Comparing Healthcare Facilities to Demographic Standards in the Pakistani Rural Environment

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Abstract: The population of Pakistan is increasing, with approximately 2% growth. Over the years, the country’s healthcare system has struggled to meet the needs of the population. Nevertheless, because of shortages compared to population distribution, people are facing primary healthcare challenges, specifically in rural environments. Because of the absence of standard health services, the quality of the health sector deteriorated over time. Therefore, this study aims to compute the shortage of health facilities in Badin, Pakistan, per local health standards. The information related to available health institutes was obtained from the office of the Director-General Health Office with the help of a questionnaire. The current population was determined, and the same was projected up to the year 2035 with the help of a compound interest model. The linear model was executed and found to be significant, with the values of R = 0.996, R² = 0.991, and Sig. F-change = 0.000. The Badin sub-region needed 201 basic health units, 37 rural health centers, and 746 dispensaries. The public health institutes were found unavailable as per demographic standards. This research set a platform for local authorities to take certain actions in framing essential policies to curtail the shortage of health institutions. This study is significant, as it confers existing and futuristic health institute demands. This research can serve as a model for remote sub-regions to address primary healthcare issues, including the fight against diseases and viruses. This research may also contribute to sustainable goal number 3, i.e., Good Health and Well-being.

Keywords: population; health standards; linear model; basic health units; rural health centers; dispensaries

1. Introduction

Health is seen as the prime sector of sustainable social development. Public health plays a pivotal role in satisfying the population’s health demands [1]. Public sector organizations are concerned about providing appropriate and equitable healthcare access to the entire population [2]. Access to amenities is mandatory to propel socio-economic activities in urban and rural sub-regions [3]. For example, the Human Development Index (HDI) is marginal in most of the rural sub-regions of Pakistan [4,5]. The education data suggested that girls’ enrollment was higher by about 50% in rural regions that were accessible by all-weather roads compared to the lower road-density areas [6–8]. In the same way, rural communities were observed to have lower infant mortality rates than the societies that were not facilitated by basic services. The health sector is one of the essential parameters within the deprived rural regional environments of developing countries [9]. The backlog of public sector health facilities enhanced the distances between health institutes and rural settlements. This situation can damage the health activities of the rural population and upsurge the deaths caused by COVID-19 [10]. Thus, to strengthen and promote health activities, the backlog was determined with the help of demographic standards accompanied by road-connectivity policy guidelines. It is anticipated that health standards can be enhanced, as this measure can portray a current and futuristic picture of health services to decision-makers. However, to simplify the study’s concept, the following research questions are added:
how to compute public sector basic health institutions’ demand per population standards?

ii. what are the current and projected requirements of health institutions, i.e., hospitals, basic health units (BHUs), rural health centers (RHCs), and dispensaries, per demographic standards in the Badin sub-region?

Due to a lack of appropriate health institutions and infrastructure, rural people may not be able to obtain healthcare services [11]. One of the reasons is a shortage of rural health facilities based on population characteristics [12]. The faster population growth rate in developing countries [13,14] restricted the availability of resources [15]. In such circumstances, urbanization is unavoidable, as most emerging countries anticipate a greater shift in demographic features [16]. In search of a better life, rural people travel to urban areas where services are readily available [17]. It is a grave reality that rural areas are left on their own compared to urban settlements in most developing countries [18]. Thus, remote areas were found to be short of basic services, including healthcare [19,20].

Pakistan is also one of the developing countries where people are struggling to acquire basic health services. Government hospitals are available in the District and Taluka headquarters in Pakistan. The health services are provided according to the hierarchy of settlements [21,22]. RHCs have been tasked with curing the rural population’s illnesses, while BHUs and dispensaries are responsible for facilitating small towns and villages, respectively. These are all public health institutions that cater low-cost health services to rural areas categorically. Nonetheless, the country’s healthcare system is in poor shape, with shortages of drugs and healthcare facilities [23]. It was discovered that public sector healthcare institutions encountered enormous challenges over the years [24]. There could be a variety of causes responsible for miserable healthcare conditions, i.e., a lack of financial aid, medicines, medical personnel, and health institutions [25]. Accordingly, this study was conducted to compute the existing and futuristic shortages of public sector health institutions according to the standards of population distribution in Badin, Pakistan. The public sector health services backlog was determined up to the year 2035 with the help of local demographic standards [26,27]. In particular, the demand was calculated for RHCs, BHUs, and dispensaries. The shortage was ascertained after performing a linear test on the existing and projected population. This research found a substantial backlog of health institutes per the demographic standards. If facilitated by concerned planning agencies, the computed deficit and the proposed connectivity guidelines can improve health standards [28–30]. If health services are given as per the population distribution, these can be accessed with ease and comfort.

From the Pakistani perspective, the research concept is novel and underscores the health sector by computing the backlog (existing and futuristic) per the demographic standards. For the first time, the policy implications are also proposed, focusing on the connectivity patterns of health institutions in remote environments [31,32]. The manuscript is subdivided into five important sections. The first section highlights the basic theme or research concept. The second section clarifies the appropriate methodology to achieve the goal of this study. The third section clarifies the results and discussion together with the proposed road connectivity policy implications. The fourth section clarifies the limitations of the study. The fifth section of this article concludes the entire discussion and conveys the key study findings.

2. Methodology

To clarify the methodology, this research illuminated the mandatory steps that were followed to achieve the aim. The research methodology’s process flow can be seen in Figure 1.

The executed methodological steps of this study can be seen in Figure 1. To complete the aim, the data were retrieved from the District Census Report 2017 and the Directorate General Health Office, Sindh, Pakistan. The demographics were projected up to the year 2035. The population-projection exercise was validated with the help of a linear test. The current and futuristic health institutes’ requirements were determined successfully [33,34].
For the sustainable connectivity of health services, road patterns were suggested by keeping in view the local conditions in the study area.

**Study Area**

Talpur et al. [35] conducted a study to measure the travel accessibility of rural households living in Badin, Pakistan, using a time–space prism. Households (having no vehicle ownership) took 41.36 min to reach desired destinations using the travel mode ‘walk’. Nonetheless, when the population traveled through other travel modes, the average time was noted as an hour (62.77 min), depending on the travel distances they commuted to reach their destinations. Households who have vehicles, like a car/jeep (personal), walked for shorter distances and took a time of about 22 min. These households drove their vehicles for longer distances that took a minimum travel time of 1 h and sixty-five minutes. Commuters took 55 min when they traveled by bus to access their respective destinations. It is evident from the case study that most of the trips were performed using the travel mode ‘walk’. It can also be observed that 61% of the population did not possess their vehicles. Travel distance and time data also clarified that the local population was struggling to reach desired destinations, including health facilities. A high proportion of the total generated trips, i.e., 48%, was observed by travel mode ‘walk’. It can be concluded that the accessibility standards of the Badin population were not appropriate for accessing health facilities.
essential locations. Therefore, this study was rationalized to compute the shortage of health facilities per the population standards in one of the remote sub-regions of the country, i.e., Badin, Pakistan. Badin can be considered one of the depressed sub-regions of the country, where people were struggling to access health services [36]. The Badin population statistics showed a growth of 46.28% in the past seventeen years, accompanied by an average annual growth rate of 2.26%. If this trend continues, the population will double in a couple of decades [37]. The study area map can be seen in Figure 2.

Figure 2. Badin sub-region [38].
The study area’s household size was approximately six. The total rural population of the Badin sub-region was found to be around 883,497 persons, i.e., approximately 75% of the total population [39,40]. Taluka-wise population statistics are revealed in Figure 3.

![Figure 3. Badin population (Taluka wise).](image)

By observing Figure 3, the x-axis shows Talukas (Blue Line), e.g., 1 for Badin, 2 for Talhar, 3 for Matli, 4 for Tando Bago, and 5 for Golarchi. In the same way, the orange line clarifies the current population of the study area. Mathematical expressions 1 and 2 were executed to project future populations [41,42].

\[
P_t = P_0(1 + r)^n \\
r = \left(\frac{P_t}{P_0}\right)^{\frac{1}{n}} - 1
\]

where
- \(P_t\) = projected population;
- \(P_0\) = current population;
- \(r\) = annual growth rate;
- \(n\) = number of years.

The demographics of the study area were projected with the help of Equations (1) and (2). It is worth mentioning here that population characteristics were studied according to the Union Councils (UCs) of each respective Taluka. A UC is a lower-level administrative tier in the country. This study was articulated to compute the shortage of health institutions according to local standards, as highlighted in Table 1.

The local health standards are indicated in Table 1. According to a national reference manual, depending on the terrain and communication, five to ten BHUs should be provided to each RHC. It would not be wrong to state that health standards could improve by calculating the current and futuristic shortages of health institutions. It should be noted that the following steps were carried out to determine the existing and estimated number of health facilities, i.e., hospitals, BHUs, RHCs, and dispensaries:
i. The available number of health facilities was collected from the concerned authorities during the phase of data collection;

ii. The population was projected for all UCs with the help of equations 1 and 2 (the compound interest formula) up to the year 2035;

iii. The health standards were collected from the National Reference Manual (NRM) for the availability of health services;

3. Results and Discussions

Health care in rural areas is a critical component of social growth. Despite all other sustainable development concerns, Badin’s rural sub-region has struggled with health inaccessibility for many years. Residents were found struggling to acquire health facilities. According to local demographic characteristics, this problem persists due to a scarcity of health institutions. The lack of health services eventually increased the distance for rural dwellers, which made it difficult to reach within time. The shortage of health facilities was determined according to local standards until the year 2035. Figure 4 depicts the current and future demographic characteristics.

Table 1. Health standards of Pakistan [43].

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>Type</th>
<th>Function</th>
<th>Facilities</th>
<th>Demographic Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dispensary</td>
<td>First aid</td>
<td>Dispenser</td>
<td>Per 3000 Population</td>
</tr>
<tr>
<td>2</td>
<td>BHU</td>
<td>Provide Medicines and Training</td>
<td>1 Doctor 2-3 Paramedics</td>
<td>5000–10,000 Population</td>
</tr>
<tr>
<td>3</td>
<td>RHC</td>
<td>Provide Medicines and Training</td>
<td>3 Doctors 25 Beds</td>
<td>50,000 Population</td>
</tr>
<tr>
<td>4</td>
<td>Taluka Hospital</td>
<td>3 Basic Specialties/Dentistry</td>
<td>60 Beds</td>
<td>One/Taluka Town</td>
</tr>
<tr>
<td>5</td>
<td>District Hospital</td>
<td>All Medical Facilities 6-10 specialties</td>
<td>100–250 Beds</td>
<td>One/District Head Quarter Town</td>
</tr>
</tbody>
</table>

Figure 4. Badin’s demographic characteristics.
In Figure 4, the x-axis displays Talukas (Blue Line), e.g., one for Badin, two for Talhar, three for Matli, four for Tando Bago, and five for Golarchi. The existing population numbers can be seen in the orange line, while the green line verifies the projected population.

The population data for each Taluka in the Badin sub-region were forecasted using the conventional growth rate. Figure 5 illustrates the rate of expansion.

The national standards were referred to determine the shortage of primary rural health institutions in the Badin sub-region. It is believed that the availability of health facilities according to demography could increase health standards.

To validate the population-projection process, the linear model was executed with the help of SPSS-22.0. The value of R was recorded as 0.996, which indicated a strong positive correlation between the existing and the anticipated population. To test the variance, the coefficient of determination $R^2$ was used. The $R^2$ value was found to be 0.991 (99%), which showed a strong positive association between the existing and the projected population. The significant F-change value was recorded as 0.000, which further confirms the validity of the model, as shown in Table 2.

### Table 2. Linear Model $^b$.

<table>
<thead>
<tr>
<th>Linear Model</th>
<th>R</th>
<th>$R^2$</th>
<th>$R^2$ Change</th>
<th>F-Change</th>
<th>Sig. F-Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.996 $^a$</td>
<td>0.991</td>
<td>0.991</td>
<td>334.231</td>
<td>0.000</td>
</tr>
</tbody>
</table>

$^a$ Predictors: (constant), existing population. $^b$ Dependent variable: projected population 2035.

It is clear from Table 2 that the existing and projected population data are highly correlated. The regression model coefficients were also generated during the data analysis phase. The residuals can be seen in Table 3.

The analytical process was executed to calculate the existing and futuristic backlog of public sector health institutions, per local demographic standards. Furthermore, a probability plot (P-P plot) was also executed to confirm the population-projection process. The plot is shown in Figure 6.
Table 3. Model coefficients $^a$.

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>$-29,998.396$</td>
<td>$27,312.072$</td>
<td>$-$</td>
<td>$-1.098$</td>
</tr>
<tr>
<td>Current Population</td>
<td>2.058</td>
<td>0.113</td>
<td>0.996</td>
<td>18.282</td>
</tr>
</tbody>
</table>

$^a$ Dependent Variable: Projected Population 2035.

Figure 6. Probability plot of regression standardized residual.

The residuals were found to be parallel to the regression line, as depicted in Figure 6. It is simplified that the linear model is substantial, which further confirms the statistical exercise. The total number of available public health institutions is given in Figure 7.

Figure 7. Available basic health facilities.

As mentioned in Figure 7, only one district hospital was available in Badin. There were five Talukas in the study area, so one Taluka Hospital per Taluka was available, as per national standards. The available number of RHCs, BHUs, and dispensaries was found to be 15, 70, and 160, respectively. Taluka-wise, the health-institution shortage was determined and estimated up to the year 2035. The health scenario for Taluka Badin is specified in Figure 8.
Figure 8. Available and estimated health facilities (Badin Taluka).
In Badin Taluka, more health facilities would be required in the future. Badin Taluka’s population was recorded as higher than compared to the rest of the Talukas. The Taluka needed approximately 60 BHUs and 212 dispensaries to cope with the national standards. The information about Taluka Talhar’s health situation is mentioned in Figure 9.

According to population characteristics, one RHC would be required each in UC Saeed Pur and UC Paro Lashri until 2035, while 25 BHUs and 89 dispensaries would be needed for the Talhar Taluka. The health profile of Taluka Matli is given in Figure 10.

As shown in Figure 10, a considerable number of rural health facilities would be required, i.e., 7 RHCs, 48 BHUs, and 148 dispensaries in Taluka Matli. Taluka Tando Bago’s health statistics can be seen in Figure 11.

Concerning Figure 11, the total number of 10 RHCs, 49 BHUs, and 176 dispensaries would be needed by the year 2035. The health scenario of Golarchi Taluka can be seen in Figure 12.

In total, 8 RHCs, 35 BHUs, and 121 dispensaries would be required up to the year 2035. In this way, the health institutes’ demand was effectively computed for all five Talukas of the Badin sub-region. Health institutes were not found to be available according to the local standards of population distribution. It would not be wrong to declare that Badin residents’ health standards were not observed up to the mark. Thus, there is a dire need for health institutions to upgrade the health standards of local inhabitants. In another way, a proper road network hierarchy is also mandatory to access basic health services. For that reason, this study puts forward connectivity guidelines hereafter.

Figure 9. Available and estimated health facilities (Talhar Taluka).
Figure 10. Available and estimated health facilities (Matli Taluka).
Figure 11. Available and estimated health facilities (Tando Bago Taluka).
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Proposed Road Connectivity

Rural households may travel to different locations on a daily or weekly basis as needed (for example, workplaces, department stores, medical and educational facilities). As shown in Figure 13, these facilities should be evenly spaced next to highways and a village. The distance traveled to reach activities that were dispersed over a bigger area was greater. The average trip time and distance may be lowered if the places are close to one another.

Figure 12. Available and estimated health facilities (Golarchi Taluka).

Figure 13. Roadside connectivity.
If destinations are close enough to one another, they could be simple to reach on foot. The centered origin can reduce the average distance to each destination, as shown in Figure 14.

![Figure 14. Centralized connectivity.](image)

Traffic flow would be enhanced if health facilities were established on both ends of rural settlements, as shown in Figure 14. Rural places with adequate road connectivity can increase resident’s connectivity. Roads are available in every rural community and are essential for carrying out daily tasks.

To encourage the density, the existing and future shortage was determined for the health facilities of the study area. The outcome of this social sector exercise may offer a clear picture to the concerned authorities about the current and future conditions of the health sector. Road connectivity was also proposed for the sustainable connectivity of health services, which could improve accessibility. Therefore, the study findings and the proposed road connectivity patterns can offer a background to the planning agencies in formulating policies.

4. Research Limitations

This study was conducted to compute the shortage of public health facilities according to national demographic standards. The research intention was to facilitate government agencies, as these could pay attention to this problem and plan remedial measures to fight future pandemics. While performing this study, the following limitations were observed.

i. The demographic features of the study area, i.e., Badin, Pakistan were procured from the census report. Meanwhile, the quantity of available public health institutions was retrieved with the help of a questionnaire from the office of Director-General Health, Sindh;

ii. Only a statistical test, i.e., the linear model, was used to validate the population-projection exercise. This is the only parameter in the study that required a statistical test. No further statistical tests were performed;

iii. This study did not measure the travel accessibility of the residents while commuting to reach health institutes. This research work will be conducted in the future;

iv. Only existing and futuristic shortages of health institutions were computed per local demographic standards. For better connectivity, road patterns were proposed to connect local inhabitants with health institutions;

v. The population of Pakistan is increasing at a growth rate of 2.0. Hence, the demand for health institutions keeps mounting at a greater pace. The output of this study is helpful for planning until the year 2035. After that period, population projection should be carried out again to determine the demand for health services per the local population standards.

Keeping in view the local conditions, this research may be considered a first step that portrays the picture of the health sector for one of the depressed sub-regions of Pakistan, namely Badin. Equally distributed health facilities can ease travel fatigue for patients and their attendants. In this way, precious lives can be saved, which may improve the human development index and other related parameters.
5. Conclusions

Pakistan is a developing country with a financial status not comparable to Italy, China, the United States, the United Kingdom, and Russia. Considering the economic turmoil, the country cannot meet the necessary number of hospitals and health facilities. From the literature, it was found that 61% of the total population in Badin was devoid of personal vehicles. The total ratio of generated trips by travel mode ‘walk’ was recorded as 48 percent. Thus, to reduce the distance between people and health facilities, the backlog of public sector health institutes, according to the local demographic standards, was determined. This study aimed to compute the number of public sector health institutes, i.e., hospitals, BHUs, RHCs, and dispensaries per the demographic standards in Badin, Pakistan [44]. The number of available health facilities was procured from the Director-General Health Office, Sindh, Pakistan. The population statistics were obtained from the District Census Report 2017 and projected up to the year 2035. To validate the process of population projection, a linear test was executed. The linear model showed significant values of 0.000. The national health standards were referred to determine the existing and futuristic health institutions’ shortage for each Taluka of the Badin sub-region. For better access, road connectivity strategies were also suggested. A massive shortage of health institutes was found per the local demographic standards that can be reviewed in Figures 8–12. The health sector’s condition in the sub-region was not found to be satisfactory. The gap was discovered categorically to eliminate health problems. There is a dire need to promote a rural healthcare system to face the challenges. This whole discussion is a role model for the concerned authorities. The planning agencies can formulate health programs to better the health standards in the study area. Nonetheless, policies should be devised accordingly to control the outbreak of future pandemics in the distant sub-regions of developing countries.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Department of City & Regional Planning Research & Ethics Committee (protocol code 04323, 15 December 2023).

Informed Consent Statement: Not applicable.

Data Availability Statement: All data generated or analyzed during this study are included in this article.

Acknowledgments: The author appreciates the efforts and dedication of the undergraduate students of the Department of City and Regional Planning, Mehran University of Engineering and Technology, Jamshoro, Pakistan, for their support in the data-collection phase to complete this study.

Conflicts of Interest: The author declares no conflicts of interest.

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