

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

TITLE (PROVISIONAL)	Understanding geographic variations in health system performance: A population-based study on preventable childhood hospitalizations
AUTHORS	Silwal, Pushkar; Exeter, Daniel; Tenbensen, Tim; Lee, Arier

VERSION 1 – REVIEW

REVIEWER	Muhammad Irfan Universiti Sains Malaysia - Kampus Kesihatan
REVIEW RETURNED	31-May-2021

GENERAL COMMENTS	<p>I appreciate the authors for writing an interesting article titled “understanding geographic variations in health system performance: A population-based study on preventable childhood hospitalizations”.</p> <p>Following are the suggestions that may improve the write-up.</p> <ol style="list-style-type: none">1. Although the English language is generally excellent requires few improvements throughout the manuscript such as using punctuations, caps, and abbreviations/acronyms. The abbreviations should be written in full on the first instance and later abbreviations should only be used.2. Why did the authors presented data of 2008-2018 only?3. Why data from only 20 districts were included? an introduction of the study area and population would be helpful in this regard.4. How much population of children was represented in the dataset?5. Appendix 2 provides information on ASH conditions but discussing the contribution of each condition toward ASH would be more useful.6. Paragraphs number 1 and 3 should be part of the result section.
-------------------------	---

REVIEWER	Mirko Di Martino Department of Epidemiology of the Regional Health Service Lazio
REVIEW RETURNED	19-Nov-2021

GENERAL COMMENTS	<p>SUMMARY</p> <p>Childhood Ambulatory Sensitive Hospitalization (C-ASH) refers to the hospital events related to the health conditions potentially preventable in the ambulatory care setting, among children aged 0-4. C-ASH rate is used as a measure of health care system performance in NZ. C-ASH rate vary across the districts. The aim of the study is to understand the time-trend and the district-wide variations of C-ASH exploring the extent to which the variation is explained by the key socio-demographic, economic, geographic and macrolevel health system characteristics.</p> <p>Analyses shows strong inter-district variability in the average number</p>
-------------------------	---

	<p>of observed C-ASH per 1000 children, during the study period (2008-2018). The odds of C-ASH also vary across the districts (DHB as an independent predictor variable, reference DHB=Auckland). Finally, ethnicity, deprivation and rurality emerged like the factors strongly associated with C-ASH. No consistent time-trend was observed.</p> <p>REVISION The work is really very interesting; however, the reading is weighed down by the presence of numerous abbreviations, that often forced the reader to go back to search for the first appearance of the acronym in the text. I would advise authors, if possible, to create a list of abbreviations, which could make reading easier.</p> <p>I need to ask the authors for explanations on some methodological aspects that I have not be able to understand.</p> <p>1. The final model contains two terms of interaction (DHB-Year and DHB-Ethnicity) but no results are reported for them. Are they statistically significant? How have the parameters of the interaction terms been interpreted? How have the ORs relating to DHB been interpreted, considering that the district is part of two distinct terms of interaction?</p> <p>2. The 'Results' not mention the analysis of estimated C-ASH events per 1000 population, by DHB. Why was this analysis done? What information did it adds, considering the aim of the study? Why weren't the estimated and the observed C-ASH events compared?</p> <p>As it has been described, the model seems unsuitable for data analysis, because it does not take into account the hierarchical structure of data. The final model includes both covariates measured on the patients (i.e., age and gender) and covariates not attributable to the patient but to the DHB (i.e., finance and human resources). In my opinion, the most correct way to analyze the available data is through the introduction of random effects and therefore through mixed effects model. In particular, the multilevel methodology would provide a set of tools suitable for simultaneous analyzing variables classified at different levels of the hierarchy. A two-level multilevel logistic regression, with the introduction of 1st level (child) and 2nd level (DHB) variables, would allow to obtain an estimate of the variability between the districts, by controlling for the "composition effect" of patients. A similar methodology, albeit with a model complicated by the presence of a cross-classified level, was used in Di Martino et al., Chronic polytherapy after myocardial infarction: the trade-off between hospital and community-based providers in determining adherence to medication, BMC Cardiovasc Disord (2021); 21:180 - https://doi.org/10.1186/s12872-021-01969-9.</p>
--	---

REVIEWER	Roy Grant Public health research and policy consultant
REVIEW RETURNED	20-Jan-2022

GENERAL COMMENTS	<p>This is a well written paper and a well-designed and executed study. There are a few areas where I think it could be strengthened.</p> <p>Abstract, Conclusion - this seems too tentative. Isn't there anything learned from the study that can be presented with some degree of certainty? For example, the last bullet in the immediately following section, Strengths and Limitations, could be highlighted in the</p>
-------------------------	--

	<p>abstract.</p> <p>The first three paragraphs of the Discussion Section read more like Results than Discussion. I suggest moving any data points that are introduced in the Discussion Section to the Results Section.</p> <p>While an extensive list of ambulatory sensitive hospitalization conditions is presented in Appendix 2, examples should be presented in the text, focusing on those which were most prevalent in the data set.</p> <p>Page 8, line 24, first sentence. Hospitalization rates for ambulatory care sensitive conditions are often used as a measure of access to care, an important element of health system performance (Introduction, page 4, line 13). The sentence is a bit of an overstatement.</p> <p>Availability of transportation is a factor that is increasingly recognized as having an impact on access to care and hospitalization for ambulatory care sensitive conditions. Did the data set provide any information about public transit availability? Might this be available by district and added to the data set? Limited public transit options and inability to afford and maintain automobiles in poor rural counties are major factors in higher rates of rural hospitalizations for ambulatory care sensitive conditions (in pediatrics, principally for asthma). Your finding regarding urban-rural differences could be better contextualized if you are able to account for urban-rural differences in access to transportation and/or geographic distribution of ambulatory care sites within the district, which impacts distance to travel for care. If it is not possible to explore this issue in the data (and I recognize that doing so, if possible, would be quite time-consuming), I suggest that you include at least a brief acknowledgment of the potential importance of transportation access in the Discussion Section. The title references geographic variations, and this is likely to suggest to the reader that transportation issues affecting access to care will be discussed.</p>
--	--

VERSION 1 – AUTHOR RESPONSE

Response to the Reviewer: 1

Dr. Muhammad Irfan, Universiti Sains Malaysia - Kampus Kesihatan, Pir Mehr Ali Shah Arid Agriculture University

Comments to the Author:

I appreciate the authors for writing an interesting article titled “understanding geographic variations in health system performance: A population-based study on preventable childhood hospitalizations”.

Following are the suggestions that may improve the write-up.

1. Although the English language is generally excellent requires few improvements throughout the manuscript such as using punctuations, caps, and abbreviations/acronyms. The abbreviations should be written in full on the first instance and later abbreviations should only be used.

- Thank you. All abbreviations/acronyms have been checked, minimized, and a list of acronyms added at the end of the manuscript.

2. Why did the authors presented data of 2008-2018 only?

Added in the data analysis section (para 1):

- 'The coverage of the denominator population before 2008 were less than 90% of the total estimated resident population, and therefore excluded from the analysis. At the time of request, 2018 was latest year for which the data was available'.

3. Why data from only 20 districts were included? an introduction of the study area and population would be helpful in this regard.

Added in the introduction section (para 3):

- There are 20 DHBs as the sub-national administrative units responsible for planning, delivering and funding of health services in NZ. created under the New Zealand Public Health and Disability Act 2000.
- Healthcare delivery system in NZ is highly decentralized, even though the core administration functions linked to the overall public sector management, e.g., national service frameworks and the national-level contracts for some services, are centralized. The MOH is responsible for providing main advisory services (stewardship role) on the concerned policy issues to the government, and 20 District Health Boards (DHBs) have been responsible for planning and funding of overall services in the country with the DHB owned hospitals, Public Health units, Primary Health Organizations (PHOs) and other private and Non-Governmental Organizations providing services for the last 20 years (from 2000 to 2021)

4. How much population of children was represented in the dataset?

Added in the discussion section – first point in the limitations part. It is made clearer now.

- This analysis also features a few limitations.
- First, the denominator population comes from the PHO enrolment dataset. The proportion of the estimated resident population (ERP) covered in the data ranges from 96.1% in 2017 to 99.3% in 2012 for all age groups, and from 91.0% in 2008 to 93.3% in 2013 for the study population.

5. Appendix 2 provides information on ASH conditions but discussing the contribution of each condition toward ASH would be more useful.

- Added a new table – Table 1.

6. Paragraphs number 1 and 3 should be part of the result section.

- Moved to the results section (para 2) and edited as required.

Response to the Reviewer: 2

Dr. Mirko Di Martino, Department of Epidemiology of the Regional Health Service Lazio
Comments to the Author:

REVISION

The work is really very interesting; however, the reading is weighed down by the presence of numerous abbreviations, that often forced the reader to go back to search for the first appearance of the acronym in the text. I would advise authors, if possible, to create a list of abbreviations, which could make reading easier.

I need to ask the authors for explanations on some methodological aspects that I have not be able to understand.

- The final model contains two terms of interaction (DHB-Year and DHB-Ethnicity) but no results are reported for them. Are they statistically significant? How have the parameters of the interaction terms been interpreted? How have the ORs relating to DHB been interpreted, considering that the district is part of two distinct terms of interaction.
- Sorry, I noticed the error re two interaction terms. There was only one interaction term (DHB-Year) included in the previous version. That was done to understand if DHBs behave differently for the different study years. The model is clarified (details of the model parameters added), and findings presented in Figure 2 now.
- The 'Results' do not mention the analysis of estimated C-ASH events per 1000 population, by DHB. Why was this analysis done? What information did it adds, considering the aim of the study? Why weren't the estimated and the observed C-ASH events compared?
- The last paragraph in the results section is from the interaction model. The model description is made clearer now in the methods section, model 3.

As it has been described, the model seems unsuitable for data analysis, because it does not take into account the hierarchical structure of data.

- Thank you. we had tried the mixed effect model earlier. But it was not included in the manuscript, mainly because of the small number of clustering units (only 20 DHBs), and ICC is quite small. Now, results from both mixed and fixed effect models are included, the issues are also acknowledged and clarified.
- Please note that model structures are clarified/described in methods section and results presented in the results section.
- The final model includes both covariates measured on the patients (i.e., age and gender) and covariates not attributable to the patient but to the DHB (i.e., finance and human resources).

In my opinion, the most correct way to analyse the available data is through the introduction of random effects and therefore through mixed effects model. In particular, the multilevel methodology would provide a set of tools suitable for simultaneous analysing variables classified at different levels of the hierarchy.

A two-level multilevel logistic regression, with the introduction of 1st level (child) and 2nd level (DHB) variables, would allow to obtain an estimate of the variability between the districts, by controlling for the "composition effect" of patients.

A similar methodology, albeit with a model complicated by the presence of a cross-classified level, was used in Di Martino et al., Chronic polytherapy after myocardial infarction: the

trade-off between hospital and community-based providers in determining adherence to medication, *BMC Cardiovasc Disord* (2021); 21:180 -

- Mixed effect random intercept model with DHB as a cluster/grouping variables is added now, as mentioned above. Details provided in the methods and results sections in the revised version.

Response to the Reviewer: 3

Mr. Roy Grant, Public health research and policy consultant

Comments to the Author:

This is a well written paper and a well-designed and executed study. There are a few areas where I think it could be strengthened.

Abstract, Conclusion - this seems too tentative. Isn't there anything learned from the study that can be presented with some degree of certainty? For example, the last bullet in the immediately following section, Strengths and Limitations, could be highlighted in the abstract.

Changed now incorporating findings from the mixed-effect model:

- 'The variation in childhood ASH is explained only minimal at the DHB level, and only partly by the covariates included in the analysis. Unlike the general ASH measure, the childhood ASH used in this analysis provides insights into the acute conditions sensitive to primary care services. The residual variations, therefore, could be because of the district and local health sector agencies' inputs. However, further information specific to the DHBs would be required to ascertain the level of performance variations'.

The first three paragraphs of the Discussion Section read more like Results than Discussion. I suggest moving any data points that are introduced in the Discussion Section to the Results Section.

- Moved and edited.

While an extensive list of ambulatory sensitive hospitalization conditions is presented in Appendix 2, examples should be presented in the text, focusing on those which were most prevalent in the data set.

- Details of the hospitalization causes (conditions) provided in a new table, Table 1 now. However, we extracted it only for the start and end years, 2008 and 2018.
- As our focus is not on the specific causes or hospitalization conditions, but on the overall ASH, we prepared main dataset (merging of the numerator and denominator dataset) only for the 'overall ASH variable'.

Page 8, line 24, first sentence. Hospitalization rates for ambulatory care sensitive conditions are often used as a measure of access to care, an important element of health system performance (Introduction, page 4, line 13). The sentence is a bit of an overstatement.

- Edited now

Availability of transportation is a factor that is increasingly recognized as having an impact on access to care and hospitalization for ambulatory care sensitive conditions. Did the data set provide any information about public transit availability? Might this be available by district and added to the data set? Limited public transit options and inability to afford and maintain automobiles in poor rural counties are major factors in higher rates of rural hospitalizations for ambulatory care sensitive conditions (in paediatrics, principally for asthma). Your finding regarding urban-rural differences could be better contextualized if you are able to account for urban-rural differences in access to

transportation and/or geographic distribution of ambulatory care sites within the district, which impacts distance to travel for care. If it is not possible to explore this issue in the data (and I recognize that doing so, if possible, would be quite time-consuming), I suggest that you include at least a brief acknowledgment of the potential importance of transportation access in the Discussion Section. The title references geographic variations, and this is likely to suggest to the reader that transportation issues affecting access to care will be discussed.

- Added: mentioned in the introduction section and also acknowledged in the discussion section as a limitation. Para 2 of the limitations part in Discussion section. '... . Lack of transport is one of the important factors affecting access to health services in society[13]. New Zealand Health Survey 2020/21[53] reports that one percent of the children aged 0-14 years had unmet need for GP services due to lack of transport, which is higher among Māori and pacific children and those living in the most deprived areas. We could not include transport variable in the analysis as no individualized DHB-level information was available for the study population over the study years.'

VERSION 2 – REVIEW

REVIEWER	Muhammad Irfan Universiti Sains Malaysia - Kampus Kesihatan
REVIEW RETURNED	21-Mar-2022
GENERAL COMMENTS	The authors have incorporated the suggested changes.
REVIEWER	Roy Grant Public health research and policy consultant
REVIEW RETURNED	11-Mar-2022
GENERAL COMMENTS	Very successful revision.