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)	Spatial Patterns and Determinants of Postnatal Care Use in Ethiopia: Findings from the 2016 Demographic and Health Survey
AUTHORS	Sisay, Malede; Geremew, Tesfahun; Demile, Yeshambel; Alem, Asaye; Kassahun, Desalew; Melak, Melkitu; Alemu, Kassahun; Awoke, Tadesse; Andargie, Asrat

VERSION 1 - REVIEW

REVIEWER	Ghada Saad-Haddad American University of Beirut, Lebanon
REVIEW RETURNED	19-Jul-2018

GENERAL COMMENTS	It was a pleasure reviewing this manuscript and the findings of this research are an important addition to the literature. The use of mapping and spatial analysis is a very useful tool and adds to the strength of the paper. I cannot comment on the methods of the spatial analysis and feel that a specialist in this field can provide a better review. You may want to adjust the color scales for the figures to become distinguishable in black and white prints of the manuscript. Overall, the messages from this study are clear. Nevertheless, the English and the grammar need to be reviewed and revised. I feel that the discussion and the conclusion can be richer. I have provided more detailed comments and edits in the attached document, for your consideration. Thank you and all the best, Ghada Reviewer's Comments by Section Title: Instead of 'A finding from' use 'Findings from the…' Background: 1. It would be useful to add a paragraph about the benefits of postnatal care in order to highlight its importance. 2. The last sentence in this section is very clear and important and it should be reiterated in the conclusion of the paper based on the findings. Methods:

3. Does the Health Sector Development Plan in Ethiopia refer to PNC specifically and does it stipulate who are the providers and facilities who offer PNC?

4. Are the Health Centers distributed equally across the country, to allow women easy access to care?

5. The sections: Study design, study population, sampling technique and data source, can be combined into one coherent paragraph.

6. With regards to the study population, you state that you included in your analysis all women who gave birth in the last five years preceding the survey. Can you please specify if these are all births per woman or is it the last birth of all the women of childbearing age who gave birth in the last five years?

7. In the section on 'Variables' and wherever it appears later on, it may be better to reword the phrase 'women's health check-up after discharge or home delivery' to 'women's postnatal health checkup after health facility discharge or home delivery'.

8. When listing the independent variables on p.5 line 35, reword 'antenatal care visit' to 'number of antenatal care visits'.

9. For the independent variables I think it would be insightful to add parity or birth order (similar to the variable in the women's characteristics), yet you will need to consider collinearity with mother's age. Additionally, it may be useful to consider type of delivery, whether normal vaginal delivery or C-Section delivery. This may affect women's PNC utilization patterns.

Results:

10. More care needs to be taken care with regards to the wording in this section. The sentences and the English require revision.

11. It would be useful to state briefly which independent variables were excluded at each stage of multilevel analysis.

Discussion:

12. On p.8 line 58 – are you able to retrieve the PNC utilization coverage from a DHS report in order to compare the coverages across time?

13. On p.9 line 6-7, what do you mean by 'study characteristics'?

14. On p.9 lines 16-17, where you state the varied geographical utilization of PNC within Ethiopia. Can you elaborate on why the geographic patterns are like this? As I understood from the figures, the hotspots are in very specific limited geographic areas. What is the possible reason for increase use there?

15. To your knowledge, were there any qualitative studies looking at the reasons or barriers of maternal health care use among Ethiopian women? This can provide useful insight to the utilization patterns in the country.

16. P.10 line 2: please rephrase 'attended less than one ANC' to 'reported not receiving any ANC'.

17. P.10 line 4: the possible reasons for the positive effects of ANC on PNC is that ANC offers women an entry point to the healthcare system as well as providing counselling and awareness of the benefits of PNC. Additionally, if the ANC experience was positive then women are more eager to attend a PNC visit.

18. P.10 lines 15-17: do you have a reference to cite confirming the idea about 'healthcare decision making among older Ethiopian women?

19. P.10 line 17-20: This sentence is unclear and needs revising.

Limitations:

20. The limitations are discussed adequately but it is not clear what you mean by 'This is less helpful to explain causality'. The inferential analysis conducted is meant to explain causality. Of course it cannot explain the whole picture because as you

mentioned later in the paragraph, there are unmeasured variables that may affect the outcome and were not considered in this analysis.
21. Can you specify any unmeasured variables that you believe would provide insight?
22. With regards to the limitation about recall bias, please provide a reference.
Conclusion:
23. The conclusion can be elaborated further. There is repetition of the results. And the recommendation of strategies to increase access is too general, I feel. It would be useful to state the need for more community level interventions or specific awareness campaigns to target the poorer or those living in rural places. It is also important to mention that while awareness needs to be increased, there needs to be a review of the quality of PNC services currently being offered in order to assess whether these women find PNC visits unnecessary. Furthermore, assessment of women's perspectives can provide valuable information with regards to utilization patterns.

REVIEWER	Felix Ogbo
	WSU - Australia
REVIEW RETURNED	20-Jul-2018

GENERAL COMMENTS	General comments
	The authors investigated geographical variations and identified the determinants of PNC utilisation among women after delivery in Ethiopia using the 2016 EDHS. The article is important given the high burden of maternal and infant mortality attributable to a lack of health service use in the country. However, there are specific areas in the manuscript that need significant improvement before it can be considered for publication. Importantly, the language needs substantial improvement. I suggest that the authors seek the service of someone who is fluent in the English Language to help edit the content of the manuscript.
	Specific comments:
	Title: I would suggest that title reads " Spatial Patterns and Determinants of Postnatal Care Use in Ethiopia: findings from the 2016 Demographic and Health Survey".
	Abstract:
	Page 2, line 4: revise the sentence, please
	line 6: infant not child is more specific and should be used in the manuscript.
	Line 35: poverty is confusing
	Line 35-39 has the same information, revise
	Page 3: information on strengths and limitation should be more specific, and the language revise.
	Line 8 and 19: "Associated with", not predict
	Background:
	Maternal or infant mortality are not the only issues associated with non-use of PNC, please also provide information on previous Ethiopian national studies on PNC use.
	I suggest that authors substantially edit the introduction section as the rationale for the study is not explicit
	the Methods:

	Authors, please delete these sub-headings (study design, population, sampling and thematically arrange the information in 1-3 paragraphs, with Data source, given that the study was based on one source. Provide reference/s where appropriate.
	Be specific with the independent variables
	Please delete the information on data processing and analysis
	What did authors do to reduce the potential effect of recall bias; I suggest that authors restrict the analyses to the most recent birth. This would mean a re-analysis of the data if this was not done. Summarise the information disease cluster area and use one heading for the data analysis and provide the spatial and logistics analyses in sub-headings. Also, indicate what command was used to adjust for the clustering and weight.
	Results – please edit the language in this section as noted above
	Page 8: why use factors associated here?
	Line 19-25: please delete. Present the results as they are.
	Use compared to or with instead of 'than'
	Discussion
	Summarise in the first paragraph the key findings from the analysis, highlighting the most important results.
	Page 8, line 52-54: please delete
	Line 58: I disagree
	Page 9, line 2 & 13-15: I also disagree
	Line 39: please revise and include appropriate reference/s
	I would suggest that the authors should unpack the significant modifiable factors in the study, and provide reasons for any similarities and gaps, and clear policy messages/recommendations as appropriate.
	Page 10, line 33: which include?
	Line 28-30: that is not entirely correct as noted above.
	Table 3: be consistent – let the ref be on top
	Also, double the references and reference them appropriately; e.g., ref 20 is incorrect

REVIEWER	Diwakar Mohan and Michael Peters Johns Hopkins Bloomberg School of Public Health
REVIEW RETURNED	08-Aug-2018

GENERAL COMMENTS	Thank you for the opportunity to review your study. The study is novel one and would be greatly beneficial in the understanding of postnatal care.
	General comment – The manuscript needs English language editing to rectify grammatical errors and improve the language.
	Background- The background deals with the issues of PNC in great detail but does not get to the need for / significance of spatial statistics in analysis of such health care seeking behavior. The topic of spatial analysis is complex one and it would be good for the authors to spend some time in explaining the concepts and the questions under consideration. Considering the health system structure of the Ethiopian health system, it might appear that any study of the geographical variation in the use of PNC would be more useful at the level of the regions and other administrative divisions like Woredas rather than at the EA level.

The background should also make reference to some of the Spatial Analysis Report (SAR) manuals published by the DHS (https://www.dhsprogram.com/publications/publication-search.cfm?type=45). SAR 8 and 14 are probably the most relevant to the cluster analysis being attempted. The authors should take note of the limitations of the data for sub-national analysis.

Methods-
1. It is unclear from the data source section what data points are being used for the analysis. One can assume that the geocodes of the EAs have been used but this needs to be explicitly made clear.
2. Urban and rural populations are very heterogenous in their patterns of maternal health care seeking behavior and the relationship with other predictors. Also, urban clusters have higher values that might bias any analysis for outliers.
3. The number of women who may have had a delivery in the last 5 years and hence become part of the denominator would be very small. This has the potential to give rise to small-number instability, especially when looking for outliers. One solution is to aggregate data to higher levels ("regionalization") to possibly Woredas.

4. The use of and description of the Global Moran's I is correct but LISA (Local Indicators of Spatial Autocorrelation) was not described at any point and

5. The description of SaTScan, in the is insufficient. In my opinion, a case for the use of the SaTScan has not been made. To my knowledge, SaTScan is beneficial in detecting outlier values for surveillance of disease conditions. Since the objective of the paper is to understand and explain the clustering of PNC use, I don't understand the need for detection of outliers.

6. The multilevel logit regression is appropriate to assess the factors for PNC use. The methods section would benefit from more details on the variables used in the multilevel model.

7. There is no effort to explain the clustering of the variables like education or socioeconomic status that have been identified as important predictors in the multilevel model. The clustering of PNC use may very well explained by the clustering of the predictors rather than any characteristic of PNC use.
Results-
Figure 3 is merely a representation of regional level estimates of PNC use that has been.

Discussion: Only briefly discussed the spatial implications of the findings by mentioning hotspots in passing. It is important to describe what the LISA results (high and low clustering) means in terms of utilization. The discussion could do more to put the spatial findings in perspective and what they mean for PNC use in Ethiopia.

2. Response to Reviewer 1:

General comment – The manuscript needs English language editing to rectify grammatical errors and improve the language.

• Comment accepted and the language is edited by language professional.

Background-

The background deals with the issues of PNC in detail but does not get to the need for / significance of spatial statistics in analysis of such health care seeking behavior. The topic of spatial analysis is complex one and it would be good for the authors to spend some time in explaining the concepts and the questions under consideration.

• Comment accepted and the manuscript is revised accordingly

Considering the health system structure of the Ethiopian health system, it might appear that any study of the geographical variation in the use of PNC would be more useful at the level of the regions and other administrative divisions like Woredas rather than at the EA level.

• Yes, it is possible to use different level in the analysis. Therefore, in this study, we examined regional variations. However, the Ethiopian health service has expanded significantly and there is a policy focusing on expanding primary health coverage universally. We want to assess the effects of individual and household factors in Ethiopian women.

The background should also make reference to some of the Spatial Analysis Report (SAR) manuals published by the DHS (https://www.dhsprogram.com/publications/publication-search.cfm?type=45). SAR 8 and 14 are probably the most relevant to the cluster analysis being attempted. The authors should take note of the limitations of the data for sub-national analysis.

• Thank very much, Comment accepted and the manuscript is reviewed accordingly.

Methods-

1. It is unclear from the data source section what data points are being used for the analysis. One can assume that the geocodes of the EAs have been used, but this needs to be explicitly made clear.

• DHS are nationally representative surveys that collect information on a wide range of topics such as demographic, socioeconomic, family planning and domestic violence amongst other areas. This paper analyses data collected using the women's questionnaire, which asks about women's demographic characteristics, reproductive history, pregnancy history (number of children, birth interval, weight of child, wantedness of child) and postnatal care.

• The other characteristics are delineate geographic locations, boundaries, main access, and landmarks in or outside the EA. The details of data measurement given in the final EDHS report (An EA is a geographic area covering on average of 181 households).

2. Urban and rural populations are very heterogeneous in their patterns of maternal health care seeking behavior and the relationship with other predictors. In addition, urban clusters have higher values that might bias any analysis for outliers.

• We really appreciate your concern. As we included methods and results section, outliers are controlled by performing spatial scan statistical analysis.

3. The number of women who may have had a delivery in the last 5 years and hence become part of the denominator would be very small. This has the potential to give rise to small-number instability, especially when looking for outliers. One solution is to aggregate data to higher levels ("regionalization") to possibly Woredas.

• In fact, after rigorous literature reviewed on the available data, we used region as cluster variables. We aggregated data to regional levels and adjust for possible confounding by individual and household characteristics in Ethiopian women.

• The geographic datasets (also known as GPS data) contain a single record per cluster in which the survey was conducted and provide the latitude, longitude and elevation for the survey cluster, for use in Geographic Information Systems (GIS).

4. The use of and description of the Global Moran's I is correct but LISA (Local Indicators of Spatial Autocorrelation) was not described at any point and The description of SaTScan, in the is insufficient. In my opinion, a case for the use of the SaTScan has not been made. To my knowledge, SaTScan is beneficial in detecting outlier values for surveillance of disease conditions. Since the objective of the paper is to understand and explain the clustering of PNC use, I do not understand the need for detection of outliers.

• We really appreciate your concern and revised accordingly. As you indicated, we used SaTScan to detect outlier values due to different variables included cultures, accessibility of health services.

5. The multilevel logit regression is appropriate to assess the factors for PNC use. The methods section would benefit from more details on the variables used in the multilevel model.

• Corrected.

6. There is no effort to explain the clustering of the variables like education or socioeconomic status that have been identified as important predictors in the multilevel model. The clustering of PNC use may very well explained by the clustering of the predictors rather than any characteristic of PNC use.

• Revision has been made.

Results-

The use of mapping and spatial analysis is a very useful tool and adds to the strength of the paper. I cannot comment on the methods of the spatial analysis and feel that a specialist in this field can provide a better review. You may want to adjust the color scales for the figures to become distinguishable in black and white prints of the manuscript.

• Another copy of map is provided.

Figure 3 is merely a representation of regional level estimates of PNC use that has been.

• Yes, the figure illustrate clearly the variability of PNC use between regions. That why we used regions as cluster variable.

Discussion: Only briefly discussed the spatial implications of the findings by mentioning hotspots in passing. It is important to describe what the LISA results (high and low clustering) means in terms of utilization. The discussion could do more to put the spatial findings in perspective and what they mean for PNC use in Ethiopia.

• Revision has been made

3. Response to Reviewer 2:

Reviewer Name: Felix Ogbo

Institution and Country: WSU - Australia

Please state any competing interests or state 'None declared': None

Please leave your comments for the authors below

General comments

The authors investigated geographical variations and identified the determinants of PNC utilisation among women after delivery in Ethiopia using the 2016 EDHS. The article is important given the high burden of maternal and infant mortality attributable to a lack of health service use in the country. However, there are specific areas in the manuscript that need significant improvement before it can be considered for publication. Importantly, the language needs substantial improvement. I suggest that the authors seek the service of someone who is fluent in the English Language to help edit the content of the manuscript.

Specific comments:

• Comment accepted and the language is edited by language professional.

Title: I would suggest that title reads " Spatial Patterns and Determinants of Postnatal Care Use in Ethiopia: findings from the 2016 Demographic and Health Survey".

• Corrected.

Abstract:

Page 2, line 4: revise the sentence, please

line 6: infant not child is more specific and should be used in the manuscript.

Line 35: poverty is confusing

Line 35-39 has the same information, revise

Page 3: information on strengths and limitation should be more specific, and the language revise.

Line 8 and 19: "Associated with", not predict

• Revision has been made in the abstract section based on the comments.

Background:

Maternal or infant mortality are not the only issues associated with non-use of PNC, please also provide information on previous Ethiopian national studies on PNC use.

I suggest that authors substantially edit the introduction section, as the rationale for the study is not explicit

• Thank you. Some additional explanations have been included in this version.

the Methods:

Authors, please delete these sub-headings (study design, population, sampling and thematically arrange the information in 1-3 paragraphs, with Data source, given that the study was based on one source. Provide reference/s where appropriate.

Be specific with the independent variables

Please delete the information on data processing and analysis

What did authors do to reduce the potential effect of recall bias; I suggest that authors restrict the analyses to the most recent birth. This would mean a re-analysis of the data if this was not done.

Summarise the information disease cluster area and use one heading for the data analysis and provide the spatial and logistics analyses in sub-headings. Also, indicate what command was used to adjust for the clustering and weight.

• The comments have been well taken and revision is done. The method section has been made major revisions. All data sources, variables and analysis methods revised. We assess the predictors of each of these indicators separately and with reference to the most recent birth (see the whole method sections).

Results – please edit the language in this section as noted above

Page 8: why use factors associated here?

Line 19-25: please delete. Present the results as they are.

Use compared to or with instead of 'than'

• Modification has made including language errors.

Discussion

Summarise in the first paragraph the key findings from the analysis, highlighting the most important results.

Page 8, line 52-54: please delete

Line 58: I disagree

Page 9, line 2 & 13-15: I also disagree

Line 39: please revise and include appropriate reference/s

I would suggest that the authors should unpack the significant modifiable factors in the study, and provide reasons for any similarities and gaps, and clear policy messages/recommendations as appropriate.

Page 10, line 33: which include?

Line 28-30: that is not entirely correct as noted above.

Table 3: be consistent – let the ref be on top

Also, double the references and reference them appropriately; e.g., ref 20 is incorrect

• All concerns have been well taken and addressed in the revision.

4. Response to Reviewer 3:

Reviewer Name: Diwakar Mohan and Michael Peters

Institution and Country: Johns Hopkins Bloomberg School of Public Health

Please state any competing interests or state 'None declared': None declared

Please leave your comments for the authors below

Please find my comments in the attached word document

Title: Instead of 'A finding from' use 'Findings from the…'

• Corrected

Background:

1. It would be useful to add a paragraph about the benefits of postnatal care in order to highlight its importance.

• Accepted

2. The last sentence in this section is very clear and important and it should be reiterated in the conclusion of the paper based on the findings.

• Corrected

Methods:

3. Does the Health Sector Development Plan in Ethiopia refer to PNC specifically and does it stipulate who are the providers and facilities who offer PNC?

• A strategy afforded an effective framework for improving health in the country including maternal and neonatal health.

4. Are the Health Centers distributed equally across the country, to allow women easy access to care?

• No, it depends on the population of the region.

5. The sections: Study design, study population, sampling technique and data source, can be combined into one coherent paragraph.

• Corrected

6. With regards to the study population, you state that you included in your analysis all women who gave birth in the last five years preceding the survey. Can you please specify if these are all births per woman or is it the last birth of all the women of childbearing age who gave birth in the last five years?

• Yes, it the last birth of all the women of childbearing age who gave birth in the last five years.

7. In the section on 'Variables' and wherever it appears later on, it may be better to reword the phrase 'women's health check-up after discharge or home delivery' to 'women's postnatal health checkup after health facility discharge or home delivery'.

• Accepted and changed

8. When listing the independent variables on p.5 line 35, reword 'antenatal care visit' to 'number of antenatal care visits'.

• Accepted and modification has been done.

9. For the independent variables I think it would be insightful to add parity or birth order (similar to the variable in the women's characteristics), yet you will need to consider collinearity with mother's age. Additionally, it may be useful to consider type of delivery, whether normal vaginal delivery or C-Section delivery. This may affect women's PNC utilization patterns.

• We were modelled these characteristics, but they were insignificant variables according to model diagnosis criteria

Results:

10. More care needs to be taken care with regards to the wording in this section. The sentences and the English require revision.

• Thank you. Modification has been done.

11. It would be useful to state briefly, which independent variables were excluded at each stage of multilevel analysis.

• Comment is accepted and corrected.

Discussion:

12. On p.8 line 58 – are you able to retrieve the PNC utilization coverage from a DHS report in order to compare the coverages across time?

• Yes, we used the report from previous studies.

13. On p.9 line 6-7, what do you mean by 'study characteristics'?

• It is corrected as "sociocultural characteristics variations".

14. On p.9 lines 16-17, where you state the varied geographical utilization of PNC within Ethiopia. Can you elaborate on why the geographic patterns are like this? As I understood from the figures, the hotspots are in very specific limited geographic areas. What is the possible reason for increase use there?

• The reason may be due to increase awareness and development of infrastructures.

15. To your knowledge, were there any qualitative studies looking at the reasons or barriers of maternal health care use among Ethiopian women? This can provide useful insight to the utilization patterns in the country.

• There is, but too limited.

16. P.10 line 2: please rephrase 'attended less than one ANC' to 'reported not receiving any ANC'.

• Corrected

17. P.10 line 4: the possible reasons for the positive effects of ANC on PNC is that ANC offers women an entry point to the healthcare system as well as providing counselling and awareness of the benefits of PNC. Additionally, if the ANC experience was positive then women are more eager to attend a PNC visit.

• Thank you. comments has been taken.

18. P.10 lines 15-17: do you have a reference to cite confirming the idea about 'healthcare decision making among older Ethiopian women?

• In Ethiopian culture, adults are more respected people.

19. P.10 line 17-20: This sentence is unclear and needs revising.

• It is revised.

Limitations:

20. The limitations are discussed adequately but it is not clear what you mean by 'This is less helpful to explain causality'. The inferential analysis conducted is meant to explain causality. Of course it cannot explain the whole picture because as you mentioned later in the paragraph, there are unmeasured variables that may affect the outcome and were not considered in this analysis.

• Revision has been made

21. Can you specify any unmeasured variables that you believe would provide insight?

• Additional information is included

22. With regards to the limitation about recall bias, please provide a reference.

• Accepted and corrected.

Conclusion:

23. The conclusion can be elaborated further. There is repetition of the results. And the recommendation of strategies to increase access is too general, I feel. It would be useful to state the need for more community level interventions or specific awareness campaigns to target the poorer or those living in rural places. It is also important to mention that while awareness needs to be increased, there needs to be a review of the quality of PNC services currently being offered in order to assess whether these women find PNC visits unnecessary. Furthermore, assessment of women's perspectives can provide valuable information with regards to utilization patterns.

• Revision has been made.

VERSION 2 – REVIEW

REVIEWER	Ghada Saad-Haddad Faculty of Health Sciences, American University of Beirut, Lebanon
REVIEW RETURNED	26-Oct-2018

GENERAL COMMENTS	The authors have taken the reviewers' comments into consideration and have edited the manuscript accordingly. However, the English level still requires further work, especially the abstract, the background and the discussion.

I have not performed any spacial data analysis so i cannot comment on the soundness of the methodology. With regards to the results of the spacial analysis, as someone who is unfamiliar with the technical terms, I found it hard to understand the results. Additionally, It would be useful to describe the LLR and how it is interpreted in the results (page 8, line 6). Also on page 8, line 10 you mention that the second cluster is in the East but it seems to me that it is in the West of the country.

Your use of the term PNC is not standard across the paper. Sometimes you use 'postnatal care', or 'PNC' or 'postnatal health checkup after discharge or home delivery'. Please stick to one standard terminology across the paper.

The discussion is thorough (nevertheless requires major proofreading), giving examples of other countries in the region, and the revised version of the conclusion is good.

Thank you.

REVIEWER	Diwakar Mohan
	Johns Hopkins University, USA
REVIEW RETURNED	15-Nov-2018

GENERAL COMMENTS	Spatial Patterns and Determinants of Postnatal Care Use in Ethiopia: A finding from Demographic and Health Survey, 2016
	Thank you for taking the time to address the concerns raised in the previous review. The study explores the use of postnatal care in Ethiopia and using the recent DHS data and would be greatly beneficial in the understanding of postnatal care.
	General comment – The manuscript still needs English language editing to rectify grammatical errors and improve the language. I started listing each of these but there are too many of them. Capital case for letters is used in many instances, when it should not be used.
	Examples -
	Page 3 Line 35 – cares should be care.
	Page 3 Line 40 – Ethiopian should be Ethiopia
	Pg8 ln 14
	Major considerations:
	- Study still does not address the geographic displacement of DHS EA clusters - this would be expected to affect any type of cluster analysis. Usually in the DHS, EAs are displaced by 5km to prevent identification of the respondents or the community. There is no mention of how this is accounted for in the analysis.
	- As mentioned in the previous review, the relevance of the Satscan analysis to this problem is not clear or made more explicit. Satscan (as I understand) is used to detect spatial outliers (hotspots) from a baseline background. In this study almost entire provinces are classified as such hotspots. Figure 3 provides the same level of information as figure 2 with more simple methods.
	- PNC is an outcome associated with covariates like wealth, education etc (according to the present study). Any extreme

values in the Satscan analysis would be explained by urban/rural location of the cluster, baseline educational and wealth levels of the population and health system access. This raises questions about the analysis like, for eg, - what is the expected value of a cluster? If a cluster is more wealthy than the adjacent clusters, then it can have higher PNC utilization and potentially be classified as a spatial outlier. Then this spatial outlier is a function of its wealth rather the value of PNC.

- Methods section does not have the description for Global Moran statistic which is listed for figure 1 while Anselin Local Moran's I is described in the methods. If LISA is performed, it would be good to have a map representing the clusters.
Authors do not distinguish what kind of clusters were found in results (high-high, low-low, high-low, low-high: this is the crux of any cluster analysis)
Are EAs considered the cluster in this instance? If yes, the random nature of DHS sampling results in large gaps in the neighborhood of an EA.
For example, in one instance an EA may be 5 km away from another EA and in another instance the nearest EAs may be 50 km apart. The clustering technique works only if the boundaries/ locations of all the clusters in the neighborhood of a cluster are known or can be quantified. The solution for the above may be to aggregate the EA estimates to higher administrative units whose boundaries are well defined and all such aggregated clusters have estimates of the outcome variable.

Discussion
The discussion needs editing by an English reader. The discussion needs a lot of work in terms of the inferences made and references used.
The reduction in PNC levels may be due to changes in the definition as used by DHS. It might be good to compare them and provide an opinion. It is unlikely due to sample differences since the DHS is designed to provide a representative sample.
Clarify what is meant by problem impact. If mass media is an important predictor, then this can be tested using the data.
For the postnatal use reference (33-36), it might be better to use the DHS reports. The reference for Tanzania (36) , for example, is from just 3 districts.

Very little of the discussion is spent on discussing the spatial differences covered extensively in the results.

Minor considerations:
1. Pg 4 Ln 5 – Reference for the statement.

2. The last paragraph in the background has too many concepts / claims / sentences without any references.
3. Pg 6 ln 18 – Rephrase. Refer to other studies describing how this is expressed.
4. Pg 7 ln 21-22 – what are the numbers following each state?
5. Pg 10 ln 40 – The experiences precede the study not follow it.
6. The use of the word "outlier" to describe values that are surrounded by dissimilar values (High-low / low-high) is not the correct statistical definition. They should use the phrase' s "spatial outliers" to distinguish

	7.The urban/rural splits have an influence on the size / interpretation of the clusters and no adjustment appears to have been made (at least none described).

VERSION 2 – AUTHOR RESPONSE

Responses to Reviewer(s)' Comments:

Reviewer # 1:

The authors have taken the reviewers' comments into consideration and have edited the manuscript accordingly. However, the English level still requires further work, especially the abstract, the background and the discussion.

We thank for positive feedback and revision has been made.

I have not performed any spacial data analysis so i cannot comment on the soundness of the methodology. With regards to the results of the spacial analysis, as someone who is unfamiliar with the technical terms, I found it hard to understand the results. Additionally, it would be useful to describe the LLR and how it is interpreted in the results (page 8, line 6). Also, on page 8, line 10 you mention that the second cluster is in the East but it seems to me that it is in the West of the country.

Reviewer brings up important points. we have attempted to address under the methodology section (methods, page 6 & results, page 7 – 8)

Your use of the term PNC is not standard across the paper. Sometimes you use 'postnatal care', or 'PNC' or 'postnatal health checkup after discharge or home delivery'. Please stick to one standard terminology across the paper.

We have edited as suggested.

The discussion is thorough (nevertheless requires major proofreading), giving examples of other countries in the region, and the revised version of the conclusion is good.

We agree to this point and changed the method section significantly.

Reviewer # 3

General comment – The manuscript still needs English language editing to rectify grammatical errors and improve the language. I started listing each of these but there are too many of them. Capital case for letters is used in many instances, when it should not be used.

Examples -

Page 3 Line 35 – cares should be care.

Page 3 Line 40 – Ethiopian should be Ethiopia

Pg8 ln 14

We have fixed this mistake. Revision has been made in the whole section of manuscript.

Major considerations:

- Study still does not address the geographic displacement of DHS EA clusters - this would be expected to affect any type of cluster analysis. Usually in the DHS, EAs are displaced by 5km to prevent identification of the respondents or the community. There is no mention of how this is accounted for in the analysis.

We agree to this point. We included it in the limitation part of the revision paper (Discussion, page 10).

- As mentioned in the previous review, the relevance of the SaTScan analysis to this problem is not clear or made more explicit. SaTScan (as I understand) is used to detect spatial outliers (hotspots) from a baseline background. In this study almost entire provinces are classified as such hotspots. Figure 3 provides the same level of information as figure 2 with more simple methods.

Reviewer makes a good point that clarifying the spatial analysis is important in the context of a multilevel model. We have added a sentence per reviewer's suggestion.

The Rationale of using SaTScan: SaTScan used a circular window to detect the spatial scan statistics and better feature of probability model selection. SaTScan also solves the problem of fixed size cluster detection, it uses different size spatial scan circular window and the spatial scan statistic is more powerful (Methods, page 6 -7)

- PNC is an outcome associated with covariates like wealth, education etc. (according to the present study). Any extreme values in the SaTScan analysis would be explained by urban/rural location of the cluster, baseline educational and wealth levels of the population and health system access. This raises questions about the analysis like, for e.g., - what is the expected value of a cluster? If a cluster is more wealthy than the adjacent clusters, then it can have higher PNC utilization and potentially be classified as a spatial outlier. Then this spatial outlier is a function of its wealth rather the value of PNC.

As suggested, method is updated in the revised version of the paper (methods, page 6).

- Methods section does not have the description for Global Moran statistic which is listed for figure 1 while Anselin Local Moran's I is described in the methods. If LISA is performed, it would be good to have a map representing the clusters.

Revisions done in this paper based on reviewers' comments.

Authors do not distinguish what kind of clusters were found in results (high-high, low-low, high-low, low-high: this is the crux of any cluster analysis). Are EAs considered the cluster in this instance? If yes, the random nature of DHS sampling results in large gaps in the neighborhood of an EA.

For example, in one instance an EA may be 5 km away from another EA and in another instance the nearest EAs may be 50 km apart. The clustering technique works only if the boundaries/ locations of all the clusters in the neighborhood of a cluster are known or can be quantified. The solution for the above may be to aggregate the EA estimates to higher administrative units whose boundaries are well defined and all such aggregated clusters have estimates of the outcome variable.

We have added information in method sections

Discussion

The discussion needs editing by an English reader. The discussion needs a lot of work in terms of the inferences made and references used. The reduction in PNC levels may be due to changes in the definition as used by DHS. It might be good to compare them and provide an opinion. It is unlikely due to sample differences since the DHS is designed to provide a representative sample.

Clarify what is meant by problem impact. If mass media is an important predictor, then this can be tested using the data.

For the postnatal use reference (33-36), it might be better to use the DHS reports. The reference for Tanzania (36), for example, is from just 3 districts. Very little of the discussion is spent on discussing the spatial differences covered extensively in the results.

Thank you very much for sharing this observation with us. We very much agree to this point and changed our manuscript accordingly. We added several sentences to the abstract, the results, the discussion and the conclusions concerning this issue.

Minor considerations:

1. Pg 4 Ln 5 – Reference for the statement.

We fixed this.

2. The last paragraph in the background has too many concepts / claims / sentences without any references.

changed as suggested.

3. Pg 6 ln 18 – Rephrase. Refer to other studies describing how this is expressed.

changed as suggested.

4. Pg 7 ln 21-22 – what are the numbers following each state?

Thank you, we have included it (Table 1)

5. Pg 10 ln 40 – The experiences precede the study not follow it.

The correction has been made.

6. The use of the word "outlier" to describe values that are surrounded by dissimilar values (High-low / low-high) is not the correct statistical definition. They should use the phrase's "spatial outliers" to distinguish

The text has been revised as suggested.

7. The urban/rural splits have an influence on the size / interpretation of the clusters and no adjustment appears to have been made (at least none described).

We appreciate the positive feedback from the reviewer. We have added text to emphasize this importance on the limitations section.

REVIEWER	Diwakar Mohan
	Johns Hopkins University
REVIEW RETURNED	23-Mar-2019

| GENERAL COMMENTS | The manuscript has multiple instances of grammatical errors and poor use of the english language. I have attached a PDF highlighting the instances. |
| | The reviewer provided a marked copy with additional comments. Please contact the publisher for full details. |

VERSION 3 – AUTHOR RESPONSE

Author's response to reviewers

Comments: The manuscript has multiple instances of grammatical errors and poor use of the English language. I have attached a PDF highlighting the instances.

Response: We strongly appreciate the reviewer's comment on this point. The manuscript is checked carefully again to improve its Grammar. In the revised version, the said typographical errors are corrected substantially at all the places (see the track changed document attached)