

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Cross-sectional study of the efficiency and scale effect of county public hospitals in Shandong Province, China
<b>AUTHORS</b>	Li, Qian; Tian, Liqi; Jing, Xiaolin; Chen, Xianghua; Li, Jiangfeng; Chen, Huixin

### VERSION 1 – REVIEW

<b>REVIEWER</b>	Sarah Barber World Health Organization Centre for Health Development Kobe, Japan
<b>REVIEW RETURNED</b>	Sarah Barber World Health Organization Centre for Health Development Kobe, Japan

<b>GENERAL COMMENTS</b>	<p>The study addresses a very important topic in China and elsewhere: the appropriate number of hospital beds and the threshold for efficiency. This issue is of paramount importance in China in particular and has the potential to inform major policy debates on hospitals reform.</p> <p>General</p> <p>a) The authors could present the broader context of global studies that try to identify the optimal number of hospital beds. They could provide the theoretical basis for the study, including the relationships between volume, efficiency and quality; discuss those hospital procedures that result in efficiency gains from larger volume, and thresholds in other countries and settings (See for example, Hospitals in a Changing Europe, 2002, by the EURO Observatory on Health Systems and Policy). The discussion could place their findings within the context of other studies, for example, some studies in Europe propose optimal bed numbers as &lt;600.</p> <p>b) The methods used in prior studies and their limitations could be discussed. In this context, the DEA should be explained fully upfront and justified in terms of how it may/may not improve on other methods. The outcome of interest should be identified in terms of how efficiency is being measured. The whole section on intro to DEA could be shortened, cited, and moved to the background.</p> <p>c) The situation in China should be explained well in terms of the incentives for increasing the number of beds and how/whether this has changed over time. I do not think that increasing hospitals beds is for efficiency gains! It is about how health care providers</p>
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	<p>and hospitals are paid. This may lead to a more constructive discussion about how to address the problem identified by the authors.</p> <p>d) The paper should be reorganized in a logical way. For example, the paragraph on page 3 should probably be moved to the discussion as to whether efficiency is the outcome of interest for hospital administrators. Also on page 3- methods should be limited to the methods. The inclusion criteria should be described. The method section now includes a section about the setting or the introduction could include the description of Chinese hospitals and Shandong province. This is now in the methods section.</p> <p>There is some unclear wording and typos throughout the paper that should be clarified by working with a strong English language editor. The strengths and limitations for example should be in a paragraph form. The authors use “efficiency” and “effectiveness” interchangeably, starting from the abstract. These are two different concepts. It would be useful to define efficiency upfront and be consistent with the terms.</p>
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<b>REVIEWER</b>	Sayem Ahmed International Centre for Diarrhoeal Disease Research Bangladesh, HSPSD
<b>REVIEW RETURNED</b>	23-Dec-2019

<b>GENERAL COMMENTS</b>	<p>I would like to thank the authors for conducting this important study. Inefficiency is a long-standing problem in healthcare sector. Conducting hospital efficiency studies can be useful for the policymaker to understand the source/factors of inefficiencies and develop a relevant policy to improve the efficiency situation. In the current study, authors conducted efficiency of 68 county-level public hospitals in Shandong province of China. I have the following comments and suggestions on this manuscript,</p> <p><b>Abstract:</b></p> <p>1) In the abstract author repeated “68 county public hospitals”. The author should avoid such repetition and include briefly the input and output variables used in the method section of the abstract to make it stand-alone section. In the conclusion section of the abstract authors could briefly state their policy recommendation rather just repeating the key results.</p> <p><b>Background:</b></p> <p>2) The author discussed Data Envelopment Analysis in the introduction section (page 2, last para and page 3 first) which should be moved to method section. The reader will be current efficiency conditions in hospitals setting in China and why the current study important in this section. I suggest to focus more on such discussion.</p> <p>3) In page 3 line 26, the author stated: “Unexpectedly, the number of beds in a hospital in China has reached 10,000”. What is the name of this hospital? I also suggest to cite the source of this information. The reader will expect very specific information from the author.</p> <p><b>Method:</b></p> <p>4) In page 3, last para, the author mentioned: “68 county public hospitals that met the study inclusion criteria were eventually included”. However, I cannot find the list of inclusion-exclusion criteria used for this selection. Why these inclusion criteria were applied for hospital selection.</p>
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	<p>5) The author used secondary data from “health statistics information reporting system” (page 4, para 2). More detailed information of this is required (e.g data collection period, approach, total sample facilities- 71 maybe, briefly information gathered from the facilities). The author can include a citation of this dataset (reports/weblink).</p> <p>6) Table 1 is not clear, “Number of nurses” should be an input indicator but included under output. Also, the authors included the total income of the hospital as an outcome. This is not applicable to public facilities as these facilities are highly subsidized and non-profit. I suggest removing this from the model.</p> <p>7) The application of the chi-square test to assess the association between efficiency score and bed sizes is not sufficient. I suggest applying Tobit regression or other censored model in this case.</p> <p>Results</p> <p>8) In table 3, the column title is not clear. I also suggest to check other tables and revise accordingly.</p> <p>9) I suggest to include efficiency scores of all 68 hospitals in the appendix for a better understanding of the situations of the hospitals.</p> <p>Discussion:</p> <p>10) In page 11, para 1, the author mentioned: “The blind expansion of bed size is a common problem in Chinese hospitals.” This should be supported by citation.</p> <p>11) I cannot see explanations on the association between bed size and efficiency score. In theory, due to economies of scale higher bed size should result in higher efficiency score. However, the authors found that they were not associated. What other factors affecting this association should be discussed in this section.</p> <p>12) In the discussion section, the author should include a para on strength and limitations of the current study.</p> <p>13) In general, the entire manuscript needs to be checked for grammatical issues.</p>
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### VERSION 1 – AUTHOR RESPONSE

Dear Dr Sarah,

I carefully read your affirmations and comments on our study and sincerely thank you for your hard work. I will make a concrete response below.

a)Response to your first comment.

In the introduction section (para 2), I added some international research background on hospital efficiency and scale, and discussed the relationship between efficiency, scale, cost, and quality. It provided a solid theoretical basis for this study. In the discussion section (the last and fifth para), I focused on adding to the previous research on the exploration of the optimal bed size in other countries and regions and discussed the bed threshold. This made the article more convincing and fulfilling.

b)Response to your second comment.

In the methods section, I have added a stand-alone subsection on efficiency evaluation methods. It stated the methods used in previous studies and their limitations, and emphasized the advantages of the DEA, which filled the shortcomings of previous efficiency evaluation methods. The whole section on intro to DEA was be shortened.

c)Response to your third comment.

In the introduction section (para 2), the study explained the motivation for Chinese hospitals to continually increase the number of beds. The government's intervention policy had not achieved the expected results, and the size of hospital beds was still expanding.

d)Response to your fourth comment.

The arrangement of the entire paper had been reorganized in a reasonable way. The background on Chinese hospitals and Shandong province in methods section was moved to the introduction. At the same time, the inclusion criteria of the sample hospitals were described in the method section (para 1).

Finally, enlisting the help of a professional copy-editing service to improve the quality of the English throughout our manuscript.

Thank you again sincerely!

Best wishes!

Dear Dr Sayem,

I carefully read your affirmations and comments on our study and sincerely thank you for your hard work. I will make a concrete response below.

Abstract:

1)The study corrected the repeat of "68 county public hospitals." Inputs and outputs variables were briefly described in the method subsection of abstract. In the conclusion of abstract , the study mainly concluded policy interventions to improve hospital efficiency and avoided blind expansion of beds.

Background:

2) The content on Data envelopment analysis in the introduction was moved to the method section. In the introduction, we added a broader background to international research. The efficiency status of Chinese hospitals and the motivation for increasing the number of beds were described. These provided theoretical support for the importance of conducting research.

3)"Unexpectedly, the number of beds in a hospital in China has reached 10,000."

The hospital named the first affiliated hospital of Zhengzhou University with three branched hospitals. It is a third-grade city public general hospital that provides medical services to residents of Henan Province and neighboring provinces and is the largest public hospital in China. The total number of beds in the three branches hospitals is more than 10,000. However, the information from news reports does not cover more content, so there were no sources to cite. If the reviewer or reader needs additional specific information, I will do my best to provide you with that.

Method:

4)In the method section, the study explained the inclusion criteria for 68 hospitals. First, the hospital must be a general public hospital. Second, variables should not include missing and abnormal values. Third, the study selected counties with one and only one general public hospital.

5)The data set was collected from the health statistics information reporting system of the Hospital Management Research Institute of Qingdao University and provided by 71 county public hospitals. The data collection time is from March to June 2018. It is mainly provided by the statisticians of each hospital to the Institute of Hospital Management of Qingdao University through electronic data sheets, and then all the data is consolidated by the Hospital Management Institute. Since the specific data set involved some private information of the hospital, we were very sorry that we cannot provide the complete data set.

6) The number of nurses in the manuscript was indeed an input indicator. This may be due to a system conversion error when submitting the manuscript. In addition, in China, although public hospitals are non-profit and subsidized by government, government subsidies account for a very small percentage, and hospital are more economic self-sufficiency. Therefore, the study using total income as an output can also reflect the financial capacity of the hospital.

7) Prior to the study, the Tobit regression method was also considered. But the data only includes 2017, and it was impossible to form panel data for Tobit regression. So the study only used statistical methods. In the future, our research will continue to track the efficiency of county public hospitals in the years after 2017 to conduct longitudinal studies. Thanks to the reviewers for your critical comments.

Results

8) The table title, row and column headings have been modified throughout the article.

9) Appendix 2 is the efficiency scores of all 68 county public hospitals, sorted in ascending order by bed size.

Discussion:

10)“ The blind expansion of bed size is a common problem in Chinese hospitals.”has been supported by citation.

11) The study did not find a relationship between bed size and technical efficiency and pure technical efficiency. In the discussion section (para 2), the possible reasons for the insignificant difference and other factors affecting the relationship between beds and technical efficiency were stated. However, the study found the impact of bed size on hospital scale efficiency and returns to scale. The study drew a scatter plot (Figure 1) of the relationship between bed size and scale efficiency and returns to scale, which can be seen more intuitively.

12) At the end of the discussion section, the study added a separate section on limitations of the current study.

13) Finally, Enlisting the help of a professional copy-editing service to improve the quality of the English throughout our manuscript.

Thank you again sincerely!

Best wishes!