GeoGraphical Distribution of health resources in the Kingdom of Saudi Arabia: Is it equitable?

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Abstract

Introduction: The aim of this study is to evaluate the inequality of geographical distribution of health centers, hospitals, hospital-beds and physicians among the thirteen administrative areas that comprises the map of the Kingdom of Saudi Arabia (KSA). It uses the Lorenz curves and the Gini coefficient.

Methods: A data matrix of the thirteen administrative areas by four health resources was constructed based on the available government data of the Central Department of Statistics and Information (CDSI). This data matrix is for 22 years starting from 1992 to 2013 for the health resources with the exception of the data for physicians, which is available up to 2007. To obtain the relative share of an area of each health resource, the total number of it is divided by the corresponding total population of the area. Total populations, of administrative areas, were projected using the between censuses declared growth rates. Human population calculator was used to run the projection at this website. Thus, relative shares are used instead of numbers because they provide a more realistic picture. Lorenz curves were constructed depending on excel, while Gini coefficients were calculated using an online Gini calculator.

Results: The results of this study have demonstrated that health services are geographically distributed in an equitable manner between administrative areas. Among the studied health resources, hospital-beds ranks first as the most equitably distributed resource followed by physicians. Health centers and hospitals came on the third and fourth ranks. The average Gini coefficients calculated for the period (1997 – 2013) revealed values of 0.1508 for physicians; 0.1854 for hospital-beds; 0.2231 for health centers and 0.2245 for Hospitals.

Conclusion: The study showed that, according to the Lorenz curves and Gini coefficients, the four health resources are equitably distributed among the areas. This tells us that geographic distribution of health services does not stop health authorities from reaching populations wherever they are in KSA.

Key words: Health care resources, Inequality, Lorenz curve, Gini coefficient, administrative area.
Introduction

Inequality in health services distribution has become a worldwide challenge among different countries where health inequality has a progressive trend. This fact has been repeated in different studies. Ameryoun, A et al. (2011) stated that inequality in distribution of health services and accessibility to such services has become a major issue in most health systems, therefore, it is vital to develop a good method of detecting inequalities in the distribution of health resources. According to him, different countries utilize different methods for such a purpose. These methods include the customer reports or policy makers’ views and in some countries they use scientific and clear-cut measures to quantify health care equality. According to Horev T et al. (2004), the U.S. health sector is mostly concerned with racial or ethnical differences. Therefore, understanding the geographical distribution of health resources, patterns of accessibility to such resources, and improvement of these resources will lead to better planning to make health services accessible by all.

Health Services in Saudi Arabia

Health services in Saudi Arabia have developed enormously over the recent years, as evidenced by the availability of health facilities throughout all parts of the Kingdom. As cited by Zohair A. Sebai et al. (2001), the Saudi Ministry of Health (MOH) provides over 60% of these services while the remaining resources are provided by other government agencies and the private sector. Bassi, J (2015) classified the healthcare sector in Saudi Arabia as the largest in the Middle East with huge potential for further development (http://www.tamimi.com). He attributed this to rapid population growth rate among the other Gulf countries. It is well known that Saudi nationals and foreigners working with the government are entitled to free health care, which is also available to religious pilgrims. In (2014) Saudi nationals working in the private sector were declared as no longer be able to access free treatment in government hospitals. This is justified since all Saudi nationals in the private sector must have private health insurance provided for by their employers. Expatriate workers, on the other hand, must shoulder private health insurance to receive healthcare; insurance cost is paid for by expatriates themselves or by their employers. The Kingdom is characterized by a rapidly growing population, rising life expectancies, increasing per capita incomes and high incidence of lifestyle related diseases.

The commitment of the Kingdom's government to improve the health sector is crystal clear. The figures of the public spending on healthcare and social affairs reached a total of $ 43 billion, amounting to 19% of the national budget and 4.8% of the GDP. Figure (1) below shows financial resources put under the disposal of the (MoH), presented as a percentage of the total fiscal year budget of the Kingdom by budget year. Until (2015), the healthcare share of the total budget was increasing steadily, the trend line reveals a steady increase of the financial resources allotted to healthcare. The shares range between (5.6% & 7.25%). Bassi, J (2015) expected that such spending is expected to rise to an estimated $ 48.3 billion by 2018. He added that, in 1970 there were 74 hospitals with just over 9,000 beds in KSA. By 2005, there were 350 hospitals with nearly 48,000 beds serving 22.7 million people. The Saudi national budget for 2015 budget announced funding for 27 new hospitals and health facilities, in addition to the continuing construction of 117 hospitals and 8 medical cities. Overall, the health ministry is planning to raise hospital capacity to 68,000 beds by 2016.
The population in KSA is expected to grow significantly over time. As a result it is envisaged that health care expenditure will increase dramatically. Demand for hospital beds is likely to grow to 70,000 and the number of hospitals is likely to rise to 502. KSA is expected to become the largest healthcare market in the gulf countries, accounting for 58.2 per cent of the total market in 2018, according to a report by investment bank Alpen Capital. A report released by the Oxford Business Group (http://www.oxfordbusinessgroup.com) stated that majority of state-run hospitals belong to the Ministry of Health. Accordingly, 268 hospitals with a total of 38,970 beds were operated by the ministry in 2013. Between 2009 and 2013 the numbers of hospitals and beds increased by 9.8% and 17.1%, respectively.

A series of development plans in Saudi Arabia have established the infrastructure for the expansion of curative services throughout the country. In addition, there have been speedy developments in medical education and the training of future Saudi health professionals. Future challenges facing the Saudi health system need to be addressed in order to achieve the ambitious goals set by the most recent health development plan. These include the optimum utilization of current health resources with competent health management skills, the search for alternative means of financing these services, and the maintenance of an equitable distribution of these services among the thirteen administrative units.

**Objectives and Research Questions**

The main purpose of this paper is to evaluate the "fairness" of the distribution of health resources in the Kingdom of Saudi Arabia (KSA) as distributed among its thirteen administrative areas. The Lorenz curve and the Gini Coefficient will be used to measure health equality and resources. The number of health centers, hospitals, hospital beds, and physicians has been steadily increasing in numbers in most countries. Saudi Arabia is no exception. The paper addresses the following research questions: First, do administrative areas receive equal relative shares of each of the mentioned four variables? Second, are these increments result in an equitable distribution of health resources in KSA?
for all people in all areas? Finally, what method should be used to measure the inequality of health resources?

It is worth mentioning that availability of health facilities in a geographical area implies some accession to these facilities by their population. Accessibility will improve as more facilities are established, however; more facilities do not imply equitable distribution among areas or populations. In addition, equitable distribution does not mean designation of equal amounts of resources to each region.

Data and Methods

A data matrix of the thirteen administrative areas by the four health resources mentioned below was constructed based on the available government data of the Central Department of Statistics and Information (CDSI). This data matrix is for 22 years starting from 1992 to 2013 for the health resources with the exception of the data for physicians, which is available up to 2007. To obtain the relative share of an area of each health resource, the total number of, for example, health centers, is divided by the corresponding total population of the area and multiplied by k, which equals 100,000 (for health centers and hospitals), 1000 (for hospital beds) and 10,000 (for physicians). Looking at the absolute numbers of each area variable regardless of its corresponding population will lead to a faulty conclusion. Total populations, of administrative areas, were projected using the declared growth rates (by the CDSI) between censuses. Human population calculator was used to run the projection at this website (http://www.metamorphosisalpha.com/ias/population.php). Thus, relative shares are used instead of numbers because they provide a more realistic picture.

To measure the inequalities of health resources, we utilize the Lorenz curve. The Lorenz curve compares the distribution of a given variable with the uniform distribution (of same variable) that represents equality. This uniform distribution is shown by a diagonal line, the perfect equality line (Thomas V et al. (2011). The farther the Lorenz curve lies from this line, the higher the inequality. In this curve, the horizontal axis (X) represents the cumulative percentage of population and the vertical axis (Y) illustrates the percentage of some value of a variable (e.g. health centers) held by the corresponding cumulative proportion of the population. In this paper, the X axis demonstrates the cumulative percentage of population of KSA administrative areas while the Y axis illustrates the cumulative percentage of a corresponding type of health resources under study (health center, hospital, hospital beds or physicians). The common usage of the Lorenz curve in the literature seems to be that for magnitudes other than income or wealth, Lorenz curves are called “Concentration Curves.” One should be mindful of it when reading that literature and not be confused by it.

The Gini measure is a method used for the evaluation of the equality of distribution of health care services. This coefficient (or index) compares the cumulative frequency curve of distribution of a variable with the equal distribution of it (Le Grand J. (1985), and Wan GH (2001. This index has been used in many medical studies such as survival studies, prediction of improvement rate, the number of Primary Care Physicians, and the number of hospital beds (Horev T et al., 2004).

In Lorenz curve cumulative percent of population is illustrated on horizontal axis while cumulative percent of other variable is figurate on vertical axis. The Gini coefficient is calculated as a proportion of two areas, the area of the egalitarian triangle as the denominator and the area between the Lorenz curve and the egalitarian line as the numerator (Feldstein MS. (1964)). Its
mathematical formula is as follows:
\[ Gini = \sum_{i=1}^{n} XiYi + 1 - \sum_{i=1}^{n} Xi + 1Yi \]

In this study, \( X \) represents the cumulative percentage of the population and \( Y \) represents the cumulative percentage of health resource ratios. The Gini coefficient ranges between 0 and 1, where theoretically, zero corresponds to a perfect equality and 1 corresponds to a perfect inequality. According to Miao CX, et al. (2007), the Gini coefficient takes the following values and interpretations:

- Gini coefficient smaller than 0.2 means an absolute equality
- Values between 0.2 and 0.3 indicate a high equality
- Between 0.3 and 0.4, an inequality
- Between 0.4 and 0.6, a high inequality
- Greater than 0.6, an absolute inequality

Populations and their corresponding health facilities ratio data of all administrative areas were entered into Excel software and manipulated to generate the Lorene curve for each of the four variables. In this paper the author computed the Gini coefficient for each resource type using the online GINI calculator (http://www.peterrosenmai.com/).

The focus of this paper will be on assessment of the inequality of the geographical distribution of health resources in the Kingdom of Saudi Arabia, namely ratios of health centers, hospitals, hospital-beds, and number of physicians in the thirteen administrative areas. The data of the year 2013 is used to draw the Lorenz curves and to calculate the Gini coefficients for the variables of health center, hospital and hospital-beds. Gini coefficient of physicians is calculated for the year 2007 because it was the last year where data are available for the thirteen areas.

Results and Discussion

Health Facilities Relative Shares in the Thirteen Administrative Areas

Table (1) shows the ratios calculated for the thirteen administrative area of the Kingdom. The same ratios are depicted and presented in the four maps shown on Figures (2 & 3) below. These figures reveal the distribution of relative shares of each of the four variables (health facilities) of each of the thirteen administrative areas in the year 2013. Health center shares (in Figure 2) range between 4.6 in Makkah & 22.4 in Al-Baha per 100,000 populations. This result portrays the persistent variations among administrative areas. Hospital shares are no exception. Figure 2 also explains that the number of hospitals per 100,000 populations ranges between 0.50 in Makkah & 2.4 in Al-Baha.

Disparities also exist in the number of hospital-beds per 1000 populations. Also in Figure 3, the relative shares range between 1.0 in Makkah & 2.9 the Northern Boarders. Figure 3 reveals the number of physicians per 10,000 populations in each area. The shares range between 7.9 in Al-Riyadh & 18.1 in Al-Jouf.
Table (1): Populations & Ratios of Health Services by Administrative Area

<table>
<thead>
<tr>
<th>Administrative Areas</th>
<th>Populations</th>
<th>Health Centers</th>
<th>Hospitals</th>
<th>Hospital Beds</th>
<th>Physicians 2007&lt;sup&gt;1&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Al-Baha</td>
<td>450733</td>
<td>22.4</td>
<td>2.4</td>
<td>2.4</td>
<td>13.7</td>
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<tr>
<td>Al-Jouf</td>
<td>483138</td>
<td>10.8</td>
<td>2.3</td>
<td>2.8</td>
<td>18.1</td>
</tr>
<tr>
<td>Al-Madinah</td>
<td>1962558</td>
<td>7.8</td>
<td>1.0</td>
<td>1.4</td>
<td>10.5</td>
</tr>
<tr>
<td>Al-Qaseem</td>
<td>1337563</td>
<td>11.9</td>
<td>1.3</td>
<td>2.0</td>
<td>12.3</td>
</tr>
<tr>
<td>Al-Riyadh</td>
<td>7516959</td>
<td>5.8</td>
<td>0.6</td>
<td>1.1</td>
<td>7.9</td>
</tr>
<tr>
<td>Aseer</td>
<td>2095854</td>
<td>15.1</td>
<td>1.3</td>
<td>1.5</td>
<td>10.8</td>
</tr>
<tr>
<td>Eastern Region</td>
<td>4533841</td>
<td>5.5</td>
<td>0.7</td>
<td>1.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Hail</td>
<td>654736</td>
<td>15.3</td>
<td>1.7</td>
<td>1.7</td>
<td>12.0</td>
</tr>
<tr>
<td>Jazan</td>
<td>1497377</td>
<td>10.4</td>
<td>1.3</td>
<td>1.2</td>
<td>9.7</td>
</tr>
<tr>
<td>Makkah</td>
<td>7688609</td>
<td>4.6</td>
<td>0.5</td>
<td>1.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Najran</td>
<td>555129</td>
<td>11.7</td>
<td>1.8</td>
<td>1.9</td>
<td>15.4</td>
</tr>
<tr>
<td>Northern Borders</td>
<td>350972</td>
<td>12.8</td>
<td>2.3</td>
<td>2.9</td>
<td>15.7</td>
</tr>
<tr>
<td>Tabouk</td>
<td>866803</td>
<td>8.4</td>
<td>1.3</td>
<td>1.3</td>
<td>10.6</td>
</tr>
</tbody>
</table>

Source: Calculated by the author from CDSI data.

<sup>1</sup> Physicians ratios are calculated using 2007 populations and number of physicians.
Figure (2): Ratios of Health Centers and Hospitals by Area in 2013
Source: Author
Figure (3): Ratios of Hospital-beds and Physicians by Area in 2013
Source: Author
The Lorenz Curves

Figure 4 depicts the Lorenz curve of health centers derived for the thirteen areas in 2013. The figures that appear on the curve points represent the corresponding cumulative percentage shares of health centers (vertical axis) that consumed by the corresponding cumulative percentage populations (horizontal axis). The first bottom right point on the curve reveals that (40.7%) of the population enjoys only (26.7%) of health centers. The second point on the row shows a much better share where (65.8%) of the population consumes only (45.9%) of the service. The gap declines as one goes up to the upper left curve points. The inequality of the distribution is exemplified by the gap between the curve and the perfect equality line.

The above interpretation applies for the remaining 4 Lorenz curves. Hospital beds and physician curves have the least and lowest gaps, respectively, between the perfect line and the Lorenz curve.
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Figure (5): Lorenz Curve of Hospitals (2013)

Source: Author

Figure (6): Lorenz Curve of Hospital-Beds (2013)

Source: Author
Gini Coefficient Analysis

Coefficients in Table 2 below are calculated for each health facility to explain the degree of inequality of the resource spatial distribution amongst the thirteen administrative areas in Saudi Arabia. These coefficients are calculated for each resource to check for performance over time. The time span is five years. Because data was not available, the coefficient is calculated only four times for the physicians.


<table>
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</thead>
<tbody>
<tr>
<td>Health centers</td>
<td>0.21855</td>
<td>0.222125</td>
<td>0.21001</td>
<td>0.23144</td>
<td>0.2335</td>
<td>0.2231</td>
</tr>
<tr>
<td>Hospitals</td>
<td>0.2122</td>
<td>0.20964</td>
<td>0.20702</td>
<td>0.24822</td>
<td>0.24532</td>
<td>0.2245</td>
</tr>
<tr>
<td>Hospital beds</td>
<td>0.17788</td>
<td>0.17639</td>
<td>0.17685</td>
<td>0.19925</td>
<td>0.19643</td>
<td>0.1854</td>
</tr>
<tr>
<td>Physicians</td>
<td>0.15869</td>
<td>0.17951</td>
<td>0.12247</td>
<td>0.14244</td>
<td>N.A.</td>
<td>0.1508</td>
</tr>
</tbody>
</table>

Source: Coefficients are calculated by the author using online Gini calculator
Given the classification provided by Miao CX, et al. (2007), Table 2 suggests an optimistic conclusion that all distributions could be classified as highly equal between 1992 & 2013. The highest average registered for a health resource is that of hospitals (0.2245), followed by health centers (0.2231), hospital-beds (0.1854) and physicians, the lowest, (0.1508).

Distributions of physicians and hospital beds, however, are clearly classified as indicative of absolute equality with their Gini coefficients smaller than 0.20. This fact could be regarded an applause result of health policy makers and planners in KSA. With such massive area of the kingdom (2,150,000 km² (830,000 sq. miles)), Maintenance of such equitable distribution overtime demonstrates a high potential watchful planning that cares for equitability and accessibility of health resources.

Figure (8) below depicts the values of the above coefficients. The objective is to compare the trend of inequality over time. It is clear that physician health services show the least equitable distribution.

In addition, there is a trend indicative of increasing equality now and perhaps in the near future. The remaining three resources (hospital beds, health centers and hospitals), have upward trend lines with hospitals having the most steep trend implying a regressive future equality.

Comparing these findings with that of Horev T et al. (2004), the Gini coefficient was used in a study in the U.S. in 1998 to measure the distribution of hospital beds. The findings showed coefficients of 0.0571–0.4303 in different states. The 1970–1997 trend indicated progressive equality in the distribution of hospital beds. The northern states have been reported to enjoy an equal distribution of hospital beds.

Although the obtained Gini coefficients in our study are representative of equality distribution of these resources throughout the country, the equitability of geographical distribution of each resource may be different within various administrative areas if these coefficients are calculated for provinces (lower administrative areas) within each administrative area.
This study is significant in the sense that it assesses inequality of geographical distribution of individual in Saudi Arabia. However, it must be noted that, this study is based on cross-sectional data and conducted with data spanning from the year 1992 to 2013. Furthermore, the distribution of the selected four health facilities is evaluated to measure inequality between administrative areas in certain years with a gap of five years.

**Usefulness of Results and Conclusion**

The findings of this study can be used by managers and policy makers of healthcare system in KSA for planning to reduce inequality in distribution of health care services. It helps in enhancing of allocation of health facilities across areas. Such studies should be conducted on a regular basis to assess progress in equality of distribution of health facilities. The use of the Lorenz curve and the Gini coefficient will lead to a better understanding of current health resources and thus, improvement of the quality of health services. The measure of inequality in the distribution of the health facilities and or resources may depend strongly on the underlying measure of health care needs. In cases of a non-uniform distribution of health care needs across geographical areas, measures other than population levels may have to be developed in order to ensure a more meaningful measurement of distributional inequalities of health services.

The results of this study have demonstrated that health services are geographically distributed in an equitable manner. However, it is important to monitor these trends in the future. Use of other health resources such as total health workforce and the use of smaller geographic areas in future studies may lead to more accurate indicators of health resource distributions that help planners and policy makers allocated these services more optimally. Also, demographic characteristics can also be used as a grouped variable to estimate and calculate inequality in health resources distribution. In their conclusive statement of their research, JIN, Jian et al. (2015) mentioned that equality of China’s demographically assessed distribution of health care resources is greater than that of its geographically measured distribution. Coefficients expressed by population imply there is ready access to healthcare in all regions, whilst the Coefficients by geographical area apparently indicate inequality. This evidence should motivate researchers not to confine their studies on geographical areas but to look for other attributes such as ethnicities, nationalities, population densities and other grouping attributes.

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Ministry of Finance

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