PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Geospatial Analysis of Pediatric Surgical Need and Geographic Access to Care in Somaliland: A Cross-Sectional Study
AUTHORS	Cotache-Condor, Cesia; Moody, Katelyn; Concepcion, Tessa; Mohamed, Mubarak; Dahir, Shukri; Adan Ismail, Edna; Cook, Jonathan; Will, John; Rice, Henry; Smith, Emily

VERSION 1 – REVIEW

REVIEWER	Edward Tan Radboud UMC
REVIEW RETURNED	24-Aug-2020

GENERAL COMMENTS	Review BMJ open Geospatial Analysis of Pediatric Surgical Need and Care in Somaliland Congratulations to the authors on their interesting, informative and very relevant work. It was shocking to read how far Somaliland is removed from reaching the LCoGS proposed target of at least 80% coverage of essential surgical care by 2030, emphasizing the relevance of this topic. Using geospatial tools to better identify critical areas and strategically allocate resources and interventions is important for the Government and NGO's in Somaliland improving health care. Some points of feedback: - Please mention the used age cut-off point for the definition of a child - The methods section is referring to previous work. It would increase readability to add one or two sentences how the survey was conducted instead of referring. - The reviewer is not so familiar with geospatial tools; In general you are referring to literature concerning countries using geospatial tools; could you elucidate how reliable are these tools? Resulted these data in improvement of health care in these countries? - The first paragraph of results might better belong integrated at the start of the discussion as a summary of the most important findings - Perhaps the authors could elaborate on the term 'surgical conditions' and what type of conditions are included. Does this concern acute as well as elective surgery? When including acute surgeries, there might be an underestimation of the problem as there could be a pre-hospital patient selection. Critically ill patients could have deceased in the field and were not included in this study. - What is expected to cause the differences between regions in prevalence of surgical conditions, and the differences among age categories? This could be discussed in the discussion section. - Table 4 there is a typo in Sanaag and surgical capable hospitals

	catchment percentage 111 ? Points of discussion: - It would have been interesting if the data collected to assess surgical infrastructure and capacity included information on the available medical staff. The beds and operating theatre can be available, but will be useless when understaffed. - The label 'Bellwether hospital' was based on whether a type of surgery is performed, but not based on the surgical outcomes - What is regarded as a delay to receiving surgery? Not all surgical conditions require immediate operative management after diagnosis. The impact of delay on morbidity and mortality varies per condition.

REVIEWER	Marilyn Butler Oregon Health & Science University, Surgery
REVIEW RETURNED	06-Sep-2020

GENERAL COMMENTS	In this manuscript, the authors describe an analysis of unmet children's surgical needs in Somaliland, using geospatial analysis to assess accessibility to surgical care by public transportation and by foot according to the optimal parameter of 2 hours suggested by the Lancet Commission on Global Surgery. The authors stratified data on surgical burden by age using the SOSAS household survey, and they used 2 surgical assessment tools to evaluate the capacity of hospitals to treat surgical conditions. They then used 4 different geospatial tools to estimate the geographical distribution of pediatric surgical conditions and access to care in Somaliland. Their analysis suggested that less than 10% of children have timely access to care across Somaliland, while also identifying areas where surgical access is substantially limited, with wait times for surgery exceeding 3 years. They conclude that their tools could be used to strategically allocate resources and increase capacity to improve the surgical care of children in Somaliland. I cannot comment on the tools used, but the authors seem proficient in their use. If anything, their findings probably understate the true deficiencies in children's surgical care, as they used adult bellwether hospitals as their benchmark of access to children's surgical care; whereas, in reality, those hospitals likely lack qualified pediatric anesthetic care and instruments, as well as safe pre- and post-operative care by providers trained in pediatric resuscitation. In addition to the delays mentioned in the discussion, there is likely a failure to recognize surgically correctable anomalies. The authors identify other limitations to the study and assumptions made in the geospatial analysis. I applaud the authors for their thorough study and for their beautifully written manuscript.

REVIEWER	Richard Beare Monash University, Medicine
REVIEW RETURNED	03-Dec-2020

GENERAL COMMENTS	I am reviewing this paper from the geospatial analysis perspective. I am not qualified to comment on the surgical, hospital assessment, or socio economic aspects or international political aspects. I believe that a more specialised epidemiological opinion on the validity of the estimations based on the sample numbers is

warranted.

I suspect that there may be political sensitivities around the use of "Somaliland". The introduction describes is as "not formally recognised", and wikipedia says "self declared and internationally recognised as part of Somalia". However the paper mentions a Somaliland Ministry of Health. BMJ and editors will probably want to provide guidance on wording here.

The authors have collected what is likely to be very important data. I am concerned that the visualisation selections may not be appropriate or sufficient to convey the messages to readers.

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The message of the paper isn't clear to me. The intention may be

1) survey-> prevalence estimate
2) prevalence estimate + transport network -> cases with hospital access
3) hotspots/coldspots -> does access imply treatment.

At the moment it is a jumble of methods and data. The geospatial methods for visualisation and basics of area calculation can be removed, or dramatically reduced, unless they produce numbers that are important later.

Something resembling a study design summary would help with this.

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Sampling is of key importance for this type of study. More detail on the "two stage" process is required here, even though it is presumably described in previous publications.

A map of the sampled locations should be included. I assume that the hot/cold spot map is an indicator of where sampling occurred, but something indicating density would help. For example, one dot per village, with size relating to the number of families surveyed.

The validity of the visualisation provided and statistics depend on both sampling and population density. For example, there are large green areas with moderate estimated prevalence of surgical conditions (eastern end), but we cannot tell where the nearest sampling was, or what the underlying population density is. It may be that weighted interpolation isn't the appropriate way of displaying this valuable data.

For example, if I assume that the hot and cold spots are related to sampling locations then it is likely that most of the eastern part of the map is extrapolated and may not be meaningful. It may also be that a map of absolute numbers rather than prevalence is more informative. Based on the road network I would guess that there is a relatively high population density in the eastern part.

I am not clear on the following. "Surgical conditions in this study (n=221)" . Does this mean 221 children in the 1503 surveyed had a surgical condition? Or 221 different surgical conditions were seen,

possibly in many more than 221 children? Or were slightly fewer than 221 children observed, some with multiple conditions? Later there's a mention of 196 children.

More in the introduction about the type of questions being answered by the geospatial approach. i.e visualisation, hotspots, estimated distribution, accessibility etc. The emphasis in the rest of the paper is on the geospatial methods, rather than how the inform us. This needs to shift somewhat, as the methods are not novel and don't need to be described in great detail. A few more sentences on this in the introduction would be appropriate.

Thiessen polygons - please also use "Voronoi" to describe this term. It isn't clear how this is being used. Possibly the areas in the bottom rows in table 2

However, I cannot get these mean areas to add up to something close to the total area quoted in methods:

e.g. total of 5 bellwether hospitals: 5*44569 = 222845.
Quite different to the quoted total area of 179119. Don't expect these to be identical, but that is a 25% difference.

The area based calculations are not especially informative, and the Thiessen polygon methodology could be removed from methods in order to improve clarity.

Similarly, the interpolation approach is standard and appears to be used only to create the colour overlay on the map. It doesn't need to be a major part of methods.

Use of the road network to compute catchment zones is sensible. However there are no details. What is the source of road data (e.g. openstreetmap?) and what tools were used to compute travel times/road distances? There's a comment about using areal base maps for comparison to account for war damage, which sounds like a huge task.

Is public transport commonly available? If there is a road, can a public transport vehicle be presumed to travel on it frequently? This is the assumption that has been made in the analysis, but there's no justification of whether this is realistic. I can imagine that it becomes less realistic as distance from urban areas increases. Even if rural public transport options are common, the real time to hospital becomes travel time + wait time.

It would also make some sense if the road network was correlated with population density and thus could be used to inform the interpretation of the interpolation results

Legend for the hotspot/coldspot map is the same for both types. Hospitals should be shown on the same map, as hospitals corresponding to cold spots would make sense.

Finally, maps are a great opportunity for beautiful figures. I found these disappointing. Consider a parallel interactive version too, which helps readers and reviewers appreciate the data.

Typos:
Methods, line 35: 176,119 square kilometres.

VERSION 1 – AUTHOR RESPONSE

Reviewer #1: Dr. Edward Tan, Radboud UMC

Congratulations to the authors on their interesting, informative and very relevant work. It was shocking to read how far Somaliland is removed from reaching the LCoGS proposed target of at least 80% coverage of essential surgical care by 2030, emphasizing the relevance of this topic. Using geospatial tools to better identify critical areas and strategically allocate resources and interventions is important for the Government and NGO's in Somaliland improving health care.

1. Some points of feedback: Please mention the used age cut-off point for the definition of a child.

RESPONSE:

We thank the reviewer's wise comment about the need to include our definition of "child". We have included this definition in the methods section.

In the text: The **METHODS** section was updated to include the definition of child in our study.

2. The methods section is referring to previous work. It would increase readability to add one or two sentences how the survey was conducted instead of referring.

RESPONSE:

We agree with the reviewer's astute comments about expanding the explanation on how our survey was performed. Paragraph 2 and 3 of the *study design, participants and data collection* section already contains some information. We have added some sentences to expand the information already provided.

In the text: The **METHODS** section, under ***study design, participants and data collection,*** was updated to include additional information about how the survey was implemented.

3. The reviewer is not so familiar with geospatial tools; In general, you are referring to literature concerning countries using geospatial tools; could you elucidate how reliable are these tools? Resulted these data in improvement of health care in these countries?

RESPONSE:

We thank the reviewer's question regarding the reliability of geospatial tools in leading to outcome improvements. Although we find in the literature the relevance, reliability, and rigor of geospatial analysis across several disciplines,[12] we cannot evaluate the geospatial methods in terms of outcomes improvement (i.e., improvement of the health care). Data alone cannot result in a change of outcomes. For this to happen, the implementation of specific interventions is needed (i.e., an increased number of hospitals could increase health coverage). The geospatial analysis cannot be seen as an intervention. Instead, the geospatial tools strengthen the identification and analysis of a specific problem. In some way, we can compare these tools with the traditional statistical tools (i.e., regression analysis). As with geospatial tools, we believe that it is not correct to measure the latter's reliability by asking questions regarding changes in the outcome because that is out of their use scope.

4. The first paragraph of results might better belong integrated at the start of the discussion as a summary of the most important findings.

RESPONSE:

We thank the reviewer's astute recommendation. We have already provided a summary of the most important findings of our study in the first paragraph of the discussion. We believe that moving the shorter summary from the results section would create redundancy and leave the results section without a quick overview of the study's results. We also believe that having a brief summary in the results section often helps the reader to prepare for a more detailed reporting of results in the following paragraphs.

5. Perhaps the authors could elaborate on the term 'surgical conditions' and what type of conditions are included. Does this concern acute as well as elective surgery? When including acute surgeries, there might be an underestimation of the problem as there could be a pre-hospital patient selection. Critically ill patients could have deceased in the field and were not included in this study.

RESPONSE:

We thank the reviewer for this excellent suggestion. We have included the definition of "surgical conditions" that was used in this study. Also, we agree that we might have underestimated the unmet

burden of acute surgeries due to a pre-hospital patient selection. We have included this comment as a limitation in our study.

In the text: We updated the **METHODS** section, under ***Study design, participants and data collection***, and the **Limitations** sections to include the reviewer's suggestion.

6. What is expected to cause the differences between regions in prevalence of surgical conditions, and the differences among age categories? This could be discussed in the discussion section.

RESPONSE:

We thank the reviewer for this smart question. We couldn't find strong evidence to discuss the specific reasons behind the prevalence of surgical conditions by age and region. However, we believe that overall, regional and age differences are related to rurality and poverty. For instance, some of the most rural and poor regions, such as Awdal, have a high prevalence of under-five surgical conditions (especially congenital anomalies). One of the reasons behind this might be poor antenatal care and nutritional deficiencies during pregnancy. As mentioned, we did not include these speculations in the discussion section.

7. Table 4 there is a typo in Sanaag and surgical capable hospitals catchment percentage 111 ?

RESPONSE:

We appreciate the reviewer pointed out a typo in Table 2, and we have corrected it.

In the text: The typo in **Table 2** was fixed.

8. Points of discussion: It would have been interesting if the data collected to assess surgical infrastructure and capacity included information on the available medical staff. The beds and operating theatre can be available, but will be useless when understaffed.

RESPONSE:

We thank the reviewer's smart comment. We agree that assessing surgical infrastructure and workforce capacity is a critical part in evaluating access to surgical care. However, these components are out of the scope of our current study. As we have mentioned in the introduction and discussion, The Lancet Commission on Global Surgery (LCoGS) has proposed 6 indictors to measure access to surgical care. Addressing all indicators together is critical to understand the surgical landscape of a country. However, it does not allow for an analysis of each indicator at a micro-level. We have recently published a paper accounting for this broad view of the surgical system in Somaliland.[3] Therefore, we aimed to analyze indicator 1 "geographic access to care" at the micro-level in our current study. We acknowledge this point might not be clear in the title and study aims. Therefore, we have updated these sections to provide more clarity in the scope of our study.

In the text: The **TITLE** and study aims included in the **INTRODUCTION** section and **ABSTRACT** have been updated to clarify "geographic access to care".

9. The label 'Bellwether hospital' was based on whether a type of surgery is performed, but not based on the surgical outcomes.

RESPONSE:

We agree with the reviewer's comment regarding the definition of "bellwether hospitals." As we mentioned in our study, the LCoGS defines "bellwether" as the three critically essential procedures – laparotomy, cesarean delivery, and fixation of an open fracture– that are used as proxy measures of a functional health system that can treat a broad range of surgical conditions. However, as we also mentioned in our limitations, there is still no consensus about how to measure this proxy indicator, especially for children. Therefore, we proposed to define a hospital as a "bellwether" if they reported performing at least one laparotomy, at least one open fracture fixation, and at least one Cesarean section over a six-month period. We did not use surgical outcomes to define "bellwether hospitals" because this measure is already included in the 4th indicator ("perioperative mortality") proposed by the LCoGS. Thus, it is out of our current study's scope, which is only based on the 1st indicator of the LCoGS.

10. What is regarded as a delay to receiving surgery? Not all surgical conditions require immediate operative management after diagnosis. The impact of delay on morbidity and mortality varies per condition.

RESPONSE:

We thank the reviewer's astute comments regarding delays in surgery. We agree that not all surgical conditions require immediate operative care and or have immediate impacts on morbidity and mortality. Therefore, we have used this term in a broad way, as the time children with current unmet needs are still waiting to receive surgery. Furthermore, we stratified this variable in four categories (<1 month, 1-12 months, 1-3 years, and >3 years) to account for a broad spectrum of surgical conditions. We believe that risk of disability and death might exist within these stratified categories, especially for the "1-3 years" and ">3 years" categories.

Reviewer #2: Dr. Marilyn Butler, Oregon Health & Science University

In this manuscript, the authors describe an analysis of unmet children's surgical needs in Somaliland, using geospatial analysis to assess accessibility to surgical care by public transportation and by foot according to the optimal parameter of 2 hours suggested by the Lancet Commission on Global Surgery. The authors stratified data on surgical burden by age using the SOSAS household survey, and they used 2 surgical assessment tools to evaluate the capacity of hospitals to treat surgical conditions. They then used 4 different geospatial tools to estimate the geographical distribution of pediatric surgical conditions and access to care in Somaliland. Their analysis suggested that less than 10% of children have timely access to care across Somaliland, while also identifying areas where surgical access is substantially limited, with wait times for surgery exceeding 3 years. They conclude that their tools could be used to strategically allocate resources and increase capacity to improve the surgical care of children in Somaliland. I cannot comment on the tools used, but the authors seem proficient in their use. If anything, their findings probably understate the true deficiencies in children's surgical care, as they used adult bellwether hospitals as their benchmark of access to children's surgical care; whereas, in reality, those hospitals likely lack qualified pediatric anesthetic care and instruments, as well as safe pre- and post-operative care by providers trained in pediatric resuscitation. In addition to the delays mentioned in the discussion, there is likely a failure to recognize surgically correctable anomalies. The authors identify other limitations to the study and assumptions made in the geospatial analysis.

I applaud the authors for their thorough study and for their beautifully written manuscript.

RESPONSE:

We thank the reviewer's smart comments. Furthermore, we agree with the reviewer's highlights of our limitations. As mentioned, there is no consensus about how to categorize a bellwether hospital for children. Therefore, we defined it as a hospital that performed the three bellwether procedures used to analyze surgical care for adults. We recognize that this definition may not be transferable for analysis of surgical care for children and, therefore, might underestimate the true deficiencies in children's surgical care. Likewise, the true burden of pediatric surgical conditions might be underestimated. However, despite this limitations, we believe our study contributes to a baseline characterization of the geographic access to pediatric surgical care in Somaliland.

Reviewer #3: Dr. Richard Beare, Monash University

I am reviewing this paper from the geospatial analysis perspective. I am not qualified to

comment on the surgical, hospital assessment, or socio-economic aspects or international political aspects.

1. I believe that a more specialized epidemiological opinion on the validity of the estimations based on the sample numbers is warranted.

RESPONSE:

We agree with the reviewer's smart suggestion about the need for a specialized epidemiological opinion. Our team includes a member with a Ph.D. in Epidemiology. This person has supervised our project at each step of the process, from the population sampling to the data collection, data analysis, and reporting of results.

2. I suspect that there may be political sensitivities around the use of "Somaliland". The introduction describes is as "not formally recognised", and wikipedia says "self declared and internationally recognised as part of Somalia". However the paper mentions a Somaliland Ministry of Health. BMJ and editors will probably want to provide guidance on wording here.

RESPONSE:

We thank the reviewer's astute comment. Although Somaliland is not formally recognized as an independent country, important international institutions such as the World Bank refer to this country as "Somaliland".[45] We believe that there is no risk of political sensitivities around the use of "Somaliland" if this country's status and background are clearly stated in our study. Furthermore, previous research published by BMJ Open has referred to this country as "Somaliland".[6]

3. The authors have collected what is likely to be very important data. I am concerned that the visualization selections may not be appropriate or sufficient to convey the messages to readers.

The message of the paper isn't clear to me. The intention may be:

1) survey-> prevalence estimate

2) prevalence estimate + transport network -> cases with hospital access

3) hotspots/coldspots -> does access imply treatment.

At the moment it is a jumble of methods and data. The geospatial methods for visualization and basics of area calculation can be removed, or dramatically reduced, unless they produce numbers that are important later. Something resembling a study design summary would help with this.

RESPONSE:

We thank the reviewer's astute comment. As suggested by the reviewer, we have created a summary table of the geospatial analysis tools and related objectives and data used in the study. Furthermore, we have substantially reduced the geospatial methods for visualization and basics of area calculation. However, important details were kept, especially for the service area – network analyst.

In the text: We have created a new **TABLE 1** and updated the **METHODS** section to reflect these changes. The enumeration of **TABLE 2 & 3** and the **RESULTS** section was updated according to the new changes.

4. Sampling is of key importance for this type of study. More detail on the "two stage" process is required here, even though it is presumably described in previous publications.

RESPONSE:

We agree with the reviewer's wise suggestion. We included additional information regarding the sampling process –especially the two-stage methodology– from our previous published work.

In the text: We updated the **METHODS** section, under **Study design, participants and data collection** to reflect the additional information regarding the sampling process.

5. A map of the sampled locations should be included. I assume that the hot/cold spot map is an indicator of where sampling occurred, but something indicating density would help. For example, one dot per village, with size relating to the number of families surveyed.

RESPONSE:

We thank the reviewer's smart suggestion. We included two new maps as supplementary materials. The first map displays the number of hospitals assessed by region and by classification (surgically capable and bellwether). The second map depicts the sampling locations (by number of surveyed households and children). The child population density was also displayed in the background.

In the text: Two new maps were added under **Supplementary Material 1 & Supplementary Material 2**. We updated the **METHODS** section to include information regarding these new maps.

6. The validity of the visualization provided, and statistics depend on both sampling and population density. For example, there are large green areas with moderate estimated prevalence of surgical conditions (eastern end), but we cannot tell where the nearest sampling was, or what the underlying population density is. It may be that weighted interpolation is not the appropriate way of displaying this valuable data. For example, if I assume that the hot and cold spots are related to sampling locations then it is likely that most of the eastern part of the map is extrapolated and may not be meaningful. It may also be that a map of absolute numbers rather than prevalence is more informative. Based on the road network I would guess that there is a relatively high population density in the eastern part.

RESPONSE:

We agree with the reviewer's smart comment. The visualization and statistics depend on both sampling and population density. Following this and a previous suggestion (#5), we have included a map with sample locations and population density by region. As explained in our study, a representative and stratified sampling was performed across the country. Therefore, we believe that our interpolation method is still meaningful. Although we have mentioned in our limitations that some areas (specifically the eastern end) have been extrapolated due to unknown data, we would like to clarify that these are areas with very low population density and high insecurity because of their proximity to Somalia. This is the reason behind the unknown data. We did not want to mention the insecurity reason in the limitations because that could be politically sensitive.

On the other hand, we believe that a map depicting prevalence is always more useful than a map with absolute numbers. Raw numbers are not usually informative in terms of population density. For instance, 100 cases in Sool might have a different interpretation than 100 cases in Maduri Jeex. Thus, the epidemiological science uses point prevalence (total number of cases / total population at a certain point in time) to better represent the frequency of disease.

7. I am not clear on the following. "Surgical conditions in this study (n=221)". Does this mean 221 children in the 1503 surveyed had a surgical condition? Or 221 different surgical conditions were seen, possibly in many more than 221 children? Or were slightly fewer than 221 children observed, some with multiple conditions? Later there's a mention of 196 children.

RESPONSE:

We thank the reviewer for pointing out the need to clarify the mentioned sentence. From 1,503 children surveyed, our study found that 196 children reported 221 surgical conditions. Which means some of these children had more than one surgical condition. We acknowledge that this information

was not clear in our methods section. Therefore, we have updated the wording of the methods section to differentiate between the number of surgical conditions and the number of children. We have also enhanced the wording in the figures.

In the text: We updated the **METHOS** sections and the captions of related **FIGURES & TABLES.**

8. More in the introduction about the type of questions being answered by the geospatial approach. i.e visualization, hotspots, estimated distribution, accessibility etc. The emphasis in the rest of the paper is on the geospatial methods, rather than how the inform us. This needs to shift somewhat, as the methods are not novel and don't need to be described in great detail. A few more sentences on this in the introduction would be appropriate.

RESPONSE:

We thank the reviewer's wise comment. We added some sentences to reflect better the types of questions being answered by the geospatial approach in the healthcare field, especially in epidemiology and health services research, since our study is a combination of both areas.

In the text: We updated the **INTRODUCTION** section to include the reviewer's suggestion.

9. Thiessen polygons - please also use "Voronoi" to describe this term.

It isn't clear how this is being used. Possibly the areas in the bottom rows in table 2

However, I cannot get these mean areas to add up to something close to the total area quoted in methods: e.g. total of 5 bellwether hospitals: 5*44569 = 222845.

Quite different to the quoted total area of 179119. Don't expect these to be identical, but that is a 25% difference.

RESPONSE:

We thank the astute reviewers' suggestion regarding the best term to use instead of "Thiessen polygons". As suggested, we have used "Voronoi" throughout the study. The areas of coverage reported in the bottom rows of table 3 (former table 2) correspond with the use of the Voronoi diagram. We have edited the caption in table 3 to clarify this point.

We also thank the reviewers' clarifying question regarding the calculation of areas of coverage. This problem in the calculation occurred because of two reasons: 1) the total area cited in the methods sections was extracted from governmental documents instead of using the area from our current map, and 2) we used the "measure a feature tool" to calculate areas. In this revised version, we cited the national are using data from our current map. The "measure an area" tool was used to have more precise calculations for all polygons. Supplementary material 3 provides details of all our calculations for both types of hospitals. The exact national area can be obtained if all individual polygons are added. However, as we explain in the methods, we report the area of coverage for each region in means. Therefore, the sum of means will always differ from the national area.

In the text: We added **Supplementary material 3** to provide details about the calculation of the area of coverage provided in Table 3. The **METHODS** section and **RESULTS** section were updated accordingly.

10. The area based calculations are not especially informative, and the Thiessen polygon methodology could be removed from methods in order to improve clarity. Similarly, the interpolation approach is standard and appears to be used only to create the colour overlay on the map. It doesn't need to be a major part of methods. Use of the road network to compute catchment zones is sensible. However there are no details. What is the source of road data (e.g. openstreetmap?) and what tools were used to compute travel times/road distances? There's a comment about using areal base maps for comparison to account for war damage, which sounds like a huge task.

RESPONSE:

We agree with the reviewer's astute comments about the methodology. The mentioned methodologies were drastically reduced to improve clarity. We used the Service Area tool in the Network Analyst package in ArcMap. This information and further details are included in the summary Table 1 (as requested by the reviewer in comment #3). We also added the citation for the road network data that we used thought the study. We confirm that areal base maps were used as part of the data cleaning process. This exhaustive task took several months.

In the text: We updated the **METHODS** section to add the citation for the road network.

11. Is public transport commonly available? If there is a road, can a public transport vehicle be presumed to travel on it frequently? This is the assumption that has been made in the analysis, but there's no justification of whether this is realistic. I can imagine that it becomes less realistic as distance from urban areas increases. Even if rural public transport options are common, the real time to hospital becomes travel time + wait time. It would also make some sense if the road network was correlated with population density and thus could be used to

inform the interpretation of the interpolation results.

RESPONSE:

We thank the reviewer's smart questions and comments. We confirm that we have made assumptions on constant speed and constant transport availability. We acknowledge that there is no evidence on whether these assumptions are realistic. We only count on verbal information from our local coauthors, who indicate that transportation availability is not frequent, and speed is also limited because the roads are mostly in bad shape. Therefore, our approach is conservative, and we mentioned that our results might underestimate the true travel distance as a limitation in our study.

We agree that a statistical test of the correlation of roads and population would help inform the interpretation better. However, in this case, that might not be true. We mentioned that several roads were damaged during the civil war and remain that way in the present time. Therefore, the availability of roads cannot fully and accurately explain the point made by the reviewer. We also explain this limitation in the respective section.

In the text: We included the mentioned limitation in the **DISCUSSION** section.

12. Legend for the hotspot/coldspot map is the same for both types. Hospitals should be shown on the same map, as hospitals corresponding to cold spots would make sense.

RESPONSE:

We agree with the reviewer's astute comments. The added hospitals the hotspot layer. We found some hot spots in areas with hospitals. This finding was already examined in the discussion section. Our data suggest that the presence of hospitals does not ensure receiving care. Other important factors such as financial hardship, workforce capacity, and infrastructure capacity might play a huge role in the delivery of surgical care for children in Somaliland.

In the text: We updated **Figure 1** to include hospital points alongside the hotspot layer.

14. Finally, maps are a great opportunity for beautiful figures. I found these disappointing. Consider a parallel interactive version too, which helps readers and reviewers appreciate the data.

RESPONSE:

We agree with the reviewer's astute comments about creating a parallel interactive version of the maps. However, we do not count on granular data and the necessary tools to undertake this work.

15. Typos: Methods, line 35: 176,119 square kilometres.

RESPONSE:

We thank the reviewer for pointing out the typo. We have corrected it.

In the text: We updated the **METHODS** section to reflect the correction of the typo.

VERSION 2 – REVIEW

REVIEWER	Edward Tan Radboud UMC
REVIEW RETURNED	27-Mar-2021

GENERAL COMMENTS	Great improvement of the manuscript,

REVIEWER	Richard Beare Monash University, Medicine
REVIEW RETURNED	07-Apr-2021

GENERAL COMMENTS	First, a general comment that I should have made first time around. The analysis splits hospital access into two categories – surgical capable and bellwhether hospitals. It is sensible to treat bellwhether hospitals as a separate class, for the scenario where a more capable service is required. However, the second analysis should probably include both hospital types, as it is unlikely that patients near a bellwhether hospital will travel to a less capable hospital for a simple procedure. i.e. this analysis would include all hospitals that are at least surgical capable. This grouping could be included as a third class, to better fit the current structure, and mostly has an effect on Table 3 and the Voronoi analysis. Interactive maps – I'd encourage you to revisit this idea as it makes some of the interpretation much easier, and the investment is quite low (free software and hosting services). I am happy to help with this (not requesting authorship) if you are willing to share the data. We use R to manipulate the data and leaflet to display interactively. Since my review is not anonymous, I will point to examples in my own work in this area as an example. We have found the maps very useful in assisting convey the article's message. Tutorial paper: https://www.frontiersin.org/articles/10.3389/fneur.2019.00743/full supporting web site: https://richardbeare.github.io/GeospatialStroke/ a linguistics map: https://richardbeare.github.io/marijatabain/ipa_illustrations_all.html Our original work on stroke ECR services: https://www.ahajournals.org/doi/full/10.1161/STROKEAHA.116.015323 https://gntem2.github.io/Google-Map-to-Victorian-ECR-Hospitals/

Other points:

Page numbers below are from the “Page x of 59” labels.

Line 9, page 5: Recommend “estimate” instead of “measure”. Please check usage of “measure” elsewhere in the manuscript

Line 30, page 5: “may limit analysis of travel times” - I don’t think this phrasing is conveying the correct meaning. I think the point you are trying to make is about “accuracy of travel time estimates”. Something along the lines of “Estimates of travel time may be inaccurate due to incomplete knowledge of the extent of damage to the road network caused by previous civil conflict”. You could also restate one of your discussion points about real travel times being likely to be longer than estimated ones due to this damage.

Line 25, page 11: “Network Analyst” is introduced here. Make it clear that this is an arcmap package. I was confused until I found it mentioned later. Something like Arcmap/Network Analyst should be sufficient.

Line 46, page 11: The Voronoi section needs some work. The idea of coverage at the “regional level” needs to be refined. I’m not sure if you’re examining a scenario in which patients can only travel to hospitals in their region. After looking closely at supplementary material, I think you’re trying to get a measure of average coverage of hospitals in a region, taking into account the idea that some patients may attend hospitals in neighbouring regions. The average is required for scenarios in which the hospitals are quite close together. (leading to one small Voronoi polygon in Adwal, for example). This is starting to address the hospital loading question, rather than accessibility.

There needs to be a clearer description of what you’re trying to show with this analysis.

My best guess:
Estimate the catchment area for surgically capable and bellwether hospitals under the assumption that patients travel to the closest hospital. Mean coverage of hospitals, reported by region, was based on the intersection of region boundaries and Voronoi polygons of hospitals located within the region. The extra class of all hospitals will have an impact here.

Also, there was no need to completely remove the original Thiessen terminology, if you find that is used in other domains.

Table 2: Caption says 196 children, but the total column has 154 + 26 + 7 = 187. Did some of the 196 never have surgery, answers never provided etc?

Lines 22-29, Page 16. Wording of sentence beginning: “Even though …” is strange. I don’t understand the message here.

Line 3, Page 17. “increased educational efforts on identified”?

Line 10, page 18. The “limit analysis” phrase – possibly should be

	about accuracy. Figures: Hospital locations are not all visible – i.e we can't see n=15 surgical and n=5 bellwether hospitals, so there must be several that are located in close proximity. If these hospitals are in the same town (Adwal must have 3 in close proximity), then perhaps indicate with a larger H. Interactive maps would help with this too. Some clues about colocation come from the Voronoi diagrams where H markers appear on the Voronoi boundary (at the displayed resolution), rather than in the middle. Supplementary figure 2 – these look very nice. Please include source of the data for background dots in the caption.

VERSION 2 – AUTHOR RESPONSE

Reviewer #1: Dr. Edward Tan, Radboud UMC

Great improvement of the manuscript.

RESPONSE:

We thank the reviewer's positive feedback after our first revision. We are very grateful for his contribution to our study.

Reviewer #3: Dr. Richard Beare, Monash University

Congratulations to the authors on a dramatically improved manuscript. I have highlighted some minor recommendations in the attachment.

RESPONSE:

We thank the reviewer's positive feedback after our first revision and the additional minor revisions suggested to make this study as strong as it can be.

1. First, a general comment that I should have made first time around. The analysis splits hospital access into two categories – surgical capable and bellwhether hospitals. It is sensible to treat bellwhether hospitals as a separate class, for the scenario where a more capable service is required. However, the second analysis should probably include both hospital

types, as it is unlikely that patients near a bellwhether hospital will travel to a less capable hospital for a simple procedure. i.e. this analysis would include all hospitals that are

at least surgical capable. This grouping could be included as a third class, to better fit the current structure, and mostly has an effect on Table 3 and the Voronoi analysis.

RESPONSE:

We agree with the reviewer's suggestion. The two categories were already classified in the same way the reviewer is suggesting because we had the same thought process regarding travel patterns to the nearest hospital (explained in the methods). According to our definition, the "surgically capable" category includes all hospitals, including bellwether hospitals (n=15). The "bellwether" category only includes a fraction of the hospitals that meet a specific criterion (explained in the methods) (n=5). However, we have improved the wording of the methods section to make the classification clearer to the readership. We did not reword the results section because we believe this section already conveys the message. Please find below an extract of the results section:

"*From a total of 15 hospitals included in this study, all were classified as surgically capable hospitals,* ***and 5 of them*** *were classified as bellwether hospitals*."

In the text: We have updated the **METHODS** section to reflect the mentioned clarification.

2. Interactive maps – I'd encourage you to revisit this idea as it makes some of the interpretation much easier, and the investment is quite low (free software and hosting services). I am happy to help with this (not requesting authorship) if you are willing to share the data. We use R to manipulate the data and leaflet to display interactively. Since my review is not anonymous, I will point to examples in my own work in this area as an example. We have found the maps very useful in assisting convey the article's message.

Tutorial paper:

https://www.frontiersin.org/articles/10.3389/fneur.2019.00743/full

supporting web site: https://richardbeare.github.io/GeospatialStroke/

a linguistics map: https://richardbeare.github.io/marijatabain/ipa_illustrations_all.html

Our original work on stroke ECR services:

https://www.ahajournals.org/doi/full/10.1161/STROKEAHA.116.015323

https://gntem2.github.io/Google-Map-to-Victorian-ECR-Hospitals/

RESPONSE:

We thank the reviewer's astute comment that interactive maps would be ideal. However, our data is not granular enough to make these stratified-type maps without losing statistical interpretation. In addition, we do not feel the interactive maps would not add to the clinical interpretation of our findings. Although we wish we had the granular data capable of these types of maps, our limited datapoints are not robust enough to make these maps to be interpretable with some degree of certainty.

3. Other points: Page numbers below are from the "Page x of 59" labels. Line 9, page 5: Recommend "estimate" instead of "measure". Please check usage of "measure" elsewhere in the manuscript.

RESPONSE:

We thank the reviewer's wise comment. We have changed the wording (estimate instead of measure) as recommended.

In the text: We have used estimate instead of measure throughout the document.

4. Line 30, page 5: "may limit analysis of travel times" - I don't think this phrasing is conveying the correct meaning. I think the point you are trying to make is about "accuracy of travel time estimates". Something along the lines of "Estimates of travel time may be inaccurate due to incomplete knowledge of the extent of damage to the road network caused by previous civil conflict". You could also restate one of your discussion points about real travel times being likely to be longer than estimated ones due to this damage.

RESPONSE:

We thank the reviewer's suggestion. We have changed the wording of this sentence according to the reviewer's suggestion.

In the text: We have updated the **strengths and limitations** section according to the reviewer's suggestion.

5. Line 25, page 11: "Network Analyst" is introduced here. Make it clear that this is an arcmap package. I was confused until I found it mentioned later. Something like Arcmap/Network Analyst should be sufficient.

RESPONSE:

We thank the reviewer's suggestion. As mentioned in the methods, all geospatial analyses were performed with ArcMap packages. Therefore, we added a clarification on the caption corresponding to table 1 indicating that all analysis were made in ArcMap. We did this to avoid the confusion that only the Network Analyst package was used from ArcMap.

In the text: **TABLE 1 caption** was updated according to the reviewer's suggestion.

6. Line 46, page 11: The Voronoi section needs some work. The idea of coverage at the "regional level" needs to be refined. I'm not sure if you're examining a scenario in which patients can only travel to hospitals in their region. After looking closely at supplementary material, I think you're trying to get a measure of average coverage of hospitals in a region, taking into account the idea that some patients may attend hospitals in neighbouring regions. The average is required for scenarios in which the hospitals are quite close together. (leading to one small Voronoi polygon in Adwal, for example). This is starting to address the hospital loading question, rather than accessibility. There needs to be a clearer description of what you're trying to show with this analysis.

My best guess: Estimate the catchment area for surgically capable and bellwether hospitals under the assumption that patients travel to the closest hospital. Mean coverage of hospitals, reported by region, was based on the intersection of region boundaries and Voronoi polygons of hospitals located within the region. The extra class of all hospitals will have an impact here. Also, there was no need to completely remove the original Thiessen terminology, if you find that is used in other domains.

RESPONSE:

We thank the reviewer's suggestion. In this analysis, we have already examined the scenario in which patients can only travel to the closest hospital (mentioned in the methods section). For most of the cases, this means that patients can only travel to the closest hospital within their region. However, if we perform the analysis for only bellwether hospitals, we can see that some regions do not have even one hospital that is within their frontiers. In this case, we assumed that they would travel to the closest hospital from a neighboring region. We updated the methods section to include the assumption.

Furthermore, we agree that this analysis also addresses a loading question, and this is mentioned in the discussion. It is worth noting that the loading issue is closely related to the availability issue in our study.

No additional analysis was needed because of the reasons already stated in the response to SUGGESTION #1.

In the text: The **METHODS** section was updated to clarify the reviewer's inquiry.

7. Table 2: Caption says 196 children, but the total column has 154 + 26 + 7 = 187. Did some of the 196 never have surgery, answers never provided etc?

RESPONSE:

We thank the reviewer for pointing out the need to clarify the numbers in the table's total column. The total number of 187 can be explained by missing data for 9 children (187 + 9 = 196). We have added a row in table 2 to indicate the missing data.

In the text: We updated the **TABLE 2** to reflect the missing data.

8. Lines 22-29, Page 16. Wording of sentence beginning: "Even though …" is strange. I don't understand the message here.

RESPONSE:

We thank the reviewer for pointing out the need to clarify the mentioned sentence. We have reworded the last part of the paragraph containing the mentioned sentence to achieve more clarity.

In the text: We updated the third paragraph of the **DISCUSSION** section to clarify the writing according to the reviewer's suggestion.

9. Line 3, Page 17. "increased educational efforts on identified"?

RESPONSE:

We thank the reviewers for pointing out this typo and we have fixed it.

In the text: We fixed the mentioned typo on paragraph 4 of the **DISCUSSION** section.

10. Line 10, page 18. The "limit analysis" phrase – possibly should be about accuracy.

RESPONSE:

We agree with the reviewer's wise suggestion. We have updated the mentioned sentence.

In the text: We updated the mentioned sentence that belong to the last paragraph of the **DISCUSSION** section.

11. Figures: Hospital locations are not all visible – i.e we can't see n=15 surgical and n=5 bellwether

hospitals, so there must be several that are located in close proximity. If these hospitals are in the same town (Adwal must have 3 in close proximity), then perhaps indicate with a larger H. Interactive maps would help with this too. Some clues about colocation come from the Voronoi diagrams where H markers appear on the Voronoi boundary (at the displayed resolution), rather than in the middle.

RESPONSE:

We thank the reviewer's astute suggestion. As the reviewer guessed, some hospitals were very close, and therefore it is difficult to differentiate them. However, we believe that having different sizes for the symbology would generate more confusion in the regions were more than one symbology is provided. Furthermore, we already included a detailed description of hospital's distribution and frequency in **Supplementary material 3,** and we believe this will suffice the lecture and interpretation of the other figures. Therefore, we decided not to make additional changes to the figures.

12. Supplementary figure 2 – these look very nice. Please include source of the data for background dots in the caption.

RESPONSE:

We thank with the reviewer's wise suggestion. We have provided the required citation in the methods section.

In the text: We updated the **METHODS** section to include the required citation.

VERSION 3 – REVIEW

REVIEWER	Richard Beare Monash University, Medicine
REVIEW RETURNED	05-Jul-2021

GENERAL COMMENTS	Congratulations on the final product! Minor comment - I still find the wording of one of the corrections strange: "Another example is Maroodi Jex, a region that concentrated ..." Perhaps: Another example is the low rates of surgical access in the rural areas of northern Maroodi Jex, the region with more hospitals than any other, due to concentration of hospitals in the capital city of Hargeisa