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Original Article

Are Doctors Equally Distributed Throughout the World?

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Abstract

Background: As the vital and scarce resource of the health system, physicians are responsible for treating patients and saving lives and the equitable distribution of physicians among the whole population is a prerequisite to achieving health for all. We aimed to investigate inequality in physician distribution in the world using the Gini coefficient.

Methods: This descriptive-analytical study was conducted in 2021. The number of physicians and the population of countries were obtained from the WHO and United Nations (UN) databases. The Gini coefficient was calculated in three different modes and the distribution of physicians among countries in various Human Development Index (HDI) groups was determined using the physician ratio per 10,000 population.

Results: There were generally more than 13 million doctors in the world. About 43% of the world's physicians were available to 20% of the world's population in very high HDI countries, and 12% of the population had access to about 1% of physicians in low HDI countries. An average of 19.5 physicians are distributed per 10,000 population worldwide. The Gini coefficient between the four groups of HDI countries was 0.55, and that of all countries in the world was 0.640.

Conclusion: There was a shortage and inequality in the distribution of physicians worldwide. Governments should eliminate inequality in the distribution of the medical workforce, in particular physicians, by redoubling their efforts and accurate planning.

Keywords: Physicians; Doctors; Gini coefficient; Human development index; World countries

Introduction

A fundamental principle of health systems worldwide is equality and public access to health services. Regardless of their impact on health, these values are important factors in establishing the foundations of equity and justice in a health system (1). Human resources are the main building blocks of the health system and the first source of healthcare reform (2). Although the need to address inequalities in the medical workforce distribution has been an important political issue for long years, few effective initiatives and approaches have been proposed to overcome this problem, thus inequality in the distribution of health professionals remains a global challenge (3).

Therefore, the WHO and the Organization for Economic Cooperation and Development OECD have emphasized the need to measure

equality in the distribution of health system resources (1). Besides quantity, the appropriate medical workforce distribution is reported as one of the important factors affecting the quantity and quality of health services (4). As the vital and scarce resource of the health system, physicians are responsible for treating patients and saving lives, and the equitable distribution of physicians among the whole population is a prerequisite to achieving health for all (2, 5).

On the other hand, there is a marked association between a higher ratio of primary care physicians to the population and lower all-cause mortality, lower mortality of mothers and infants <5 yr old, increased measles immunization coverage, and longer life expectancy (1, 6, 7). However, inequality in the geographical distribution of physicians is a major social problem in numerous countries (8). Physicians are concentrated in specific locations, which faces many populations with physician shortages and causes political concerns in many countries (5).

The WHO has determined a minimum density threshold of 22.8 skilled health professionals (doctors, nurses, and other staff) per 10,000 population to provide basic health coverage (9). However, many countries do not reach this standard around the world. Countries that have reached the recommended minimum are still facing substantial inequalities in the workforce distribution between urban and outlying areas (3).

The ratio of medical manpower to population is greatly variable in different countries. Although the number of physicians per unit population is increasing in most developed countries, increasing the physician-to-population ratio does not necessarily improve the unequal distribution of physician to population (5, 10). Inequality in the physician-to-population distribution has been confirmed in various studies in the European Union (11), Japan (12), Brazil (13), Iran (14), Sudan (15), and Cameroon (7). According to the above issues, the description and analysis of inequality in the healthcare manpower distribution are of paramount importance. Therefore, it is essential to monitor changes in human resource inequalities in healthcare to identify gaps, allowing for a better understanding of abandoned countries and regions and facilitating the implementation of effective and appropriate interventions. Thus, we aimed to investigate inequality in physician distribution in the world using the Gini coefficient, which measures the deviation from the uniform distribution and indicates whether the resources are evenly distributed in all regions according to their population size (1). The Gini coefficient and the study procedure are detailed in the following.

Materials and Methods

Data on the number of physicians and the population of countries were obtained from the WHO (16) and UN (17) databases. The calculation was based on the population data of countries, the HDIindex in 2020, and the number of physicians in 2018 or 2019. If the information of some indices was not available in the main databases, valid databases, such as the website of the Ministry of Health of that country, were used in each country. If information from a country could not be obtained from any source, that country was removed from the research population.

Based on the HDI index, the UN grouping (2020) (18) divided the countries of the world into four categories: very high HDI, high HDI, medium HDI, and low HDI. The HDI index (the result of the three factors: life expectancy, literacy level, and gross domestic product or GDP) is a number between zero and one, and a larger index represents a more developed country. The UN included six countries in none of the above groups due to the absence of information, and 189 countries were included in the study, among which 66, 53, 37, and 33 countries were in the very high, high, medium, and low groups, respectively. In this descriptive-analytical study, inequality in per capita distribution of physician-to-population was measured using the Gini coefficient, which shows the deviation created in the Lorenz curve between the observed and expected distributions. Gini coefficient values range between 0 and 1, with higher values indicating

greater inequality (1). Typically, Gini values of 0.2-0.35, 0.35-0.5, and 0.5-0.7 indicate relatively balanced, relatively unequal, and completely unequal distributions, respectively (19). The Gini coefficient was calculated using the following formula (20).

$$G = 1 - \sum_{i=0}^{n} (Y_{i+1} + Y_i) * (X_{i+1} + X_i)$$

n: Total number of groups

Yi: Cumulative percentage of nurses in the in the group

Xi: Cumulative percentage of the population in the group

In the Lorenz curves drawn here, the populations of countries and the number of physicians are shown by the horizontal and vertical axes, respectively. In the present study, the Gini coefficient was calculated in three different modes: the Gini coefficient of cohort countries in individual four HDI groups, the Gini coefficient between the four groups, and the Gini coefficient in all countries of the world. The distribution of physicians among countries in various HDI groups was determined using the physician ratio per 10,000 population. The cumulative distribution of physicians among countries of various groups based on the population of countries was determined using the Pareto chart. This curve determines the largest number of physicians that are available in each group of countries. All calculations were done in Excel 2019 software.

Patient and public involvement

It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

Ethics approval and consent to participate

All methods were strictly performed in accordance with the Ethical Guidelines of the Declaration of Helsinki. In addition, this study was approved by the Ethics Committee of the Shiraz University of Medical Sciences (Code: 25908).

Results

China and Palau are respectively the most and the least populous countries in the high and very high HDI categories. HDI levels above and below the global average (0.682) were respectively observed in about 58.5% and 41.5% of the world's population. There were generally more than 13 million doctors in the world. About 43% of the world's physicians were available to 20% of the world's population in very high HDI countries, and 12% of the population had access to about 1% of physicians in low HDI countries. Most doctors were male (52.37%) in the world, and 56% of the world's physicians were in the average age range of 25-44 yr. A higher percentage of physicians over 44 yr of age were available in very high HDI countries (Table 1).

Table 1: Distribution of doctors in different countries based on HDI indicator

Grouping	*Factor*	*Very high HDI*	*High HDI*	*Medium HDI*	*Low HDI*	*Ave / Sum*
Population	Max num.	332,915,073	1,444,216,107	1,393,409,038	211,400,708	Sum:7,800,775,176
	Average num.	24,224,955	58,641,460	64,283,712	29,515,895	
	Min num.	18,169	53,544	116,254	1,002,187	
	Total num.	1,574,622,110	2,990,714,471	2,269,929,924	965,508,671	
	%Of total num.	20.185	38.339	29.099	12.377	Sum:100
Doctor	Max num.	866,911	2,859,548	1,293,084	80,543	Sum:13,338,901
	Average num.	89,580	108,322	54,424	5,693	
	Min num.	258	70	25	149	
	Total num.	5,733,084	5,524,470	1,904,843	176,504	
	%Of total num.	42.980	41.416	14.280	1.324	Sum:100

An average of 19.5 physicians are distributed per 10,000 population worldwide. The highest and the lowest physician-to-population ratios (36.14/10000 and 1/10000, respectively) belonged to very high and low-HDI countries (Fig. 1). The results of the Pareto chart revealed that more than 80% of physicians were present in very high HDI countries (Fig. 2).

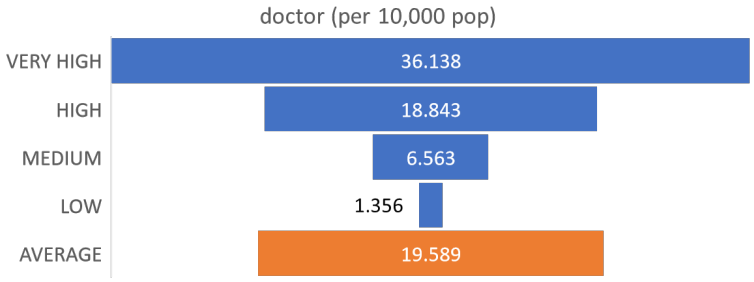

Fig. 1: Distribution of doctors per 10,000 population in the 4 HDI groups countries

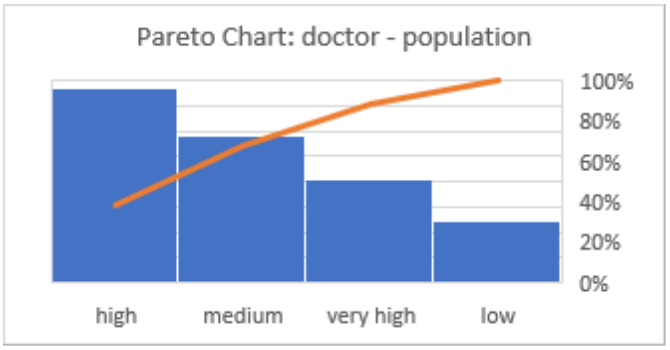

Fig. 2: Pareto curve of doctor distribution to the population in 4 HDI groups countries

The highest (0.396) and the lowest (0.155) Gini coefficients belonged to low and medium HDI countries. The Gini coefficient between the four groups of HDI countries was 0.55, and that of all countries in the world was 0.640 (Table 2). The Lorenz curves of the physician distribution for each of the four HDI countries, between the four HDI countries, and all countries in the world are shown in Fig. 3.

Table 2: Gini coefficient of doctor's distribution in the world

Gini Coefficient	***In each group***				***Between Groups***	***All over the world***
	Very high HDI	High HDI	Medium HDI	Low HDI		
	0.227	0.265	0.155	0.396	0.550	0.640

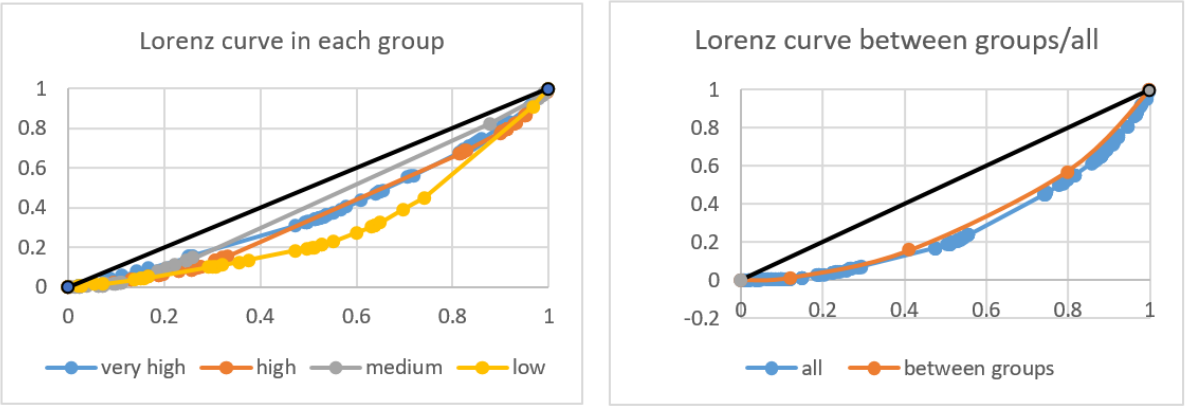

Fig. 3: Lorenz curves for doctor distribution per population. a) Lorenz curve in each HDI group country and b) Lorenz curve between HDI groups and total world countries

As observed in the curves in Fig.3, the arc (curvature) of the obtained curves indicates the equal distribution of doctors in the studied groups. In the figure on the left (in each group), the yellow curve that belongs to the group of low HDI countries exhibits the greatest curvature from the middle line, indicating the unequal distribution of doctors in this group of countries compared to the other groups. However, the gray curve (belonging to the medium HDI country group) has the lowest curve compared to the other groups, representing the most equal distribution of doctors among these countries. The same analysis is true for the figure on the right. When the status of doctors in all countries in the world is examined as a group, more inequality can be noticed in their distribution compared to the time when they are compared in each of the four HDI groups. Information that is more detailed is presented in Fig. 3 and the slope of the curves in Table 2.

Discussion

Countries need to improve the shortage of medical manpower to achieve the Millennium Development Goals (MDGs), in particular health-related goals, as health personnel enhances community health both directly and indirectly, highly associated with sustainability in human and economic development (7).

This study aimed to investigate equality in physician distribution worldwide. About 43% and about 1% of physicians in the world are in very high and low HDI groups, respectively. Although inequality in the distribution of health professionals is a global challenge, it is more pronounced in Low-Income and Middle-Income Countries (LMICs), which face more challenges in the burden of infectious diseases, injuries, and non-communicable diseases than developed countries. A robust primary care network is necessary to address this issue (3).

Our data indicated an average of 19.5 physicians distributed per 10,000 population worldwide. The countries of the HDI group were largely different in terms of the number of physicians per population. As such, the highest (36.14/10000) and the lowest (1.10000) physician-to-population ratios belonged to the countries in very high and low HDI groups, respectively. In a study authors found a physician-to-population ratio of 1.82/1000 in China (4).

Therefore, the type of healthcare system can affect the physician distribution pattern. On the other hand, different health insurance systems also influence the equal distribution of physicians (5). The highest (0.155) and the lowest (0.396) Gini coefficients belonged to the countries of low HDI and medium HDI groups. The Gini coefficient between the four groups of HDI countries was 0.55, and that of all countries in the

world was 0.640. The Gini coefficient-based inequality in the distribution of physicians varied between 0.29 and 0.30 in Poland between 2010 and 2017 (21).

Another study reported a Gini coefficient of 0.532 for the distribution of physicians and a coefficient of 0.434 for the total number of nurses and physicians, indicating inequality in different provinces of Fiji (22). In China, the highest inequality was found between urban and rural areas in the distribution of nurses among healthcare workers, and the Gini coefficient of physicians improved from 0.313 to 0.191 between 1985 and 2011. The growth of healthcare workers cannot fulfill the widespread health needs of the rapidly growing population in urban areas. The equitable improvement of health worker distribution did not result from improvements in the country but from the reduction of urban areas. Inequality in healthcare worker distribution was affected not only by the implementation of health policies but also by the development of the whole country (4).

Another study examined the geographical distribution of physicians in Japan and the United States, which experienced 55% and 47% increases in the number of physicians per capita, respectively, between 1980 and 2005. Gini coefficients against the population were similar between Japan and the United States and remained almost invariable in both countries for the past 25 years. Despite the continuous increase in the number of physicians, they are not distributed based on population distribution in both countries (5).

Some US health economists suggest that in a healthcare system where physicians can select their treatment site without regulations and where medical institutions are largely managed as non-profit, increasing physician-to-population ratios narrow the concentration gap between surplus areas and physician shortage (23-26). This hypothesis is based on the economic principle that competition for more customers equalizes the distribution of suppliers. With an increase in physicians, they are "distributed" into less populated areas where they can make more profit than in larger communities where the market is saturated.

A study in Turkey aimed to more closely examine the impact of the Health Transformation Program policies implemented in 2003 to reduce the imbalance in the distribution of health human resources between 2002 and 2016 in Turkey. The geographical imbalance for healthcare professions decreased significantly during 15 years so that the Gini coefficient of GPs increased from 0.18 to 0.09 (20).

In China, from 2002 to 2017, more closely investigated the impact of implementing medical reforms aiming at the equitable regional distribution of physicians implemented in 2009. The annual growth rates of the number of physicians were 2.38% and 4.44% for the periods 2002-2009 and 2010-2017, respectively. Gini coefficients between different regions of China decreased after medical reforms, but those between urban and rural areas showed an increase (27).

In Japan, the number of physicians in this country increased from 183/100,000 in 1996 to 206.3/100,000 in 2006. The Gini coefficient of physician distribution was 0.33 (12). Indonesia has been decentralized since 2001, and the government has enacted various laws to achieve equitable distribution of healthcare resources in the age of decentralization. In Indonesia, the trend of physician distribution per 10,000 population increased from 1.59 in 2006 to 5.12 in 2014, with an improved Gini coefficient from 0.38 to 0.29 (28).

Despite an increase in the number of per capita GPs in Australia, their distribution became increasingly more inequitable between 1986 and 1996, with poor service offered in rural and outlying areas (29). Investigations on the inequality of health resources are a requisite to establish justice and reduce inequality.

Therefore, examining the inequality of health resources, especially human resources such as physicians and their redistribution in different areas, is of paramount importance for health planners. In this regard, increasing medical equipment, providing welfare facilities, and job advantages can be useful in the establishment of doctors in

cities. It is therefore suggested to increase physical resources of health, such as specialized hospitals, beds, and medical equipment, in the province and distribute them in the cities appropriately to motivate physicians sufficiently to work in the cities of the province. Financial incentives, tariffs, and increasing student admission in necessary specialized fields will also be useful for long-term service in the province (30).

In addition to other determinants, the density of health human resources is important in calculating changes in maternal mortality, infant mortality, and under-five mortality in countries. The impact of this density is greater on reducing maternal mortality than that of infant mortality, probably because qualified health personnel can better handle diseases that pose mothers at risk. Investment in health human resources should be considered as part of a strategy to achieve the MDGs to improve maternal health and reduce infant mortality (31).

In healthcare systems, human resources are considered a key element that helps maintain the entire system, but it often becomes the weakest link in this system due to workforce shortages. Health needs and demands are growing much faster than healthcare capacities on the globe, which increases the high demand for human resources in healthcare and leads to a shortage of healthcare workers in many regions. The difference between supply and demand for health professionals is a major driver of the migration of healthcare workers.

On the one hand, this deficiency is visible at different geographical scales, and it exacerbates the spatial inequalities of healthcare professionals on the other hand. Most highly skilled health professionals worldwide live and work in main areas, whereas the health status of a population is usually worse in surrounding areas. Hence, shortages of healthcare workers are observed in areas where there is the highest demand for the medical workforce (10).

Although the calculations of the Gini coefficient and the Lorenz curve do not reveal considerable differences between countries in each of the four main HDI groups, the calculation of this index indicates a sharp difference between countries in various groups and in the whole world. Due to the increased Gini coefficient exceeding the 0.5 border, a large difference is observed in physician distribution per 10,000 population in different countries (Fig. 3).

The planners and policy-makers of the health system are facing various problems in the distribution of resources in the health sector, which may lead to the disproportionate distribution of these important and strategic resources in this sector (32).

Since the Gini coefficient in each group has not generally exceeded 0.4, it can be concluded that inequality is not frequently seen in the distribution of physicians in the groups. However, there is a direct relationship between the development index and the inequitable distribution of physicians in the four groups according to the classification of countries based on the development index and the results of the Gini coefficient calculated in each group. Thus, the inequitable distribution of physicians is more visible in the low HDI group than in all the other groups.

Conclusion

Human resources play a major role in meeting the goals defined by the health system. This study focused on the equal distribution of the world's nursing workforce. The geographical distribution of nurses was disproportionate to the population distribution. Also, there was more inequality across world than in countries with different HDI groups. This study helps adopt better planning and utilization of resources to improve the healthcare system.

Governments should eliminate inequality in the distribution of the medical workforce, in particular physicians, by redoubling their efforts and accurate planning.

Journalism Ethics 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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Conflict of interest

The authors declare that there is no conflict of interest.

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