PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Association between spatial accessibility to fire protection services and unintentional residential fire injuries or deaths: a cross-sectional study in Dallas, Texas
AUTHORS	Min, Soojin; Kim, Dohyeong; Lee, Chang Kil

VERSION 1 – REVIEW

REVIEWER	Dr Michelle Ball Senior Lecturer, Victoria University, Australia
REVIEW RETURNED	07-Jun-2018

GENERAL COMMENTS	This well written paper covers an interesting topic in a fairly straightforward and meaningful way. There are some problems with the framing of the objectives, particular the first sentence which lacks context. The references used to describe risk factors for death in fire are also a little old. More recent work is most certainly available and should have been cited. Also, when explaining the limitations of the study in the discussion section, the authors have not considered that the reason for injury or death resulting from a fire is not always related to the response of emergency services. Where a person is involved in ignition a rapid response may reduce the severity of injury, but this was not able to be accounted for in the current study. Some people with be injured or die in a fire as a result of their proximity or involvement with ignition, regardless of the response of emergency services. Although perhaps out of my purview, I might question the relevance of this paper to this specific publication. The results may bare little significance to the medical community. It may be more widely read by an appropriate audience if submitted to a journal concerned with fire and emergency services, or even urban design.

REVIEWER	Richard Fry Swansea University, Wales, UK.
REVIEW RETURNED	26-Jul-2018

GENERAL COMMENTS	This is a well written, interesting paper. However I have concerns over the interpretation and implementation of the 2SFCA algorithm used to create the spatial accessbility scores. These are outlined as follows: 1) (p8 line 3) The term circular catchment areas is ambiguous. Much of the international lierature related to geographic accessibility uses network or euclidean terminology. It as widely been demonstrated that network measures provide a better measure of access, in part due to the underlying topography, but

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	also as most road networks include turn restrictions and one way streets when taking into account distance measures. It is not clear from the description in the paper which method was used. 2)The distance decay statement (p8 line 51) is unclear. There has been plenty of published work on the 2SFCA method that include distance decay (e.g. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4938577/) - for most part the catchment is used with distance decay so that services on the edge of the catchement are less desirbale then those closer to the point of access. 3) The authors fail to discuss the cumalative opportunity elements to the 2SFCA - this is critical in defining whether an area as better service provision than its neighbour. That is, an area is better served if it has >1 service providers, this is calculated by summing the suply/demmand ratios in the area and is integral to the 2SFCA method. It is inclear whether the authors have done this from their description. 4) Linked to the previous comment, the choice of 4 minutes as a catchment area, in my opinion is flawed. I understand the target - but by putting a hard barrier of 4 minutes as their catchment the authors are implying that the fire service won't respond to a fire if it is beyond the 4 minute barrier. This is the whole point of gravity modelling. In this scenrio you would set your distance decay to start at 4 minutes or 2.22 miles marker and decay away. This better models whether a fire crew can reach a household within the critical four minutes and still models access beyond the time/distance. The 5% of fires that were beyond the 2.22 miles are probably the ones that you are interested in from a policy perspective as they, on face value, seem to be the ones which are underserved. 3) The authors, rightly, highlight that fire service provision is not a consumer choice and that fire services must travel to the consumer locations (p9.1). However, the 2SFCA model described here describes measuring access from the census block thereby implying consumer choice. The authors need to consider whether they need to reverse the supply and demmand ratio so that the fire stations become the point of access and the census population weighted centroid becomes supply (or where the potential fires exist). Also they shoudl consider whether adding in information on the number of fire trucks available at each fire station would add value to the supply-demand ratio. The paper as it stands needs to address the points above on the underlying spatial modelling before assessing whether the relationships between accessibility and fires is significant.

VERSION 1 – AUTHOR RESPONSE

Comments from Reviewers:

[Reviewer 1: Dr. Michelle Ball]

This well written paper covers an interesting topic in a fairly straightforward and meaningful way.

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(1) There are some problems with the framing of the objectives, particular the first sentence which lacks context.

We have revised the first sentence to provide the overall context of this paper as suggested (please see the texts highlighted in red in page 4).

(2) The references used to describe risk factors for death in fire are also a little old. More recent work is most certainly available and should have been cited.

We have removed some old references and replaced them with more recent ones as suggested (please see the new references highlighted in red).

(3) Also, when explaining the limitations of the study in the discussion section, the authors have not considered that the reason for injury or death resulting from a fire is not always related to the response of emergency services. Where a person is involved in ignition a rapid response may reduce the severity of injury, but this was not able to be accounted for in the current study. Some people with be injured or die in a fire as a result of their proximity or involvement with ignition, regardless of the response of emergency services.

Although the current study excluded arson cases and fires with unknown causes, we agree with you that there may have been other factors that have contributed injuries or deaths, which was not clarified by the current study. We have mentioned other contributing factors in the Introduction section and included this as a limitation in the Discussion section (please see the texts highlighted in red in pages 5 and 16-17).

(4) Although perhaps out of my purview, I might question the relevance of this paper to this specific publication. The results may bare little significance to the medical community. It may be more widely read by an appropriate audience if submitted to a journal concerned with fire and emergency services, or even urban design.

Thanks for the suggestion. In fact, we were thinking about submitting it to an injury or safety journal but also found that numerous articles have been published in BMJ Open addressing fire safety issues. We have added an article published in BMJ Open to the revised manuscript. We believe that not only the medical community but also a broader readership of this journal finds our contribution valuable.

[Reviewer 2: Dr. Richard Fry]

This is a well written, interesting paper. However I have concerns over the interpretation and implementation of the 2SFCA algorithm used to create the spatial accessbility scores. These are outlined as follows:

1) (p8 line 3) The term circular catchment areas is ambiguous. Much of the international lierature related to geographic accessibility uses network or euclidean terminology. It as widely been demonstrated that network measures provide a better measure of access, in part due to the underlying topography, but also as most road networks include turn restrictions and one way streets when taking into account distance measures. It is not clear from the description in the paper which method was used.

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We agreed that the Method section did not clearly indicate that we used 2-mile Euclidian radius to construct circular catchment areas. We have clarified the Method section as suggested (please see the texts highlighted in red in page 10).

2)The distance decay statement (p8 line 51) is unclear. There has been plenty of published work on the 2SFCA method that include distance decay (e.g. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4938577/) - for most part the catchment is used with distance decay so that services on the edge of the catchement are less desirbale then those closer to the point of access.

We have clarified how we handled distance decay effects in the Method section as suggested (please see the texts highlighted in red in pages 9-10). We also argued that the original 2SFCA method's assumption of absence of distance decay effects within catchment areas was applicable to spatial accessibility to fire protection services in our paper due to the supply and demand characteristics unique to fire protection services, where assigned fire responding units must travel to consumers' locations regardless of distance from fire stations (provider locations).

3) The authors fail to discuss the cumalative opportunity elements to the 2SFCA - this is critical in defining whether an area as better service provision than its neighbour. That is, an area is better served if it has >1 service providers, this is calculated by summing the suply/demmand ratios in the area and is integral to the 2SFCA method. It is inclear whether the authors have done this from their description.

We agree that the cumulative opportunity element is a critical point in defining the level of service provided in an area. We have done exactly what was pointed out in Step 2 of the 2SFCA method so that each catchment area around a population location captures a sum of service capacity of providers within the area. We have revised the texts clarifying the process (please see the texts highlighted in red in pages 9-10).

4) Linked to the previous comment, the choice of 4 minutes as a catchment area, in my opinion is flawed. I understand the target - but by putting a hard barrier of 4 minutes as their catchment the authors are implying that the fire service won't respond to a fire if it is beyond the 4 minute barrier. This is the whole point of gravity modelling. In this scenrio you would set your distance decay to start at 4 minutes or 2.22 miles marker and decay away. This better models whether a fire crew can reach a household within the critical four minutes and still models access beyond the time/distance. The 5% of fires that were beyond the 2.22 miles are probably the ones that you are interested in from a policy perspective as they, on face value, seem to be the ones which are underserved.

We agree that distance decay effects need to be considered when discussing spatial accessibility to health care providers discussed in most literature. However, due to the supply and demand characteristics unique to fire protection services, where assigned fire responding units must travel to consumers' locations regardless of distance from fire stations (provider locations), we suggest distance decay effects are not present within a catchment area. We set 2-mile-radius circular catchment areas based on the NFPA's recommendation, and recognized population centers that do not capture fire stations in their catchment areas as relatively underserved areas. Following your suggestion, we re-ran the model with a distance decay starting at 2 miles marker, but found no significant difference in the model results due to a low number of fire cases beyond the catchment area. Instead, we added one additional variable to the models, fire at night time, which slightly changed the model results. Please see the changes in Tables 1 and 2, along with the revised texts highlighted in red in pages 11-13.

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5) The authors, rightly, highlight that fire service provision is not a consumer choice and that fire services must travel to the consumer locations (p9.1). However, the 2SFCA model described here describes measuring access from the census block thereby implying consumer choice. The authors need to consider whether they need to reverse the supply and demmand ratio so that the fire stations become the point of access and the census population weighted centroid becomes supply (or where the potential fires exist).

While it is a constructive suggestion to reverse the supply and demand ratio so that the fire stations become the point of access and the population centers become supply, reversing the ratio will change the definition of the spatial accessibility to services established by numerous studies where higher spatial accessibility score indicates better accessibility. If we change the ratio, higher score will indicate lower accessibility where more population shares the given services. Some research using the 2SFCA method to measure spatial accessibility to fire protection services maintained the service-to-population ratio (Guo et al, Social Indicators Research, 2018; Wisniewski, Geomatics, Land management and Landscape, 2017). We suppose that the consumer choice is aligned with the service provider choice as responding units are dispatched based on the proximity to the fire location, and the consumers would want the service to be originated from the nearest fire station.

Also they shoudl consider whether adding in information on the number of fire trucks available at each fire station would add value to the supply-demand ratio.

It is a great point that adding the number of fire trucks at each fire station would add value. We have considered that each station has a fire engine, which pumps water and is the most critical firefighting apparatus (mentioned in page 6). It is still our limitation that we are not able to capture other types of firefighting apparatus including fire trucks that support firefighting activities by carrying ladders and other equipment, as we clarified in the Discussion section (please see the texts highlighted in red in page 16).

The paper as it stands needs to address the points above on the underlying spatial modelling before assessing whether the relationships between accessibility and fires is significant.

As responded in details above, we have refined our spatial modeling and confirmed that the relationship between accessibility and fires remains significant. Please see the revised model results in Tables 1 and 2.

VERSION 2 – REVIEW

REVIEWER	Richard Fry Swansea Univeristy, Wales
REVIEW RETURNED	01-Mar-2019

GENERAL COMMENTS	The authors have adequately addressed my concerns over the implementation of 2SFCA and made appropriate ammendments to the models and text. An interesting study, and I can see how the tool developed can be used for service planning in the future.

REVIEWER	Joe Nolan Northern Kentucky University
REVIEW RETURNED	06-Mar-2019

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GENERAL COMMENTS	Please note that I am only performing a review of the statistical analysis in this paper. I do not have experience with the 2SFCA method, but note that another reviewer seems to have that experience and has made comments in regard to that methodology. My comments pertain to the abstract, as well as the analysis beginning on page 11. Overall, the methodology is sound but I have some issues with the interpretation. With some minor revision, in particular addressing the 7 points below (with points 5-7 being of particular import), I believe the analysis will be fairly sound. 1. Abstract: Spatial accessibility is not an "outcome measure". The main outcome measure is whether or not there was an injury or death. Spatial accessibility is your main predictor of interest. Additionally, leave the odds ratios out of the abstract. Without their associated confidence intervals, one shouldn't necessarily be trying to take any meaning from those numbers (see additional notes below). 2. General: The logistic regression model seems appropriate to the outcome variable, as it is a binary assessment of whether fire related injury or death occurred. Initially modelling on things that we know might impact the chance of injury/death makes good sense. Building from there to assess factors of interest seems to be good form. 3. P11, line 40: Table 1 seems to contain estimated regression coefficients and their SE's. This is not particularly useful information but does help illustrate the modeling and is, importantly, followed by odds ratios with confidence intervals being found in Table 2. 4. The index score of spatial accessibility needs a better definition, early in the paper. 5. P13, lines 30-50. The odds ratios here are being improperly interpreted. The odds ratio itself is a sample statistic – sampling a different time frame would result in a different value. The confidence intervals, rather than the point estimate for OR, should be interpreted instead. This makes a big difference because for example, the sentence stating "an increase of 1 in spatial accessibility score was expected to be associated with about a 10 percent decrease (OR=0.90) in the odds of involving injury for an unintentional residential fire incident" has not been shown. What is shown is that an increase of 1 in spatial accessibility score was expected to be associated with something between 1% and 20% decrease in the odds (using the CI). If the data showed "at least 10%" that would almost surely be something relevant. But you need to clearly admit that it could be as low as 1% which might not be an actionable number. 6. Pages 14-15, lines 53-55, 3-5. This appears to be a census comparison? If in fact those two numbers are based on a census rather than a sample, it is inappropriate to do a hypothesis test. 7. Page 15, lines 13-15. Same comment as previous.

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VERSION 2 – AUTHOR RESPONSE

Reviewers' Comments to Author:

Reviewer: 2

Reviewer Name: Richard Fry

Institution and Country: Swansea University, Wales

Please state any competing interests or state ‘None declared’: None declared

The authors have adequately addressed my concerns over the implementation of 2SFCA and made appropriate amendments to the models and text. An interesting study, and I can see how the tool developed can be used for service planning in the future.

(Response) Thanks for your positive view of our revised manuscript.

Reviewer: 3

Reviewer Name: Joe Nolan

Institution and Country: Northern Kentucky University, USA

Please state any competing interests or state ‘None declared’: None Declared

Please note that I am only performing a review of the statistical analysis in this paper. I do not have experience with the 2SFCA method, but note that another reviewer seems to have that experience and has made comments in regard to that methodology. My comments pertain to the abstract, as well as the analysis beginning on page 11. Overall, the methodology is sound but I have some issues with the interpretation. With some minor revision, in particular addressing the 7 points below (with points 5-7 being of particular import), I believe the analysis will be fairly sound.

(Response) Thanks for your comment that our methodology is sound. Below you can see how we responded to each of your issues.

1. Abstract: Spatial accessibility is not an “outcome measure”. The main outcome measure is whether or not there was an injury or death. Spatial accessibility is your main predictor of interest. Additionally, leave the odds ratios out of the abstract. Without their associated confidence intervals, one shouldn’t necessarily be trying to take any meaning from those numbers (see additional notes below).

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(Response) As suggested, we revised the section of “Main outcome measures” to clarify the main outcome measure and the main predictor of our regression model. We also removed the odds ratios from the abstract, following the suggestion. Please see the sections of “Main outcome measures” and “Results” in abstract of the revised manuscript.

2. General: The logistic regression model seems appropriate to the outcome variable, as it is a binary assessment of whether fire related injury or death occurred. Initially modelling on things that we know might impact the chance of injury/death makes good sense. Building from there to assess factors of interest seems to be good form.

(Response) Thanks for your positive feedback.

3. P11, line 40: Table 1 seems to contain estimated regression coefficients and their SE’s. This is not particularly useful information but does help illustrate the modeling and is, importantly, followed by odds ratios with confidence intervals being found in Table 2.

(Response) Thanks for your positive feedback.

4. The index score of spatial accessibility needs a better definition, early in the paper.

(Response) As suggested, we elaborated and moved up the definition of the spatial accessibility index score to Page 10-11 (highlighted in red) after explaining the 2SFCA method.

5. P13, lines 30-50. The odds ratios here are being improperly interpreted. The odds ratio itself is a sample statistic – sampling a different time frame would result in a different value. The confidence intervals, rather than the point estimate for OR, should be interpreted instead. This makes a big difference because for example, the sentence stating “an increase of 1 in spatial accessibility score was expected to be associated with about a 10 percent decrease (OR=0.90) in the odds of involving injury for an unintentional residential fire incident” has not been shown. What is shown is that an increase of 1 in spatial accessibility score was expected to be associated with something between 1% and 20% decrease in the odds (using the CI). If the data showed “at least 10%” that would almost surely be something relevant. But you need to clearly admit that it could be as low as 1% which might not be an actionable number.

(Response) As suggested, we added the CI next to OR in the texts explaining Table 2 as well and removed the interpretation of the point estimate for OR. Please see the highlighted texts in page 13 of the revised manuscript.

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6. Pages 14-15, lines 53-55, 3-5. This appears to be a census comparison? If in fact those two numbers are based on a census rather than a sample, it is inappropriate to do a hypothesis test.

(Response) We agree that the hypothesis test (t-test) is inappropriate as the numbers are based on the entire census block groups. We removed the t-test result from the sentence.

7. Page 15, lines 13-15. Same comment as previous.

(Response) Likewise, we removed the t-test result from the sentence.

VERSION 3 – REVIEW

REVIEWER	Joe Nolan Northern Kentucky University
REVIEW RETURNED	07-Apr-2019

GENERAL COMMENTS	All of my comments from the previous review were sufficiently addressed.

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