



Equality in the Distribution of Maternal and Child Care Providers in the Public Sector of Lorestan Province, Iran

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Abstract

Background: Equitable distribution of health services is the main goal of all countries, but this objective is more closely monitored and planned at the national level.

Objectives: The purpose of this study was to investigate the distribution of care providers of mother and child as vulnerable groups at the provincial level in one of the provinces of Iran in 2011-2017.

Methods: The Gini coefficient, dissimilarity index, and Gaswirth index were used to assess the distribution of maternal and child care specialists. The time trend of inequality was estimated using regression analysis. The calculations were performed using STATA-14 software.

Results: The mean Gini coefficients of pediatricians, gynecologists, and midwives in the study period were 0.25, 0.32, and 0.36, respectively. The mean dissimilarity indices for the mentioned specialists in the study period were 15, 14.7, and 10.9, respectively. The mean Gaswirth indices were 0.99, 0.78, and 0.49, respectively. The results of the regression analysis showed that the effect of time on inequalities was not significant.

Conclusions: The results of the study showed that there was some inequality in the distribution of human resources related to maternal and child health. Therefore, health policymakers are proposed to design and implement a sustainable policy for the fair distribution of these workforces at the provincial level. Equality of indicators at the national level does not necessarily imply equitable distribution at the county level. Therefore, it is proposed to measure and monitor the indicators at provincial/state levels, as well.

Keywords: Health Service Accessibility, Health Equality, Maternal-Child Health Services, Health Workforce, Iran

1. Background

Equal access and equitable distribution of health sector resources are one of the main goals of health systems and one of the main challenges for health policymakers (1, 2). Among the various resources of the health sector, human resources constitute one of the important foundations of health care. The health sector is strongly dependent on these resources for the provision of high-quality services. The distribution of human resources in the health sector is one of the most important factors affecting access, equity, and equality of any health system (3-5). Evidence suggests that there are significant inequalities in the distribution of health human resources between countries and within a country (6).

The 2006 World Health Organization (WHO) report showed that African countries, despite having the greatest burden of disease (around 24% of the world), only have 3% of the health workforce, while North American countries account for 37% of the world's health workforce (7). Although the unequal distribution of human resources is more evident in developing countries, due to their problems and weaknesses in information infrastructures (8, 9), developed countries are also struggling; for example, OECD countries continue to face the unequal distribution of physicians (10). Some studies have shown that inequality in human resources is on a growing trend (11, 12).

Evidence suggests that the mentioned inequalities are directly related to health outcomes. These consequences can include reduced health in the community, waste and

inefficiency of resources, and increased health expenditures for both people and the health system (13). Thus, the inequalities in the distribution of health human resources and their implications have led health policymakers to consider reforming the human resources distribution system (14) and adopting specific, scientific, and evidence-based policies to reduce inequality in the distribution and allocation of these resources in different regions (15). The first step to reducing inequality in the distribution of human resources is to be aware of the community's status in terms of access to health services (16, 17).

In recent years, the geographical distribution of human resources has been studied in several studies in Iran (3, 18). The trend of human resource development in Iran has shown a significant increase over the past three decades, but their distribution does not seem to be fair (19-21). These studies are limited to examining the distribution of resources such as nurses and doctors and investigating the distribution status of these resources among the provinces of the country. There are a few studies on the distribution of workforce associated with the health of mothers and children in the districts of a province. This is despite that women play a key role in shaping culture and education, as well as maintaining and promoting the health of the household and society (22). Thus, in recent decades, the importance of women's health has been increasingly recognized throughout the world (23).

Maternal and child mortality rates are the main indicators of the degree of development of countries (24). Therefore, maintaining and promoting the health of mothers and children as the most vulnerable population groups plays an important role in the health care sector (21, 25, 26). The maternal mortality rate in Iran dropped significantly from 123 deaths per 100,000 live births in 1990 to 25 in 2015 (25). In addition, the under-five mortality rate decreased from 34.2 per 1,000 live births in 2000 to 14.9 in 2017 (27). The study of the distribution of maternal and child health-related workforce can be an effective step to reduce the mortality of these subgroups and ultimately improve community health (26, 28).

2. Objectives

Therefore, the present study examined the status of the geographical distribution of health human resources related to maternal and child healthcare, namely gynecologists, pediatricians, and midwives, in Lorestan Province. The results of this study can provide a basis for health policymakers to review the geographical distribution of human resources associated with these two vulnerable subpopulations.

3. Methods

In this cross-sectional study, we calculated inequality indices (Gini, dissimilarity, and Gaswirth) of human resources distribution related to the health of mothers and children in Lorestan Province during the period of 2011 - 2017. The sample population included nine cities in Lorestan Province. Therefore, there was no need for sampling and all the cities were analyzed. The required data on the number of midwives, gynecologists, and pediatricians working in the public sector were obtained from the province's statistical yearbooks and the Treatment Deputy of Lorestan University of Medical Sciences. Demographic data were also obtained from the provincial statistical yearbooks.

After collecting the necessary data for the study, we tried to investigate and analyze how the abovementioned human resources were distributed in Lorestan Province using the Gini coefficient. This coefficient is usually a measure of dispersion, which usually examines inequality in the distribution of income and wealth in society. In addition, this coefficient is usually used to measure inequalities in the distribution of human resources in the health sector (3, 29). The value of this index is between zero and one. Gini coefficients between 0.20 and 0.35 indicate relatively balanced distribution, 0.35 and 0.5 show relatively unequal distribution, and 0.5 and 0.70 indicate unequal distribution (30, 31). The Gini index is computed through the Lorenz curve so that this coefficient is twice the zone between the Lorenz curve and the 45° line (perfect equality line) (1, 32).

Usually, in studies that analyze inequality in the distribution of resources, the time-trend of inequality in distribution is also considered. The time trend for the inequality of the studied resources from 2011 to 2017 was estimated using the following regression:

$$G_i = \beta_0 + \beta_1 t + \epsilon_i \quad (1)$$

Where G as a dependent variable indicates the vector of the Gini coefficients of each of the resources in the years studied, ϵ_i indicates the components of error, and t represents time. The β_1 coefficient indicates the magnitude and direction of the inequality trend in the distribution of these resources. If the coefficient of the explanatory variable (β_1) is negative, it indicates that the inequality trend in the distribution of these resources is decreasing (11, 21, 33). The dissimilarity index represents the percentage of the total health variable that must be redistributed between cities to achieve perfect equality. The closer the index to zero, the better the distribution of resources and the closer the index to 100, the worse the situation (21, 34). In the

present study, the dissimilarity index was estimated using the following formula:

$$ID = \frac{1}{2} \sum_{i=1}^n |X_{ip} - X_{ih}| \quad (2)$$

In this formula, ID is the dissimilarity index, χ_{ip} is the share of live births of each city in the total live births of the province, χ_{ih} is the share of health resources of each city, and n is the total number of cities in the province.

The Gaswirth index also explains how many new health variables need to be added to the resources to increase the total population access to the access rate of the reference group (the city that has the most resources available). This indicator is calculated in two stages (35). In the first stage, using the following formula, the proportion of the total population with less access to health resources is calculated compared to the reference group.

$$U = \sum_{i=1}^{k-1} y_i (p_{ref} - p_i) \quad (3)$$

Where y_i represents the percentage of live births (in ith city) of the total live births of the province, p_{ref} denotes the health resources of the reference group, p_i shows the health resources in the ith city and k indicates the number of studied cities. In the next step, the Gaswirth index is obtained using the following formula:

$$GI = \frac{U}{\bar{P}} \quad (4)$$

Where \bar{P} presents the average of health resources in the whole province. Then, by multiplying GI in the total number of health resources, the amount that should be added to the existing number of resources to reach the access level of all cities to the reference group is obtained. All the calculations were performed using Stata software (version 14) and the DASP (version 2.3).

4. Results

Table 1 shows the number of pediatricians, gynecologists, and midwives per 1000 live births in different cities of Lorestan Province. In this table, the mean, standard deviation, minimum, and maximum of the variables in different cities of this province are depicted during the period under study.

The values of the Gini coefficient for pediatricians, gynecologists, and midwives in Lorestan Province during 2011-2017 are depicted in Table 2. The Lorenz curve is shown in Figure 1. As shown in the table, the Gini coefficients for pediatricians were 0.27, 0.18, 0.25, 0.275, 0.28, 0.3, and 0.31,

from 2011 - 2017. The values of this coefficient were 0.33, 0.3, 0.33, 0.34, 0.4, 0.24, and 0.32 for gynecologists. Also, the Gini coefficients for midwives were 0.4, 0.38, 0.36, 0.34, 0.38, 0.36, and 0.34, from 2011 - 2017. The t value was above 1.96 for the Gini coefficients for all the years and resources studied, which rejects the null hypothesis regarding the equal distribution of the resources in question.

The results of the regression analysis are presented in Table 3 to illustrate the time effect of inequality. As shown in the table, the β coefficient is negative for the effect of time on Gini coefficients regarding gynecologists and midwives, but this negative effect was not significant. The Breusch-Pagan test to investigate the heteroscedasticity of the variance of models showed no significant heteroscedasticity in the models ($P > 0.05$).

Dissimilarity and Gaswirth indices for the surveyed resources in different cities of Lorestan Province are shown in Table 4. The highest and lowest dissimilarity indicators were related to pediatricians in 2016 (19.6%) and midwives in 2017 (6.5%), respectively. Also, the highest Gaswirth indices during the study period for pediatricians, gynecologists, and midwives were in 2014 (1.5), 2014 (1.24) and 2013 (0.71), in sequence.

5. Discussion

One of the most important Millennium Development Goals is to create equity in access to health services, especially for vulnerable groups such as mothers and children (21, 30). Since the first step for fair access to health services is the equal distribution of resources, monitoring the allocation of resources based on inequality indicators is essential (32). For this reason, we investigated the geographic distribution of gynecologists, pediatricians, and midwives in Lorestan Province using the Gini coefficient, dissimilarity index, and Gaswirth index.

The findings of the present study showed that the Gini coefficient of gynecologists ranged from 0.24 to 0.4 during the study period. This indicates a relatively unfair distribution of gynecologists in the studied area. The study by Tourani et al. in 2015 also revealed that the distribution of gynecologists was very unequal between different provinces of Iran (0.70) (26). The difference in the Gini coefficient of distribution of gynecologists between Iran and the studied province was significant (0.77 and 0.4, respectively). In explaining this difference, it can be stated that most medical graduates like gynecologists tend to serve in provinces with higher levels of welfare. Since the welfare gap in Iran's provinces is higher than that in the province's cities, the distribution of gynecologists in Iran is more unequal than the province studied. In the study by Honarmand et al., Gini coefficients of distribution of gynecolo-

Table 1. Number of Pediatricians, Gynecologists and Midwives Per 1000 Live Births in Different Cities of Lorestan Province (2011 - 2017)

Cities	Variables								
	Pediatricians			Gynecologists			Midwives		
	Mean ± SD	Max	Min	Mean ± SD	Max	Min	Mean ± SD	Max	Min
Azna	0.815 ± 0.28	1.5	0.66	1.32 ± 0.49	2.25	0.68	18.8 ± 3.7	21.9	10.5
Aligudarz	1.35 ± 0.61	2.66	0.68	1.07 ± 0.34	1.5	0.67	20.4 ± 6.1	33.6	13.6
Borujerd	1.06 ± 0.18	1.29	0.8	1.22 ± 0.21	1.63	0.98	14.2 ± 2.5	19.2	11.5
Pole-Dokhtar	0.99 ± 0.55	1.87	0	1.37 ± 0.17	1.86	1.18	26.2 ± 3.1	30.3	20.5
Khorramabad	0.67 ± 0.14	0.8	0.38	0.8 ± 0.1	0.91	0.62	20.6 ± 3.2	25.2	14.7
Delfan	0.79 ± 0.23	1.1	0.54	0.72 ± 0.18	0.98	0.54	18.9 ± 3.5	26.3	14.4
Dorud	1.00 ± 0.28	1.28	0.55	0.47 ± 0.2	0.83	0.26	9.0 ± 4.4	19.2	6
Selseleh	0.73 ± 0.55	1.96	0	0.56 ± 0.23	0.67	0	23.1 ± 3.9	30.8	19.2
Kuhdasht	0.76 ± 0.19	1.1	42	0.71 ± 0.12	0.85	0.5	17.4 ± 4.0	26.7	13.9
Lorestan Province	0.91 ± 0.43	2.66	0	0.92 ± 0.41	2.25	0	18.7 ± 6.2	33.6	6

Table 2. Gini Coefficients of Distribution of Pediatricians, Gynecologists and Midwives in Lorestan Province (2011 - 2017)

Year	Resources								
	Pediatricians			Gynecologists			Midwives		
	Estimates	P Value	SE	Estimates	P Value	SE	Estimates	P Value	SE
2011	0.27	0.001	0.06	0.33	< 0.001	0.057	0.4	0.0004	0.056
2012	0.18	0.01	0.064	0.299	0.002	0.076	0.379	< 0.001	0.047
2013	0.249	< 0.001	0.05	0.334	< 0.001	0.07	0.36	< 0.001	0.047
2014	0.275	0.008	0.09	0.34	0.008	0.11	0.34	< 0.001	0.055
2015	0.28	0.0017	0.07	0.4	0.003	0.11	0.38	< 0.001	0.055
2016	0.31	0.003	0.085	0.24	0.002	0.06	0.36	< 0.001	0.048
2017	0.3	0.005	0.09	0.32	0.004	0.09	0.34	< 0.001	0.043

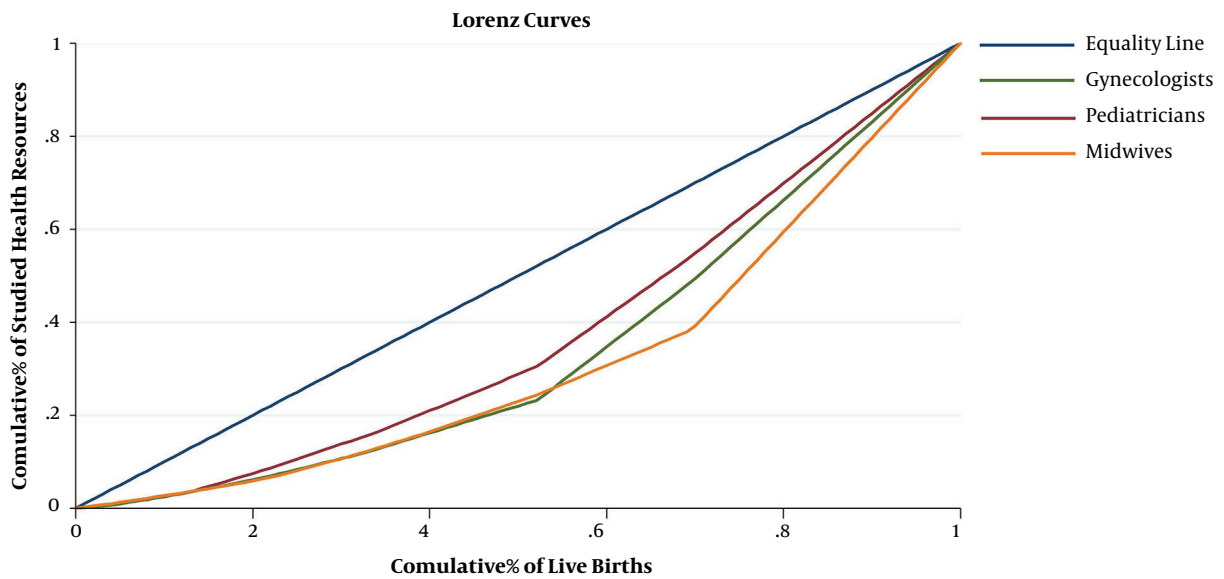


Figure 1. Lorenz curve for pediatricians, gynecologists, and midwives in Lorestan Province during the years 2011 - 2017

gists in Iran were 0.297, 0.39, and 0.15 in 2010, 2011, and 2012, respectively, which shows that the distribution of gynecologists has a different trend, such that at first the dis-

tribution situation was worse and in the final year of the study, a significant improvement in the distribution process was noted (30).

Table 3. Time-Trend Analysis of Gini Coefficients for the Resources Studied in Lorestan Province During 2011 - 2017

Variables	β -Coefficient	Standard Error	Prob > Chi ² (Breusch-Pagan)	P Value
Pediatricians	0.013	0.006	0.06	0.09
Gynecologists	-0.003	0.01	0.25	0.77
Midwives	-0.007	0.003	0.99	0.08

Table 4. Index of Dissimilarity and Gaswirth Index of Disparity for the Resources Studied Across the Cities in Lorestan (2011 - 2017)

Year	Index of Dissimilarity			Gaswirth Index		
	Pediatricians	Gynecologists	Midwives	Pediatricians	Gynecologists	Midwives
2011	8.7 ^a (3 ^b)	8.5 (3)	13.1 (83)	0.49 ^c (15 ^d)	0.58 (18)	0.49 (307)
2012	19.4 (5)	16.4 (5)	12.7 (77)	1.35 (35)	0.58 (19)	0.47 (287)
2013	14.3 (4)	14.3 (4)	15.1 (82)	1.27 (36)	0.69 (19)	0.71 (385)
2014	18.2 (7)	15.5 (5)	10 (53)	1.5 (59)	1.24 (36)	0.44(231)
2015	13.2 (4)	18.4 (5)	10.9(64)	0.94 (30)	0.72 (20)	0.46 (270)
2016	19.6 (5)	16.7 (6)	7.9 (51)	0.92 (25)	1.12 (38)	0.52 (330)
2017	13.2 (4)	13.3 (5)	6.5 (54)	0.46 (13)	0.53 (19)	0.34 (280)

^aValue of index.^bRedistributed according to the index.^cValue of index.^dIncreased according to the index.

By comparing the Gini coefficients of the distribution of Iranian gynecologists in the study by Tourani et al. in 2015 and Honarmand et al. in 2012 (0.70 and 0.15, respectively), the question comes to light that whether the Gini coefficient of the study by Tourani et al. is the continuation of Honarmand et al.'s study? Given the lack of changes in the distribution policies of gynecologists and the admission of gynecology students in Iran, the answer to the above question is negative. It seems that the difference between the results of the two studies is due to the sector the study was performed in (public, private, or both), which has not been mentioned in those articles. Kazemi Karyani et al. showed an increasing and decreasing trend in the Gini coefficient of distribution of gynecologists in one of the western provinces of Iran (Kermanshah) between 2008 and 2013. The Gini coefficient of that study was 0.49 in 2008 and 0.46 in 2013 (36).

A study conducted in Japan between 2000 and 2014 also presented an increase in inequality in the distribution of gynecologists based on the Gini coefficient, with the Gini coefficient in the year 2000 rising from 0.23 to 0.28 in 2014 (37). This is despite the fact that international and national orientations in recent decades have been in the direction of equal distribution of health services; therefore, the study of the reasons for failure in the fair distribution of health services is an inevitable necessity.

The Gini coefficient of distribution of midwives in the study changed from 0.4 in 2011 to 0.34 in 2017. The study

by Tourani et al. in 2015 also revealed that the distribution of midwives between different provinces of Iran is relatively unequal (0.40) (26). The closeness of the Gini coefficient to the distribution of midwives in Iran and the studied province (0.41 and 0.38, respectively) can be attributed to the admission rate of midwifery students based on the welfare status of provinces, while this apportionment is not applied to the admission of gynecologists.

In the study by Honarmand et al., the Gini coefficients of midwives in Iran were 0.18, 0.18, and 0.19 in 2010, 2011, and 2012, respectively, indicating that the trend of midwives' distribution was not significantly altered (30). The discrepancy between the Gini coefficients of distribution of Iranian midwives in the study by Tourani et al. in 2015 and the study by the Honarmand et al. in 2012 (0.40 and 0.19, respectively), as suggested about gynecologists, can be due to the sector the study was performed in (either public or private, or both). Comparison of the Gini coefficients of midwives' distribution in the present study and the study by Honarmand et al. in 2011 (0.4 and 0.18, respectively) and in 2012 (0.38 and 0.19, respectively) did not show a significant change; however, as discussed earlier, the Gini coefficient of distribution of gynecologists in the mentioned years improved simultaneously at country and provincial levels. It seems that the differences in employment policies and the student admissions of these two disciplines have led to different outcomes. According to the target group of these two disciplines (pregnant women), it

is suggested that equal employment policies and student admissions be applied for them. In the study by Kazemi Karyani et al., the Gini coefficient of distribution of midwives in one of the western provinces of Iran (Kerman-shah) changed from 0.25 in 2008 to 0.22 in 2013 (36).

The results by Izutsu et al. in Japan not only showed the fairer distribution of midwives in Japan compared to the current study (average 0.24 vs. 0.36), but also indicated an improvement in the midwives' distribution between 2000 and 2010 (38). In a study conducted in China (2017), the Gini coefficient of distribution of midwives was fairer than the coefficient in the current study in 2015 (0.264 vs. 0.38) (39). It seems that improving the distribution of midwives is easier than improving the distribution of gynecologists due to fewer years of education.

The results of the study indicated that the Gini coefficient of pediatricians varied from 0.18 to 0.3 during the study period. Although it indicates a relatively equal distribution of pediatricians in the studied area, it shows a worsening trend of distribution in the final years of the study. The results by Kazemi Karyani et al. revealed that Gini coefficients of distribution of pediatricians in Iranian provinces were 0.23, 0.25, and 0.21 in the years 2011, 2012, and 2013, respectively (21).

Comparison of the results of Kazemi Karyani et al.'s study and the present study indicates the similarity of the values of the Gini coefficient despite that they show the Gini coefficient for the distribution of pediatricians at the country and provincial levels. In other words, it can be claimed that in the past years, the distribution policy of Iranian pediatricians has been relatively similar at both national and provincial levels. The study by Sakai et al. in Japan as a developed country (2010) showed that the Gini coefficients for the distribution of pediatricians at the national and state levels were 0.11 and 0.37, respectively, indicating that the distribution policies of pediatricians were not similar at both levels and it was nationally more equitable than the state level (40, 41).

The study by Nomura et al. in Japan (2009) reflected that the Gini coefficient for the distribution of pediatricians changed from 0.39 in 1996 to 0.37 in 2004 (42). In a study conducted in China as a developing country (2010), the Gini coefficient of distribution of pediatricians was 0.20, which is close to the Gini coefficient of the present study (0.25) (43). The findings of the above studies indicate that the distribution of pediatricians in the studied countries not only has not worsened but also has been improving.

In the present study, the mean values of the dissimilarity index of pediatricians, gynecologists, and midwives in the study period were 15, 14.7, and 10.9, respectively. In the study by Kazemi Karyani et al., the dissimilarity index val-

ues for pediatricians in Iran in the mutual years (2011-2013) were 14.93, 14.66, and 11.99, respectively (21).

The results also showed that if the government wants to reach the access level of all cities to the reference city level, about 0.99, 0.78 and 0.49 per 10 pediatricians, gynecologists, and midwives should be added respectively. Kidaliri et al. showed that 3 out of every 10 dentists should be redistributed in the provinces of Iran. In addition, they concluded that 31,583 dentists should be added to the existing number to reach the access level of the whole population of the country to the access level of reference province Tehran (44).

One of the reasons for the unequal distribution of specialists at the provincial level is to provide the minimum specialized staff per 1,000 live births, which can be due to limited student admissions in specialized fields in the country. Some countries encourage health sector human resources to work in rural and deprived areas through financial incentives such as scholarships and lending loans to doctors working in the mentioned areas (45, 46). Therefore, it is suggested that governments use different policy tools such as reducing the length of legal obligations, apportioning specialized disciplines based on the socioeconomic status of provinces and cities, and increasing the percentage of fee-for-service for medical doctors to help more equitable distribution of specialized workforce.

The results of this study showed that the distribution policies of gynecologists, pediatricians, and midwives were not consistent at the level of the studied province, while considering the relevance of their target population (mothers and children), it is necessary that their distribution adheres the coordinated policies. The distribution of the studied human resources in some years was not in line at national and provincial levels, while human resource distribution policies are expected to be consistent at the national and provincial levels. Equality indicators at the national level did not indicate equal distribution at the county level; therefore, it is suggested that these indices be measured and monitored at provincial levels, apart from the national level.

5.1. Conclusions

The results of this study can help health system policymakers to reduce inequalities in distribution and access to human resources related to maternal and child health care. According to the results of the study, the distribution of pediatricians in Lorestan Province during the studied years was relatively equitable, but its distribution trend deteriorated over the years of study. Considering the role of this group of specialists in reducing child mortality, the fair distribution of this resource can play an important role in improving the health and welfare indicators of the

community. Regarding the relative inequalities in the distribution of studied health resources, it is suggested that distributional policies be reformed to reduce the level of inequality, eliminate the existing gap between districts in the future, and promote social equality in access to these resources and health indicators in these demographic sub-populations.

Footnotes

Authors' Contribution: Soraya Nouraei Motlagh, Sheida Abbasi-Shakaram, and Mohammad Hasan Imani-Nasab designed the study, participated in data analysis, contributed to writing the paper and several editing of the manuscript, and prepared the draft of the final report. Farhad Lotfi, Hasan Yusefzadeh, and Zahra Asadi Piri participated in preparing the draft of the final report and editing of the manuscript.

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References

- Nishiura H, Barua S, Lawpoolsri S, Kittittrakul C, Leman MM, Maha MS, et al. Health inequalities in Thailand: Geographic distribution of medical supplies in the provinces. *Southeast Asian J Trop Med Public Health*. 2004;**35**(3):735-40. [PubMed: 15689097].
- Omran-Khoo H, Lotfi F, Safari H, Zargar Balaye Jame S, Moghri J, Shafii M. Equity in distribution of health care resources; assessment of need and access, using three practical indicators. *Iran J Public Health*. 2013;**42**(11):1299-308. [PubMed: 26171343]. [PubMed Central: PMC4499072].
- Mobaraki H, Hassani A, Kashkalani T, Khalilnejad R, Chimeh EE. Equality in distribution of human resources: The Case of Iran's Ministry of Health and Medical Education. *Iran J Public Health*. 2013;**42**(Suppl1):161-5. [PubMed: 23865035]. [PubMed Central: PMC3712591].
- Nolan CT, Garavan TN. Human resource development in SMEs: A systematic review of the literature. *Int J Manage Rev*. 2016;**18**(1):85-107. doi: 10.1111/ijmr.12062.
- Rabbanikhah F, Moradi R, Mazaheri E, Shahbazi S, Barzegar L, Karyani AK. Trends of geographic distribution of general practitioners in the public health sector of Iran. *J Educ Health Promot*. 2018;**7**:89. doi: 10.4103/jehp.jehp_14_18. [PubMed: 30079360]. [PubMed Central: PMC6052776].
- Anyangwe SC, Mtonga C. Inequities in the global health workforce: the greatest impediment to health in sub-Saharan Africa. *Int J Environ Res Public Health*. 2007;**4**(2):93-100. doi: 10.3390/ijerph2007040002. [PubMed: 17617671]. [PubMed Central: PMC3728573].
- World Health Organization. *Working together for health*. Geneva: WHO; 2006.
- Lai D, Huang J, Risser JM, Kapadia AS. Statistical properties of generalized Gini coefficient with application to health inequality measurement. *Soc Indic Res*. 2007;**87**(2):249-58. doi: 10.1007/s11205-007-9170-y.
- World Health Organization. *Framework and standards for country health information systems*. Geneva: WHO; 2008.
- Hann M, Gravelle H. The maldistribution of general practitioners in England and Wales: 1974-2003. *Br J Gen Pract*. 2004;**54**(509):894-8. [PubMed: 15588532]. [PubMed Central: PMC1326105].
- Horev T, Pesis-Katz I, Mukamel DB. Trends in geographic disparities in allocation of health care resources in the US. *Health Policy*. 2004;**68**(2):223-32. doi: 10.1016/j.healthpol.2003.09.011. [PubMed: 15063021].
- Toyabe S. Trend in geographic distribution of physicians in Japan. *Int J Equity Health*. 2009;**8**:5. doi: 10.1186/1475-9276-8-5. [PubMed: 19257879]. [PubMed Central: PMC2662844].
- Graves N, Halton K, Lairson D. Economics and preventing hospital-acquired infection: Broadening the perspective. *Infect Control Hosp Epidemiol*. 2007;**28**(2):178-84. doi: 10.1086/510787. [PubMed: 17265399].
- Jin J, Wang J, Ma X, Wang Y, Li R. Equality of medical health resource allocation in China based on the Gini coefficient method. *Iran J Public Health*. 2015;**44**(4):445-57. [PubMed: 26056663]. [PubMed Central: PMC4441957].
- Fleurbay M, Schokkaert E. Unfair inequalities in health and health care. *J Health Econ*. 2009;**28**(1):73-90. doi: 10.1016/j.jhealeco.2008.07.016. [PubMed: 18829124].
- Ghazi Mirsaeid SJ, Mirzaie M, Haghshenas E, Dargahi H. Human resources distribution among Tehran University of Medical Sciences hospitals. *J Payavard Salamat*. 2014;**7**(5):432-46.
- Shahabi M, Toufighi S, Maleki MR. The nurse and specialist physicians manpower distribution by population and its relationship with the number of beds at public hospitals in Iran; 2001-2006. *J Health Adm*. 2010;**13**(41):7-14.
- Rezaei S, Karyani AK, Fallah R, Matin BK. Relative inequalities in geographic distribution of health care resources in Kermanshah province, Islamic Republic of Iran. *East Mediterr Health J*. 2016;**22**(1):19-26. [PubMed: 27117646].
- Tabatabai S, Ziaee SAM, Simforoosh N. Evidence-based health human resources planning and medical professionals' education in Iran. *BMC Health Serv Res*. 2014;**14**(Suppl 2):P123. eng. doi: 10.1186/1472-6963-14-S2-P123. [PubMed: PMC4123135].
- Ahmad Kiadaliri A, Najafi B, Haghparast-Bidgoli H. Geographic distribution of need and access to health care in rural population: An ecological study in Iran. *Int J Equity Health*. 2011;**10**:39. doi: 10.1186/1475-9276-10-39. [PubMed: 21939511]. [PubMed Central: PMC3196912].
- Kazemi Karyani A, Kazemi Z, Shaahmadi F, Arefi Z, Ghazanfari S. Determining inequality and trend of geographic accessibility to pediatricians in Iran: 2007-2013. *Int J Pediatr*. 2015;**3**(2.1):51-8.
- Dahlgren G, Whitehead M. A framework for assessing health systems from the public's perspective: The ALPS approach. *Int J Health Serv*. 2007;**37**(2):363-78. doi: 10.2190/U814-6X80-N787-807. [PubMed: 17665729].
- Ribeiro PS, Jacobsen KH, Mathers CD, Garcia-Moreno C. Priorities for women's health from the Global Burden of Disease study. *Int J Gynaecol Obstet*. 2008;**102**(1):82-90. doi: 10.1016/j.ijgo.2008.01.025. [PubMed: 18387613].
- Homaei Rad E, Samadi A, Bayazidi Y, Hayati R. Examine socio-economic factors affecting infant mortality rate in MENA countries. *Econ Model Res*. 2013;**2**(5):135-51.
- Jenabi E, Khazaei S. Maternal mortality ratio in Iran compared to other regions (1990-2015): Progress and challenges. *J Matern Fetal Neonatal Med*. 2019;**32**(8):1398-400. doi: 10.1080/14767058.2017.1406471. [PubMed: 29141469].
- Tourani S, Zarezadeh M, Raadabadi M, Pourshariati F. Association of regional disparity of obstetrics and gynecologic services with children and infants mortality rates: A cross-sectional study. *Int J Reprod Biomed (Yazd)*. 2017;**15**(3):147-54. [PubMed: 28580447]. [PubMed Central: PMC5447831].
- The World Bank. *Mortality rate, under-5 (per 1,000 live births)*. 2013. Available from: https://data.worldbank.org/indicator/SH.DYN.MORT?locations=IR&name_desc=false.

28. Tanimura S, Shima M. Quantitative measurements of inequality in geographic accessibility to pediatric care in Oita Prefecture, Japan: Standardization with complete spatial randomness. *BMC Health Serv Res*. 2011;**11**:163. doi: [10.1186/1472-6963-11-163](https://doi.org/10.1186/1472-6963-11-163). [PubMed: [21736715](https://pubmed.ncbi.nlm.nih.gov/21736715/)]. [PubMed Central: [PMC3146410](https://pubmed.ncbi.nlm.nih.gov/PMC3146410/)].
29. Theodorakis PN, Mantzavinis GD. Inequalities in the distribution of rural primary care physicians in two remote neighboring prefectures of Greece and Albania. *Rural Remote Health*. 2005;**5**(3):457. [PubMed: [16134954](https://pubmed.ncbi.nlm.nih.gov/16134954/)].
30. Honarmand R, Mozhdehifard M, Kavosi Z. Geographic distribution indices of general practitioners, midwives, pediatricians, and gynecologists in the public sector of Iran. *Electron Physician*. 2017;**9**(6):4584-9. doi: [10.19082/4584](https://doi.org/10.19082/4584). [PubMed: [28848634](https://pubmed.ncbi.nlm.nih.gov/28848634/)]. [PubMed Central: [PMC5557139](https://pubmed.ncbi.nlm.nih.gov/PMC5557139/)].
31. Kakwani NC. Applications of Lorenz curves in economic analysis. *Econometrica*. 1977;**45**(3):719. doi: [10.2307/1911684](https://doi.org/10.2307/1911684).
32. Sefiddashti SE, Arab M, Ghazanfari S, Kazemi Z, Rezaei S, Karyani AK. Trends of geographic inequalities in the distribution of human resources in healthcare system: The case of Iran. *Electron Physician*. 2016;**8**(7):2607-13. doi: [10.19082/2607](https://doi.org/10.19082/2607). [PubMed: [27648186](https://pubmed.ncbi.nlm.nih.gov/27648186/)]. [PubMed Central: [PMC5014498](https://pubmed.ncbi.nlm.nih.gov/PMC5014498/)].
33. Karagiannis E, Kovacevic M. A method to calculate the jackknife variance estimator for the Gini coefficient. *Oxf Bull Econ Stat*. 2008;**62**(1):119-22. doi: [10.1111/1468-0084.00163](https://doi.org/10.1111/1468-0084.00163).
34. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. *Soc Sci Med*. 1991;**33**(5):545-57. doi: [10.1016/0277-9536\(91\)90212-u](https://doi.org/10.1016/0277-9536(91)90212-u). [PubMed: [1962226](https://pubmed.ncbi.nlm.nih.gov/1962226/)].
35. Gastwirth JL. A graphical summary of disparities in health care and related summary measures. *J Stat Plan Inference*. 2007;**137**(3):1059-65. doi: [10.1016/j.jspi.2006.06.024](https://doi.org/10.1016/j.jspi.2006.06.024).
36. Kazemi Karyani A, Azami SR, Rezaei S, Shaahmadi F, Ghazanfari S. Geographical distribution of gynecologists and midwives in Kermanshah province (2008-2013). *J Kermanshah Univ Med Sci*. 2015;**19**(5):294-302. doi: [10.1016/j.jspi.2006.06.024](https://doi.org/10.1016/j.jspi.2006.06.024).
37. Hara K, Kunisawa S, Sasaki N, Imanaka Y. Examining changes in the equity of physician distribution in Japan: A specialty-specific longitudinal study. *BMJ Open*. 2018;**8**(1). e018538. doi: [10.1136/bmjopen-2017-018538](https://doi.org/10.1136/bmjopen-2017-018538). [PubMed: [29317415](https://pubmed.ncbi.nlm.nih.gov/29317415/)]. [PubMed Central: [PMC5781009](https://pubmed.ncbi.nlm.nih.gov/PMC5781009/)].
38. Izutsu M, Suzuki E, Izutsu Y, Doi H. Trends in geographic distribution of nursing staff in Japan from 2000 to 2010: A multilevel analysis. *Acta Med Okayama*. 2014;**68**(2):101-10. doi: [10.18926/AMO/52406](https://doi.org/10.18926/AMO/52406). [PubMed: [24743785](https://pubmed.ncbi.nlm.nih.gov/24743785/)].
39. Ren Z, Song P, Chang X, Wang J, An L. Inequality of obstetric and gynaecological workforce distribution in China. *Int J Equity Health*. 2018;**17**(1):3. doi: [10.1186/s12939-017-0716-6](https://doi.org/10.1186/s12939-017-0716-6). [PubMed: [29304827](https://pubmed.ncbi.nlm.nih.gov/29304827/)]. [PubMed Central: [PMC5756396](https://pubmed.ncbi.nlm.nih.gov/PMC5756396/)].
40. Ehara A. Situation in pediatricians before and after the launch of the new postgraduate training program in 2004-inequality in number of pediatricians did not worsen after the launch of the program compared to before the launch. *Nihon Ishikai Zasshi*. 2007;**136**(9):1804-8.
41. Sakai R, Wang W, Yamaguchi N, Tamura H, Goto R, Kawachi I. The impact of Japan's 2004 postgraduate training program on intra-prefectural distribution of pediatricians in Japan. *PLoS One*. 2013;**8**(10). e77045. doi: [10.1371/journal.pone.0077045](https://doi.org/10.1371/journal.pone.0077045). [PubMed: [24204731](https://pubmed.ncbi.nlm.nih.gov/24204731/)]. [PubMed Central: [PMC3813669](https://pubmed.ncbi.nlm.nih.gov/PMC3813669/)].
42. Nomura K, Inoue S, Yano E. The shortage of pediatrician workforce in rural areas of Japan. *Tohoku J Exp Med*. 2009;**217**(4):299-305. doi: [10.1620/tjem.217.299](https://doi.org/10.1620/tjem.217.299). [PubMed: [19346735](https://pubmed.ncbi.nlm.nih.gov/19346735/)].
43. Song P, Ren Z, Chang X, Liu X, An L. Inequality of paediatric workforce distribution in China. *Int J Environ Res Public Health*. 2016;**13**(7). doi: [10.3390/ijerph13070703](https://doi.org/10.3390/ijerph13070703). [PubMed: [27420083](https://pubmed.ncbi.nlm.nih.gov/27420083/)]. [PubMed Central: [PMC4962244](https://pubmed.ncbi.nlm.nih.gov/PMC4962244/)].
44. Kiadaliri AA, Hosseinpour R, Haghparast-Bidgoli H, Gerdtham UG. Pure and social disparities in distribution of dentists: A cross-sectional province-based study in Iran. *Int J Environ Res Public Health*. 2013;**10**(5):1882-94. doi: [10.3390/ijerph10051882](https://doi.org/10.3390/ijerph10051882). [PubMed: [23648443](https://pubmed.ncbi.nlm.nih.gov/23648443/)]. [PubMed Central: [PMC3709354](https://pubmed.ncbi.nlm.nih.gov/PMC3709354/)].
45. Grobler L, Marais BJ, Mabunda SA, Marindi PN, Reuter H, Volmink J. Interventions for increasing the proportion of health professionals practising in rural and other underserved areas. *Cochrane Database Syst Rev*. 2009;(1). CD005314. doi: [10.1002/14651858.CD005314.pub2](https://doi.org/10.1002/14651858.CD005314.pub2). [PubMed: [19160251](https://pubmed.ncbi.nlm.nih.gov/19160251/)].
46. Rabinowitz HK, Diamond JJ, Markham FW, Rabinowitz C. Long-term retention of graduates from a program to increase the supply of rural family physicians. *Acad Med*. 2005;**80**(8):728-32. doi: [10.1097/00001888-200508000-00004](https://doi.org/10.1097/00001888-200508000-00004). [PubMed: [16043525](https://pubmed.ncbi.nlm.nih.gov/16043525/)].