The Assessment of Inequality on Geographical Distribution of Non-Cardiac Intensive Care Beds in Iran

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Abstract

Background: The purpose of the present study was to evaluate the inequality of geographical distribution of non-cardiac intensive care beds in Iran using the Gini coefficient.

Methods: The population information of Iran's provinces in 2006 was obtained from The Statistical Center of Iran and the number of non-cardiac intensive care beds (including ICU, PostICU and NICU beds) in all provinces was taken from published information of Ministry of Health and Medical Education of Iran in the current year. The number of beds per 100,000 populations of each province and the Gini coefficients for each bed were calculated.

Results: Iran's population was 70,495,782. The total number of ICU, PostICU and NICU beds were 3720, 291 and 1129, respectively. Tehran had the highest percentage of each bed among all provinces. The number of each bed was 5.3, 0.4 and 1.6 per 100,000 populations of country, respectively. The calculated Gini coefficients for each bed were 0.17, 0.15 and 0.23, respectively.

Conclusion: The findings of this study showed that, according to the Gini coefficients, non-cardiac intensive care beds have an almost equal geographical distribution throughout the country. However, the numbers of beds per population are less than other countries. Since such studies can be used as a base for health systems planning about correction of inequality of health services distribution, similar studies in other health care services are recommended which can be conducted at the national or provincial level.

Keywords: *Intensive care beds, Geographical distribution, Inequity, Gini coefficient, Iran*

Introduction

Inequality in health services distribution has become a worldwide challenge among different countries (1). From the viewpoint of the Commission on Social Determinants of Health (CSDH), health inequality in various countries has a progressive trend (2). Therefore, equality in distribution of health services and equal accessibility to such services has become a major principle in most health systems (3). Nevertheless, measuring equality in health is not a straightforward task. Different countries use different methods for such a purpose. In most countries, in fact, customer reports or policy makers' views are taken as defining criteria for equality and only few countries apply scientific and precise measures to quantify health care equality (4). In the U.S., in most cases equality in health is concerned with racial or ethnical differences (3). Some studies have even placed an emphasis on the regional changes in receiving equality in healthcare (5-7). Therefore, understanding the geographical distribution of health resources, equal accessibility to such resources and improvement of them may

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lead to better planning to make health services accessible by all (3).

Although the reasons for health services distribution are mentioned as unknown (8, 9), studies show that different factors such as personal, social, economic and geographical have some effect on health (10, 11). These factors are more obvious in developed and developing countries (12) as far as geographical distribution of health services in countries become a basic problem. On the other hand, the extent to which these factors make impact differs in various countries and even in various geographical areas within a country (11).

Intensive health care services have dramatically increased in the past decades. In fact, in 1985-2000 the percentage of intensive care units beds in the U.S. increased by 71.8%. In England and Wales, averages of 1% of hospital beds are especially used for intensive care, which counts as a dramatic disparity between different hospitals (13). In addition, European healthcare standards (as of 1994) require a 2-3% intensive care beds proportion (14). However, the ratio of ICU beds in 2007 in the U.S. was 2.8 to 10,000 population (from 1.01 to 5.95), which shows a marked and uneven distribution of healthcare resources across the country (15).

One of the most important indices of inequality of health services is the assessment of accessibility to the hospital intensive care services (16) and it is shown that people who have less ease of access to these cares also have lower health level (17). Since inhabitants in regions with lower hospital beds have lower health levels (18), assessment of the number and type of intensive care beds and their distribution can be used as an indirect method for assessment of the level of accessibility to the hospital intensive cares. However, there is a lack of information about the geographical distribution of intensive care beds in developing countries (19).

The Gini coefficient, which is based on and calculated from Lorenz curve, is a method for the evaluation of the equal distribution of health care services. This index compares the cumulative frequency curve of distribution of a variable with the equal distribution of it (20, 21). This index has been used in many medical studies such as survival studies (22), prediction of improvement rate (23), the number of Primary Care Physicians (24) and the number of hospital beds (3).

Since we have no data about the geographical distribution of non-cardiac intensive care beds in our country, this study was conducted with the aim of assessment of the inequality of the geographical distribution of non-cardiac intensive care beds (ICU, PostICU and NICU beds) in Iran by Lorenz curve and Gini coefficient.

Materials and Methods

In this study, the population data of Iranian provinces based on the latest population census in 2006 conducted by the Statistics Center of Iran was used. The number of non-cardiac intensive care beds (ICU, PostICU and NICU beds) in each province in 2006 was based on the latest published information of the Ministry of Health and Medical Education of Iran.

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 egalitarian line (25). The farther the Lorenz curve lies from this line, the higher the inequality (26) (Fig. 1). In this curve, horizontal axis (X) represents the cumulative percentage of population and vertical axis (Y) illustrates the percentage of some value held by the corresponding cumulative proportion of the population (26). In our study, the X axis illustrates the cumulative percentage of population of Iran's provinces and the Y axis shows the cumulative percentage of each type of non-cardiac intensive care beds in Iran's provinces.

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 (18). Its mathematical formula is as follows:

$$Gini = \sum_{i=1} X_i Y_{i+1} - \sum_{i=1} X_{i+1} Y_i$$

Or

$$G_i = 1 - \sum_{k=1}^{n} (X_k - X_{k-1})(Y_k - Y_{k-1})$$
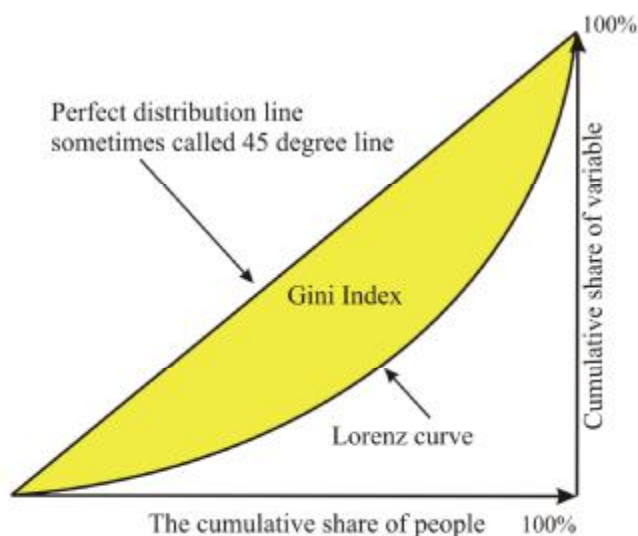
Fig. 1: In Lorenz curve cumulative percent of population is illustrated on horizontal axis while cumulative percent of other variable is figurate on vertical axis

In this study, X was the cumulative percentage of the population and Y was the cumulative percentage of each type of non-cardiac intensive care beds. The Gini coefficient ranges between 0 and 1, where theoretically, zero corresponds to a perfect equality and 1 corresponds to a perfect inequality. However, practically, a 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; and greater than 0.6, an absolute inequality (27).
Population data and the number of non-cardiac intensive care beds of all provinces were entered into Excel software. The number of each intensive care beds per 100,000 populations and cumulative number of them was calculated for each province and with Lorenz curve, the Gini coefficient via above formula was computed for each bed type.

Results

The total population of Iran was 70,495,782 in 2006 and the total numbers of ICU, PostICU and NICU beds in this year were 3720, 291 and 1129, respectively. Tehran had the highest percentage of each bed among all provinces. The number of these beds per 100,000 populations in the country was 5.3, 0.4 and 1.6, respectively. Table 1 shows country population, the number and percentage of ICU, PostICU and NICU beds and the number of beds per 100,000 populations according to the population of each province. Fig. 2 illustrates the geographical distribution of each bed on the map by province.
With the cumulative percentage of population and cumulative percentage of each bed, the Lorenz curves were drawn as shown in Fig. 3. The Gini coefficient for ICU, PostICU and NICU beds were calculated as 0.17, 0.15 and 0.23, respectively.

Table 1: Iran population, the number and percentage of non-cardiac intensive care beds and beds number per 100.000 population in each province

Province	Population (person)	ICU beds			Post-ICU beds			NICU beds		
		Count	%	Count/100.000 Population	Count	%	Count/100.000 Population	Count	%	Count/100.000 Population
Ilam	545,787	9	0.2	1.6	0	0.0	0.0	4	0.4	0.7
Semnan	589,742	51	1.4	8.6	0	0.0	0.0	15	1.3	2.5
Kohkiluyeh o Buyer Ahmad	634,299	13	0.3	2.0	0	0.0	0.0	1	0.1	0.2
South Khorasan	636,420	40	1.1	6.3	0	0.0	0.0	9	0.8	1.4
North Khorasan	811,572	27	0.7	3.3	6	2.1	0.7	20	1.8	2.5

Table 1: Continued…

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Chahar Mahal o Bakhtyari	857,910	21	0.6	2.4	2	0.7	0.2	10	0.9	1.2
Bushehr	886,267	24	0.6	2.7	0	0.0	0.0	4	0.4	0.5
Zanjan	964,601	32	0.9	3.3	3	1.0	0.3	7	0.6	0.7
Yazd	990,818	78	2.1	7.9	3	1.0	0.3	20	1.8	2.0
Qom	1,046,737	47	1.3	4.5	22	7.6	2.1	15	1.3	1.4
Qazvin	1,143,200	35	0.9	3.1	3	1.0	0.3	8	0.7	0.7
Ardebil	1,228,155	51	1.4	4.2	8	2.7	0.7	8	0.7	0.7
Markazi	1,351,257	30	0.8	2.2	3	1.0	0.2	6	0.5	0.4
Hormozgan	1,403,674	35	0.9	2.5	6	2.1	0.4	6	0.5	0.4
Kurdestan	1,440,156	38	1.0	2.6	0	0.0	0.0	10	0.9	0.7
Golestan	1,617,087	50	1.3	3.1	3	1.0	0.2	17	1.5	1.1
Hamedan	1,703,267	65	1.7	3.8	18	6.2	1.1	7	0.6	0.4
Lorestan	1,716,527	53	1.4	3.1	6	2.1	0.3	20	1.8	1.2
Kermanshah	1,879,385	90	2.4	4.8	10	3.4	0.5	54	4.8	2.9
Gilan	2,404,861	80	2.2	3.3	3	1.0	0.1	4	0.4	0.2
Sistan o baluchestan	2,405,742	68	1.8	2.8	8	2.7	0.3	25	2.2	1.0
Kerman	2,652,413	92	2.5	3.5	0	0.0	0.0	9	0.8	0.3
West Azarbayjan	2,873,459	170	4.6	5.9	18	6.2	0.6	36	3.2	1.3
Mazandaran	2,922,432	179	4.8	6.1	6	2.1	0.2	42	3.7	1.4
East Azarbayjan	3,603,456	222	6.0	6.2	7	2.4	0.2	32	2.8	0.9
Khuzestan	4,274,979	206	5.5	4.8	0	0.0	0.0	37	3.3	0.9
Fars	4,336,878	299	8.0	6.9	8	2.7	0.2	110	9.7	2.5
Isfahan	4,559,256	124	3.3	2.7	0	0.0	0.0	26	2.3	0.6
Khorasan Razavi	5,593,079	238	6.4	4.3	34	11.7	0.6	221	19.6	4.0
Tehran	13,422,366	1,253	33.7	9.3	114	39.2	0.8	346	30.6	2.6
Total	**70,495,782**	**3,720**	**100.0**	**5.3**	**291**	**100.0**	**0.4**	**1,129**	**100.0**	**1.6**
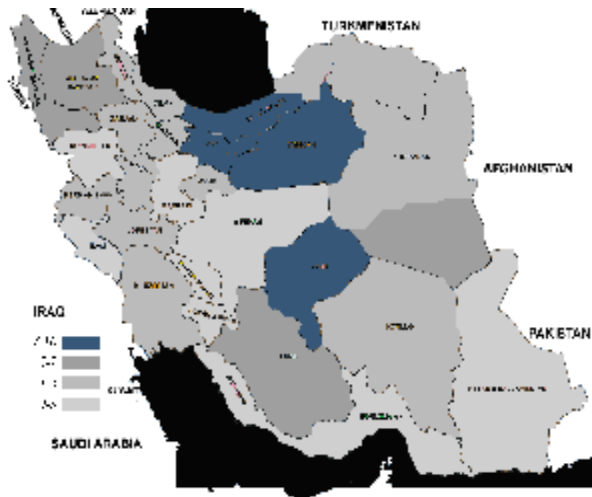
Distribution of ICU beds based
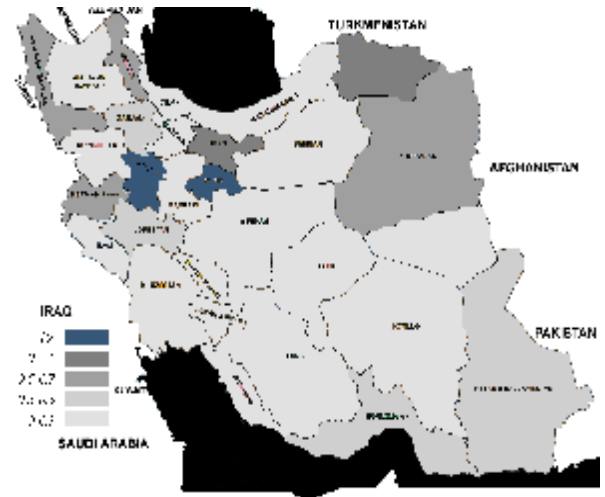
Distribution of PICU beds based
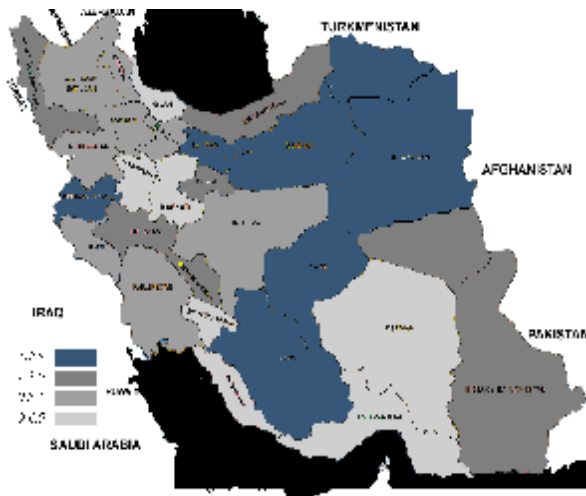
Distribution of NICU beds based

Fig. 2: Distribution of non-cardiac intensive care beds based on beds number per 100.000 populations in each province of Iran

Lorenz Curve Of ICU Beds

Lorenz Curve Of PostICU Beds

Lorenz Curve Of NICU Beds
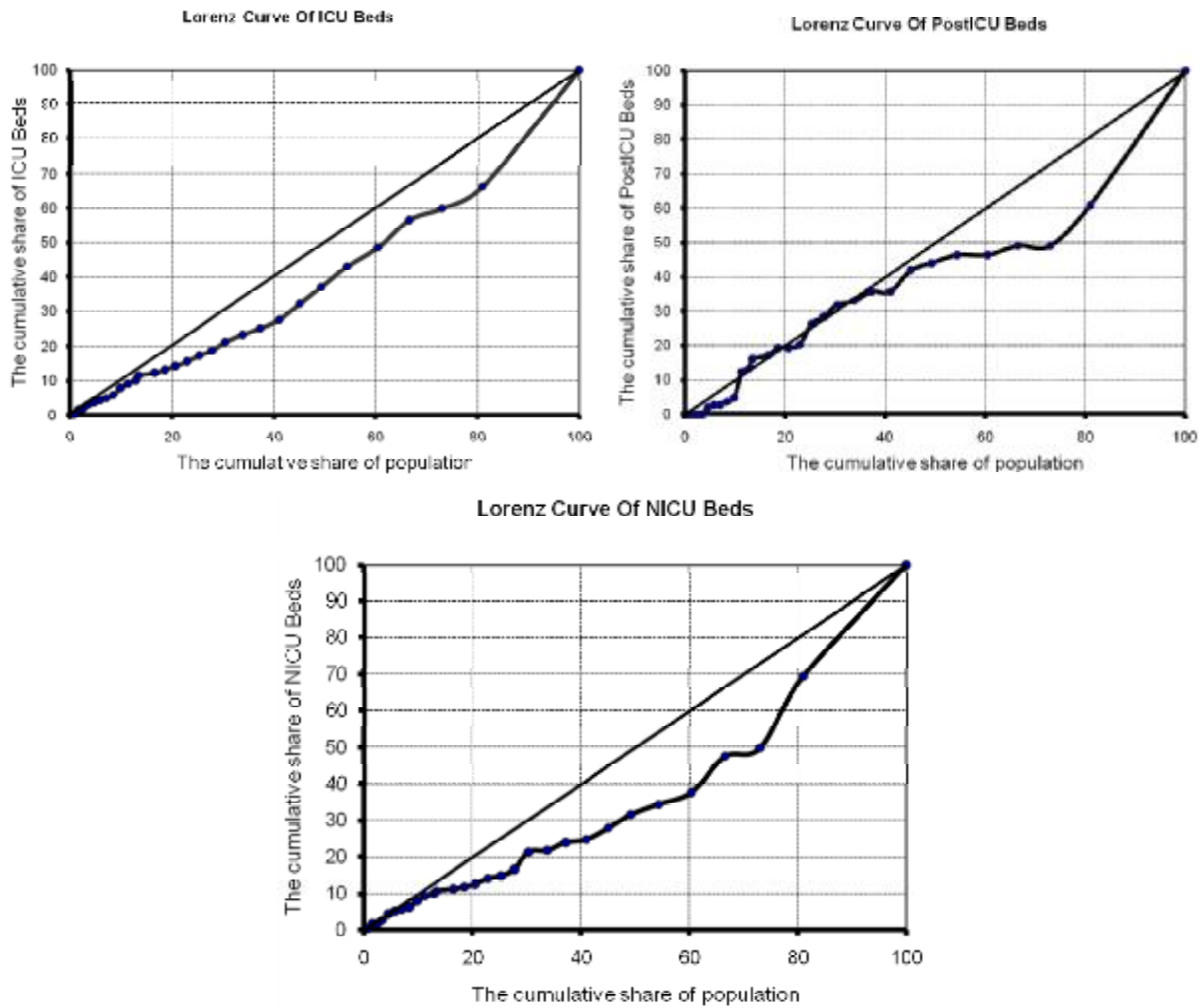
Fig. 3: Lorenz curve of non-cardiac intensive care beds

Discussion

The findings of the present study show that the Gini coefficient for the ICU and PostICU beds in Iran is less than 0.2 and for NICU beds it is slightly more; thus it seems that the ICU and PostICU beds have more equal distribution than NICU ones. However, in spite of the slight difference, it can be assumed that the distribution of all non-cardiac intensive care beds based on Gini coefficient is equal throughout the country.

In this study, the numbers of ICU, PostICU and NICU beds per 100,000 populations in the country were 5.3, 0.4 and 1.6, respectively. The proportion of ICU beds per 100,000 people in 2005

were as varied as follows: 20 in the U.S., 9.3 in France, 13.5 in Canada, 24.6 in Germany, 3.5 in England, 21.9 in Belgium, 8.4 in the Netherlands and 8.2 in Spain (28). In South Africa, there were 4,168 ICU beds counted in 2005 of which 86% were installed in three provinces. The proportion of bed varied greatly in different provinces of this country, from 1:20,000 to 1:80,000 (19). The distribution of secondary and tertiary health services in the Palestine is also reported to be unequal, mostly concentrated in the downtown. In the Gaza Strip and in the Eastern Strip the proportions of IU beds per 1,000 were 1.4 and 1.2, respectively (29). Although there is a great dif-

ference between statistics of ours with developed countries and we are far from the ideal point, factors such as defined criteria for intensive care beds and its measurement, consideration of private hospital beds, neonatal beds, psychological beds and other intensive care beds may be causes accounting for this difference (30).

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 (3). 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 (3). Although the obtained Gini coefficients in our study are representative of equality distribution of these beds throughout the country, the geographical distribution of each bed may be different among various provinces and the centers of each province may have higher number of intensive care beds than other areas. Among all provinces, in Tehran, the capital of Iran, the ratios of all beds were almost two times higher than other provinces. In addition, it must be considered that, although the Gini coefficient of Post ICU beds was almost equal to the ICU beds, the number of such beds in some provinces was zero.

Overall, past studies about health status throughout the country showed that Isfahan, Tehran and Markazi provinces had ideal health status, while Ardebil, Golestan and Qom provinces did not have an appropriate health status and the health status of Khuzestan, Sistan Baluchestan and Kohkiluyeh Buyer Ahmad were very poor (31). Studies in some countries such as England (32), Turkey (17), Italy (33), Australia (30) and the USA (34) have shown that inhabitants of rural areas or in vicinity of big cities have lower levels of accessibility to intensive cares. Moreover, these people are in lower socioeconomical status and consequently in lower health status. Because of centralization policies especially in developing world, the population around big cities may become higher and higher, thus the need for all types of hospital beds, especially intensive care beds, will increase dramatically (35).

In addition, it must considered that merely the number of intensive care beds cannot be a representative of appropriate use of them and other factors such as coordination between prehospital emergency cares and hospitals, accurate programming for better use of intensive care units, presence of a intensive care specialists, presence of complete treatment guidelines, good nutritional support for patients of these wards and training of family members of patients for co-operation with treatment personnel can lead to the appropriate use of these facilities.

This study is the first one in the field of assessment of inequality of geographical distribution of non-cardiac intensive care beds in Iran in which each type of bed was evaluated separately. However, it must be noted that, this study was a cross sectional one and conducted in 2006. In addition, the distribution of beds was assessed throughout the country not in each province separately due to lack of information sources from the geographical distribution of beds in each province. However, the findings of this study can be used by managers and policy makers of health system for planning to abolish inequality in distribution of health care services alongside other indices. Therefore, such studies which should be done continuously and use of indices about all types of health care services which represent inequality in their distribution, such as Lorenz curve and Gini coefficient, could lead to a better understanding and consequently planning for improvement of quality of services.

In conclusion, this study showed that, according to the Gini coefficients, geographical distribution of non-cardiac intensive care beds did not differ significantly and all of them, especially ICU and PostICU beds, had equal geographical distribution throughout the country. However, some provinces had no PostICU beds. In addition, except Tehran, there are little differences among other provinces. Such studies can be used as a base for health systems planning to correct inequality of health services distribution. Therefore, similar studies in all health care services should be carried out at national or provincial levels for obtaining more data.

Ethical Considerations

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors.

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