PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Association between district-level safety and self-rated health: a multilevel study in an urban setting
AUTHORS	Kim, Seung-Sup; Choi, Jaesung; Park, Kisoo; Chung, Yeonseung; Park, Sangjo; Heo, Jongho

VERSION 1 - REVIEW

REVIEWER	Antony Chum Centre for Research on Inner City Health, St Michael's Hospital, Canada
REVIEW RETURNED	13-Mar-2014

GENERAL COMMENTS	**Summary of review**: The main purpose of this paper is to understand the association between the perception of neighbourhood safety and self-rated health while adjusting for the effects of district-level crime rate and other confounders. This presents a *major issue* for model specification because “perception of safety” is influenced by the district-level crime rate; therefore, the inclusion of both predictors in the model may violate the independence assumption of regression analysis. However, given a number of major revisions to the manuscript and the models (most notably, a mediation analysis to test whether perception of safety is a mediator between crime rate and self-rated health), I believe this paper can make an original contribution to the literature on the effects of neighbourhood crime and safety on residents’ health. **Major issues** 1) The main purpose of this paper is to understand the association between the perception of neighbourhood safety and self-rated health while adjusting for the effects of district-level crime rate and other confounders. However, as the authors acknowledged on p.5, “previous studies did not adjust for districtlevel crime rate as a potential confounder although crime-rate has been reported to influence perception of neighborhood safety as well as residents' health outcomes”, there is a potential pathway linking objective crime rate!subjective perceptions of safety!self-rated health. Given that the construction of subjective notion neighbourhood safety is informed by the objective level of crime (see new study by Lavasi, et al (2014) - http://bmjopen.bmj.com/content/4/3/e004058.abstract), to simply treat crime rate as a “confounder” (where its effects should be “controlled out”) ignores

	the complex relationships that may exist among these variables. I recommend that the authors conduct a mediation analysis to test whether perception of safety is a mediator between crime rate and self-rated health. For details on how to conduct mediation analysis with multilevel data see: Bauer, D. J., Preacher, K. J. & Gil, K. M. (2006) Conceptualizing and testing random indirect effects and moderated mediation in multilevel models: New procedures and recommendations. Psychological Methods, 11(2), 142-163. On a related note, the authors can improve the manuscript by providing information on the bivariate association between crime rate and perceived safety given the theoretical linkage between the 2 variables. In multivariate models, multicollinearity diagnostics of the models (e.g. tolerance and variance inflation factor [VIF]) will also be useful for readers. 2) The literature review of the limitations of previous studies on the effects of crime/safety on health (p. 4-5) appears to be selective and exaggerates the novelty of the present study. For example, the authors claim that "sample size or the sample size within neighbourhood of previous studies was too small to be representative for each neighbourhood". This is not true – see for example Sunquist et al (2006), which includes the entire population of Stockholm County aged 35–64 years. See also minor issue #1. • Sundquist, K., Theobald, H., Yang, M., Li, X. J., Johansson, S. E., & Sundquist, J. (2006). Neighborhood violent crime and unemployment increase the risk of coronary heart disease: A multilevel study in an urban setting. *Social Science & Medicine, 62*(8), 2061-2071 3) More discussion of the district level crime rate is needed. What types of crimes are included? Does it include both violent and property crimes? If "white-collar" crimes are also included, how is this justifiable in the context of the study? Can the authors comment on the gap between unreported crimes and the data that is used? **Minor issues** 1) The authors state that "unavailability in appropriate neighborhood measure may explain why there is scant hierarchical or multilevel analysis which allows for estimating the influence of neighborhood measures on residents' health outcomes" (p.5). This statement is not true. There is a plethora of multilevel studies linking the effects of neighbourhood measures to resident's health. See for example: o Riva, Mylene, Gauvin, Lise, & Barnett, Tracie A. (2007). Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. *Journal of Epidemiology and Community Health, 61*, 853-861. o Sellstrom, Eva, & Bremberg, Sven. (2006). The significance of neighbourhood context to child and adolescent health and well-being: A systematic review of multilevel studies. *Scandinavian* *Journal of Public Health, 34*, 544-554.

	2) Please provide information on sample size of the level-2 units (p.6) i.e. what is the mean, range and standard deviation for households included in each district. 3) Issues with the exposure variable (perceived neighbourhood safety) a) the authors can provide more clarity to the construction of the exposure variable by presenting the exact formula used to calculate the “district-level perceived neighbourhood safety” (p. 6), this would help readers better understand the scaling of the variable and exactly how the household levels weights work. b) the survey wording “very agree” and “very disagree” seem awkward (p.6). Could this be a translation issue? c) The authors should comment on the psychometric reliability and validity of using a single question to gauge the perception of neighbourhood safety. d) There was no reasons given for why the authors have decided to dichotomize their 5-level scale of perceived safety. My concern is that the loss of information on the gradient of perceived safety may bias the results towards the null.

REVIEWER	Reginald Tucker-Seeley Harvard School of Public Health, USA
REVIEW RETURNED	18-Mar-2014

GENERAL COMMENTS	The goal of the submitted manuscript was to examine the association between district-level safety and self-rated health of individuals in the district. The authors present many limitations with previous work in this area in the introduction and this was helpful to the reader; however, it was not clear whether their study addressed the limitations listed. In particular, how does this manuscript address the limitation of “measurement error of the perceived neighborhood safety”? There are several additional issues with the submitted manuscript that dampen my enthusiasm. The issues are discussed below: 1) In a sample of over 7,000 respondents, it is astonishing that there were no missing observations. It would have been helpful to mention exactly how this was possible. 2) Given the critiques on perceived neighborhood safety presented in the introduction, it was surprising to see district level average perceived neighborhood safety measured in the very way critiqued. How does the measure of perceived neighborhood safety used in this study address the limitations the authors presented? 3) Given that the district level perceived safety variable is the aggregated individual level perceived safety variable and both are included in the model, how do the authors address the potential multi-collinearity that is present by including both of these variables in the model? (e.g. potential impact on standard errors) 4) Why did the authors use multilevel models (and not marginal or GEE models)? Was it necessary (or of interest) to model the variability between districts? Are the authors interested in the variability between the districts? They appear to only be interested in the fixed (average) effects as indicated by only reporting the odds ratio. Although the random intercepts are mentioned in the data

	analysis section, they are not mentioned in the results section or listed in the tables. 5) Is there a different pathway linking individual level perceived safety and group (or aggregated) district level perceived safety to the health of the residents? If so, the authors should be more explicit when describing “perceived neighborhood safety” in the discussion and when include either “individual level” or “aggregated or district level” when discussing “perceived neighborhood safety”. 6) It should be noted that finding a statistically significant finding is not generally presented as a study strength. 7) Lastly, it is unclear what data is included in the “district level crime rate.” Does this include all crimes? It would have been helpful to include the types of crimes that are included in this rate as some crimes might be included that do not necessarily influence the safety of the residents (e.g. non-violent crimes or non-larceny crimes).

VERSION 1 – AUTHOR RESPONSE

A. **Responses for the comments from Referee I**

1. Comment: The main purpose of this paper is to understand the association between the perception of neighbourhood safety and self-rated health while adjusting for the effects of district-level crime rate and other confounders. However, as the authors acknowledged on p.5, “previous studies did not adjust for district-level crime rate as a potential confounder although crime-rate has been reported to influence perception of neighborhood safety as well as residents' health outcomes”, there is a potential pathway linking objective crime rate subjective perceptions of safety to self-rated health. Given that the construction of subjective notion neighbourhood safety is informed by the objective level of crime (see new study by Lavasi, et al (2014) - http://bmjopen.bmj.com/content/4/3/e004058.abstract), to simply treat crime rate as a “confounder” (where its effects should be “controlled out”) ignores the complex relationships that may exist among these variables. I recommend that the authors conduct a mediation analysis to test whether perception of safety is a mediator between crime rate and self-rated health.

For details on how to conduct mediation analysis with multilevel data see: Bauer, D. J., Preacher, K. J. & Gil, K. M. (2006) Conceptualizing and testing random indirect effects and moderated mediation in multilevel models: New procedures and recommendations. Psychological Methods, 11(2), 142-163.

On a related note, the authors can improve the manuscript by providing information on the bivariate association between crime rate and perceived safety given the theoretical linkage between the 2 variables. In multivariate models, multicollinearity diagnostics of the models (e.g. tolerance and variance inflation factor [VIF]) will also be useful for readers.

1. Response: We agree that the suggested causal pathway (crime rate -> perceived safety -> self-rated health) would be an interesting hypothesis to be investigated. However, we did not proceed further to check this causality and its related mediation for two reasons.

First, though we found significant negative correlation (-0.26 with 95% CI (-0.28, -0.23)) between district-level crime rate and district-level safety, but we failed to find any significant association between district-level crime rate and self-rated health in a simple multi-level modeling. We believe that mediation by district-level safety would be worth to investigate when district-level crime rate is indeed associated with both district-level safety and self-rated health, which is not our case.

Second, the primary goal of our study is to examine the association between district-level perceived safety and self-rated health. Crime rate was considered as one of the potential confounders (not as a primary explanatory variable). Analysis of such causal pathway may be another research topic which

would be investigated in a structural equation modeling framework adjusting for potential confounders, which we think is beyond the scope of our paper.

2. Comment: On a related note, the authors can improve the manuscript by providing information on the bivariate association between crime rate and perceived safety given the theoretical linkage between the 2 variables. In multivariate models, multicollinearity diagnostics of the models (e.g. tolerance and variance inflation factor [VIF]) will also be useful for readers.

2. Response: We agree that the correlation between district-level crime rate and district-level safety (-0.26 with 95% CI (-0.28, -0.23)) may have caused multicollinearity and hidden a true effect of district-level crime rate on self-rated health. As we used multi-level models with 3-level hierarchy, tolerance and VIF are not straightforward to calculate. Instead, we checked if crime rate is significantly associated with self-rated health when we exclude district-level safety from the model, however we did not find any association. Also, district-level safety is significant regardless of including crime rate in the model. Therefore, we believe that that such multicollinearity, if there is, wouldnot be a major issue to change our findings.

3. Comment: The literature review of the limitations of previous studies on the effects of crime/safety on health (p. 4-5) appears to be selective and exaggerates the novelty of the present study. For example, the authors claim that “sample size or the sample size within neighbourhood of previous studies was too small to be representative for each neighbourhood”. This is not true. see for example Sunquist et al (2006), which includes the entire population of Stockholm County aged 35.64 years. See also minor issue #1. . Sundquist, K., Theobald, H., Yang, M., Li, X. J., Johansson, S. E., &Sundquist, J. (2006). Neighborhood violent crime and unemployment increase the risk of coronary heart disease: A multilevel study in an urban setting. Social Science & Medicine, 62(8), 2061-2071

3. Response: Thanks a lot for your comment. We revised a paragraph below to clarify the limitations of our previous draft. And the suggested paper from Social Science & Medicine included the entire population in Stockholm as reviewer mentioned, but the paper did not assess perceived neighborhood safety which is an exposure variable of our interest. Based on our literature review, we could not find a paper which assessed perceived neighborhood safety from entire population in a region. So we believe that the representative sampling from each district in Seoul is still strength of our paper.

“ (p5 in the revised manuscript) However, these earlier studies suffer from the following limitations. First, most of previous studies used individual-level neighborhood perceived safety as exposure variable, which could be influenced by several factors such as prior individual experience of victimization or individual health conditions other than neighborhood-level safety.[11,12] This could be particularly a critical issue in previous cross-sectional studies because of the potential reverse causation, meaning that the sick are more likely to perceive their neighborhood as unsafe.[7,13]The second limitation is lack of representativeness of samples within the operationalized definition of neighborhood. Few studies had enough sample size or the sample size within neighborhood to be representative for each neighborhood.[6,8,14] Unless the responses are obtained from a representative sample of participants within each neighborhood, aggregated perceived neighborhood measures can potentially be prone to measurement errors. The final limitation is that previous studies did not adjust for district-level crime rate as a potential confounder although crime-rate has been reported to influence perception of neighborhood safety as well as residents' health outcomes.”

4. Comment: More discussion of the district level crime rate is needed. What types of crimes are included? Does it include both violent and property crimes? If “white-collar” crimes are also included, how is this justifiable in the context of the study? Can the authors comment on the gap between unreported crimes and the data that is used?

4. Response: Thank you for the comment. Considering reviewer's comments, we conducted an extra analysis with a different measure of district-level crime rate, '5 index crime rate'. '5 index crime rate'

are calculated based on five major serious crimes (i.e. murder, robbery, rape, assault and theft), which has been adopted by the Korean police to indicate violent crime rate since 1990. However, our sensitivity analysis using '5 index crime rate' does not qualitatively differ from our earlier findings using total crime rate.

"(p12 in the revised manuscript) Second, different types of crime have different effects on the perceived risk or fear of crime. For example, murder, rape, and personal theft may have higher effects on the fear of crime than larceny and auto-theft. Hence, total crime rate that was used in this research to indicate district-level crime rate would not be a proper measure when searching its association with the residents' health condition.24 However, when we conducted a post-hoc analysis with '5 index crime rate' including five different crimes (i.e. murder, robbery, rape, assault and theft), which has been adopted by Korean police to indicate violent crime rate, no association was observed in relation to self-rated health."

5. Comment: The authors state that "unavailability in appropriate neighborhood measure may explain why there is scant hierarchical or multilevel analysis which allows for estimating the influence of neighborhood measures on residents' health outcomes" (p.5). This statement is not true. There is a plethora of multilevel studies linking the effects of neighbourhood measures to resident's health. See for example: o Riva, Mylene, Gauvin, Lise, & Barnett, Tracie A. (2007). Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. Journal of Epidemiology and Community Health, 61, 853-861. oSellstrom, Eva, & Bremberg, Sven. (2006). The significance of neighbourhood context to child and adolescent health and well-being: A systematic review of multilevel studies. Scandinavian Journal of Public Health, 34, 544-554.

5. Response: Thanks a lot for your comments. We acknowledge that there are plenty of literature which used neighborhood measures. We wanted to highlight that there are only a few papers examining the relationship between perceived neighborhood safety and residents' health using multi-level analysis. Following the reviewer's suggestion, we revised the paragraph. Please check a revised paragraph above which was shown in our response for the "3. Comment"

6. Comment: Please provide information on sample size of the level-2 units (p.6) i.e. what is the mean, range and standard deviation for households included in each district.

6. Response: For each district, the number of households is 146.6 on average with standard deviation 25.57. The maximum and minimum number of households was 198 and 108, respectively. We provided them in the method section.

"(p7 in the revised manuscript) The final sample used in the data analysis of this research consists of 7,761 individuals from 3,665 households from 25 administrative districts in Seoul. The number of households in each district was 146.6 on average, ranging from 108 to 198."

7. Comment: The authors can provide more clarity to the construction of the exposure variable by presenting the exact formula used to calculate the "district-level perceived neighbourhood safety" (p. 6), this would help readers better understand the scaling of the variable and exactly how the household levels weights work.

7. Response: Let x_{ijk} be self-perceived neighborhood safety for i^{th} district, j^{th} household, and k^{th} individual. It was originally measured in a 5-level ordinal scale (1 to 5 for "strongly agree" to "strongly disagree") and we converted it to a dichotomous variable (1 for 3,4,5 representing "safe" and 0 for 1,2 representing "unsafe").

Let z_i be district-level safety for i^{th} district and n_{ij} be the household size (number of individuals) for i^{th} district and j^{th} household. Then, z_i is calculated as:

$$z_i = \sum_j w_{ij}\bar{x}_{ij} = \sum_j \frac{n_{ij}}{\sum_j n_{ij}} \quad \bar{x}_{ij} = \sum_j \frac{n_{ij}}{\sum_j n_{ij}} \quad \frac{\sum_k x_{ijk}}{n_{ij}} = \frac{\sum_j \sum_k x_{ijk}}{\sum_j n_{ij}}$$

where w_{ij} is the weight for the average safety of i^{th} district and j^{th} household. As in the last equation, the district-level safety (z_i) calculated in this way is essentially the sample proportion of individuals who answered “safe”in each district.

8. Comment: the survey wording “very agree” and “very disagree” seem awkward (p.6). Could this be a translation issue?

8. Response: Thanks a lot for pointing out this issue. We changed the manuscript: “very agree” to “strongly agree”, “very disagree” to “strongly disagree”.

9. Comment: The authors should comment on the psychometric reliability and validity of using a single question to gauge the perception of neighbourhood safety.

9. Response: Thank you for your comment. This should be one of limitations in the study. Thus we added two sentences in the limitation paragraph as shown below:

“(p 13 in the revised manuscript) Second, this study assessed perceived neighborhood safety through a single-item measure. This item may not reflect multi-dimensional aspects of the neighborhood safety.”

10. Comment: There was no reasons given for why the authors have decided to dichotomize their 5-level scale of perceived safety. My concern is that the loss of information on the gradient of perceived safety may bias the results towards the null.

10. Response: We agree that dichotomizing an ordinal-scale variable may result in loss of information. First of all, when we included individual reporting of perceived safety as a covariate, we included the variable in the original 5 ordinal scales without dichotomization.

Second, to construct district-level perceived neighborhood safety as an exposure variable of our interest, we dichotomized the individual-level perceived safety, and then we calculated the district-level safety by averaging the individual-level safety perception. The resulting score was obtained as an interval-scale variable corresponding to the sample proportion of people who answered the neighborhood as “safe” in each district. To use an ordinal-scale perceived safety for aggregate measure of district-level perceived safety, one can use an ordinal-scale reporting of perceived safety as a continuous variable (i.e. an interval-scale variable). We avoided using the individual perceived safety as a continuous variable because the equal-spacing assumption among the values 1 to 5 may not be true.

B. **Responses for the comments from Referee II**

1.Comment: In a sample of over 7,000 respondents, it is astonishing that there were no missing observations. It would have been helpful to mention exactly how this was possible.

1. Response: All respondents answered on questionnaire items we use in this study such as gender, age, self-rated health, and perceived neighborhood safety. This enables us to conduct analyses based on the entire sample participated in the first wave of SWPS without listwise deletion or missing value imputation for handling missing data. To clarify this, we revised a study population paragraph as you can see below. Furthermore, please also note that another key covariate, district-level crime rate, comes from the official statistics provided by supreme prosecutors' office in South Korea.

"(p7 in the revised manuscript) A total of 7,761 individuals completed the interviews in Wave 1. The SWPS have been publicly released [http://panel.welfare.seoul.kr]. All respondents answered on questionnaire items we used in this study, we were able to conduct our analyses based on the entire sample participated in the first wave of SWPS without listwise deletion or missing value imputation for handling missing data.

2. Comment: Given the critiques on perceived neighborhood safety presented in the introduction, it was surprising to see district level average perceived neighborhood safety measured in the very way critiqued. How does the measure of perceived neighborhood safety used in this study address the limitations the authors presented? :

2. Response: Thanks a lot for your comment. As reviewer pointed out, we used a measure to assess perceived neighborhood safety, which has been adopted in previous studies. The difference between previous literature and our research is that previous studies used individual-level perceived neighborhood safety as an exposure variable instead of constructing district-level perceived neighborhood safety as done in our study. We revised a paragraph to clarify why this difference is important. Please check a paragraph below.

" (p5 in the revised manuscript) However, these earlier studies suffer from the following limitations. First, most of previous studies used individual-level neighborhood perceived safety as exposure variable, which could be influenced by several factors such as prior individual experience of victimization or individual health conditions other than neighborhood-level safety.[11,12] This could be particularly a critical issue in previous cross-sectional studies because of the potential reverse causation, meaning that the sick are more likely to perceive their neighborhood as unsafe.[7,13] The second limitation is lack of representativeness of samples within the operationalized definition of neighborhood. Few studies had enough sample size or the sample size within neighborhood to be representative for each neighborhood.[6,8,14] Unless the responses are obtained from a representative sample of participants within each neighborhood, aggregated perceived neighborhood measures can potentially be prone to measurement errors. The final limitation is that previous studies did not adjust for district-level crime rate as a potential confounder although crime-rate has been reported to influence perception of neighborhood safety as well as residents' health outcomes."

3. Comment: Given that the district level perceived safety variable is the aggregated individual level perceived safety variable and both are included in the model, how do the authors address the potential multi-collinearity that is present by including both of these variables in the model? (e.g. potential impact on standard errors) :

3. Response: Thanks you for the comment. The individual-level safety is incorporated as a binary variable and the district-level safety is as an interval scale variable (i.e., proportions). Because of the scale difference, the sample correlations were low as 0.22 using both Pearson and Spearman methods, which indicates that multi-collinearity may not be an issue in our results.

If such multi-collinearity occurs in our results, it may have hidden the true effect of either individual-level or district-level safety on self-rated health because of the inflated standard errors. To check this, we fit a model including individual-level safety only (excluding district-level safety) fully adjusting for SES variables and crime rate and found that individual-level safety is NOT significant. This is consistent with the result from the model including both safety variables with a full adjustment. Also, district-level safety was significant regardless of including individual-level safety in the model. So, we assume that such multi-collinearity is not likely to be an issue in our results.

4. Comment: Why did the authors use multilevel models (and not marginal or GEE models)? Was it necessary (or of interest) to model the variability between districts? Are the authors interested in the variability
between the districts? They appear to only be interested in the fixed (average) effects as indicated by only reporting the odds ratio. Although the random intercepts are mentioned in the data analysis section, they are not mentioned in the results section or listed in the tables.

4. Response: We used multi-level analysis because the multi-level models are useful in either situation where random effects estimation is of interest or within-cluster correlations need to be accounted for in modeling multi-level data.

In our study, we used multi-level models to incorporate within-cluster correlations for multi-level data. For two-level hierarchical data, this can be done either using multi-level model with random intercept (equivalent to assuming exchangeable correlation within cluster) or using marginal or GEE models. However, our data is three-level hierarchical data (i.e., Individuals are nested in households and households are nested in districts) and we tried to incorporate both within-household and within-district correlations using household-specific and district-specific random intercepts, which cannot be done with marginal or GEE models.

5. Comment: Is there a different pathway linking individual level perceived safety and group (or aggregated) district level perceived safety to the health of the residents? If so, the authors should be more explicit when describing “perceived neighborhood safety” in the discussion and when include either “individual level” or “aggregated or district level” when discussing “perceived neighborhood safety”.

5. Response: Thank you for your comment. In page 13, we explained possible three pathways linking district-level perceived neighborhood safety to self-rated health irrespective of neighborhood crime rate. We revised the sentence to make it clear that the pathways district-level perceived neighborhood safety to self-rated health irrespective of not only neighborhood crime rate but also individual-level perceived neighborhood safety as below:

“There could be several pathways linking district-level perceived neighborhood safety to self-rated health irrespective of neighborhood crime rate and individual-level perceived neighborhood safety.”

6. Comment: It should be noted that finding a statistically significant finding is not generally presented as a study strength:

6. Response: Following reviewer's suggestion, we deleted a sentence and revised a paragraph about strengths of this paper as you can see below.

"(p 13 in the revised manuscript) Despite these limitations, our study has the strength in that we used representative samples for each operationalized administrative district, which enabled multi-level analysis using an district-level aggregate measure of perceived safety whereas most of previous studies used individual reporting of perceived safety as an exposure variable. Furthermore, to our knowledge, this is one of the first studies to examine the association between district-level perceived neighborhood safety and health outcome after adjusting for district-level crime rate."

7. Comment: Lastly, it is unclear what data is included in the “district level crime rate.” Does this include all crimes? It would have been helpful to include the types of crimes that are included in this rate as some crimes might be included that do not necessarily influence the safety of the residents (e.g. non-violent crimes or non-larceny crimes).

7. Response: Thanks a lot for your comments. First, ‘district-level crime rate’ used in this study includes all types of crime as a numerator, meaning that all crimes may potentially influence safety perception of residents. Thus, crime rate was calculated by dividing the total number of crimes by the total number of residents in each district. To clarify the meaning of 'district-level crime rate' which was used in this study, we revised the method section as you can see a paragraph below.

Furthermore, following reviewer's comments, we conducted an extra analysis with a different measure of district-level crime rate, '5 index crime rate'. '5 index crime rate' includes five major serious crimes (i.e. murder, robbery, rape, assault and theft), which has been adopted by the Korean police to indicate violent crime rate since 1990. However, the data analysis with '5 index crime rate' does not qualitatively differ from our earlier findings using total crime rate. We revised discussion section accordingly. Please check a paragraph below.

"(p12 in the revised manuscript) Second, different types of crime have different effects on the perceived risk or fear of crime. For example, murder, rape, and personal theft may have higher effects on the fear of crime than larceny and auto-theft. Hence, total crime rate that was used in this research to indicate district-level crime rate would not be a proper measure when searching its association with the residents’ health condition.24 However, when we conducted a post-hoc analysis with '5 index crime rate' including five different crimes (i.e. murder, robbery, rape, assault and theft), which has been adopted by Korean police to indicate violent crime rate, no association was observed in relation to self-rated health."

VERSION 2 – REVIEW

REVIEWER	Antony Chum Centre for Research on Inner City Health, St Michael's Hospital
REVIEW RETURNED	28-May-2014

GENERAL COMMENTS	My main concern of this study is regarding the theoretical basis for the pathway linking district level safety and self-rated health. My primary concern regarding this study is the theoretical basis underlying the collective sense of safety: specifically – how it is conceptualized and modeled. I fail to understand why the authors decided to control out the effects of 1) individual perceived safety and 2) crime rate. There was no adequate explanation for why this is done, and more importantly, the reader is left wondering if a substantial core component of “aggregate-level safety” has been ignored as a result of these adjustments. It makes little sense to conceive of a collective sense of safety that is not at least partly informed by crime and individuals’ rating of safety – see (Gray, Jackson, & Farrall, 2008). Given the “over-adjusted” model that is presented in the study, I believe that the odd ratios presented in table 2 do not accurately capture the true extent to which collective safety may influence self-rated health. Unless the authors can account for potential complex feedback effects between collective safety rating, crime rates, and individual

	safety rating, the multilevel model used in this paper do not adequately capture the relationship among these variables. The current method used leads to an over-adjusted model where the estimates are unreliable and inaccurate. Gray, Emily, Jackson, Jonathan, & Farrall, Stephen. (2008). Reassessing the fear of crime. European Journal of Criminology, 5(3), 363-380.

REVIEWER	Reginald Tucker-Seeley Harvard School of Public Health/ Dana-Farber Cancer Institute
REVIEW RETURNED	03-Jun-2014

GENERAL COMMENTS	The authors have addressed my concerns from the original submission.

VERSION 2 – AUTHOR RESPONSE

Response to the Reviewer #1
We really appreciate the comments from the reviewer #1 on how to improve the manuscript. We hope that this response addresses all of the reviewer's points and helps to enhance the quality of the revised manuscript.

Comments from Reviewer I.
My main concern of this study is regarding the theoretical basis for the pathway linking district level safety and self-rated health. My primary concern regarding this study is the theoretical basis underlying the collective sense of safety: specifically how it is conceptualized and modeled. I fail to understand why the authors decided to control out the effects of 1) individual perceived safety and 2) crime rate. There was no adequate explanation for why this is done, and more importantly, the reader is left wondering if a substantial core component of "aggregate-level safety" has been ignored as a result of these adjustments. It makes little sense to conceive of a collective sense of safety that is not at least partly informed by crime and individuals' rating of safety. see (Gray, Jackson, & Farrall, 2008).
Gray, Emily, Jackson, Jonathan, & Farrall, Stephen. (2008). Reassessing the fear of crime. European Journal of Criminology, 5(3), 363-380.
Given the "over-adjusted" model that is presented in the study, I believe that the odd ratios presented in table 2 do not accurately capture the true extent to which collective safety may influence self-rated health. Unless the authors can account for potential complex feedback effects between collective safety rating, crime rates, and individual safety rating, the multilevel model used in this paper do not adequately capture the relationship among these variables. The current method used leads to an over-adjusted model where the estimates are unreliable and inaccurate.
Response for the comments
Thanks a lot for your comments. The issue is how we can deal with two variables (i.e. crime rate and individual-perceived safety) to examine the association between district-level perceived safety and self-rated health.
First, as the reviewer clarified, district-level crime rate can influence district-level safety perception as well as self-rated health. If the goal of our paper were to examine the association between crime rate and health outcome, the effect estimate in our study would be inaccurate if we adjusted for district-level perceived safety because the variable could be a part of pathway linking crime rate to health outcome (District-level crime rate ◊ District-level perceived safety ◊ Health outcome).
However, the goal of this paper is to examine the association between district-level perceived safety and self-rated health. Based on the hypothesis we want to test, we think that district-level crime rate could be a relevant confounder in the association of our interest because it (district-level crime rate)

satisfies three necessary conditions for a variable to be a confounder.
(1) Risk factor for outcome variable (poor-self rated health)
(2) Associated with exposure variable (district-level perceived safety)
(3) Not a mediator in a pathway linking exposure to outcome variable.
As the reviewer mentioned, the remained question would be how we can interpret the significant association between district-level perceived safety and poor self-rated health after adjusting for district-level crime rate. Regarding this issue, we revised the paragraph below to clarify the difference between district-level perceived safety and district-level crime rate and to discuss the differential associations between two variables in relation to health outcomes. Please check the below.
“ (From Discussion Section) The differential association between district-level perceived safety and crime rate in relation to self-rated health could be explained in three ways. First, mass media may increase individual-level perceived neighborhood insecurity regardless of their neighborhood crime rates, especially when they reported the crime in ways of exaggeration.20,21 The mass media tend to emphasize criminal stories which can draw attention from audience.22 Previous studies called this phenomenon as "cultivation effect" meaning that exposure to the world of television cultivates exaggerated perceptions of viewers and magnifies viewers' fear about crime.23 The residents who watched news about neighborhood crimes are more likely to perceive their neighborhood more vulnerable regions to crime regardless of regional crime rate.21
Second, different types of crime would have different effects on the perceived risk or fear of crime. For example, murder, rape, and personal theft may have higher effects on the fear of crime than larceny and auto-theft. Hence, total crime rate that was used in this research might not be sophisticated enough to capture the association between the prevalence of crime in the district and the residents’ health condition.24 However, when we conducted a post-hoc analysis using a different measure, '5 index crime rate', which includes major five serious crimes (i.e. murder, robbery, rape, assault and theft) that has been adopted by Korean police to indicate violent crime rate, still we could not find association with residents’ self-rated health.
Finally, if social and physical resources of neighborhood are deteriorated or deprived, residents tend to perceive neighborhood safety more irrespective of the objective neighborhood crime rate.25 The poor quality of social and physical environment, such as dilapidated houses or having no formal or informal neighborhood networks, may work as a trigger to make residents perceive their neighborhood dangerous.26,27”
Second, as the reviewer stated, the role of individual perceived safety is not clear in our current study, we decided not to include "individual-perception of district safety" as a main confounder. Therefore, the observed association after adjusting for demographic information, SES, and district-level safety (without individual perceived safety) would be our main results. We re-analyzed the data, and we revised the table 2, “Result Section” of the abstract and others accordingly.
And, we found significant association between district-level perceived safety and poor self-rated health after adjusting for "individual-perception of district safety" in addition to demographic influences, SES, and district-level perceived safety. Although " individual-perception of district safety " is not a confounder in our study, the finding would be meaningful for future research to explore pathway linking district-level perceived safety to health outcome. We thought that it would be meaningful to share the results, that's why the results was shown in the revised table 2. However, if the reviewer and the editor think that we need to remove the variable from the table 2, we will follow it.