EQUALITY OF GEOGRAPHICAL DISTRIBUTION OF KIDNEY TRANSPLANT BEDS IN IRAN: A GINI INDEX STUDY

Shahram TOFIGHI1, Mohammad MESGARPOUR2, Ahmad AMERYOUN3

1 Assistant professor of management of health care system, Health Management Research Center, Military Medicine Institute, Baqiyatallah University of Medical sciences, Tehran, Iran
2 MSc. of management of health care system, Health Management Research Center, Economic Health Department, Baqiyatallah University of Medical sciences, Tehran, Iran

INTRODUCTION

The prevalence of chronic kidney deficiency in the world accounts for 242 in 1000 individuals to which 8% is added annually with a mortality rate of 18% in the U.S. More than 307,000 Americans were reported to suffer from chronic kidney deficiency in the last decade. The occurrence of new cases of this disease is reported to be 79,102 individuals with a mortality rate of 57,000 patients (1, 2). The existing statistics in Iran indicate an increasing growth of chronic kidney deficiency among the Iranian population. In fact, the figures show that there are 15,000 kidney patients (2.5 individuals per 1,000 population) and 3,175 new occurrence of this disease (0.53 individuals per 10,000 population) (3). This figure was down to 137 cases per one million population in 1997 and 357 cases per one million population in 2006, indicating a linear occurrence growth of 13.82 cases per one million people in 1997 up to 63.8 occurrences in 2006 (4).

The prevalence and occurrence of Renal Replacement Therapy (RRT) in Iran in 2000 were recorded to be 238 and 44.9 individuals, respectively, per one million population who received hemodialysis (53.7%) and kidney transplant (45.5%) (5, 6). However, studies have shown that survival rate of transplant patients is higher than that of dialysis patients. Preference of transplant to dialysis is accounted by lower costs transplant patients is higher than that of dialysis patients. Preference of transplant to dialysis is accounted by lower costs transplant patients is higher than that of dialysis patients.

Conclusion: The obtained Gini coefficient in this study reveals a high degree of inequality in the geographical distribution of kidney transplant beds in Iran. Therefore, health system managers are urged to consider the findings of this study in their large-scale health planning in order to remove such unequal distribution of health services.

Keywords: Kidney transplant beds, Geographical distribution, Inequality, Gini coefficient

Objectives: Kidney transplant is today one of the most common treatments prescribed for end stage renal diseases, which is annually performed in great numbers in Iran. On the other hand, the fair distribution of public health services is one of the most important goals that health systems are seeking to realize. Among different health services, equal accessibility to advanced treatments, including kidney transplant, is of utmost importance. Hence, the present study attempts to examine the equality, or lack thereof, of the geographical distribution of kidney transplant beds in Iran using the Gini coefficient index.

Methods: The demographic and population data for different provinces of Iran are based on the 2006 census survey reported by the Statistics Center of Iran and the data on the number of kidney transplant beds by province were obtained from the Iranian Ministry of Health in the same year. The proportion of kidney transplant beds was calculated for a population of 100,000 in each province and the corresponding Gini coefficient was calculated. The Gini index is a coefficient ranging from 0 to 1 in which a coefficient lower than 0.2 shows complete equality, one between 0.2 and 0.3 represents high equality, one between 0.3 and 0.4 indicates inequality, one between 0.4 and 0.6 shows high inequality and a measure higher than 0.6 represents complete inequality in the distribution of the given variable.

Findings: Iran recorded a total population of 70,495,782 in 2006 and a total number of 294 kidney transplant beds. The Province of Tehran had more than half the beds installed in its hospitals while 17 provinces had no kidney transplant beds at all. The proportion of kidney transplant beds per 100,000 nationwide population was 0.4, with a corresponding Gini coefficient of 0.44.

Conclusion: The obtained Gini coefficient in this study reveals a high degree of inequality in the geographical distribution of kidney transplant beds in Iran. Therefore, health system managers are urged to consider the findings of this study in their large-scale health planning in order to remove such unequal distribution of health services.

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most important problem faced in kidney transplant is the insufficiency of kidney donation, the selection of appropriate receiver and equal accessibility to kidney transplant constitute the bases of the transplant process. Therefore, development of transplant wards to decrease waiting time for transplant has always been a fundamental basis of this treatment method (9).

Identifying the number and types of special care beds and their distribution may prove as an indirect measurement of the accessibility to inpatient special care. Despite the fact that in many cases the proportion of beds to population may be used as a measure of the distribution of health services, a high proportion of beds to the population does not necessarily imply an equal accessibility of the population to such facilities and services. Therefore, examining the distribution of a service in a given geographical location could be a supplementary criterion to the existing measures of central tendencies (11). The Gini coefficient, which is based on the Lorenz curve, is a measurement method to examine the equal distribution of health services. This coefficient compares the cumulative frequency curve for the distribution
of a given variable with the normal distribution of that variable (which shows equality) (12, 13). The Gini coefficient is used in many medical studies, including the measurement of survival time (14), prediction of improvement of diseases (15), the number of primary care physicians (16), seasonal temperature change in bipolar patients (17), using mental health services (18) and services provided by pediatricians (19).

Since there is not any statistics regarding the geographical distribution of kidney transplant beds in Iran, the present study attempts to examine the equality of the geographical distribution of kidney transplant beds in Iran using the Gini coefficient and the Lorenz curve.

**METHODS**

This study made use of the demographic data of Iranian provinces surveyed in 2006 at the latest census conducted by the Statistics Center of Iran. The number of kidney transplant beds by province was obtained from the last report published by the Ministry of Health of Iran in 2006.

The Gini coefficient and the Lorenz curve were used to study the inequality of the geographical distribution of CCU and PostCCU beds. The Lorenz curve compares the distribution of a given variable with the normal distribution (of same variable) that represents equality. This equality distribution is shown by a diagonal line. The farther the Lorenz curve lies from this line, the higher the inequality. As an example, in income distribution studies the Lorenz curve shows the cumulative proportion of income as a function of the cumulative proportion of the population. In fact, this curve is a method for graphic illustration of these cumulative measures (Figure 1). In this curve, the X axis represents the cumulative percentage of population and the Y axis shows the percentage of the variable which is expressed as the proportion of the cumulative population (20). The 45-degree line is called the equality line because of showing the completely equal distribution (21). In our study, the X axis represents the cumulative percentage of population of Iranian provinces and the Y axis shows the cumulative frequency of each type of CCU and Post CCU beds in the Iranian provinces.

The Gini coefficient is calculated as a proportion of two areas. The area under the diagonal line is considered as the denominator and the area between the diagonal line and the Lorenz curve is regarded as the numerator (21). Therefore, the Gini coefficient is defined as the division of the area between diagonal line and the Lorenz curve by all the area below the diagonal line. Mathematically speaking,

$$G_1 = 1 - \sum_{k=1}^{n} \frac{(X_k - X_{k-1})(Y_k + Y_{k-1})}{n}$$

Where X represents the cumulative percentage of the population and Y represents the cumulative percentage of each type of beds. The Gini coefficient ranges between 0 and 1 in which, theoretically, 0 represents complete equality and 1 shows complete inequality of the distribution of a given variable. In practice, however, a coefficient below 0.2 is considered complete equality, one ranging between 0.2 and 0.3 shows high equality, one ranging between 0.3 and 0.4 indicates inequality; a coefficient varying between 0.4 and 0.6 indicates high inequality and a coefficient larger than 0.6 represents complete inequality (22).

The demographic data and also the number of CCU and Post CCU beds by province were entered into MS Excel spreadsheet. The number of each type of CCU and Post CCU bed per 100,000 people and the cumulative percentages of each type of bed by province were calculated. Finally, the Gini coefficients for each type of bed were calculated by plotting the Lorenz curve and using the above formula.

**RESULTS**

According to the 2006 census survey, Iran had a population of 70,495,782 people and a total number of 294 kidney transplant beds. Table 1 shows the population data, number and percentage of kidney transplant beds and the proportion of beds to 100,000 people by province. As can be seen in this table, more than half of the beds were installed in the Province of Tehran while there were no kidney transplant beds in 17 provinces (Ardabil, Elam, East Azerbayjan, Bushehr, Chahar Mahal Bakhtiari, Southern Khorasan, Zanjan, Semnan, Qazvin, Qom, Kermanshah, Kerman, Kohkiluyeh va Boyer Ahmad, Golestan, Markazi, Hormozgan and Yazd).

There was 0.4 kidney transplant bed per 100,000 people at the national level. The Lorenz curves for this type of bed are shown in Figure 2, calculated using the cumulative percentage of population and the cumulative percentage of kidney transplant beds. The Gini coefficient obtained was 0.44.
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Discussion
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beds in Iran while 17 provinces, comprising a third of the total
population of Iran, have not these beds at all. According to the
obtained Gini coefficient, there is a highly unequal geographical
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Accessibility to and distribution of health services for chronic
kidney deficiencies are challenged in different countries. The occurrence of ESRD patients needing RRT in developing and
third world countries is reported to range between 34 and 240
cases per one million people though the number of patients
actually receiving RRT is very low (23). Most Asian and Af-
rican countries lack national programs with state support for
ESRD patients and patients do not have equal accessibility to
RRT treatments. Dialysis facilities are mainly located in large
urban areas and rural areas which are economically at a low
level have almost no dialysis or kidney transplant centers,
requiring patients to travel long distances to find treatment.
Even in some cases, families have to move to another habitat
which may cause a job change or a drop in income (24). In
addition, there is almost no long-term hem dialysis (HD) in
most Asian and African countries and most patients refuse to
continue with HD and in fact only 30-40% of patients in large
HD centers maintain HD after the first four weeks (24).
Furthermore, because of lack of trained nutritionists, many
patients receive inadequate appropriate nutrition supplements
and erythropoietin, leading to malnutrition and debility (24).
Studies in the U.S. show that African-Americans, women,
and the elderly with diabetes have a lower chance of receiv-
ing a transplant kidney (6). Therefore in different countries,
dialyses or kidney transplant treatment of patients is highly
correlated with their economic status (24).

Studies in developed countries, e.g. England (25), Turkey (26),
Italy (27), Australia (28) and the U.S. (29) indicate that rural or
city outskirts inhabitants have limited access to special care
services. Furthermore, since these inhabitants are of lower
socio-economic status, they face more health problems. Cen-
tralization, especially in the developing countries, may attract a
greater population toward the city outskirts, increasing the need
for more inpatient health services in general and special care
services, including kidney transplant, in particular (30).

Inappropriate and unequal distribution of health services may
cause problems in the process of patient treatment. On the
one hand, there may not be adequate facilities to furnish ac-
ceptable health services to the patients and these patients may
have difficulty in referring or travelling to the healthcare cen-
ters. On the other hand, the existing overcrowded health cen-
ters may not be able to dispense quality services to the pa-
tients and these patients may fail to follow up their treatment
course due to the long distance they need to travel. Therefore,
their health problems become more complicated and ad-
vanced imposing higher costs on the health system. This re-
quires that specialty health services be distributed equally and
adequately, as primary health services, across the country (6).
Five factors are taken into account to measure the quality of
health services: establishing the effectiveness of the services,
measuring the impact, measuring the efficiency of the ser-
vie, accessibility of the intervention and appropriate dis-
tribution of the health service. Therefore,
examining the accessibility of special care services, such as kidney transplant, and their geographical distribution in a given area may considerably contribute to the equality of receiving health services.

This study is the first of its kind examining the geographical equality of kidney transplant beds in Iran. As the results show, there is an unequal geographical distribution of this type of health services in Iran in which more than half of the provinces lack such service. However, one should note that the number and geographical distribution of kidney transplant beds cannot by themselves represent the condition and quality of this type of health service. Rather, other variables, including appropriate planning for the use of existing beds, employment of experienced specialists and medical staff, development of preventive and treatment programs and training the patient's family to cooperate with the medical staff, will considerably optimize the utilization of the existing treatment facilities. This study was conducted in a certain period of time (2006) to examine the geographical distribution of kidney transplant beds at the national level and not by province. However, with the increased prevalence of end stage renal diseases in the country (4) and the emphasis of the WHO for adopting the equal distribution of health services as an additional measure (31), the results of such studies may be used by health system managers and authorities to plan for the removal of this inequality in the distribution of health services along other measures. In addition, similar studies may provide continued monitoring over the offering and equal distribution of health services and may help to develop appropriate plans for improving such services.

**Conclusion**
The obtained Gini coefficient in this study shows a high degree of inequality in the geographical distribution of kidney transplant beds in Iran. Since Iran is a pioneering country in the region in the performance of kidney transplant, it is essential for the country to offer an equal distribution of this type of advanced treatment across the nation and to the whole society. Therefore, health system managers are strongly recommended to consider the results of such studies for the development of large-scale health programs eliminating any inequality in the distribution of health services.

References