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Trends in hospital capacity and utilization in Puerto Rico by health regions, 2010–2020

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Like many under resourced, island communities, most of the municipalities in Puerto Rico are medically underserved. However, there is limited information about changes in hospital capacity and any regional disparities in availability of hospital services in Puerto Rico, especially given the multiple public health emergencies the island has faced in recent years (e.g. hurricanes, earthquakes, and COVID-19). This study described the trends in hospital capacity and utilization for the Island of Puerto Rico and by health regions from 2010 to 2020. We analyzed the 2021–22 Area Health Resource File (AHRF) and aggregated the data by seven health regions, which are groupings of municipalities defined by the Puerto Rico Department of Health. Ten-year estimates for hospital utilization were adjusted for population size by health region. During the more recent five-year period, there were decreases in hospitals, hospital beds, and surgeries, which represent a shift from the earlier five-year period. Over the 10 years of the study period, there was an overall decrease in population-adjusted measures of hospital utilization on the island of Puerto Rico—despite multiple disasters that would, theoretically, increase need for health care services. We also found variation in hospital capacity and utilization by health regions indicating the rate of change was not uniform across Puerto Rico. The capacity of Puerto Rico's hospital system has shrunk over the past decade which may pose a challenge when responding to recurrent major public health emergencies, especially within specific health regions.

Keywords Puerto Rico, Hospitals, Health care utilization, Health infrastructure, Islands

Residents of Puerto Rico face the constant threat of public health emergencies[1–3]. For example, two category 5 storms—Hurricanes Irma and Maria—struck the island in September 2017 and caused mortality and morbidity and in 2019 a cluster of earthquakes also caused major damage and distress across the island[4–12]. However, little recent health services research has focused on Puerto Rico, with the exception of qualitative studies that have documented health care system disruptions on the island following the hurricanes and one quantitative study that documented a decline in ambulatory mental health crisis services[13–16]. Changes in hospital capacity and utilization on the island during these periods of public health emergency remains unclear. To better prepare for future challenges, it's crucial to understand how these trends are unfolding across different regions of Puerto Rico.

Puerto Rico, a territory of the United States (US), has 64 general hospitals that provide services to residents of 93 urban and rural areas across the island[17]. The Health Resources and Services Administration (HRSA) has deemed all but 6 of Puerto Rico's 78 municipalities as medically underserved areas[17], and there is considerable variation in hospital and bed capacity across the island, with more than a third of the hospitals and nearly 40% of hospital beds located in the San Juan metro area[18]. Moreover, hospitals in Puerto Rico rely heavily on Medicaid and Medicare funds. Most of Puerto Rico's residents (60%) receive public insurance coverage, about one-third have private employee-sponsored or individual purchased insurance, and the remaining 6% are uninsured[19]. Medicare benchmark payments in Puerto Rico lag far behind those offered in the US mainland[20]. Further, Medicaid, which is funded through a US government block grant, uses a matched funding cap historically set at 55% which yields a Medicaid provider reimbursement much lower than the states[19,20].

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Despite facing limited resources and a heavy reliance on public funding, there's a lack of recent quantitative data on how hospital capacity and utilization are changing across Puerto Rico's health regions other than a well-documented decrease in surgical cases in Puerto Rico.[21,22]. This study aims to address this gap in knowledge by analyzing trends in hospital beds, admissions, surgeries, and emergency department visits from 2010 to 2020. By examining these trends on a regional level, we can gain valuable insights into the evolving healthcare landscape of Puerto Rico.

Methods

We analyzed the 2021–22 Area Health Resource File (AHRF), which is a county-level file that includes data for each state and US territory in the United States from more than 50 sources such as the American Hospital Association, American Medical Association, Census Bureau, National Center for Health Statistics, and Centers for Medicare and Medicaid Services. AHRF contains over 6000 variables on health facilities, health professions, resource scarcity, health status, economic activity, health training programs, and socioeconomic and environmental characteristics and the data are released annually[23].

For this study, hospital measures of capacity and utilization were only available in 5-year increments: 2010, 2015, 2020. We aggregated the data by health regions, which are groupings of municipalities defined by the Puerto Rico Department of Health: Metro (North), Ponce (Southeast-Southwest), Mayaguez (East), Fajardo (Northwest), Caguas (West), Bayamon (Southwest), and Arecibo (Northeast)[17]. Figure 1 provides a map of the Puerto Rico health regions. Hospital capacity was measured by the number of short-term general hospitals and hospital beds. Short-term general hospitals are healthcare facilities that provide a range of acute care services for a limited duration, typically less than 30 days, with a focus on treating acute illnesses, injuries, surgeries, and other urgent health conditions. Hospital utilization was measured by hospital admissions, inpatient days, surgeries, and emergency department visits in short-term general hospitals. We calculated the aggregated net change (number and percent) for each measure at the health region and for the entire island. The net change in numbers was calculated by subtracting the raw number for each measure (2015–2010 and 2020–2015). The percentage change was calculated by dividing the net number change with the value in the most recent year for that 5-year period and then multiplying by 100. Population adjusted ten-year rates of change were calculated by dividing each health region's utilization measure by the Census population estimates, multiplying that number by 10,000, and subtracting the 2020 rate from 2010 rate.

This study analyzed publicly available data about hospital characteristics aggregated at the health region level. Therefore, this study was not considered to be human subjects research by the university institutional review board. The STROBE guidelines for reporting observational research were followed.

Results

Table 1 shows the net changes, both number and percentage, in hospital capacity and utilization in Puerto Rico's health regions from 2010 to 2015. During this period, there was a net increase of three hospitals and 134 hospital beds across the island. However, the changes in hospital capacity varied significantly by region. The Mayaguez region experienced the most substantial growth, adding three hospitals and 117 hospital beds, representing a 30% and 11% increase, respectively. In contrast, the Metro and Bayamon regions saw a reduction in hospital capacity, with the Metro region losing one hospital and 307 beds, a decline of 7% and 11%, respectively.

Hospital admissions decreased by 19,119 across Puerto Rico, with the most notable reduction in the Metro region, which saw a decrease of 14,897 admissions, or 13%. By contrast, the Arecibo region reported an increase of 5,168 admissions, representing a 10% rise. Inpatient days declined by 141,113, primarily driven by the Metro region, which experienced a reduction of 148,350 inpatient days (19%). Again, Arecibo saw the largest net increase of 52,607 (18%) inpatient days. Surgeries increased overall by 9,054, with the Metro region reporting the highest net increase (11,438 surgeries, 12%). However, Bayamon experienced a significant reduction of

Figure 1. Map of Puerto Rico Health Regions. Health regions are groupings of municipalities defined by the Puerto Rico Department of Health: Metro (North), Ponce (Southeast-Southwest), Mayaguez (East), Fajardo (Northwest), Caguas (West), Bayamon (Southwest), and Arecibo (Northeast). Image Attribution: The Eloquent Peasant original from User:NordNordWest in wikicommons at File:USA Puerto Rico location map.svg, CC BY-SA 3.0 via Wikimedia Commons. Page URL https://commons.wikimedia.org/wiki/File:Map_of_PR_regions_defined_by_the_PR_Department_of_Health.jpg.

Health region	Number						
	Population	Hospitals	Hospital beds	Admissions	Inpatient days	Surgeries	Emergency department visits
Metro	−62,744	−1	−307	−14,897	−148,350	11,438	−65,522
Ponce	−39,422	0	−21	−4133	−19,363	1262	−72,346
Mayaguez	−33,583	3	117	4368	20,525	3267	50,557
Fajardo	−8664	1	48	−142	2618	1546	−13,548
Caguas	−26,649	1	165	−3105	363	6778	−26,232
Bayamon	−34,884	−1	−89	−6378	−49,513	−13,634	−44,055
Arecibo	−26,562	0	221	5168	52,607	−1603	−40,204
Total	−232,508	3	134	−19,119	−141,113	9054	−211,350
	Percentage						
Health region	Population (%)	Hospitals (%)	Hospital beds (%)	Admissions (%)	Inpatient days (%)	Surgeries (%)	Emergency department visits (%)
Metro	−8	−7	−11	−13	−19	12	−21
Ponce	−8	0	−2	−8	−7	3	−54
Mayaguez	−7	30	11	9	8	8	28
Fajardo	−7	50	26	−2	6	23	−71
Caguas	−5	14	15	−6	0	18	−14
Bayamon	−6	−25	−11	−17	−22	−46	−46
Arecibo	−6	0	23	10	18	−5	−36
Total	−7	6	2	−5	−6	3	−20

Table 1. 5-Year Net Changes in Short Term General Hospital Capacity and Utilization in Puerto Rico Health Regions, 2010–2015. Analysis of the 2021–22 Area Health Resource File. Health regions are groupings of municipalities defined by the Puerto Rico Department of Health. The net change in numbers was calculated by subtracting the measure in 2015 from the same measure in 2010. The percentage change was calculated from the net number change and dividing by the value in 2015 and then multiplying by 100.

13,634 surgeries (46%). Emergency department (ED) visits decreased by 211,350, with the largest reduction in the Ponce region, which saw 72,346 fewer visits (54%). Mayaguez was the only region to report an increase in ED visits, with an additional 50,557 visits (28%).

Table 2 illustrates the changes in hospital capacity and utilization from 2015 to 2020. Overall, the population decreased by 10% percentage points which was greater than the prior 5-year period of a 7% decline. During this period, there was a net reduction of three hospitals and 42 hospital beds across Puerto Rico. The Ponce and Mayaguez regions each lost two hospitals, while the Metro region added one hospital. Despite this overall reduction, the Caguas region saw an increase of 257 hospital beds (19%) while the Metro region had a 1% increase in hospital beds.

Hospital admissions decreased significantly by 78,145, with reductions observed in all regions. The Metro region experienced the largest net decline, with 22,097 fewer admissions (23%). Inpatient days also saw a substantial reduction, totaling 433,569 fewer days, with the most significant net decrease in the Metro region (142,282 days, 22%). The only region to report an increase in inpatient days was Caguas, with an additional 12,880 days (4%). Surgeries decreased by 40,037 overall, with the Metro region reporting the largest net reduction of 12,998 surgeries (16%). Arecibo was the only region to report an increase in surgeries, adding 4797 surgeries (12%). ED visits decreased by 69,239, with the largest net reduction in Mayaguez, which saw 94,892 fewer visits (113%). In contrast, the Caguas region reported an increase of 71,075 ED visits (28%).

Table 3 provides the ten-year population adjusted rates of change in hospital utilization by health region. Over the ten-year period from 2010 to 2020, Puerto Rico experienced significant declines in population-adjusted hospital utilization rates per 10,000 population. Overall, the island saw a net decrease over the 10-year span of 1144 hospital admissions, 5826 inpatient days, 3261 emergency department visits, 89 surgeries, and 5711 outpatient visits per 10,000 population. Despite the general trend of declining population-adjusted utilization, certain health regions experienced increases in specific areas. In the Caguas region, there was an increase of 14 admissions, 852 inpatient days, and 1304 emergency department visits per 10,000 population. The Arecibo region saw an increase of 304 inpatient days and 160 surgeries per 10,000 population. The Metro region reported an increase of 125 surgeries and 4750 outpatient visits per 10,000 population. Additionally, the Ponce region had a slight increase of 8 surgeries per 10,000 population, and the Mayaguez region saw an increase of 56 surgeries per 10,000 population.

Conversely, declines were observed in most regions across multiple metrics. The Metro region experienced a decrease of 288 admissions, 2404 inpatient days, and 507 emergency department visits per 10,000 population. Ponce saw reductions of 255 admissions, 1484 inpatient days, 1,334 emergency department visits, and 4272 outpatient visits per 10,000 population. Mayaguez experienced decreases of 108 admissions, 646 inpatient days,

Health region	Number						
	Population	Hospitals	Hospital beds	Admissions	Inpatient days	Surgeries	Emergency department visits
Metro	−79,157	1	37	−22,097	−142,282	−12,998	−17,414
Ponce	−53,885	−2	−128	−17,066	−99,788	−7,034	−24,302
Mayaguez	−44,618	−2	−94	−14,008	−77,131	−4,482	−94,892
Fajardo	−11,939	0	−67	−4,614	−24,066	−4,240	−3,011
Caguas	−37,478	0	257	−2,190	12,880	−12,004	71,075
Bayamon	−51,308	0	−31	−6,886	−40,779	−4,076	−22,305
Arecibo	−36,454	0	−16	−11,284	−62,403	4,797	21,610
Total	−314,839	−3	−42	−78,145	−433,569	−40,037	−69,239
Health region	Percentage						
	Population (%)	Hospitals (%)	Hospital beds (%)	Admissions (%)	Inpatient days (%)	Surgeries (%)	Emergency department visits (%)
Metro	−12	7	1	−23	−22	−16	−6
Ponce	−12	−40	−14	−48	−55	−22	−22
Mayaguez	−10	−25	−10	−41	−40	−12	−113
Fajardo	−10	0	−57	−136	−114	−165	−19
Caguas	−7	0	19	−5	4	−45	28
Bayamon	−10	0	−4	−22	−22	−16	−30
Arecibo	−9	0	−2	−28	−27	12	16
Total	−10	−6	−1	−27	−25	−16	−7

Table 2. 5-Year Net Changes in Short Term General Hospital Capacity and Utilization in Puerto Rico Health Regions, 2015–2020. Analysis of the 2021–22 Area Health Resource File. Health regions are groupings of municipalities defined by the Puerto Rico Department of Health. The net change in numbers was calculated by subtracting the number of hospital capacity or utilization in 2020 from the same measure in 2015. The percentage change was calculated from the net number change and dividing by the value in 2020 and then multiplying by 100.

	Hospital utilization rates per 10,000 population				
	Admissions	Inpatient days	ED Visits	Surgeries	Outpatient visits
Metro	−288	−2404	−507	125	4750
Ponce	−255	−1484	−1334	8	−4272
Mayaguez	−108	−646	−651	56	−1022
Fajardo	−312	−1342	−1038	−169	−190
Caguas	14	852	1304	−32	−878
Bayamon	−155	−1107	−929	−237	−1356
Arecibo	−41	304	−106	160	−2744
Total	−1144	−5826	−3261	−89	−5711

Table 3. Population Adjusted 10-year Changes in Short Term General Hospital Utilization by Puerto Rico Health Regions, 2010–2020. Analysis of the 2021–22 Area Health Resource File. Health regions are groupings of municipalities defined by the Puerto Rico Department of Health. Total represents the sum of all seven health regions. Ten-year rates of change were calculated by dividing utilization by Census population estimates for the health region, multiplying by 10,000, and subtracting 2020 rates from 2010 rates.

651 emergency department visits, and 1022 outpatient visits per 10,000 population. In Fajardo, the decreases included 312 admissions, 1342 inpatient days, 1,038 emergency department visits, 169 surgeries, and 190 outpatient visits per 10,000 population. Bayamon reported declines of 155 admissions, 1107 inpatient days, 929 emergency department visits, 237 surgeries, and 1356 outpatient visits per 10,000 population. Lastly, Arecibo experienced decreases in admissions (− 41) and emergency department visits (− 106) per 10,000 population, despite increases in other areas.

Discussion

This study described the trends in hospital capacity and utilization on the island of Puerto Rico from 2010 to 2020, a period marked by significant public health emergencies, including Hurricanes Irma and Maria in 2017, a series of earthquakes in 2019, and the onset of the COVID-19 pandemic in 2020. These disasters had profound impacts on the healthcare system, and our findings provide insight into how hospital capacity and utilization

evolved over this decade. However, the data were limited by available measures and other measures of hospital capacity and utilization, such average number of days of hospitalization per patient, bed occupancy rate, and waiting time per patient, were not available.

From 2010 to 2015, there was an increase in hospital capacity and surgeries across Puerto Rico. However, during the same period, there were decreases in hospital admissions, inpatient days, and emergency department visits. These findings suggest a complex interaction between increased capacity and decreased utilization. One possible explanation is that the increased capacity was a response to the anticipated demand following disasters such as Hurricanes Earl, Otto, and Irene in 2010–11, yet the actual utilization did not match this capacity due to population displacement and reduced healthcare-seeking behavior in the immediate aftermath of these events. In contrast, from 2015 to 2020, we found a net reduction in hospital capacity and significant decreases in hospital admissions, inpatient days, surgeries, and emergency department visits. These reductions coincided with a period of ongoing recovery from the hurricanes, the impact of the earthquakes, and the COVID-19 pandemic, highlighting the strain on the healthcare system and potentially reflecting ongoing challenges in healthcare access and delivery[1–3].

The ten-year trends showed a general decline in population-adjusted hospital utilization rates, including reductions in admissions, inpatient days, emergency department visits, and surgeries. Despite these overall declines, some regions, such as Caguas and Arecibo, saw increases in specific utilization measures, indicating regional variations in healthcare needs and resources. The observed decrease in hospital utilization following major disasters may be attributed to several factors. Disasters can disrupt healthcare services, leading to temporary closures of facilities and displacement of healthcare workers[13–17]. Additionally, residents may prioritize immediate survival needs over healthcare, resulting in decreased utilization of hospital services[12]. Moreover, infrastructure damage and power outages can impede hospital operations and accessibility, further reducing utilization[17,24]. The increase in hospital capacity during 2010 to 2015, despite decreasing utilization measures, suggests a proactive approach to enhance healthcare infrastructure in anticipation of increased demand due to disasters. However, the subsequent decrease in capacity and utilization from 2015 to 2020 indicates ongoing challenges in maintaining healthcare services in the face of recurring disasters and a shrinking population.

Prior studies have shown that emergency department visits generally increase over time, particularly following disasters due to injuries and acute health issues[25–27]. Our findings, however, suggest a declining trend in ED visits in Puerto Rico, which may be inconsistent with mainland trends and warrant further investigation[28]. Ongoing recovery efforts, population displacement, and changes in healthcare-seeking behavior may possibly contribute to these differences[21–23]. Another significant factor contributing to the decline in hospital utilization is the ongoing population decline and economic contraction that has beset Puerto Rico since 2006 when Congress eliminated corporate tax benefits for conducting business in US territories[29]. This prolonged economic downturn has led to substantial outmigration and a shrinking population, which may have reduced the overall demand for healthcare services, despite the increased need due to natural disasters and public health emergencies.

Overall, the shrinking capacity of Puerto Rico's hospital system poses significant challenges in responding to major public health emergencies. The reliance on public funding, coupled with the ongoing population decline and the impact of compounding disasters, underscores the need for strategic planning and resource allocation to ensure adequate healthcare capacity and utilization across the island[20]. Our study highlights the importance of regional analysis in understanding healthcare trends and addressing disparities. The varying trends across health regions suggest that interventions must be directed toward addressing specific regional needs and challenges. Additionally, further research is warranted to explore the underlying factors contributing to the observed trends and to develop strategies to enhance healthcare resilience in Puerto Rico.

Conclusion

This study described recent trends and regional variation in short term general hospital services in Puerto Rico. Our findings provide insights that can be used by hospital administrators, public health officials, and public safety officers to better prepare for and respond to public health emergencies. The decreases in hospital capacity and utilization in Puerto Rico are commensurate with the population decline and economic contraction that have been ongoing for nearly two decades[17,18,29]. Moreover, the reliance on public funding on the island may present a challenge for hospitals to meet demand, suggesting decreases in utilization may not be entirely driven by population decline[19,20]. Possibly exacerbating these hospital trends on the island are compounding public health disasters such as hurricanes, earthquakes, and infectious disease outbreaks that impact hospitals[21,23,30]. The capacity of Puerto Rico's hospital system has shrunk over the past decade which may pose a challenge when responding to recurrent major public health emergencies, especially within specific health regions.

Data availability

The Area Health Resources File data used in this study are publicly available from the Health Resources & Services Administration: https://data.hrsa.gov/topics/health-workforce/ahrf.

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Author contributions

JPS performed the data analysis. JPS wrote the first draft of the manuscript. All authors contributed to the study conception, interpretation of findings, and subsequent drafts of the manuscript. All authors read and approved the final version of the manuscript.

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Competing interests

The authors declare no competing interests.

Additional information

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