Author's response to reviews

Title: Distribution of health care resources in Mongolia using the Gini coefficient

Authors:
Oyunchimeg Erdenee (oyunchimeg2186@gmail.com)
Sekar Paramita (saparamita@gmail.com)
Chiho Yamazaki (kchiho@gunma-u.ac.jp)
Hiroshi Koyama (hkoyma@gunma-u.ac.jp)

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Author's response to reviews:

Response to Reviewer 1

Thank you for your valuable review of our article. We were delighted to learn that the reviewer considered our manuscript to be a “very interesting proposal of human resource analysis in health using Gini coefficient.” We have revised the manuscript according to each of your points.

- Major questions
  1. The analysis design did not allow completion - The authors concluded that "The imbalance of the distribution of health care resources is the greatest problem in Mongolia." This affirmation is only valid for the distribution per km2 (density per area), since the distribution by population (density per population) did not prove to be a problem.

Response: We agree that the statement did not correctly indicate our results. Therefore, we have modified the statement accordingly:

• Page 2, Lines 44–46 (Abstract); Page 14, Lines 317–319 (Manuscript)

“The imbalance of the distribution of health care resources is the greatest problem in Mongolia” was changed to read as follows:
“Although the distributions of health care resources per population were adequate for the population size, a striking difference was found in terms of the distributions per geographical area.”

(2) The authors concluded that "This imbalance leads to the disproportionate accessibility of health care services and poor health outcomes in the nation." A specific study was not conducted to explore this question, it is not plausible to conclude, although it is possible to discuss it.

Response: We agree that the study necessary to support this conclusion has not been conducted, and the quoted statement has been modified and moved to the discussion section from the conclusion section.

• Page 11, Lines 239–241

“This imbalance leads to the disproportionate accessibility of health care services and poor health outcome in the nation” was changed to read as follows:

“In this context, imbalanced distributions of health care resources per geographical area may be a barrier contributing to the disproportionate accessibility of health care services, especially in rural areas.”

(3) In Discussion, the authors state that "We found that Mongolia had a sufficient number of physicians, nurses, and hospital beds." This affirmation is very difficult to carry out because is needed a study on the health system of Mongolia: accessibility, financing, labor market, technological resources in health. The reference 14 presents this idea with several examples. I believe it is superficial to assert "sufficient" resources only with density estimators. The year of publication of this reference is 2013 and not 2015, as described in the references.

a_universal_truth_report.pdf
Response: We agree that the resources should not be declared sufficient in the country based on density estimators alone. Therefore, we have modified the relevant statements in the discussion and conclusion sections.

• Page 10, Lines 226–227

“We found that Mongolia had a sufficient number of physicians, nurses, and hospital beds” was changed to read as follows:

“Our results show that human resources exceeded the target numbers set in the Human Resource Policy of the Health Sector in Mongolia [14].”

The following reference [14] was also added:

• Page 14-15, Lines 323–326

“Additional studies should be done continuously and should incorporate other types of health care resources for understanding the planning of improvements in service quality” was changed to read as follows:

“Additional studies should be done continuously and should incorporate other types of health care resources, including technological resources and financing, to identify the overall circumstances of health resources in the country.”

We have also corrected the year of publication of the reference mentioned from 2015 to 2013.

• Page 19, Lines 423–426

(4) I believe the authors are attaching great importance to the issue of geographical inequality (density per 1000 km2). However, if population density inequality (per 10,000 people) does not go along with inequality by area, the best result will only show that there are no resources in places where there are also no people: places with large deserts, forests, and others.

Response: Distribution per population unit is suitable for determining which health care resources are needed in the certain areas in the community in populations with sedentary lifestyles, such as those in urban and suburban areas. However, remote and rural people in Mongolia do not live in one place throughout the year; rather, they have a nomadic lifestyle. Therefore, in this context, distribution per area unit might be more suitable for determining the available health care resources. For this reason, in the first stage of our investigation, we used two indicators (distribution per area and distribution per population) simultaneously to identify differences. Our future work will further investigate these issues, especially in terms of accessibility of remote and disadvantaged Mongolians.

We have modified the quoted statement to describe the inherently nomadic lifestyle of remote Mongolians specifically, because these circumstances may make the Mongolian context different from other countries in important ways. In the discussion and conclusion sections, we have made the following changes:

• Page 11, Lines 234–239

“In addition, some of the cultural and social factors [15,16], such as the nomadic lifestyle of herders in remote areas, who move to a new place every season to provide food for their livestock, and poor infrastructure, might account for this gap between rural and urban areas” was changed to read as follows:
“In addition, certain cultural and social factors [15,16], especially the nomadic lifestyle, might account for the gap between rural and urban areas. An inherently nomadic lifestyle is a unique feature in rural areas, where herders are not rooted in a permanent setting across the seasons; rather, these people must move to a new place to provide food for their livestock and to maintain their livelihood.”

- Pages 2–3, Lines 46–48; Page 14, Lines 319–321

“Thus, geographical imbalances need to be taken into consideration when formulating policies, rather than simply increasing the number of health care resources” was changed to read as follows:

“Because of the nomadic lifestyle among rural and remote populations in Mongolia, geographical imbalances need to be taken into consideration when formulating policy, rather than simply increasing the number of health care resources.”

- Minor questions

(1) Demographic density is missing in Table 1;

Response: Demographic density for each province has been added to Table 1.

- Page 7, Line 157

Table 1 Comparison of health care resources and population by province

(2) Mongolian Human Development Index (HDI) is missing, I recommend being presented in the text.

Response: We agree that the Human Development Index is an important measure, and the Mongolian HDI is now presented in the introduction section.
“The Human Development Index value for Mongolia was 0.73 in 2015 [5].”

Response to Reviewer 2

Thank you for your valuable review of our paper. We have revised the manuscript according to each of your points.

1. The authors stated that the aim of the study is to clarify the difference in resource distribution between urban and rural areas. However, no answer to this question is provided in the results section. The authors should show the results that correspond with aim.

Response: We agree that the results section was did not correspond sufficiently with the aim. Therefore, we have revised the first paragraphs of the results section to reflect the aim and to clarify the results for the readers.

“Ulaanbaatar had the highest numbers of both physicians and beds per 10000 people; however, Gobi-Altai had the highest number of nurses per 10000 people. Further, Orkhon and Darkhan-Uul (suburban areas) had slightly higher numbers of health care resources than did the other provinces. The average number of physicians per 1000 km2 was 1228 in Ulaanbaatar, 193 in suburban provinces, and 2.7 in rural provinces. The average number of nurses per 1000 km2 was 1185 in Ulaanbaatar, 260 in suburban provinces, and 4 in rural provinces. The average number of hospital beds per 1000 km2 was 2248 in Ulaanbaatar, 453 in suburban provinces, and 7.4 in rural provinces. Umnugobi, one of the rural provinces, had the lowest number of physicians and nurses, with less than one physician per 1000 km2” was changed to read as follows:

“The urban area in the study had the highest numbers of physicians (42.4) and hospital beds (77.6), but one rural province, namely Gobi-Altai, had the highest number of nurses (44.3) per
10000 population, on average. Suburban areas had slightly higher numbers of these resources than did the rural provinces, with the exception of hospital beds. Rural areas had the lowest numbers of resources, on average.

In terms of the distribution of physicians and nurses per 1000 km2 area, the urban study area had 1228 and 1185, suburban areas had 193 and 260, and rural areas had 2.7 and 4, respectively. Further, the number of hospital beds was 2248 in the urban area, 453 in suburban areas, and 7.4 in rural areas, on average.”

2. To show the difference in resource distribution between urban and rural areas, statistical comparisons between two groups (i.e. urban and rural areas) or three groups (i.e., urban, suburban and rural areas) are necessary.

Response: We agree with this comment and have now incorporated Mann–Whitney U tests (urban + suburban vs. rural) to examine these differences. The results of the U test are shown in Table 1.

• Page 7, Line 157

We also made following revisions throughout the paper.

Abstract
• Page 2, Line 31

“We compared urban and rural areas using the Mann–Whitney U test…”

• Page 2, Lines 36–38

“Urban and rural areas were significantly different only in the distribution of physicians per population. However, in terms of the distribution per area, there were statistical differences in physicians, nurses, and hospital beds.”
Methods section
• Page 5, Lines 115–116

“First, the Mann–Whitney U test was employed to compare distributions between urban and rural areas.”

Results section
• Page 7, Lines 150–154

“Results from the U test showed that, in terms of the distribution per population, there was a statistically significant difference only for physicians (p = 0.04); the distributions of nurses and hospital beds were not statistically different in urban and rural areas. In contrast, in terms of the distribution per area, there were statistically significant differences for all three health resources (p = 0.007) by location type.”

• Page 7, Line 158 (Table 1 legend)

“Mann–Whitney U test: urban + suburban vs. rural; ★ P < 0.05, ★★ P < 0.01”

• Page 10, Line 217-218

“There was a statistically significant difference in the distribution of physicians in in urban and rural areas, with urban areas having the highest number of physicians.”

3. The authors stated that the distribution of physicians per 1,000 km² was highly skewed. Considering the fact that 62% of physicians are concentrated into Ulaanbaatar that occupies only 0.3% of land area, this conclusion is quite natural. However, 62% of physicians are concentrated into Ulaanbaatar where 45% of population lives. Does this fact really assure the equity of physician distribution?
Response: The results indicated that physicians were distributed equally in Mongolia in terms of distribution per population unit (Gini coefficient = 0.18). However, urban and rural areas differed significantly (p = 0.04) in terms of the number of physicians per population unit as assessed by the U test.

In contrast, the distribution of physicians per area unit was unequal, with a Gini coefficient of 0.74 throughout the country. Further, urban and rural areas differed significantly (p = 0.007) in terms of the number of physicians per area unit, as assessed by the U test.

Therefore, taken together, our results do not indicate equity in the distribution of physicians in Mongolia.

4. In reference to Fig. 4A, the authors stated that there is no inequity between urban and rural areas. However, figures depicted by using GIS would change their image by changing the cut-off value of physician density. How the authors determine the cut-off value? Why did not the authors use cut-off value of 22.8 physicians per 1,000 population?

Response: We performed a cluster analysis to determine the cut-off values. Our purpose in clustering was to show the current condition of differences in the distributions among areas and provinces in Mongolia, rather than comparing these distributions with other countries in the world. Therefore, we did not employ any international standard as a cut-off value.

To clarify this point, we have added information about the cut-off values in the methods section. This information was not mentioned in the previous version of the manuscript. Thank you very much for drawing our attention to this issue.

• Page 6, Lines 136–138

“We performed a cluster analysis to determine cut-off values, and differences among the provinces were depicted on a map using these cut-off values to show contrasts in distribution density.”

In response to this comment, we have also revised the presentation of Figure 4A in the text to provide a clear interpretation.
“The distribution of physicians per population unit was found to be balanced among all areas (Fig. 4A), and there was little difference between rural and urban populations. In contrast, the distribution of physicians per area unit (Fig. 4B) was imbalanced and is depicted using multiple colors because of gaps in the distribution density” was changed to read as follows:

“Comparing Figures 4A and 4B shows that the distribution of physicians per 10000 population (minimum = 16.6, maximum = 42.4) was found to be better balanced than was the distribution of physicians per 1000 km² area (minimum = 0.9, maximum = 1228), which had a very large range, as is depicted using multiple colors on the map.”

The revised manuscript has been sent to a language editing service and revised by an English editor as per your recommendation.

Other changes
We have revised the following words, sentences, and paragraphs to improve the clarity and conciseness of the manuscript:

• Page 1, Line 1
The phrase “rural and urban areas of” have been omitted from the title of the manuscript to make it more concise.

• Page 2, Line 29; Page 5, Line 98; Page 7, Line 159
The phrase “urban and rural” was changed to “urban, suburban, and rural” to improve clarity.

• Page 2, Lines 33–35 (Originally submitted manuscript)
The following sentence has been omitted from the abstract to improve conciseness: “The data used in this study were provided by the Ministry of Health and Sports and the National Statistical Information Service of Mongolia.”
• Page 4, Line 85 and Figure 1
The number of the communes in the introduction section has been corrected from “1568” to “1613.”

• Page 5, Line 102; Page 8, Line 166; Page 9, Line 190; Page 10, Line 213; Page 13, Line 279; Page 15, Line 340; Page 17, Line 376; Page 18, Line 400; Page 19, Line 439, 443
“The Ministry of Health and Sports” was corrected to “The Ministry of Health.”

• Page 6, Lines 123–125
The “Analysis” subsection of the methods section has been reorganized to improve clarity, and the following sentence has been moved from the beginning of the “Analysis” section to the current location:

“Two indicators were calculated: the distribution of health resources per 10000 population and the distribution of health resources per 1000 km2 area.”

• Page 6, Lines 137–138 (Originally submitted manuscript)
The following sentence has been omitted from results section to improve conciseness: “In 2014, the total population of Mongolia was 2995949, and the numbers of physicians, nurses, and hospital beds were 9356, 11052, and 20891, respectively.”

• Page 8, Lines 166–169 (Figure 3 legend)
The following sentence has been revised to be more concise:

“Figures 3A and 3B illustrate the gap between the real and ideal distributions for the three health care resource variables. Figure 3A shows distributions share of the population and Figure 3B shows distributions share of the area” was changed to read as follows:

“Figures 3A (distributions per share of the population) and 3B (distributions per share of the area) illustrate the gap between the real and ideal distributions for the three health care resource variables.”
• Page 9-10, Lines 202–210

The following paragraphs have been revised to improve the clarity and conciseness:

“Similarly, to the findings for physicians, the distribution of nurses per population unit was balanced (Fig. 4C), and rural and urban areas had roughly the same distributions. However, the distribution of nurses was imbalanced per area unit and is therefore shown using multiple colors on the map (Fig. 4D). The distribution of hospital beds per population unit was balanced among all provinces, and there were few differences across the provinces (Fig. 4E). The distribution of hospital beds per area unit, in contrast, was imbalanced (Fig. 4F). However, the distribution of hospital beds was more balanced than was the distribution of nurses (Fig. 4D) or physicians per area unit (Fig. 4B)” was changed to read as follows:

“Similarly, comparing Figures 4C and 4D shows that the distribution of nurses per 10000 population (minimum = 27, maximum = 44) was more balanced than was the distribution of nurses per 1000 km² area (minimum = 1, maximum = 1185), which was highly imbalanced, as is shown using multiple colors on the map. Further, Figure 4E illustrates that the distribution of hospital beds per 10000 population (minimum = 54.8, maximum = 77.6) was nearly balanced, with only slight differences across the provinces. In contrast, the distribution per 1000 km² area (minimum = 2.5, maximum = 2284) was highly imbalanced, as can be seen in Figure 4F.”

• Page 11, Lines 231–234

The following sentence has been revised to improve clarity:

“Geographical difficulties and limited transportation in remote areas have created more hurdles for the public in distant places in terms of accessing health services [12]” was changed to read as follows:

“Geographical difficulties, extreme weather conditions (with temperatures as low at −40 C and as high at 35 C), and limited transportation have created obstacles for the population in distant places in terms of accessing health services [12].”
• Page 11, Line 252
The word “sufficient” was corrected to “adequate.”