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Distribution of physicians and hospital beds based on Gini coefficient and Lorenz curve: A national survey

Original Article

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Abstract

Introduction: Inequality is prevalent in all sectors, particularly in distribution of and access to resources in the health sector. The aim of current study was to investigate the distribution of physicians and hospital beds in Iran in 2001, 2006 and 2011.

Methods: This retrospective, cross-sectional study evaluated the distribution of physicians and hospital beds in 2001, 2006 and 2011 using Gini coefficient and Lorenz curve. The required data, including the number of physicians (general practitioners and specialists), number of hospital beds and number of hospitalized patients were obtained from the statistical yearbook of Iranian Statistical Center (ISC). The data analysis was performed by DASP software.

Results: The Gini Coefficients for physicians and hospital beds based on population in 2001 were 0.19 and 0.16, and based on hospitalized patients, were 0.48 and 0.37, respectively. In 2006, these values were found to be 0.18 and 0.15 based on population, and 0.21 and 0.21 based on hospitalized patients, respectively. In 2011, however, the Gini coefficients were reported to be 0.16 and 0.13 based on population, and 0.47 and 0.37 based on hospitalized patients, respectively. Although distribution status had improved in 2011compared with 2001 in terms of population and number of hospitalized patients, there was more inequality in distribution based on the number of hospitalized patients than based on population.

Conclusion: This study indicated that inequality in distribution of physicians and hospital beds was declined in 2011 compared with 2001. This distribution was based on the population, so it is suggested that, in allocation of resource, the health policymakers consider such need indices as the pattern of diseases and illness-prone areas, number of inpatients, and mortality.

Introduction

Nowadays, inequality in distribution of health resources and reduction or elimination of these inequalities have become one of the most important concerns of policymakers in the health sector because it is believed that access to and use of health services by people should not be influenced by gender, race, religion, geographical region, etc. (1, 2). Inequality in distribution of health resources is not limited to the developing countries; it exists in the developed countries as well although it may be less intense (3-6). A report by World Health Organization (WHO) in 2006 (7) showed that about 59 million people in the world are active in the health sector, and distribution of these resources is also unequal both between countries and within countries. In line with revealing unequal distribution of health resources among different countries, this report highlights the burden of diseases and needs against the number of workforce in the health sector and adds that Canada and United States account for 10% of the burden of diseases worldwide, while having 37% of the health manpower in the world. African countries, having 24% of burden of diseases in the world, possess only 3% of all health workforce (7, 8).

Previous studies have shown a positive relationship between the health of population in a region and access to health resource (2, 9). However, the distribution of resources in health sector affects the health status as well and is considered one of the social determinants of health (2). Unequal distribution of resources can lead to the loss of unlimited resources of health sector on the one hand, and can impose more expenses on the patient, health system and whole society, on the other hand (10). To investigate the geographical distribution of health resources, usually Gini coefficient, concentration index, Robin Hood, Thiel index, dissimilarity index, and Gaswirth index are used (11-16). Physicians and hospital beds are two significant resources of health sector whose unequal distribution and improper allocation can result in the loss of resources and increase of health costs for the health system, society, and patients (10-17).

According to the data and reports of the Ministry of Health and Medical Education in 2014, there are 116560 beds in the hospitals, 75% of which belong to the Ministry of Health, 4% to Armed Forces, 12% to Social Security Organization and 9% to private hospitals. Also, the concentration of physicians and hospital beds per population is different among countries. In 2009, there were 16 physicians per 10,000 people worldwide, being equal to 38, 36, 40 and 39% for the developed countries like Spain, Sweden, Switzerland and Norway, but equal to 2, 3, 3 and 9% for the developing countries like Afghanistan, Bangladesh, Yemen and Iran, respectively (18). In 2011-2012, there were 55, 64 and 82 hospital beds per 10 persons in developed countries such as Finland, France and Germany, whereas for the developing countries like Afghanistan, Bahrain and Iran, these valued were found to be 5, 21 and 10 hospital beds (19).

Most of the studies on unequal distribution of health resources carried out in Iran have merely been based the population irrespective of the need indices such as mortality and number of inpatients (3, 20). Although some studies have used need indices, their subjects have been limited to one domain or one specialty like distribution of dentists (21), distribution of health houses (2), or distribution of nephrologists and dialysis beds (22). On the whole, the issue of inequality in distribution of physical and human resources of the health sector is a constant challenge and argument of health policymakers in all countries around the world because inappropriate allocation of resources and imposing more expenses on the patients can be consequences of unequal distribution of resources. Therefore, in this study an attempt was made to answer three major questions: first, have physicians and hospital beds been distributed fairly in Iranian provinces?, second, have these resources been distributed based on population or the number of inpatients?, and third, how the trend of justice in distribution of these resources has changed over time?

Materials and Methods

This retrospective, cross-sectional study was conducted to analyze inequality in distribution of physicians and hospital beds in 2001, 2006 and 2011 using Gin coefficient and Lorenz curve. The study population included 30 Iranian provinces (Alborz province was excluded due to lack of data in the given years). Each province was considered a unit of analysis. The study data consisted of the number of physicians (general practitioners and specialists) per 10,000 population, number of hospital beds per 10,000 population and number of hospitalized patients in 2001, 2006 and 2011, which were obtained from the Iranian Statistical Center (statistical yearbooks of provinces) and center for statistics management and information technology of Ministry of Health and Medical Education.

Gini coefficient and Lorenz curve

One of the most important indices for analyzing inequality in distribution of human resources is Gini coefficient (1, 6, 20). The concept of Gini coefficient is closely related to Lorenz curve. The schematic of Lorenz curve is shown in Figure 1, X axis showing the cumulative percentage of population and Y axis indicating cumulative percentage of the study variable (cumulative percentage of physicians and hospital beds in this study). The numerical value of Gin coefficient in Lorenz curve is obtained by the following formula:

$$G = \frac{A}{A + B}$$

where G represents numerical value of Gini coefficient, A shows the enclosed area between the 45° line and Lorenz curve, and A+B indicates all the area under 45° line. Moreover, for interpretation of Lorenz curve regarding inequality in distribution of the study variable, it is said that the more is the distance between 45°line and Lorenz curve, the higher is the inequality rate, and the less is this distance, the less is inequality.

In addition to Lorenz curve, Gini coefficient can be calculated by the formula proposed by Brown (23):

$$G = 1 - \sum_{i=0}^{k-1} (y_{i+1} + y_i)(x_{i+1} - x_i)$$

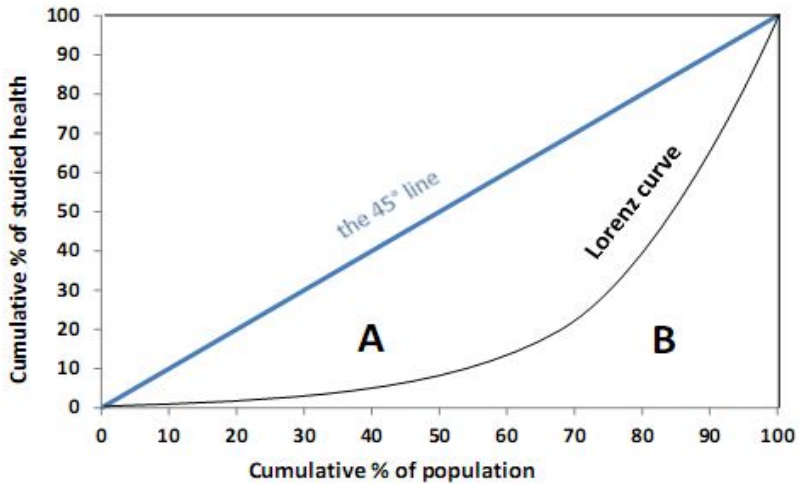


Figure 1. Lorenz curve

where Yi is the cumulative percentage of health variable in each province, Xi the cumulative percentage of population (sorted by variable) of each province, and K the number of provinces. The numerical value of Gini coefficient is between 0 and 1 variable, and the more it is close to zero, the higher is equality in distribution (in the case of this study: physicians and hospital beds), and the more it is close to 1, the more is inequality in distribution of resources (21). In this study, the data were analyzed by DASP software.

Results

The results of this study showed that the number of physicians and hospital beds per 10,000 population in 2011 had increased by 53 and 73%, respectively compared to 2001. The highest number of physicians in 2001, 2006 and 2011 was reported for Mazandaran (5.5), Chaharmahal and Bakhtiari (6.2) and Chaharmahal and Bakhtiari (9.8) provinces, respectively. The lowest number of physicians per 10,000 population, however, was found for North Khorasan province in all three periods; 0.5, 0.94 and 1.6, respectively. Further, the highest number of hospital beds per 10,000 population was reported for Yazd province in 2001 (25), 2006 (26.4) and 2011 (27.8). The lowest number of hospital beds in 2001, 2006 and 2011 was found for Lorestan (7.8), Sistan and Baluchestan (8.8) and Bushehr (9.15) provinces. The status of physicians (general practitioners and specialists) and hospital beds per 10,000 population in Iran in three periods is presented in Table 1.

The findings indicated that Gini coefficients for physicians and hospital beds in 2011 based on population index were 0.16 and 0.13, respectively. The Gini coefficients for distribution of physicians and hospital beds in Iranian provinces in 2001, 2006 and 2011 based on population are shown in Table 2.

The Lorenz curves for distribution of hospital beds and physicians based on population in Iran in three periods of 2001, 2006 and 2011 are illustrated in Figures 2A and 2B. Based on these figures, the distance between 45° line and Lorenz curve in 2011 in both variables is lower than the other two periods, indicating a reduction in inequality in distribution of hospital beds and physicians based on population.

Table 1. Number of physicians and hospital beds per 10,000 population in Iran

	2001	2006	2011
Hospital beds	9.4	15.7	16.2
Physicians	3.02	3.3	4.6

Table 2. Gini coefficients for distribution of physicians and hospital beds in Iran based on population index

	Physicians		Hospital beds	
	Value	SD	Value	SD
2001	0.19	0.027	0.16	0.02
2006	0.18	0.03	0.18	0.023
2011	0.16	0.028	0.13	0.027

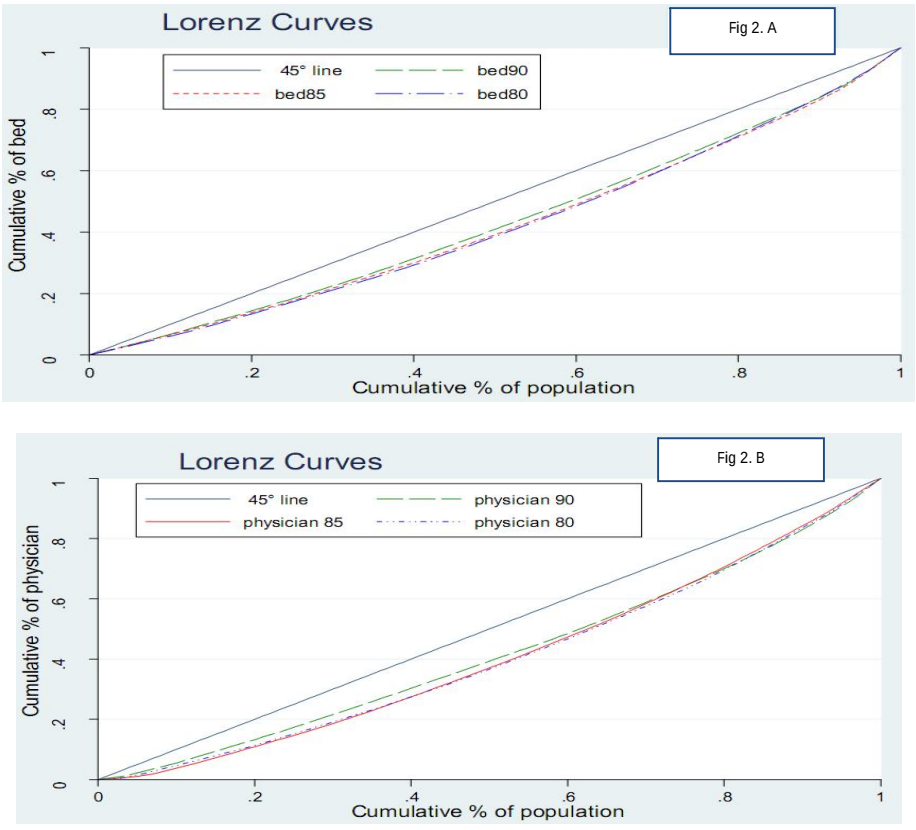


Figure 2. Lorenz curve of distribution of hospital beds (2A) and physicians (2B) based on population

Moreover, Gini coefficients for physicians and hospital beds based on the number of hospitalized patients in 2011 were 0.47 and 0.37, respectively. The Gini coefficient values for distribution of physicians and hospital beds in Iranian provinces in 2001, 2006 and 2011 based on the number of hospitalized patients are presented in Table 3.

The Lorenz curves of distribution of hospital beds and physicians based on the number of hospitalized patients for Iran in 2001, 2006 and 2011 are indicated in Figures 3A and 3B.

The changing trends of inequality in distribution of hospital beds based on population and need indices in 2001, 2006 and 2011 are illustrated in Figures 1 and 2. The results showed that inequality in both states for physicians and hospital beds was reduced, being equal for physicians and hospital beds according to population (3%) and need (1%) indices.

Table 3. Gini coefficients of distribution of physicians and hospital beds based on hospitalized patients

	Physicians		Hospital beds	
	Value	SD	Value	SD
2001	0.48	0.027	0.38	0.131
2006	0.21	0.031	0.21	0.035
2011	0.47	0.143	0.37	0.153

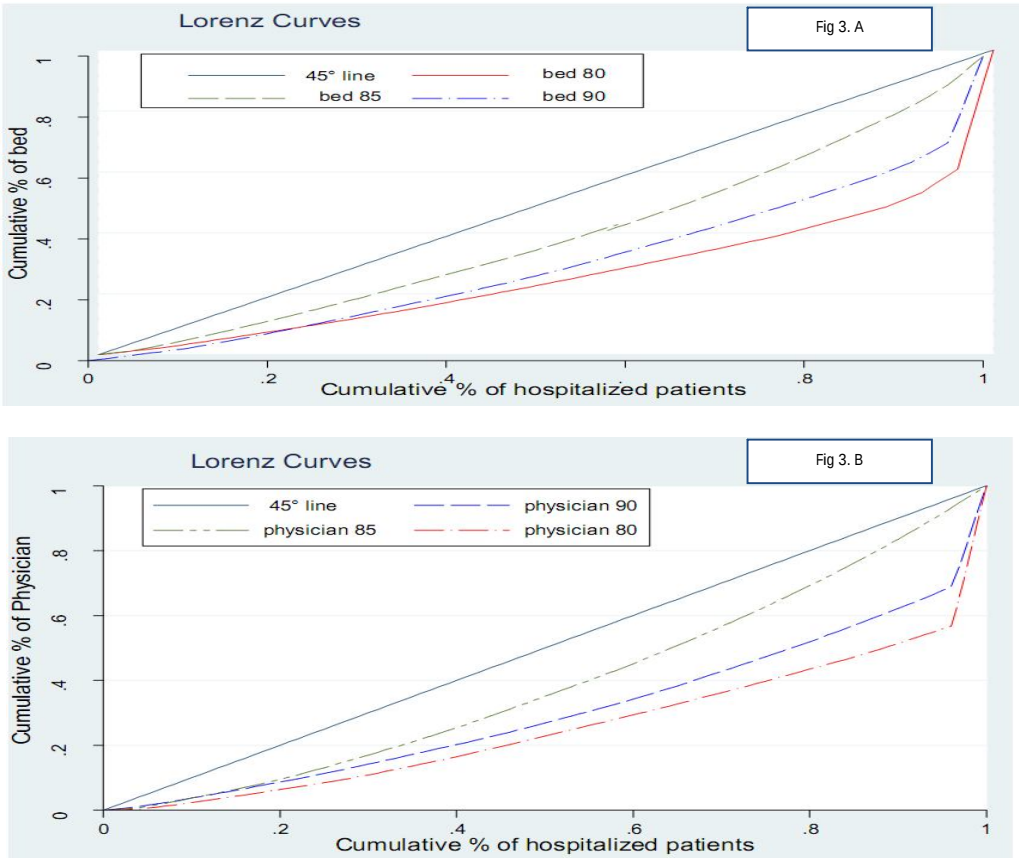
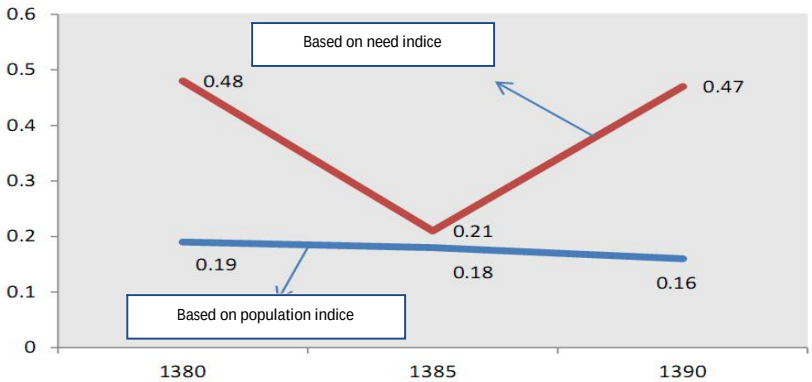
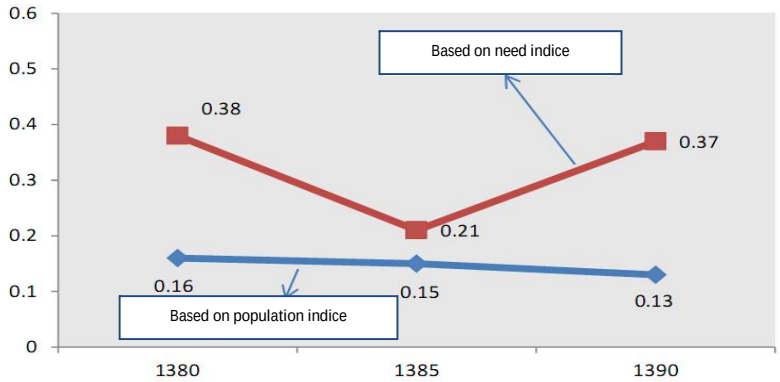


Figure 3. Lorenz curve of distribution of hospital beds and physicians based on the number of hospitalized patients



Graph 1. Inequality in distribution of physicians based on population and need indices in Iran



Graph 2. Inequality in distribution of hospital beds based on population and need indices in Iran

Discussion

The quantitative increase of the outcomes of the health sector has a positive effect on the health of the society; however, the distribution of these resources is also significant and is recognized as one of the social determinants of the health sector. Therefore, in this study an attempt was made to evaluate inequality in distribution of hospital beds and physicians (general practitioners and specialists) based on population and number of hospitalized patients in Iranian provinces in 2001, 2006 and 2011 using Gini coefficient and Lorenz curve.

In 2011, compared to 2001, the number of physicians and hospital beds per capita was escalated by 50%; however, inequality was declined very slightly (1% according to the number of hospitalized patients and 3% based on population), indicating that merely increasing the resources does not lead to equality in distribution of services. Han et al. assessed the distribution of physicians in England and Wales from 1974 to 2003 and concluded that increasing the number of general practitioners did not result in reducing inequality (24). Further, Rezaei et al analyzed inequality in distribution of the physical resources of the health sector in Iran in 2001 and 2011. They found that although supply of resources had been doubled in 2011 compared with 2001, inequality in distribution of these resources was not declined, but it was increased surprisingly (25). The current study showed that inequality in distribution of physicians and hospital beds was reduced in 2011, compared with 2001, based on population and hospitalized patients. Also, Gini coefficients for hospital beds and physicians based on population were found to be 0.19 and 0.16 in 2001 and 0.16 and 0.13 in 2011, respectively. Moreover, Gini coefficients for hospital beds and physicians based on the number of hospitalized patients were 0.37 and 0.47 in 2011 and 0.38 and 0.48 in 2001.

The findings of the present study indicated inequality in distribution of hospital beds and physicians among Iranian provinces. Inequalities in distribution of health resources have also been reported by other national and international studies (26, 27). The study of Horev et al. reported great inequality in distribution of physicians and hospital beds in different States of U.S., so that Gini coefficients for distribution of physicians varied between 0.4 in Missouri State and 0.09 in Connecticut State, and for hospital beds between 0.07 in Arizona State and 0.46 in Missouri State (28).

The research carried out by Zandian et al. on distribution of physicians and hospital beds in Ardabil province showed great inequality in distribution of health resources among the cities of Ardabil, so that Gini coefficients for general practitioners was variant between 0.54 in 2001 and 0.44 in 2009, for specialists between 0.58 in 2001 and 0.52 in 2009, and for hospital beds between 0.6 in 2001 and 0.59 in 2009 (20). Matsumotoa et al. reported a Gini coefficient of 0.175 for distribution of physicians based on population (13). In their study, Mostafavi et al. evaluated the distribution of specialists and hospital beds in State hospitals of West Azerbaijan in 2012 using Gini coefficient and Lorenz curve. They found that distribution of specialists and hospital beds was not fair across the province (29). There are many reasons for unequal distribution of health resources such as physicians and hospital beds, which is manifested in higher development and socioeconomic status of some provinces where the physicians have more tendency to work. This has been shown in other studies, too. The results of a study about geographical distribution of specialists showed that specialists were distributed unequally and mostly worked in urban areas and cities with more facilities and hospitals (30). Some countries try to provide the manpower with financial incentives in order to make them more interested in working in rural and unprivileged areas (31). These incentives include scholarship (32), direct financial incentives for people working in rural and underdeveloped areas (33), and granting loan to the physicians working in rural areas (34).

The current study indicated that the distribution policies of physicians and hospital beds in Iranian provinces are mostly performed based on population rather than need indices like mortality and diseases. This inhibits maximum use of resources and causes loss of resources. The results also showed that Gini coefficients for hospital beds and physicians when analyzed based on population are less than when analyzed based on the number of hospitalized patients. The survey conducted by Theodorakis et al. on distribution of physicians in Albania from 2001 to 2004 based on both population and need indices (crude mortality rate and consultation rate) showed that Gini coefficient based on population

index was less than that of need index. Their study also indicated that Gini coefficient for distribution of physicians based on population in 2001 was 0.121 and based on need index was 0.154 (1).

In a study entitled: "geographical distribution of physicians in Japan and United States: the effect of health system on distribution of physicians", Matsumotoa et al. reported that despite the increased number of physicians, their distribution was not carried out based on population distribution. However, distribution of physicians in United States, compared to Japan, was partly proportional to population. In general, to prevent inequality in distribution of physicians, both countries were suggested to resort to political measures (13). Oslen et al carried out a study to assess inequality in distribution of health workforce in Tanzania. Drawing Lorenz curve and calculating Gini coefficient, modified based on need, they found unequal distribution of manpower in the health sector. They discovered that distribution of specialists among different areas of Tanzania was unequal (35).

Limitations

This study had some limitations. First, the beds and physicians of Universities of Medical Sciences in the State sector were selected for analysis, which might affect the numerical value of inequality. Second, the data of this study were obtained from the statistical yearbooks of provinces and medical universities, which might cause measurement error and consequently bring about bias in the results. Third, this study was conducted at the level of provinces of Iran, so the results cannot be generalized to the individuals.

Conclusion

This study showed that although the number of physicians and hospital beds increased in 2011 compared with 2001 and 2006, no improvement was observed in distribution of resources among the provinces of the country compared with their increased number, and inequality was not declined significantly. Further, the findings indicated inequality in distribution of hospital beds and physicians in Iran, and that this distribution in provinces of Iran is done based on population rather than needs indices like the number of hospitalized patients and mortality rate. Hence, new distribution policies are suggested for the health sector to promote the efficacy of the health system based on the needs of the population, to prevent the increased costs of the health system, and to improve the outcomes of the health system.

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