilities increased from 24% [95% CI: 19.3%-29.6%] in 2015 to 36% [95% CI: 31.2%-41.1%] in 2023, while Pennsylvania rose from 18.6% [95% CI:14.2%-23.7%] in 2015 to 33.9% [95% CI: 28.6%-39.1%] in 2023.

Discussion

This study highlights significant disparities in the quality of dialysis facilities between Puerto Rico and the five mainland US states, for instance, there is a statistical difference in mean star rating and the percentage of high-quality dialysis facilities. On average, the mean star rating for dialysis facilities in Puerto Rico was 2.6 during the 2015-2023 study period. Specifically, in 2015, Puerto Rico's mean star increased slightly from 1.3 to 1.4 by 2023. Immediately following Hurricane Maria in 2018, Puerto Rico experienced a complete absence of high-quality dialysis facilities, with only 2% of dialysis facilities classified as high quality by 2023. Given these disparities and the impact of Hurricane Maria on dialysis facilities in Puerto Rico, migrating to the US mainland states may offer better access to care for migrants compared to seeking care in Puerto Rico.

` All facilities, including Puerto Rico and the five mainland US states, experienced a decrease in mean star rating in 2023. Puerto Rico declined from a 2.3 mean star rating in 2022 to a 1.4 mean star rating in 2023, a 40.2% decline on the 5-point scale. This decline could be attributed to the End-Stage Renal Disease (ESRD) Model of 2023 or the Prospective Payment System (PPS), the 21st

Century Cures Act, the CMS Methodology Update (October 2023), and the impact of the COVID-19 pandemic on dialysis facilities quality of care.

ESRD Treatment Choices (ETC) Model

The introduction of modifications to the End-Stage Renal Disease (ESRD) Treatment Choices (ETC) Model in 2023, which applies to mainland states, but not Puerto Rico, as proposed in the CY2024 ESRD Prospective Payment System (PPS) Notice of Proposed Rulemaking (CMS-1782-P), may have contributed to the observed decrease in mean star ratings for all facilities, including those in Puerto Rico and the five US mainland states. The ETC Model, designed to promote greater use of home dialysis and kidney transplants among Medicare beneficiaries with ESRD, underwent proposed enhancements to reduce Medicare expenditures while enhancing care quality. These modifications likely prompted adjustments to facility operations and treatment approaches, potentially impacting performance metrics such as star ratings. Stakeholder feedback on the proposed changes, collected during the public comment period, will play a crucial role in shaping the finalization of the ETC Model modifications and their subsequent effects on ESRD facility ratings and patient care outcomes.

21st Century Cures Act

Another potential reason for the decline in mean star ratings for 2023 could be attributed to the provision of the 21st Century Cures Act, allowing Medicare to enroll ESRD patients in private Medicare Advantage (MA) plans starting January 1, 2021, which raises concerns about the potential impact on the quality of dialysis facilities. This transition may prioritize cost containment and profit margins within the private insurance sector, potentially leading to reduced reimbursement rates for dialysis services. Consequently, dialysis facilities may face financial pressures, potentially compromising the quality of care for patients undergoing treatment. Additionally, MA plans often impose restricted networks of healthcare providers, limiting patients' choices of dialysis facilities. This limitation could result in overcrowding and increased appointment wait times, impacting the quality of service and patient experience. Furthermore, integration within traditional Medicare systems may be lost, leading to fragmented care delivery for ESRD patients. This fragmentation could

cause communication gaps between healthcare providers involved in patient care, compromising treatment coordination and overall outcomes.

CMS Methodology Update (October 2023)

The quality of dialysis facilities in Puerto Rico and five mainland US states in 2023 may be significantly impacted by the CMS Methodology update (October 2023), noted in the ESRD Measures Manual for the 2024 Performance Period. The new 2023 CMS update involved a major recalibration of the distribution baseline for Star Ratings.[12] Under this adjustment, 10% of facilities were designated a 1-Star rating, 20% received a 2-Star rating, 40% were rated with 3-Stars, 20% were allocated a 4-Star rating, and the remaining 10% attained a 5-Star rating. Consequently, data collected from the October 2023 update established a new benchmark period, with subsequent assessment periods adhering to the criteria set forth by this release, reflecting shifts in facility performance since then.[12] The decline in star ratings following this recalibration may stem from several factors. Firstly, redistributing star ratings among facilities could lead to those previously rated higher being categorized into lower rating levels, particularly impacting facilities on the borderline between two rating levels. Secondly, updated criteria introduced in the October 2023 release may differ from previous standards, making it challenging for facilities to maintain their previous ratings if they do not meet the revised criteria. Additionally, changes in performance standards or data collection methodologies implemented in the October 2023 release could impact star ratings. For example, introducing new quality measures or changing how certain metrics are weighted could influence the overall rating assigned to a facility. Lastly, the recalibration of star ratings may reflect broader shifts in the quality of care provided by dialysis facilities over time, potentially indicating an industry-wide decline in quality standards.

Impact of COVID-19

Finally, the COVID-19 pandemic may have led to a decline in the mean star rating of dialysis facilities in 2023. Studies reveal a decrease in healthcare utilization and face-to-face encounters among Medicare Advantage (MA) beneficiaries with chronic kidney disease (CDK), alongside an

increase in telehealth services.[13] COVID-19's association with high rates of acute kidney injury has strained hospital dialysis programs, causing shortages of supplies and staff. COVID-19 shed light on mental health challenges for patients and staff, highlighting the need for additional resources.[14] CDK patients faced difficulties accessing support and appointments in COVID-19-affected facilities, leading to missed appointments.[15] Furthermore, the COVID-19 pandemic contributed to a greater shift towards home dialysis, with innovative solutions such as lactate-based and homemade therapies being adopted.[14]

Limitations

Due to the utilization of cross-sectional data in this study, our ability to establish causal relationships is limited. While we can describe associations between migration patterns, facility characteristics, and quality of patient care ratings, we cannot ascertain causality or track changes in these variables over time. Longitudinal data would be essential to uncover temporal trends and causal pathways, providing a more robust understanding of the dynamics between migration patterns and dialysis facility quality. Our study heavily depended on the DFC dataset on the quality of patient star rating, which comprises process outcome measures. To address this, we explored additional quality metrics from the DFC dataset such as patient survey ratings for dialysis facilities by examining composite measures, which combine multiple individual measures or indicators to provide a comprehensive summary of complex information into a single score or index. Additionally, we analyzed patient surveys conducted biannually, in spring and fall, targeting dialysis patients who have received hemodialysis at their current facility for over three months, focusing on aspects significant to patients, such as communication effectiveness with their kidney doctors and dialysis facility staff. While the variables were present in our dataset, we observed significant missing data. The prevalence of missing variables was notable across all patient data, potentially introducing bias if included in our analysis. For instance, in 2023, Florida had 85.3% missing data, Massachusetts had 60.5%, New York had 62%, Pennsylvania had 78%, and Puerto Rico had 14%. This pattern of missing data was consistent across all years of our study. This missing data stemmed from various factors, including too few completed survey responses to generate a report, unavailability of survey data for the reporting

period, non-administration of the survey due to an insufficient number of eligible patients served by the facility, inadequate patient count to report on this measure, unreported data, inaccuracies determined by Medicare in the reported percentages, or the dialysis center not being open long enough to provide sufficient measure data. It is important to note that the mean star ratings in Puerto Rico for 2018 were missing; hence, we analyzed the average mean star ratings from 2015 to 2023. Furthermore, it's important to note the use of aggregated data rather than patient-level information in our analysis. By relying on aggregated data, we cannot determine the quality of facilities where migrants may have received care in the US. This limitation could impact the accuracy of our findings, as variations in individual facility quality may influence patient outcomes differently. Incorporating patient-level data would provide a more granular understanding of the quality of care received by migrants and allow for a more nuanced analysis of facility performance.

Conclusion

Before and after Hurricane Maria we found significant disparities in the quality of dialysis facilities in Puerto Rico compared to those in the five mainland US states we studied. This difference in quality appears to be exacerbated by federal policies that treat Puerto Ricans as second-class citizens and local financial mismanagement, which contribute to the prevalence of chronic conditions on the island.[16] Moreover, the decline in mean star ratings of dialysis facilities after Hurricane Maria in 2023 may be attributed to various reasons, including the ESRD Model's preference for home hemodialysis and the 21st Century Cures Act, which has reduced the number of dialysis facilities due to increased demand from ESRD patients. This, in turn, has resulted in a larger number of ESRD patients eligible to enroll in MA plans. Additionally, the CMS 2023 Methodology Update introduced a major recalibration of the distribution baseline for star ratings, therefore we propose that it is important to keep this in mind for the future and further examine how star ratings continue to change over time. Furthermore, the impacts of COVID-19 could have contributed to the quality of dialysis facilities. Our study highlights the importance of policymakers prioritizing equitable access to healthcare resources and implementing targeted interventions to address the identified disparities between Puerto Rico and the five mainland US states.

Tables and Figures

Table 1: *Dialysis Facility Characteristics by State (2023)*

	Puerto Rico (n= 50)	New York (n= 317)	Florida (n= 493)	Massachusetts (n= 87)	Texas (n= 746)	Pennsylvania (n= 327)
Ownership n (%)						
For Profit	96	74.44	95.09	82.56	96.51	90.1
Non-Profit	4	25.56	4.91	17.44	3.49	9.9
Chain-Owned	94.76	66.39	87.52	87.21	94.76	95.53
Services Offered n (%)						
Offers in-center hemodialysis	100	96.39	94.14	97.67	94.35	94.57
Offers peritoneal dialysis	56	43.06	61.63	69.77	49.6	58.15
Offers home hemodialysis training.	20	28.61	31	50	18.55	32.59

Figure 1: *Quality of Dialysis Facilities in Puerto Rico compared with US States (2015-2023)*

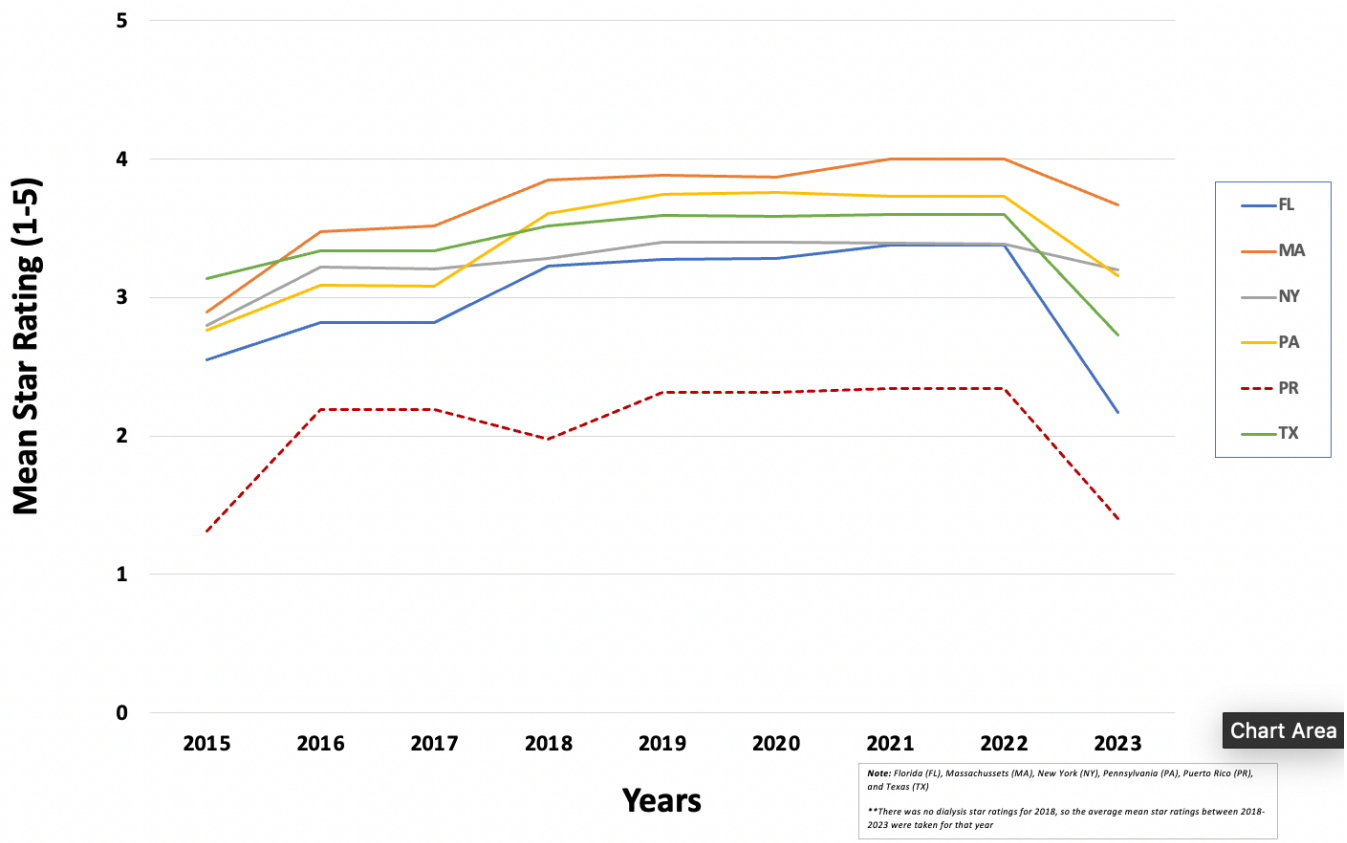

Table 1.1: *Mean Star Rating for Puerto Rico compared with US States (2015-2023)*

Year	Florida	Massachusetts	New York	Pennsylvania	Puerto Rico	Texas
2015	2.55153	2.89855	2.79757	2.76471	1.31579	3.13813
2016	2.81675	3.47826	3.21633	3.08846	2.19048	3.33579
2017	2.82011	3.51471	3.20661	3.08203	2.19048	3.33519
2018	3.22711	3.84615	3.27881	3.60915	1.98027	3.51613
2019	3.27231	3.88462	3.39789	3.74658	2.31818	3.59141
2020	3.2788	3.86667	3.39716	3.7561	2.31818	3.5888
2021	3.38095	4	3.38908	3.7309	2.34043	3.60116
2022	3.38095	4	3.38776	3.72937	2.34043	3.59942
2023	2.17087	3.67089	3.2013	3.15571	1.40426	2.72714

Figure 2: *Proportion of High-Quality Dialysis Facilities in Puerto Rico compared with US States (2015-2023)*

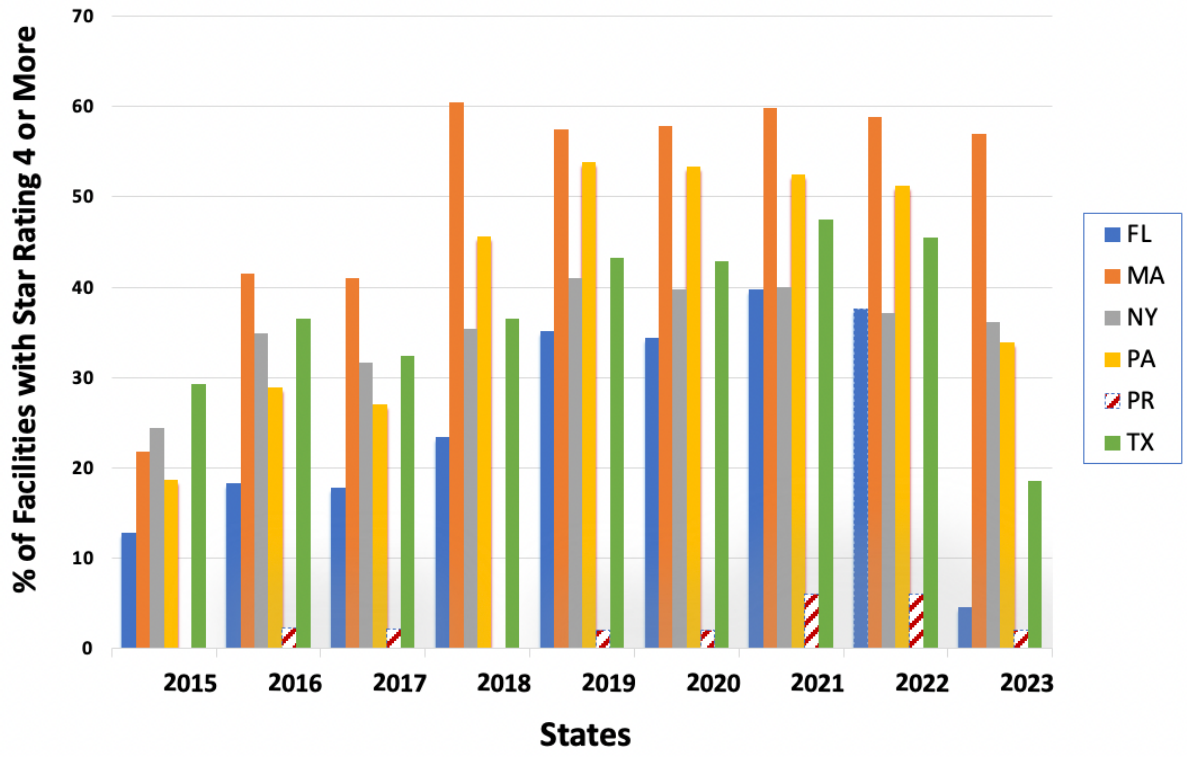

Table 2: *Proportion of High-Quality Dialysis Facilities for Puerto Rico compared with US States (2015-2023)*

Years	Florida	Massachusetts	New York	Pennsylvania	Puerto Rico	Texas
2015	12.7764	21.7949	24.4361	18.638	0	29.2769
2016	18.287	41.4634	34.9442	28.866	2.2222	36.5646
2017	17.7928	40.9639	31.5972	26.9737	2.1277	32.4242
2018	23.3906	60.4651	35.3333	45.5975	0	36.4568
2019	35.0913	57.4713	41.0095	53.8226	2	43.2976
2020	34.3936	57.8313	39.8148	53.3742	2	42.8571
2021	39.8039	59.7701	40.0602	52.439	6	47.4599
2022	37.5926	58.8889	37.1508	51.1834	6	45.4662
2023	4.5369	56.9767	36.1111	33.8658	2	18.5484

References

1. Frontera-Escudero I, Bartolomei JA, Rodríguez-Putnam A, Claudio L. Sociodemographic and health risk factors associated with health-related quality of life among adults living in Puerto Rico in 2019: a cross-sectional study. *BMC Public Health*. 2023;23(1):2150. doi:10.1186/s12889-023-17115-3

2. Monica 1776 Main Street Santa, California 90401-3208. Hurricanes Irma and Maria: Impact and Aftermath. Accessed March 22, 2024. https://www.rand.org/hsrd/hsoac/projects/puerto-rico-recovery/hurricanes-irma-and-maria.html

3. mat-report_hurricane-irma-maria-puerto-rico_2.pdf. Accessed April 18, 2024. https://www.fema.gov/sites/default/files/2020-07/mat-report_hurricane-irma-maria-puerto-rico_2.pdf

4. Welton M, Vega CMV, Murphy CB, et al. Impact of Hurricanes Irma and Maria on Puerto Rico Maternal and Child Health Research Programs. *Matern Child Health J*. 2020;24(1):22-29. doi:10.1007/s10995-019-02824-2

5. Chandra A, Marsh T, Madrigano J, et al. Health and Social Services in Puerto Rico Before and After Hurricane Maria. *Rand Health Q*. 2021;9(2):10.

6. Michaud J, Published JK. Public Health in Puerto Rico after Hurricane Maria. KFF. Published November 17, 2017. Accessed March 22, 2024. https://www.kff.org/mental-health/issue-brief/public-health-in-puerto-rico-after-hurricane-maria/

7. Andrade EL, Cordova A, Schagen CR van, et al. The impact of Hurricane Maria on individuals living with non-communicable disease in Puerto Rico: the experience of 10 communities. *BMC Public Health*. 2022;22(1):2083. doi:10.1186/s12889-022-14552-4

8. Flores Roque G. Psychological effects before, during and after Hurricane Maria. *Int J Qual Stud Educ QSE*. 2022;35(8):843-856. doi:10.1080/09518398.2022.2061072

9. puerto_rico_2023.pdf. Accessed March 22, 2024. https://www.kidney.org/sites/default/files/puerto_rico_2023.pdf

10. Kshirsagar AV, Tabriz AA, Bang H, Lee SYD. Patient Satisfaction Is Associated With Dialysis Facility Quality and Star Ratings. *Am J Med Qual*. Published online September 18, 2018. doi:10.1177/1062860618796310

11. Rivera-Hernandez M, Kim D, Nguyen KH, et al. Changes in Migration and Mortality Among Patients With Kidney Failure in Puerto Rico After Hurricane Maria. *JAMA Health Forum*. 2022;3(8):e222534. doi:10.1001/jamahealthforum.2022.2534

12. CMS ESRD Measures Manual for the 2024 Performance Period. Published online 2024.

13. Decline in Health Care Services for Patients With CKD Linked to COVID-19 Pandemic. AJMC. Published October 4, 2022. Accessed April 23, 2024. https://www.ajmc.com/view/decline-in-health-care-services-for-patients-with-ckd-linked-to-covid-19-pandemic

14. Silberzweig J, Kliger AS. Covid-19 and dialysis patients. Handbook of Dialysis Therapy. 2023. Accessed April 23, 2024. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9335159/.

15. Trivedi M. Safeguarding dialysis services during the COVID-19 pandemic. Nature News. June 11, 2021. Accessed April 23, 2024. https://www.nature.com/articles/s41581-021-00448-w.

16. Lafarga Previdi I, Vélez Vega CM. Health Disparities Research Framework Adaptation to Reflect Puerto Rico's Socio-Cultural Context. *Int J Environ Res Public Health*. 2020;17(22):8544. doi:10.3390/ijerph17228544