



Assessing equity in the distribution of hospital beds in Lorestan, western Iran: a regional analysis

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Keywords

Equity • Hospital Beds • Gini Coefficient • Lorenz Curve • Universal Health Coverage • Health Policy • Iran

Summary

Background. Equity in health service delivery ensures that resources are distributed based on need, minimizing barriers to access and reducing health disparities. Hospital beds are a critical healthcare resource, essential for providing timely and effective medical care. This study aims to evaluate the equity in the distribution of hospital beds in Lorestan Province, western Iran, using the Gini coefficient and Lorenz curve as analytical tools.

Methods. Data on the number of hospital beds and population statistics for each city in Lorestan were collected from the Lorestan University of Medical Sciences and the Statistical Center of Iran. The equity of hospital bed distribution was assessed using the Gini coefficient and Lorenz curve, with analyses conducted using R statistical software.

Results. Lorestan Province, with a population of 1,678,873, has

significant disparities in hospital bed distribution. The Gini coefficient for hospital beds was 0.27, indicating moderate inequality. The Lorenz curve showed a substantial deviation from the equity line, highlighting the imbalance. Khorramabad and Aligudarz exhibited the highest inequality, while Rumeskhan, Kuhdasht, and Poldokhtar had more equitable distributions.

Conclusions. The study reveals notable inequities in hospital bed distribution in Lorestan Province, emphasizing the need for targeted policy interventions. Strategic resource allocation, infrastructure development, and policy reforms are essential to enhance healthcare equity. Continuous monitoring and consideration of additional healthcare resources and socioeconomic factors are recommended for comprehensive future assessments.

Introduction

Equity in access to health services ensures that all individuals, regardless of their socioeconomic status, geographic location, gender, or ethnicity, have the opportunity to obtain the healthcare they need [1]. Equity in health service delivery means that resources are distributed based on need, and barriers to accessing these services are minimized [2]. Universal Health Coverage (UHC) aims to ensure that all people receive the health services they need without suffering financial hardship. By ensuring that vulnerable and marginalized populations have access to health services, equity reduces health disparities and improves overall health outcomes [3]. Equitable access to healthcare leads to early detection and treatment of diseases, reducing morbidity and mortality rates. Equity in health services fosters social cohesion and equity, contributing to societal well-being and stability [4]. Healthier populations are more productive and contribute more effectively to the economy. Equitable health systems thus support economic growth and development [5].

Hospital beds are a critical resource in healthcare systems. They are essential for providing inpatient

care, which includes not only routine medical and surgical care but also intensive care for severe illnesses and conditions [6]. Adequate availability of hospital beds ensures that patients can receive timely medical intervention, which is crucial for effective treatment and recovery. Access to hospital beds is linked to the quality of care provided. Overcrowded hospitals can lead to suboptimal care and increased risk of infections and other complications [7]. Proper allocation of hospital beds impacts patient outcomes positively by ensuring that individuals receive the necessary care without delays. This is particularly vital in emergencies and for critical care patients [8]. Adequate hospital bed availability supports public health efforts, especially during pandemics or health crises, by providing the infrastructure needed to handle sudden increases in patient volume. Efficient use of hospital beds can reduce healthcare costs by minimizing unnecessary admissions and optimizing resource utilization [9].

Equitable distribution of hospital beds means ensuring that all regions, especially underserved and rural areas, have sufficient beds to meet the healthcare needs of their populations [10]. It involves considering factors such as population density, disease burden, and geographical

challenges. Equitable distribution of hospital beds ensures that all individuals, regardless of location, have access to necessary inpatient care [11]. This reduces geographic disparities in health outcomes and optimizes the use of healthcare resources, preventing the overloading of some hospitals while others remain underutilized. It contributes to health equity by addressing the needs of marginalized and vulnerable populations who might otherwise face barriers to accessing inpatient care [12]. It also supports the efficiency of the healthcare system by allocating resources based on need and demand, thereby improving overall system performance. Additionally, equitable distribution positively impacts community health by ensuring that local populations have access to essential healthcare services, which is crucial for community-wide disease prevention and management [13]. Equitable distribution of hospital beds is essential for achieving UHC, improving patient outcomes, and ensuring the efficient functioning of the healthcare system. It plays a significant role in reducing health inequalities and enhancing the general health and well-being of the population [14].

The aim of this study is to evaluate the equity in the distribution of hospital beds in Lorestan Province, located in western Iran. Despite the recognized importance of equitable distribution of hospital beds, many regions, particularly in low- and middle-income countries, continue to face significant disparities. This is often due to a lack of comprehensive data and analysis that can guide effective resource allocation [15]. This study seeks to fill this gap by providing a detailed regional analysis of hospital bed distribution, highlighting areas of inequity and potential areas for improvement. For policymakers and decision-makers, this study offers critical insights into the current state of hospital bed allocation in Lorestan Province. By identifying disparities and highlighting underserved areas, this research provides a foundation for informed decision-making aimed at enhancing healthcare equity. The findings can guide the development of targeted interventions and resource allocation strategies that ensure all residents have adequate access to inpatient care. Furthermore, this study contributes to the broader discourse on UHC by emphasizing the necessity of equitable resource distribution as a cornerstone of health equity. Policymakers can use the insights gained from this analysis to support initiatives aimed at reducing health disparities, improving patient outcomes, and achieving UHC goals. The study's evidence-based recommendations can inform strategic planning and policy formulation, ultimately fostering a more equitable and efficient healthcare system in Lorestan and similar regions.

Methods

LORESTAN PROVINCE

Lorestan is a province located in the western part of Iran. It is characterized by its mountainous terrain. The



capital city of Lorestan is Khorramabad. As of the latest administrative divisions, Lorestan province comprises 11 counties. Each of these counties includes several cities and rural districts. Figure 1 shows the location of Lorestan Province in western Iran. The geographical location of Lorestan Province is shown in Figure 1.

DATA COLLECTION

In Lorestan province, Lorestan University of Medical Sciences (LUMS) is responsible for providing health services, including the establishment of hospitals. All government hospitals and services in the province are offered at government-regulated prices. Data on the number of hospitals and hospital beds in each city were collected from the Lorestan University of Medical Sciences website (<https://lums.ac.ir>). Population statistics for each city were obtained from the statistical center of Iran (<https://amar.org.ir>). Since the data used in this study is publicly accessible and available online to any researcher, there was no need to obtain an ethics code.

DATA ANALYSIS

To assess the equity in the distribution of hospital beds, we employed two widely used Gini coefficient [16] and the Lorenz curve indicators [17]. The Gini coefficient is a measure of statistical dispersion intended to represent the inequality of a distribution. A Gini coefficient of 0 indicates perfect equality, where every city has the same number of hospital beds per capita. A Gini coefficient of 1 indicates maximum inequality, where one city has all the hospital beds. Interpret the Gini coefficient and its range: **0**: Perfect equality. Every region has an equal number of hospital beds. **1**: Perfect inequality. All hospital beds are concentrated in one region, and other regions have none. Understanding the Coefficient: Low Gini Coefficient (close to 0): Indicates a more equitable distribution of hospital beds. Regions have similar numbers of beds, showing relatively fair access across the board. High Gini Coefficient (close to 1): Indicates greater inequality in distribution. This suggests that some regions have a disproportionate number of beds compared to others, reflecting disparities in access to healthcare resources.

To calculate the Gini coefficient for the distribution of hospital beds in Lorestan, we first computed the number of hospital beds per 1,000 population for each city. We then applied the Gini coefficient formula to this distribution. The Lorenz curve is a graphical representation of the distribution of resources (in this case, hospital beds). It plots the cumulative percentage of the total number of hospital beds against the cumulative percentage of the population. The degree of curvature of the Lorenz curve indicates the level of inequality: the closer the curve is to the line of equality (45-degree line), the more equitable the distribution. Conversely, the further the Lorenz curve is from the line of equality, the more inequitable the distribution. We analyzed the distribution of hospital beds across the cities in Lorestan using the Gini coefficient and the Lorenz curve. The results provided a quantitative and visual representation of the equity in hospital bed distribution. This analysis allowed us to identify areas with significant disparities and propose targeted policy interventions to improve equity in healthcare resource allocation. The analyses were conducted using the R statistical software, with significance determined at a p-value of less than 0.05.

Results

The population of Lorestan province was 1,678,873 people. There are 18 hospitals across the 11 cities of Lorestan province. Table I displays the population, number of hospitals, number of hospital beds, beds per 1,000 people, and hospitals per 100,000 people. The cities with the most hospitals were Khorramabad (6 hospitals), Borujerd (2 hospitals), and Aligudarz (2 hospitals). and each of the remaining cities had one hospital. In 2023, the Gini coefficient for hospital beds in Lorestan province, compared to the population of each city, was estimated at 0.27. Figure 2 displays the Gini coefficient calculated for hospital beds in each city of Lorestan province.

The highest Gini coefficients for hospital beds were observed in the cities of Khorramabad, Aligudarz, and

Delfan. The lowest Gini coefficients were observed in the cities of Rumeskhan, Poldokhtar, and Selseleh. Figure 3 presents the Lorenz curve for the number of beds and active population in Lorestan province in 2023. According to this figure, the Lorenz curve deviates significantly from the optimal limit (Equity line, 45 degrees). This increased distance between the curve and the justice line indicates a lack of proper distribution of hospital beds in Lorestan.

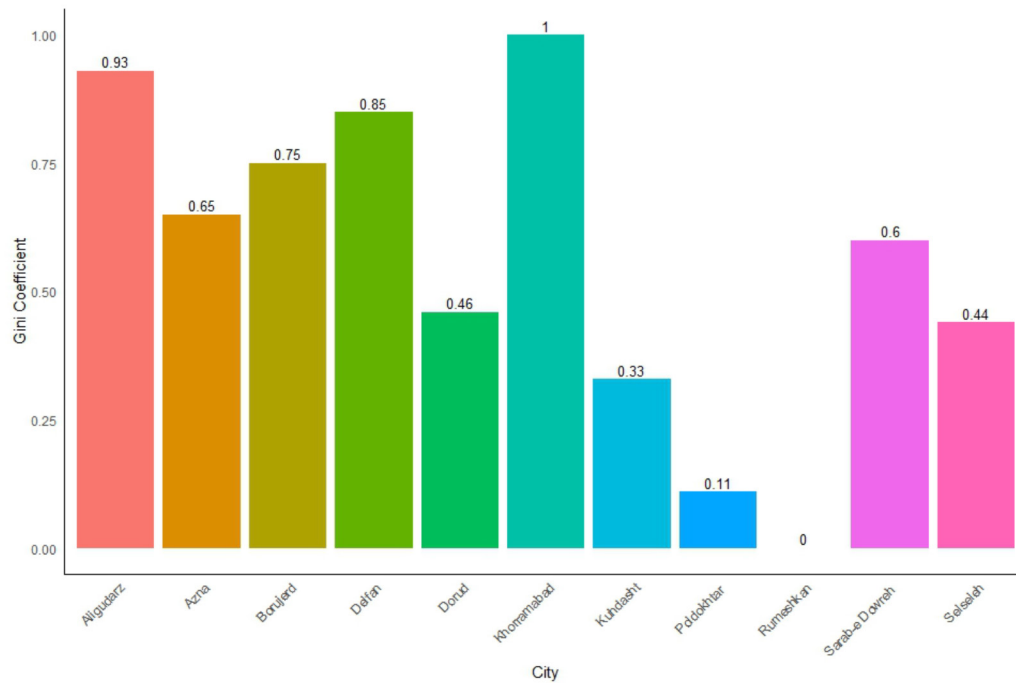
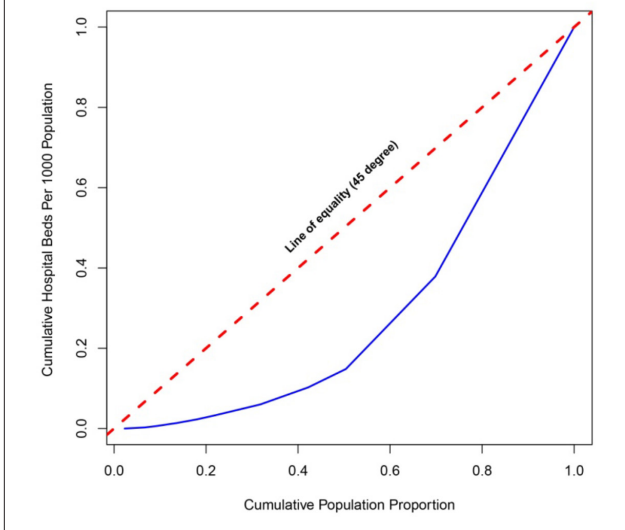
Discussion

In this study, we assessed the equity in the distribution of hospital beds across Lorestan province in western Iran. Our analysis revealed a notable disparity in the allocation of hospital beds relative to population distribution among the 11 cities. With a Gini coefficient of 0.27, the results indicate a moderate level of inequality in the distribution of hospital beds. The Lorenz curve further underscores this inequity, with a substantial deviation from the 45-degree equity line, illustrating a significant imbalance between population needs and hospital bed availability.

When comparing our findings to other studies, our Gini coefficient of 0.27 is higher than those reported by Mosadeghrad AM (0.10) [18], Rezaei S (0.19) [19], Mosadeghrad AM (0.26) [20], and Rezaei S (0.19) [21]. These lower Gini coefficients suggest that these regions have a more equitable distribution of hospital beds. Conversely, our Gini coefficient is lower than those reported by Chavehpour Y (0.55) [22], Asl IM (0.46) [13], Mosadeghrad AM (0.28) [23], Mosadeghrad AM (0.29) [24], and Mosadeghrad AM (0.61) [25], indicating that these studies found greater inequity in the distribution of hospital beds compared to our findings. The variation in Gini coefficients across different studies highlights the disparities in healthcare resource allocation in various regions. Our study's Gini coefficient being in the middle range of these comparisons suggests that while there is room for improvement, Lorestan's distribution of hospital beds is relatively more equitable than regions with higher Gini coefficients but less equitable than

Tab. I. Population, number of hospitals, number of hospital beds, beds per 1,000 people, and hospitals per 100,000 people in Lorestan province in 2023.

| City | Population | Number of Hospitals | Number of hospital beds | Beds per 1000 People | Hospitals per 100000 People |
|----------------|------------|---------------------|-------------------------|----------------------|-----------------------------|
| Khorramabad | 506471 | 6 | 929 | 1.88 | 1.18 |
| Borujerd | 326452 | 2 | 549 | 1.68 | 0.61 |
| Aligudarz | 137534 | 2 | 259 | 1.88 | 1.45 |
| Dorud | 174508 | 1 | 189 | 1.08 | 0.57 |
| Azna | 71586 | 1 | 96 | 1.34 | 1.39 |
| Rumeskhan | 39058 | 1 | 0 | 0.0 | 2.56 |
| Kuhdasht | 166658 | 1 | 128 | 0.76 | 0.60 |
| Delfan | 65547 | 1 | 118 | 1.80 | 1.52 |
| Selseleh | 75559 | 1 | 79 | 1.04 | 1.32 |
| Poldokhtar | 73744 | 1 | 29 | 0.39 | 1.35 |
| Sarab-e Dowreh | 41756 | 1 | 64 | 1.53 | 2.39 |

Fig. 2. Gini coefficient calculated for each city in Lorestan province in 2023.**Fig. 3.** Lorenz curve of hospital bed distribution based on population in Lorestan province.

those with lower coefficients. These findings underscore the need for targeted policies to address and reduce the inequities in hospital bed distribution to ensure more equitable access to healthcare services for all populations within Lorestan province.

The differences in Gini coefficients calculated for the distribution of hospital beds in different studies can be attributed to several factors [13]. Different regions may have varying levels of healthcare infrastructure development, population density, and healthcare needs.

These regional differences can significantly impact the equity in the distribution of hospital beds. Variations in study design, data collection methods, and analysis techniques can lead to different Gini coefficients [25]. For instance, differences in the time periods studied, the population data used, and the specific metrics for hospital bed distribution can all affect the results. The effectiveness and focus of healthcare policies and investments in different regions can lead to disparities in resource allocation. Regions with more robust healthcare policies and better investment in healthcare infrastructure may show lower Gini coefficients [22]. Socioeconomic conditions, such as income levels, employment rates, and education, can influence healthcare access and distribution. Regions with higher socioeconomic status may have better access to hospital beds and more equitable distribution [19]. Geographical factors, such as the urban-rural divide, terrain, and transportation infrastructure, can impact the accessibility and distribution of hospital beds. Regions with challenging geography may face more significant disparities [25]. Differences in population demographics, such as age distribution, prevalence of diseases, and population growth rates, can affect healthcare needs and the distribution of hospital beds. Regions with older populations or higher disease prevalence may require more hospital beds [26]. The balance between the demand for healthcare services and the supply of hospital beds can vary across regions. Areas with higher demand but limited supply may exhibit higher Gini coefficients [18]. The level of support and intervention from government and healthcare institutions can play a crucial role in ensuring equitable distribution. Regions with proactive

government policies and strong institutional frameworks may achieve better equity in hospital bed distribution. These factors, individually or in combination, can contribute to the observed differences in Gini coefficients across various studies. Understanding these underlying reasons can help policymakers and healthcare planners devise strategies to address inequities and improve the overall distribution of healthcare resources [22].

Khorramabad, the provincial capital with a population of 506,471, has a Gini coefficient of 1.00, indicating the highest level of inequality. This suggests that hospital beds are not equitably distributed relative to the population. Aligudarz, with a Gini coefficient of 0.93, also exhibits significant inequality. Despite a smaller population of 137,534, the distribution of hospital beds in this city is highly uneven. Borujerd and Delfan have Gini coefficients of 0.75 and 0.85, respectively. These values indicate substantial but slightly lower inequality compared to Khorramabad and Aligudarz. Borujerd, with a population of 326,452 and 549 hospital beds, and Delfan, with 65,547 people and 118 beds, demonstrate a more equitable distribution than the highest inequality cities, yet still reflect notable disparities. Dorud (0.46), Selseleh (0.44), Azna (0.65), and Sarab-e Dowreh (0.60) present more moderate levels of inequality. These cities, with varying populations and hospital bed counts, show a somewhat better balance in the distribution of healthcare resources. However, there is still room for improvement to achieve more equitable access. Rumeshkan (0.00), Kuhdasht (0.33), and Poldokhtar (0.11) exhibit the lowest Gini coefficients, indicating relatively more equitable distributions of hospital beds. Rumeshkan, notably, has no hospital beds, which simplifies its Gini coefficient calculation to 0.00. Kuhdasht and Poldokhtar, despite having fewer beds, show a more equitable distribution relative to their populations.

IMPLICATIONS FOR HEALTH POLICY

Resource Allocation. The disparities highlighted by the Gini coefficients suggest a need for targeted resource allocation to address inequities. Cities with high inequality, such as Khorramabad and Aligudarz, require strategic interventions to ensure a more balanced distribution of hospital beds.

Infrastructure Development. Investment in healthcare infrastructure, particularly in cities with fewer hospital beds like Rumeshkan and Poldokhtar, can enhance equity. Ensuring that all cities have at least a minimum threshold of hospital beds is crucial for equitable healthcare access.

Policy Reforms. Policymakers should consider reforms that promote equitable healthcare distribution, such as incentives for hospitals to expand services in underserved areas and regulations that ensure equitable access to healthcare resources.

Monitoring and Evaluation. Continuous monitoring of the distribution of healthcare resources using tools like the Gini coefficient can help track progress and identify areas needing further intervention.

By addressing these disparities, Lorestan province can

move towards a more equitable healthcare system, ensuring that all residents have fair access to necessary medical services regardless of their location.

LIMITATIONS

While this study provides valuable insights into the equity of hospital bed distribution in Lorestan Province, several limitations should be acknowledged. The study relies on publicly available data from Lorestan University of Medical Sciences and the Statistical Center of Iran. Any inaccuracies or limitations within these data sources could affect the findings. For instance, discrepancies in reporting hospital bed counts or population figures could influence the Gini coefficient and Lorenz curve analysis. The study focuses solely on the distribution of hospital beds and does not consider other critical healthcare resources such as medical staff, equipment, or outpatient services. Thus, the overall equity of healthcare access might be broader than what hospital bed distribution alone can reveal. The study does not account for geographical challenges and transportation issues that might affect access to hospital services. In mountainous and rural areas of Lorestan, physical access to hospitals can be a significant barrier despite an equitable distribution of beds. The analysis is based on data from a single year (2023), which may not capture temporal changes and trends in hospital bed distribution and healthcare needs over time. Longitudinal data would provide a more comprehensive understanding of equity trends and the impact of policy changes. The study does not integrate socioeconomic and demographic variables, such as income levels, education, and age distribution, which could influence healthcare needs and access. Including these factors might offer a more nuanced understanding of inequities in hospital bed distribution. The study does not directly assess the impact of hospital bed distribution on health outcomes. While equitable distribution is critical, the ultimate goal is to improve health outcomes. Future research should link hospital bed distribution to patient health outcomes to validate the implications of equity in resource allocation. Although the study compares Gini coefficients with other regions, differences in healthcare systems, policies, and socioeconomic contexts between Lorestan and other areas could limit the generalizability of these comparisons. The study provides recommendations for policy interventions but does not assess the feasibility and potential impact of these interventions. Further research is needed to evaluate the practical implementation and effectiveness of proposed policy measures in improving equity.

While this study provides valuable insights into the equity of hospital bed distribution in Lorestan province, it is important to acknowledge certain limitations. Firstly, the analysis was confined to a single province in western Iran, which may limit the generalizability of the findings to the broader context of Iran. The healthcare infrastructure, population distribution, and regional factors specific to Lorestan may differ from those in other provinces, leading to variations in equity levels. Therefore, caution should be exercised when extrapolating these results to other regions within the

country. Further research involving a broader range of provinces or a nationwide study would be necessary to draw more comprehensive conclusions about the equity of hospital bed distribution across Iran.

Conclusions

This study provides a comprehensive analysis of the equity in hospital bed distribution across Lorestan Province, western Iran, revealing significant disparities. With a Gini coefficient of 0.27, our findings indicate a moderate level of inequality, supported by the Lorenz curve's deviation from the equity line. Cities like Khorramabad and Aligudarz exhibit the highest inequality, while Rumeshkan, Kuhdasht, and Poldokhtar show more equitable distributions. These disparities underscore the need for targeted policy interventions to ensure a fair allocation of healthcare resources. Our study highlights the critical role of equitable hospital bed distribution in achieving UHC, improving patient outcomes, and fostering overall societal well-being. Addressing these inequities requires a multifaceted approach, including strategic resource allocation, infrastructure development, policy reforms, and continuous monitoring. By implementing these measures, policymakers can enhance healthcare access and equity, particularly in underserved and rural areas. While our analysis focuses on hospital beds, future research should incorporate other healthcare resources and consider socioeconomic and demographic factors for a more comprehensive assessment. Ultimately, improving equity in healthcare resource distribution is essential for reducing health disparities, enhancing system efficiency, and promoting the general health and well-being of the population in Lorestan Province.

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Data availability statement

Not applicable

Informed consent statement

Not applicable.

Conflict of interests statement

The authors declare that the research was conducted in

the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors' contributions

MaB, PE, SS and FS: designed the study, MeB, SA, MM, BDT conceived the manuscript; MaB, MM, MeB, SS, SA drafted the manuscript; FS, MeB, MM: revised the manuscript; MaB, MeB, MM performed a search of the literature; MeB, SA, SS, PE, and FS critically revised the manuscript; conceptualization, and methodology; MaB, SS, MM: investigation and data curation; MeB, FS: original draft preparation; MM, MaB: Final editing. All authors have read and approved the latest version of the paper for publication.

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