

## PEER REVIEW HISTORY

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### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Discrepancies between self-reported hearing difficulty and hearing loss diagnosed by audiometry: prevalence and associated factors in a national survey
<b>AUTHORS</b>	Choi, Ji Eun; Moon, Il Joon; Baek, Sun-Young; Kim, Seon Woo; Cho, Yang-Sun

### VERSION 1 - REVIEW

<b>REVIEWER</b>	Pernilla Videhult Pierre Karolinska institutet, Sweden
<b>REVIEW RETURNED</b>	19-Mar-2018

<b>GENERAL COMMENTS</b>	<p>Thank you for the opportunity to review the manuscript by Chio et al. I have several comments that the authors need to address:</p> <ol style="list-style-type: none"><li>1. The association between self-reported and audiometrically assessed hearing impairment is important and has been studied previously with different methods and in different populations. In the present manuscript, the authors show that it is less likely to self-assess the hearing as good when it is audiometrically impaired if one is older and have a history of tinnitus or occupational noise exposure. They also show that it is less likely to self-assess the hearing as not good when it is not audiometrically impaired if one is older or have a history of tinnitus, while the opposite (i.e., more likely) holds if the subject has a history of hypertension or depression. Most of the significant results found in the present investigation confirm previous findings. Therefore, the conclusion in Abstract needs to be modified. Moreover, in their manuscript, the authors need to refer to many more previous studies and discuss their own results in relation to them; 23 references in a manuscript that deals with so many aspects as that of the present one does, is way too few.</li><li>2. At various instances throughout the manuscript. I would prefer the word "objective" be removed whenever associated with pure-tone audiometry. Although less subjective than a questionnaire, pure-tone audiometry is not an objective method of hearing assessment, it is a psychoacoustic method.</li><li>3. At various instances throughout the manuscript. Please use the word "mean" instead of "average" if mean was used, which I believe it was. Average is an ambiguous word that can also signify median.</li><li>4. The entire manuscript would gain from some language improvement.</li></ol>
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	<p>5. Page 2, Abstract. I think the authors have spent too little time on the results section in Abstract. They should be more specific and give some ORs and 95% CIs and describe what was associated with underestimation and overestimation, respectively. Some basic results are also lacking, such as information on gender and the mean/median age (including a measure of variability) of the study population (very important since it is expected to have a large impact on the results). Moreover, the sentence “The overall prevalence of hearing discrepancy was 18.2%.” can be removed as that information is redundant due to the preceding sentence (“Among 14,345 participants, 1,876 (13.1%) had underestimated hearing impairment while 733 (5.1%) had overestimated hearing impairment.”).</p> <p>6. Page 2, row 22 and page 3, row 10-12: If I have correctly understood how exclusion was performed, “tympanic membrane” should be in plural.</p> <p>7. Page 2, rows 31-33. In the sentence defining objective hearing impairment, it must be specified that it is for the better ear.</p> <p>8. Page 2, row 48: The authors should be more specific and write “occupational noise exposure” instead of only “noise exposure”.</p> <p>9. Page 2, row 48: “Such as” should be removed, as the factors given were the only ones associated with hearing discrepancy in multivariate analysis.</p> <p>10. Page 3, row 14-16. The criteria for hearing loss must be better specified. For example, in the present study, a mean is used, not a threshold above &gt;25 dB HL at a single frequency.</p> <p>11. Page 3, keywords: In the list of keywords, please include the word “audiometry” or similar.</p> <p>12. Page 3, keywords: Since the term “self-reported hearing difficulty” is used in the title and throughout the manuscript, I suggest the keyword “self-reported hearing loss” be altered to “self-reported hearing difficulty”.</p> <p>13. Page 4, row 11-16: The authors write that many studies have shown that self-reported HD with a normal audiogram is related to cochlear neuropathy. In fact, this is rather new information found in animals, and very little is known about humans. This must be clarified in the text.</p> <p>14. Page 4, row 2246: Several studies have examined the association between subjective and objective hearing assessments, but only two references are given. More references are needed.</p> <p>15. Page 4, row 29-44: The sentences about BOSS are too detailed.</p> <p>16. Page 4, row 44- 46: I do not understand what the authors mean when they write that the studies have been confined to self-reported HD.</p> <p>17. Page 5, row 3 and row 22: A reference to KNHANES should be given.</p>
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	<p>18. Page 5, row 46-48: I believe “normal tympanic membrane” should be in plural?</p> <p>19. Page 6, row 9-20: Was the questionnaire in English or have the questions been translated? Please specify and give a reference to where the original questionnaire can be found.</p> <p>20. Page 7, row 24-27: It should be specified whether those with abnormal TM in either one ear or both ears were excluded.</p> <p>21. Page 7, row 31-40. Tinnitus has been assessed in an indistinct way. As tinnitus was significant in the multivariate analysis, the impact of an indistinct measure on the results should be discussed in Discussion.</p> <p>22. Page 7, row 50-55. Please describe more specifically how alcohol consumption was categorized.</p> <p>23. Page 8, row 5-9. Please give a reference to the rational for how monthly income level was calculated. I am thinking of the fact that the square root of the number of household members was used.</p> <p>24. Page 8, row 2-5. Marital status and occupation was assessed. The authors should give more details on how.</p> <p>25. Page 8, row 46-49. The authors should give more details on how the amount of stress and current depressive mood was assessed.</p> <p>26. Page 9, row 50-55. Please give a reference to where the guideline can be found.</p> <p>27. Page 10, line 20-22. The authors state that “variables found to have possible association in univariable analysis (<math>P &lt; 0.20</math>) were entered into the multivariable analysis model except for some serologic data.” Why? There are associations that may be significant only in the context of other variables.</p> <p>28. Page 10, row 47. The results section should begin with a description of basal demographics of the study population since this has a large impact on the results.</p> <p>29. Page 13, row 16. Kamil et al is reference #7, not 13.</p> <p>30. Page 13, row 20-22. The authors write that a difference between the their study and that of Kamil et al is that the latter study included participants aged <math>\geq 50</math> years, while the present investigation included participants aged <math>\geq 19</math> years. However, the participants in the present study were not young either; the mean age was 62 years according to Table 2.</p> <p>31. Page 13, rows 40-44. The authors write: “hypertension is known to increase the risk of HL via decreasing vascular supply to stria vascularis”. Since the underlying mechanism is not entirely elucidated, please add “possibly” (or similar) before “via”. Moreover, since it is not yet possible to study such an underlying mechanism in clinical studies, the authors should not refer to human studies.</p>
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	<p>32. Page 13, rows 44-46. Please add at least one reference in support of the statement that increased anxiety would lead to overestimation of HL.</p> <p>33. Page 13, rows 46-50. The authors write that their results demonstrate a clear association of non-auditory factors with hearing discrepancy after filtering out many other non-auditory factors using multivariable analysis. I believe that the authors overestimate the importance of their results and should be a bit more humble. For example, when it comes to hypertension and depression, the OR 95% CI is 1.061-2.123 (p=0.022) and 1.041-3.016 (p=0.035), respectively, thus a rather modest association.</p> <p>34. Page 14, rows 5-9. The authors write that participants exposed to occupational noise hardly underestimated their HI among participants who had objective HL and gives hidden hearing loss as an explanation. Perhaps those exposed for occupational noise are more aware than others of the status of their hearing due to hearing conservation programs? This would at least be a likely explanation in my country, Sweden. And what about the possibility that subjects exposed to occupational noise have worse hearing than others, i.e. a mean threshold well above 25 dB HL? There are studies showing that the association between self-reported and audiometrically assessed HL is dependent on the level of audiometrically assessed HL. This may perhaps also explain the tinnitus association, at least in part.</p> <p>35. Table 1. Footnote. The parentheses in the formulas are erroneous. For example, <math>(B+C/A+B+C+D)</math> should be <math>((B+C)/(A+B+C+D))</math>, etc.</p> <p>36. Tables 2 and 3. An explanation to SBP and DBP should be given in the footnote.</p> <p>37. Tables 2 and 3. Tables 2 and 3 need to be edited. For example, in Table 2, for Health screening, the reference category is "No" and presented last, while for hypertension, the reference category is also "No" but is presented first.</p> <p>38. In Table 2 and Table 3, EQ-VAS has a univariate p-value of 0.001, but was not included in the multivariate analysis. Why?</p>
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<b>REVIEWER</b>	Lauro J Gregianin Pediatric Oncology Service Departamento of Pediatrics Federal University of Rio Grande do Sul Porto Alegre, Brazil
<b>REVIEW RETURNED</b>	26-Mar-2018

<b>GENERAL COMMENTS</b>	The authors describe that in multivariable analysis, participants who under- or overestimated HI showed significantly decreased age. It will be clinically relevant to describe, if possible, which age-range means "decreased age"
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<b>REVIEWER</b>	Christopher Spankovich University of Mississippi Medical Center Jackson, Mississippi United States
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**GENERAL COMMENTS**

The manuscript provides an analysis using the KHANES dataset to determine overestimation and underestimation of self-reported hearing difficulty and measured audiometric thresholds. The analysis is in general well-executed, but it appears a very similar manuscript by Kim et al. (2017) "Discrepancy between self-assessed hearing status and measured audiometric evaluation", has performed a comparable analysis. The authors indicate in the discussion that differences include hearing loss being defined as PTA>40 dBHL and excluding participants with middle ear issues. It appears that the middle ear adjustment is accurate, but the Kim et al. manuscript does consider hearing loss with PTA>25dBHL as well, and their reported overall underestimated was 12.8% vs 13.1% reported here and overestimated 5.15% vs 7.1%. The new analysis does present some novel covariate relationships not addressed in Kim et al. 2017. I think the new analysis is useful, but there needs to be a greater inclusion of the Kim manuscript in the introduction and justification based on their findings what additional questions this new manuscript seeks to address and how that differs from the Kim paper. Please see further comments below by section:

Abstract: Page 2 Line 31. Audiometric thresholds are not an objective measure, rather they are dependent on subjective response. Rephrase as Audiometrically defined hearing impairment or something comparable.

Introduction: Page 4 Line 14. References 2 and 3 did not measure self-reported hearing loss, they were animal studies. The ideas of measures consistent with cochlear neuropathy (wave-I amp) and measured difficulty are few and contradictory. The majority show no relationship between wave-1 amplitude and measures of speech performance in noise.

Page 4 Line 46. This statement is inaccurate, Tremblay et al. did measure audiometric thresholds and based normal hearing on that, it was not just based on self-reported HD, they just limited their analysis to those with normal audiometric findings.

The introduction should be reworked to give greater rational based on findings from Kim et al. 2017. In addition, you should consider including reference to Hannula et al. 2011 and Spankovich et al. 2017.

Methods: what is the rationale for using  $p < 0.20$  for univariate associations?

Results: Page 12 Line 3 compare should be compared

Discussion: Why do you think you saw a lower self-report compared to Tremblay despite using a less strict definition of normal hearing. As demonstrated by Kim et al and Spankovich et al, the more restrictive definition of normal hearing shows lower prevalence of self-reported hearing difficulty. My guess is you have a much larger sample size and may explain difference compared to Trembaly, but you results are very consistent with Kim.

The manuscript is generally well-written, but a greater emphasis on differentiation from the Kim paper is missing.

<b>REVIEWER</b>	Robert Eikelboom Ear Science Institute Australia/ Ear Sciences Centre, The University of Western Australia
<b>REVIEW RETURNED</b>	29-May-2018

<b>GENERAL COMMENTS</b>	<p>The authors have reported their analysis of the hearing loss data in the Korean National Health and Nutrition Examination Survey, focusing on the relationship between objective measures and self-reports of impairment. Coincidentally in 2016/7 this reviewer was asked to review a manuscript from a group who conducted a similar study, and which was published in 2017; it is referenced in this submission.</p> <p>Although the stated objectives of these two studies are remarkably similar, the present investigators decided to examine only those with a normal tympanic membrane (TM), excluding those who possibly already had some feedback on hearing when seeking attention for their TM. They have also used a different definition for hearing loss (&gt;25dB in the better ear). And finally they have explored the association of many auditory and non-auditory factors. This study does not supersede the 2017 study particularly because of the differing cutoffs of HL.</p> <p>The study has been conducted thoroughly, and the findings are good contributions to the literature on self-reporting hearing loss. Some general comments:</p> <ul style="list-style-type: none"> <li>- Too little has been taken into account of previous work on self-reported hearing loss.</li> <li>- There could have been more thought given to what this means for public health policy and also for the clinical.</li> <li>- The manuscript is generally well written, but there is still some awkward phrasing. Seeking the assistance of a native English speaker is recommended to polish it.</li> <li>- The term 'hearing discrepancy' is used throughout the manuscript. It is not a discrepancy in hearing, and so needs to be replaced with something more suitable.</li> </ul> <p>Specific comments follow.</p> <p>Abstract: Page 2, Line 31: add that this was for the better ear.</p> <p>Line 35: 'determined' is probably a better word to use than 'calculated', and the first word in the sentence (prevalence) is not needed.</p> <p>Line 44: 'hearing discrepancy' is a term that is used here (and elsewhere e.g. line 50)), but it's not very helpful or meaningful. It's a discrepancy between objective and subjective status of hearing.</p> <p>Line 53: The conclusion is a bit weak. Strengths and weaknesses of the study: Is this a required section for the paper? I find it has the Kim et al. paper in mind. The strengths are the large sample, strict inclusion criteria, and inclusion of a number of auditory and non-auditory factors in the analysis.</p>
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	<p>Page 4, Line 22: The authors state that several studies have looked at this matter. There are in fact quite a few/many. For example: Sindhusake 2001, Kirk 2011, Ramkissoon 2011, Swanepoel 2013.</p> <p>Line 29: 'BOSS' is an unfamiliar abbreviation, and sighted once more in the manuscript. I suggest that it not be used. 'relevant' should be dropped – some have no obvious relevance until they are examined.</p> <p>Line 40: Add 'The' to the start of the sentence, and drop the words 'has' i.e. The results of the Beaver Dam Offspring Study demonstrated.... Why was the above-mentioned report by Kim et al. not included here? It would be good to provide a rationale as to why this alternative analysis was warranted.</p> <p>Line 46, last few words: The studies are comparing objective and subjective assessment of HL or HD? So why is this a limitation of study of Tremblay et al. (reference #8)?</p> <p>Page 5, line 46: Some justification of the inclusion criteria (normal TMs) is warranted; leaving it to the discussion appears to be a bit late.</p> <p>Line 27: The sentence should start with 'A'; and 'microphone' should be substituted with 'headphones'.</p> <p>Line 31: conditions.</p> <p>Line 33: query only: where Otolaryngologists used to operate the automated audiometers?</p> <p>Line 40: does this mean that the stimulus was 1 to 2 seconds, or the space between presentations was 1 to 2 seconds? The following sentence is (i) not clear (does it mean the starting point for the next frequency to be tested?), and (ii) not needed. The next two sentences are not really needed either.</p> <p>Line 44: Why? Please give a reference or two. Did anyone have thresholds that reached the limit of the audiometer? If so, how was the value handled? And was there a way to identify unreliability in participants?</p> <p>Page 7, line 33, and 40: "Within the past years" is obviously the translation from the Korean phrase used in the study. However, has this translation lost something? In English this phrase is quite vague, and one normally would expect it to include a number e.g. 'Within the past 2 years'. Without this the phrase has no meaning to the English hearer/reader. Even 'In recent years' is a bit better, which people may interpret as the past 3 years, or past 5 years.</p> <p>Line 50: 'never smoked'?</p> <p>Line 52: and what was the categorisation for alcohol consumption? Page 8, line 5: is a reference warranted. I am not familiar with this method of categorisation (although I am now – it incorporates economy of scale into the calculation of socio economic status). The authors have not explained why they selected these variables to include in the analysis. It may be too much to provide a</p>
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	<p>reference to each, but an overall rationale would be useful to include.</p> <p>Page 9, line 16: Why were self-reports of any other medical condition grouped as one, regardless of how many condition were reported? The list is incomplete. Can the reader find the full list of conditions that were included?</p> <p>Line 24: ...while sitting...</p> <p>Page 10, Line 22: “except for some serologic data” does that mean they were all included? Or they were not? The way the sentence is constructed the latter is suggested.</p> <p>Lines 37 and 40: ‘the’ to precede both instances of P-value</p> <p>Page 11 line 7: The word ‘within’ is not helpful. Although it may be read as less than 25dB. The definition of HL is that the PTA&gt;25 in the better ear. That means the other one is also &gt;25. So I would use the words “...of these participants was at least 25dB HL in one or both ears.”</p> <p>Line 16: PTA is used only once, and never defined.</p> <p>Line 24: first use of ‘restricted use of medical services’; what does it refer to? A whole list of medical conditions is listed; earlier it is stated that these were grouped together.</p> <p>Please be consistent with the terms HI and HD and HL.</p> <p>Discussion: Line 40: the term ‘hearing discrepancy’ does need revising.</p> <p>Page 13, Line 9: “showed significant decrease in age” wording needs revising. ...were significantly younger”? The next sentence is redundant.</p> <p>Line 31: Replace ‘natural’ with ‘not surprising’ and ‘advanced’ with ‘increasing’</p> <p>Line 44: the association between over-estimated HI and depression is dealt with a little too simplistically. At least a reference would be useful. And can hypertension and depression be considered together? Depression is also linked to increasing severity of HL.</p> <p>Line 53: “participants who had tinnitus reported their hearing status accurately” This implies all of them; reword this to be more nuanced.</p> <p>Line 55: The wording is awkward. Suggestion: It is possible that these participants had an audiometric assessment for their tinnitus and been informed about their hearing status.</p> <p>Page 14, Line 5: “noise hardly underestimated their HI” what does this mean?</p> <p>Table 2 (Page 27 line 12): what that ‘Occupation’ refer to?</p>
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	<p>Page 14, Line 12: The wording is awkward. Suggestion: "... in South Korea sourcing data from the same dataset has been recently reported, this present study has some significant variations in approach."</p> <p>Line 20: It is true that using 40dB as a cutoff means that people should more accurately a hearing impairment than if it was 25dB. But why is one the correct cutoff to use and not the other? I do not see this as a limitation of the earlier study, and strength of the current study. They are different. What is the clinical value of knowing someone has a better ear PTA&gt;25dB rather than &gt;40dB?</p> <p>Line 37: "not only relies..." and "also depends on..." and "The contribution..." These imply causation. This study has found only associations.</p> <p>Acknowledgements: Are these 150 people those who collected the data? The word participating is used; participating normally means those who are tested and examined, not those testing and examining.</p> <p>Tables: the key indicates that <math>p &lt; 0.05</math> is used to indicate significance. Is this after Bonferroni corrections?</p> <p>Table 2, Line 24 (and Table 3): reword to "Drinking alcohol in past year"</p>
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### VERSION 1 – AUTHOR RESPONSE

# Reviewer(s)' Comments to Author:

# Reviewer: 1

Reviewer Name: Pernilla Videhult Pierre

Institution and Country: Karolinska institutet, Sweden

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

Author's Response: We changed "The authors have no conflicts of interest to disclose" to "None declared".

# 1. The association between self-reported and audiometrically assessed hearing impairment is important and has been studied previously with different methods and in different populations. In the present manuscript, the authors show that it is less likely to self-assess the hearing as good when it is audiometrically impaired if one is older and have a history of tinnitus or occupational noise exposure. They also show that it is less likely to self-assess the hearing as not good when it is not audiometrically impaired if one is older or have a history of tinnitus, while the opposite (i.e., more likely) holds if the subject has a history of hypertension or depression. Most of the significant results found in the present investigation confirm previous findings. Therefore, the conclusion in Abstract needs to be modified. Moreover, in their manuscript, the authors need to refer to many more previous studies and discuss their own results in relation to them; 23 references in a manuscript that deals with so many aspects as that of the present one does, is way too few.

Author's Response: The reviewer's comment is well taken. We modified the conclusion in the abstract like: Therefore, older age, tinnitus, occupational noise exposure, hypertension, and depression should be incorporated into evaluation of hearing loss in clinical practice. And we added more previous studies in introduction including Kim et al. study.

# 2. At various instances throughout the manuscript. I would prefer the word "objective" be removed whenever associated with pure-tone audiometry. Although less subjective than a questionnaire, pure-tone audiometry is not an objective method of hearing assessment, it is a psychoacoustic method.

Author's Response: The reviewer's comment is well taken and we removed expression of "objective". Instead, we modified the "objective HL" to "audiometrically-measured HL (AHL)".

# 3. At various instances throughout the manuscript. Please use the word "mean" instead of "average" if mean was used, which I believe it was. Average is an ambiguous word that can also signify median.

Author's Response: Thank you for the valid point. We modified "average" to "mean" throughout the manuscript.

# 4. The entire manuscript would gain from some language improvement.

Author's Response: We have tried our best to edit the text throughout the manuscript. Our manuscript was edited by experienced English professionals, and edited again after revision.

# 5. Page 2, Abstract. I think the authors have spent too little time on the results section in Abstract. They should be more specific and give some ORs and 95% CIs and describe what was associated with underestimation and overestimation, respectively. Some basic results are also lacking, such as information on gender and the mean/median age (including a measure of variability) of the study population (very important since it is expected to have a large impact on the results). Moreover, the sentence "The overall prevalence of hearing discrepancy was 18.2%." can be removed as that information is redundant due to the preceding sentence ("Among 14,345 participants, 1,876 (13.1%) had underestimated hearing impairment while 733 (5.1%) had overestimated hearing impairment.").

Author's Response: Thank you for the valid point. We included the ORs and 95% CIs and described specific factors which associated with underestimation and overestimation. Also, we removed the sentence "The overall prevalence of hearing discrepancy was 18.2%.". The target population of KNHANES comprises noninstitutionalized Korean citizens residing in Korea. We described about data source in Method. In this study, 14,345 participants aged 19 and older were included in analysis. The mean  $\pm$  SD age of the study population was  $49.2 \pm 16.1$  years (ranged from 19 to 97). The study population consisted of 42.5% male and 57.5% female.

# 6. Page 2, row 22 and page 3, row 10-12: If I have correctly understood how exclusion was performed, "tympanic membrane" should be in plural.

Author's Response: We agree that this sentence should be more clarified. We included the participants who had normal TMs on both ears. Trained otolaryngologists categorized the right and left TMs into the following three groups: normal, abnormal, and could not examine. Participants were grouped as having normal TM only when TMs of both ears were normal. If participants had abnormal TM in either one ear or both ears, they were grouped as having abnormal TM. Abnormal TM findings included TM perforation, cholesteatoma (including retraction pocket), and otitis media with effusion (including the presence of a ventilation tube). Throughout the manuscript, "tympanic membrane" is expressed in plural and otologic examination was described in Method.

# 7. Page 2, rows 31-33. In the sentence defining objective hearing impairment, it must be specified that it is for the better ear.

Author's Response: Thank you for the valid point. We specified that audiometrically-measured HL defined as over 25 dB with mean hearing thresholds measured at 0.5, 1, 2, and 4 kHz in better ear. (Page 6, rows 139)

# 8. Page 2, row 48: The authors should be more specific and write "occupational noise exposure" instead of only "noise exposure".

Author's Response: Thank you for the valid point. We wrote "exposure to occupational noise" instead of "noise exposure". (Page 7, rows 158)

9. Page 2, row 48: "Such as" should be removed, as the factors given were the only ones associated with hearing discrepancy in multivariate analysis.

Author's Response: As reviewer's comment, we removed "such as".

# 10. Page 3, row 14-16. The criteria for hearing loss must be better specified. For example, in the present study, a mean is used, not a threshold above >25 dB HL at a single frequency.

Author's Response: As reviewer's comment, we specified and added the "mean". (Page 6, row 138)

# 11. Page 3, keywords: In the list of keywords, please include the word "audiometry" or similar.

Author's Response: Thank you for the valid point. We added it.

# 12. Page 3, keywords: Since the term "self-reported hearing difficulty" is used in the title and throughout the manuscript, I suggest the keyword "self-reported hearing loss" be altered to "self-reported hearing difficulty".

Author's Response: The reviewer's comment is well taken. We changed the term "self-reported hearing loss" to "self-reported hearing difficulty (SHD)".

# 13. Page 4, row 11-16: The authors write that many studies have shown that self-reported HD with a normal audiogram is related to cochlear neuropathy. In fact, this is rather new information found in animals, and very little is known about humans. This must be clarified in the text.

Author's Response: We agree that the references were about animal study. We also deleted this sentence because we felt it was unnecessary.

# 14. Page 4, row 2246: Several studies have examined the association between subjective and objective hearing assessments, but only two references are given. More references are needed.

Author's Response: We agree with reviewer's comment and more references were added.

# 15. Page 4, row 29-44: The sentences about BOSS are too detailed.

Author's Response: The reviewer's comment is well taken and the overall contents of the introduction were revised. The detailed description of previous studies is reduced, and the paragraphs that do not match the scope of the introduction are deleted. Thus, we deleted the sentences about BOSS.

# 16. Page 4, row 44- 46: I do not understand what the authors mean when they write that the studies have been confined to self-reported HD.

Author's Response: Previous studies have been focused on overestimated hearing impairment (self-reported hearing difficulty with normal audiogram). We added "with normal audiogram" at the behind the "self-reported HD" to make it clear (Page 4, row 80).

# 17. Page 5, row 3 and row 22: A reference to KNHANES should be given.

Author's Response: The reports and microdata of KNHANES are released annually and are available to the public through the official website of KNHANES (<http://knhanes.cdc.go.kr>). Previously, we mentioned about data access in the end (page 16). To provide more information about data access, we separated the subtitle into "Data source" and "Study population". We described the source of data and added the reference about data resource profile.

# 18. Page 5, row 46-48: I believe "normal tympanic membrane" should be in plural?

Author's Response: Yes, as you pointed in #6, we included the participants who had normal TMs on both ears. Throughout the manuscript, "tympanic membrane" is expressed in plural

# 19. Page 6, row 9-20: Was the questionnaire in English or have the questions been translated? Please specify and give a reference to where the original questionnaire can be found.

Author's Response: The original question is in Korean. Even though the guidebook for data users could be found at official website of KNHANES, KCDC do not provide a translated English version of guidebook. All English-language papers using KNHANES data have been translated into English.

# 20. Page 7, row 24-27: It should be specified whether those with abnormal TM in either one ear or both ears were excluded.

Author's Response: We agree that this sentence could be confusing to the readers. We included only participants whose TMs were normal on both ears. We removed the unnecessary sentences and mentioned only the inclusion criteria.

# 21. Page 7, row 31-40. Tinnitus has been assessed in an indistinct way. As tinnitus was significant in the multivariate analysis, the impact of an indistinct measure on the results should be discussed in Discussion.

Author's Response: Participants were also asked about their tinnitus experiences using the following question "Within the past year, did you ever hear a sound (buzzing, hissing, ringing, humming, roaring, machinery noise) originating in your ear?". Examiners were instructed to record either "yes" or "no". If a participant reported that they heard an odd or unusual noise at any time in past years, examiners recorded "yes". Most of variables were measured using questionnaires. For example, occupational noise exposure also assessed using questionnaire. Participants were instructed to record either "yes" or "no" for the question "Have you ever worked more than 3 months in the place where you have to speak louder to communicate with others because of noising sound?". We have described the survey method in detail to help readers to understand it.

# 22. Page 7, row 50-55. Please describe more specifically how alcohol consumption was categorized.

Author's Response: The reviewer's comment is well taken. Alcohol consumption was divided into two groups according to their drinking frequency: non-drinker and drinker. A non-drinker was defined as participant who had never drunk during the last year (Page 7, rows 166-168).

# 23. Page 8, row 5-9. Please give a reference to the rationale for how monthly income level was calculated. I am thinking of the fact that the square root of the number of household members was used.

Author's Response: The reviewer's comment is well taken. Monthly income indicates equalized monthly household income and was calculated by dividing total family income by the square root of the number of household members. Monthly income was classified into quartiles to determine monthly income level; lower, lower middle, upper middle, and upper.

# 24. Page 8, row 2-5. Marital status and occupation was assessed. The authors should give more details on how.

Author's Response: The reviewer's comment is well taken. Marital status was divided into two groups through the questionnaire: ever married and never married. The marital status question was "Have you been married?". Ever married included participants married at the time of survey, separated, widowed, or divorced. And because we did not present the types of occupation, the expression of 'occupation' changed in 'employment status'. Employment status was divided into employed and unemployed groups (row 173-178).

# 25. Page 8, row 46-49. The authors should give more details on how the amount of stress and current depressive mood was assessed.

Author's Response: The reviewer's comment is well taken. We added the details on how the self-reported stress and depression level was assessed. Participants were asked about their stress level using the following question "How much do you feel stress in ordinary life?". They were instructed to report one of the following responses to the question "extremely stressed", "quite stressed", "a little bit stressed", and "not stressed at all". The responses were re-categorized into 'low level (not stressed at all or a little bit stressed)' or 'high level (extremely or quite stressed)'. To assess the self-perceived level of depression, participants answered either "yes" or "no" to the following questions "Have you felt sorrow or despair that has affected your daily life for more than 2 weeks continuously during the past year?". (rows 194-201)

# 26. Page 9, row 50-55. Please give a reference to where the guideline can be found.

Author's Response: The Korea Centers for Disease Control and Prevention (KCDC) has published guideline for analysis through the official website of KNHANES (<http://knhanes.cdc.go.kr>). We added this statement in statistical analysis.

# 27. Page 10, line 20-22. The authors state that "variables found to have possible association in univariable analysis ( $P < 0.20$ ) were entered into the multivariable analysis model except for some serologic data." Why? There are associations that may be significant only in the context of other variables.

Author's Response: If logistic or linear regression includes as many input variables as possible, this can dilute true associations and lead to large standard errors with wide and imprecise confidence intervals, or, conversely, identify spurious associations (Common pitfalls in statistical analysis: Logistic regression, *Perspect Clin Res.* 2017 Jul-Sep; 8(3)). The conventional technique is to first run the univariate analyses (i.e., relation of the outcome with each predictor, one at a time) and then use only those variables which meet a preset cutoff for significance to run a multivariable model. This cutoff is often more liberal than the conventional cutoff for significance since its purpose is to identify potential predictor variables rather than to test a hypothesis. As many references suggested and used (Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models. New York, Springer. 2005, p.146., Simulation study of confounder-selection strategies. *Am J Epidemiol* 138:923-936., Development and validation of a prediction model for gestational hypertension in a Ghanaian cohort. *BMJ Open.* 2017;7:e012670.), we used the  $P < 0.20$ , instead of the usual  $P < 0.05$ . And serologic data was not entered into the multivariable analysis model due to significant missing data. We mentioned this in Statistical analysis.

# 28. Page 10, row 47. The results section should begin with a description of basal demographics of the study population since this has a large impact on the results.

Author's Response: We agree with reviewer's comment and we added the basic characteristics of study population. A total of 14,345 participants were ultimately eligible for this study. The mean  $\pm$  SD

age of the study population was  $49.2 \pm 16.1$  years (ranged from 19 to 97). The study population consisted of 42.5% male and 57.5% female.

# 29. Page 13, row 16. Kamil et al is reference #7, not 13.

Author's Response: Thank you for your careful observation. We corrected it.

# 30. Page 13, row 20-22. The authors write that a difference between their study and that of Kamil *et al* is that the latter study included participants aged  $\geq 50$  years, while the present investigation included participants aged  $\geq 19$  years. However, the participants in the present study were not young either; the mean age was 62 years according to Table 2.

Author's Response: The mean age of study population in current study was  $49.2 \pm 16.1$  years (ranged from 19 to 97). Among these, we analyzed the population with self-reported HD and population with audiometrically-measured HL. It is well-known that audiometric HL can dramatically increase with increasing age. For this reason, the mean age of participants with bilateral HL were relatively high even though they were all aged  $\geq 19$  years.

# 31. Page 13, rows 40-44. The authors write: "hypertension is known to increase the risk of HL via decreasing vascular supply to stria vascularis". Since the underlying mechanism is not entirely elucidated, please add "possibly" (or similar) before "via". Moreover, since it is not yet possible to study such an underlying mechanism in clinical studies, the authors should not refer to human studies.

Author's Response: The reviewer's comment is well taken. We added the possibly before 'though'. (row 349)

# 32. Page 13, rows 44-46. Please add at least one reference in support of the statement that increased anxiety would lead to overestimation of HL.

Author's Response: The reviewer's comment is well taken. We added the references. Studies have suggested that personality traits of neuroticism had a more adverse perception of their HD, and it is widely known as an important factor that influences depression (see the reference #31). Accordingly, depression may lead to an increased perception of HD.

# 33. Page 13, rows 46-50. The authors write that their results demonstrate a clear association of non-auditory factors with hearing discrepancy after filtering out many other non-auditory factors using multivariable analysis. I believe that the authors overestimate the importance of their results and should be a bit more humble. For example, when it comes to hypertension and depression, the OR 95% CI is 1.061-2.123 ( $p=0.022$ ) and 1.041-3.016 ( $p=0.035$ ), respectively, thus a rather modest association.

Author's Response: We agree with reviewer's comment. We deleted this sentence.

# 34. Page 14, rows 5-9. The authors write that participants exposed to occupational noise hardly underestimated their HI among participants who had objective HL and gives hidden hearing loss as an explanation. Perhaps those exposed for occupational noise are more aware than others of the status of their hearing due to hearing conservation programs? This would at least be a likely explanation in my country, Sweden. And what about the possibility that subjects exposed to occupational noise have worse hearing than others, i.e. a mean threshold well above 25 dB HL? There are studies showing that the association between self-reported and audiometrically assessed HL is dependent on the level of audiometrically assessed HL. This may perhaps also explain the tinnitus association, at least in part.

Author's Response: We agree with reviewer's comment and we revised as follows: It is possible that these participants had an audiometric assessment for their tinnitus or occupational health screening program and had known about their hearing status.

And we also added the following sentence: Participants exposed to occupational noise are more likely to have severe HL than other participants and the severity of HL may affect self-reported HD. (rows 356-360)

# 35. Table 1. Footnote. The parentheses in the formulas are erroneous. For example,  $(B+C/A+B+C+D)$  should be  $((B+C)/(A+B+C+D))$ , etc.

Author's Response: Thank you for your careful observation. We revised the typos.

# 36. Tables 2 and 3. An explanation to SBP and DBP should be given in the footnote.

Author's Response: Thank you for your careful observation. We commented in the footnote.

# 37. Tables 2 and 3. Tables 2 and 3 need to be edited. For example, in Table 2, for Health screening, the reference category is "No" and presented last, while for hypertension, the reference category is also "No" but is presented first.

Author's Response: Thank you for your careful observation. We changed the order of categories. The reference category "No" is presented last.

# 38. In Table 2 and Table 3, EQ-VAS has a univariate p-value of 0.001, but was not included in the multivariate analysis. Why?

Author's Response: Thank you for the valid point. Although EQ-5D, EQ-5D index, and EQ-VAS had a significant univariate p-value, these variables measured the quality of life and are highly correlated with one another. In such case, the regression model should include only one of the inter-related predictors for accuracy. Therefore, we selected the EQ-5D index as a variable to be entered into the multivariate analysis model.

# Reviewer: 2

Reviewer Name: Lauro J Gregianin

Institution and Country: Pediatric Oncology Service, Departamento of Pediatrics, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

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

Author's Response: We changed "The authors have no conflicts of interest to disclose" to "None declared".

Please leave your comments for the authors below

# The authors describe that in multivariable analysis, participants who under- or overestimated HI showed significantly decreased age. It will be clinically relevant to describe, if possible, which age-range means "decreased age"

Author's Response: We thank the Reviewer #2 for his/her positive comments regarding our manuscript. The age ranges from 19 to 97 years old, and the results means decreasing age is associated with higher incidence of over- or under estimation of hearing impairment.

# Reviewer: 3

Reviewer Name: Christopher Spankovich

Institution and Country: University of Mississippi Medical Center, Jackson, Mississippi, United States

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

Author's Response: We changed "The authors have no conflicts of interest to disclose" to "None declared".

Please leave your comments for the authors below

bmjopen-2018-022440

# The manuscript provides an analysis using the KHANES dataset to determine overestimation and underestimation of self-reported hearing difficulty and measured audiometric thresholds. The analysis is in general well-executed, but it appears a very similar manuscript by Kim et al. (2017) "Discrepancy between self-assessed hearing status and measured audiometric evaluation", has performed a comparable analysis. The authors indicate in the discussion that differences include hearing loss being defined as PTA>40 dBHL and excluding participants with middle ear issues. It appears that the middle ear adjustment is accurate, but the Kim et al. manuscript does consider hearing loss with PTA>25dBHL as well, and their reported overall underestimated was 12.8% vs 13.1% reported here and overestimated 5.15% vs 7.1%. The new analysis does present some novel covariate relationships not addressed in Kim et al. 2017. I think the new analysis is useful, but there needs to be a greater inclusion of the Kim manuscript in the introduction and justification based on their findings what additional questions this new manuscript seeks to address and how that differs from the Kim paper. Please see further comments below by section:

Author's Response: We are in complete understanding with the reviewer's concern. The difference between our study and Kim et al. was mentioned in the introduction and discussion. First, we excluded data from participants with abnormal TM who are more likely to have undergone a previous hearing evaluation. Second, we excluded normal hearing population with normal audiometry and without SHD in the analysis, and confined the concordant HI group to those who showed both SHD and AHL. Kim et al. set a reference as concordance group including normal hearing population whose self-reported hearing assessment was matched to their audiometric thresholds. Since most of the concordance group (93%) had no SHD and normal audiometry (<25dB), their analysis is likely to have a bias of depending on the hearing level rather than the discrepancy between subjective hearing assessment and audiometry itself. Sub-group analysis for participants with ≥ 25dB in Kim et al. showed that age, sex, education, occupation, and stress was irrelevant to discrepancy between subjective hearing assessment and audiometric thresholds. Bellow results is sub-group analysis of Kim et al. study.

S2 Table Subgroup analysis of self-perceived hearing difficulty using logistic regression analysis with complex sampling (reference = concordance group)

Subgroup	<25 dB			≥25 dB, <40 dB			≥40 dB			
	AOR	95% CI	P-value	AOR	95% CI	AOR	95% CI	P-value	AOR	95% CI
Related factors	Overestimation			Overestimation	Underestimation			Underestimation		



Age (10 years)	1.33	1.24-1.44	<0.001†	0.85	0.65-1.12	0.99	0.88-1.12	0.516	0.90	0.72-1.13	0.356
Sex			0.160					0.145			0.623
Male	1			1		1			1		
Female	0.89	0.75-1.05		0.61	0.04-1.01	0.86	0.66-1.12		0.91	0.61-1.34	
Education			0.174					0.891			0.331
Low	1			1		1			1		
Middle	0.84	0.69-1.04		0.96	9.53-1.76	1.01	0.73-1.40		0.74	0.44-1.23	
High	0.80	0.60-1.05		0.62	0.24-1.59	0.93	0.59-1.45		0.63	0.27-1.48	
Occupation			0.009†					0.215			0.884
Specialized worker	1			1		1			1		
Service worker	1.52	1.13-2.04		0.68	0.15-3.19	1.34	0.7-2.38		0.65	0.15-2.81	
Manual worker	1.40	1.04-1.88		1.10	0.25-4.76	1.03	0.59-1.78		0.60	0.16-2.27	
Unemployed	1.50	1.18-1.90		2.00	0.45-8.23	1.26	0.72-2.20		0.59	0.16-2.20	
Stress			0.001†					0.077			
None	1			1		1			1		0.773
Some	1.29	1.00-1.66		0.90	0.46-1.74	0.83	0.62-1.11		1.11	0.73-1.67	
Moderate	1.85	1.39-2.47		0.84	0.40-1.79	0.72	0.51-1.01		0.90	0.57-1.44	
Severe	1.93	1.26-2.94		3.03	1.10-8.32	1.13	0.62-2.06		1.28	0.56-2.90	
Anxiety/depression			0.010†					0.003†			0.465
No	1			1		1			1		
Moderate	1.39	1.13-1.72		0.60	0.33-1.07	0.63	0.46-0.86		1.07	0.65-1.77	

Extreme	1.12	0.58-2.17	0.16	0.03-0.83	0.38	0.18-0.82	0.49	0.15-1.63	
Tympanic membrane			<0.001†				0.002†		<0.001†
Normal, both	1		1		1		1		
Abnormal, unilateral	2.29	1.79-2.90	1.75	0.98-3.14	0.76	0.56-1.04	0.65	0.41-1.03	
Abnormal, bilateral	2.39	1.52-3.77	2.58	1.21-5.05	0.74	0.45-1.18	0.29	0.17-0.49	
Tinnitus			<0.001†				<0.001†		0.001†
No	1		1		1		1		
Yes	2.56	2.19-2.99	2.06	1.26-3.36	0.52	0.41-0.64	0.54	0.38-0.77	

\*Estimated rate, adjusted with weighted values

† Significance at P < 0.05

Lastly, this study analyzed more comprehensive variables including smoking status, alcohol consumption, waist circumference, body mass index, monthly income, marital status, quality of life, self-reported health status, body shape perception, noise exposure, physical activity, the use of medical service, and current disease, and serologic data.

We also tried to explain why some of our results were different from those of Kim et al.

# Abstract: Page 2 Line 31. Audiometric thresholds are not an objective measure, rather they are dependent on subjective response. Rephrase as Audiometrically defined hearing impairment or something comparable.

Author's Response: We agree with reviewer's comment and we reworded the "objective" to "audiometrically-measured".

# Introduction: Page 4 Line 14. References 2 and 3 did not measure self-reported hearing loss, they were animal studies. The ideas of measures consistent with cochlear neuropathy (wave-I amp) and measured difficulty are few and contradictory. The majority show no relationship between wave-1 amplitude and measures of speech performance in noise.

Author's Response: We agree with reviewer's comment and we deleted the paragraph because it did not fit the scope of the introduction.

# Page 4 Line 46. This statement is inaccurate, Tremblay et al. did measure audiometric thresholds and based normal hearing on that, it was not just based on self-reported HD, they just limited their analysis to those with normal audiometric findings.

The introduction should be reworked to give greater rationale based on findings from Kim et al. 2017. In addition, you should consider including reference to Hannula et al. 2011 and Spankovich et al. 2017.

Author's Response: The reviewer's comment is well taken. We added the reference (Hannula et al. 2011 and Spankovich et al. 2017.) Also, the overall contents of the introduction were revised. The detailed description of previous studies is reduced.

# Methods: what is the rationale for using  $p < 0.20$  for univariate associations?

Author's Response: The reviewer's comment is well taken and reviewer #1 also pointed out. If logistic or linear regression includes as many input variables as possible, this can dilute true associations and lead to large standard errors with wide and imprecise confidence intervals, or, conversely, identify spurious associations (Common pitfalls in statistical analysis: Logistic regression, *Perspect Clin Res.* 2017 Jul-Sep; 8(3)). The conventional technique is to first run the univariate analyses (i.e., relation of the outcome with each predictor, one at a time) and then use only those variables which meet a preset cutoff for significance to run a multivariable model. This cutoff is often more liberal than the conventional cutoff for significance since its purpose is to identify potential predictor variables rather than to test a hypothesis. As many references suggested and used (*Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models.* New York, Springer. 2005, p.146., *Simulation study of confounder-selection strategies.* *Am J Epidemiol* 138:923-936., *Development and validation of a prediction model for gestational hypertension in a Ghanaian cohort.* *BMJ Open.* 2017;7:e012670.), we used the  $P < 0.20$ , instead of the usual  $P < 0.05$ . And serologic data was not entered into the multivariable analysis model due to missing data.

# Results: Page 12 Line 3 compare should be compared

Author's Response: Thank you for your careful observation. We revised it.

# Discussion: Why do you think you saw a lower self-report compared to Tremblay despite using a less strict definition of normal hearing. As demonstrated by Kim et al and Spankovich et al, the more restrictive definition of normal hearing shows lower prevalence of self-reported hearing difficulty. My guess is you have a much larger sample size and may explain difference compared to Tremblay, but your results are very consistent with Kim.

Author's Response: Thank you for the valid point. Tremblay et al. reported that 682 participants had normal hearing by audiometry among 2783 participants. Among 682 participants with normal hearing, 82 participants had self-reported HD. Accordingly, the prevalence of overestimated HI among all participants (2.9%) was lower than 5.1% in our result, but the prevalence of overestimated HI among participants with normal hearing (12%) was higher than 6.4% in our result (6.4%). This may be due to differences in the way self-reported hearing was assessed, but we did not mention this in the discussion. Because the accuracy of hearing assessments in the present study was similar to that reported in previous studies, we thought that result of Tremblay et al. was an unusual finding and we deleted related contents.

# The manuscript is generally well-written, but a greater emphasis on differentiation from the Kim paper is missing.

Author's Response: We thank for positive comments regarding our manuscript. Previously, Kim et al. (2017) was cited in the discussion, but it has been quoted again in the introduction as other reviewers

have suggested. We describe the limitation of Kim et al (2017) study and explained the need for our study in the introduction.

# Reviewer: 4

Reviewer Name: Robert Eikelboom

Institution and Country: Ear Science Institute Australia/ Ear Sciences Centre, The University of Western Australia

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

Author's Response: We changed "The authors have no conflicts of interest to disclose" to "None declared".

Please leave your comments for the authors below

# The authors have reported their analysis of the hearing loss data in the Korean National Health and Nutrition Examination Survey, focusing on the relationship between objective measures and self-reports of impairment.

Coincidentally in 2016/7 this reviewer was asked to review a manuscript from a group who conducted a similar study, and which was published in 2017; it is referenced in this submission.

Although the stated objectives of these two studies are remarkably similar, the present investigators decided to examine only those with a normal tympanic membrane (TM), excluding those who possibly already had some feedback on hearing when seeking attention for their TM. They have also used a different definition for hearing loss (>25dB in the better ear). And finally they have explored the association of many auditory and non-auditory factors. This study does not supersede the 2017 study particularly because of the differing cutoffs of HL.

The study has been conducted thoroughly, and the findings are good contributions to the literature on self-reporting hearing loss.

Some general comments:

- Too little has been taken into account of previous work on self-reported hearing loss.
- There could have been more thought given to what this means for public health policy and also for the clinical.
- The manuscript is generally well written, but there is still some awkward phrasing. Seeking the assistance of a native English speaker is recommended to polish it.
- The term 'hearing discrepancy' is used throughout the manuscript. It is not a discrepancy in hearing, and so needs to be replaced with something more suitable.

Author's Response: We are in complete understanding with the reviewer's concerns and have tried our best to edit the text throughout the manuscript. First of all, we mentioned the difference between our study and Kim et al. and described the reason why this study is needed. Then, we have discussed some variations in approach compared to Kim et al. We also tried to explain why some of our results were different from those of Kim et al. As the reviewers recommended, we cited more references in introduction. Also, "hearing discrepancy" was changed to "discrepancy between self-reported hearing and audiometry" though out the manuscript. Actually, our manuscript was edited by experienced English professionals, and edited again after this revision.

Specific comments follow.

Abstract:

# Page 2, Line 31: add that this was for the better ear.

Author's Response: We agree with reviewer's comment. We changed the sentence as follows: Audiometrically-measured HL was defined as over 25 dB with mean hearing thresholds measured at 0.5, 1, 2, and 4 kHz in the better ear.

# Line 35: 'determined' is probably a better word to use than 'calculated', and the first word in the sentence (prevalence) is not needed.

Author's Response: We deleted the sentence during revising the abstract.

Line 44: 'hearing discrepancy' is a term that is used here (and elsewhere e.g. line 50)), but it's not very helpful or meaningful. It's a discrepancy between objective and subjective status of hearing.

Author's Response: We deleted the sentence during revising the abstract.

Line 53: The conclusion is a bit weak.

Strengths and weaknesses of the study: Is this a required section for the paper? I find it has the Kim et al. paper in mind. The strengths are the large sample, strict inclusion criteria, and inclusion of a number of auditory and non-auditory factors in the analysis.

Author's Response: The "Strengths and limitations of this study" is a required section. Kim et al. study and our study are largely different in two respects. First, we only included participants whose TMs are normal to exclude participants who have undergone a previous hearing evaluation. Second, Kim et al. study and our study differ in the control group (concordant group) comparing over- or underestimated hearing impairment groups. In Kim et al. study, the concordance group comprised those whose self-reported hearing loss was similar to their audiometric PTA results and who reported no difficulty hearing at <25 dB HL, some difficulty at ≥ 25 dB HL and <40 dB HL, and much difficulty at ≥ 40 dB HL hearing thresholds. In our study, concordant HI was defined as having both audiometrically-measured HL and self-reported HD. Thus, Kim et al. study included participants without self-reported HD and audiometrically-measured HL in the analysis, but our study did not include them.

Page 4, Line 22: The authors state that several studies have looked at this matter. There are in fact quite a few/many. For example: Sindhusake 2001, Kirk 2011, Ramkissoon 2011, Swanepoel 2013.

Author's Response: Although several studies have reported prevalence and factors associated with hearing discrepancy, these studies have focused on elderly population or self-reported HD with normal audiogram. Few studies have focused on the non-auditory factors (socioeconomic factors, psychological factors, health care utilization, or other personal information) that might influence the self-reported hearing assessment in large populations of various ages. We added more reference and the overall contents of the introduction were revised.

Line 29: 'BOSS' is an unfamiliar abbreviation, and cited once more in the manuscript. I suggest that it not be used. 'relevant' should be dropped – some have no obvious relevance until they are examined.

Author's Response: The reviewer's comment is well taken and we removed the abbreviation.

Line 40: Add 'The' to the start of the sentence, and drop the words 'has' i.e. The results of the Beaver Dam Offspring Study demonstrated....

Author's Response: Thank you for the valid point. However, we deleted that sentence during revising the whole introduction.

Why was the above-mentioned report by Kim et al. not included here? It would be good to provide a rationale as to why this alternative analysis was warranted.

Author's Response: Thank you for the valid point. We cited Kim et al. study. Although Kim et al. has been recently reported national population-based study on hearing discrepancy, this study included participants with abnormal tympanic membrane (TM) findings such as TM perforation, cholesteatoma, and otitis media with effusion. National survey of this study did not assess whether participants had previously received an audiometric evaluation. Because individuals who have abnormal TM are more likely to have undergone a previous hearing evaluation, this might have influenced hearing discrepancy. As reviewer's comment, we cited the Kim et al. study also in the Introduction session.

Line 46, last few words: The studies are comparing objective and subjective assessment of HL or HD? So why is this a limitation of study of Tremblay et al. (reference #8)?

Author's Response: Hearing discrepancy could be divided into over- and under-estimated hearing impairment. However, Tremblay et al. only reported about overestimated hearing impairment (That is, self-reported hearing difficulty with normal audiogram). We described the limitations of previous studies in introduction as follows: Previous studies have reported that accuracy of self-reported hearing difficulty (HD) is associated with auditory factors (e.g., degree of hearing loss, frequencies of hearing loss, middle ear infection etc.) as well as demographic factors. However, these studies mainly have focused on elderly population or self-reported HD with normal audiogram.

# Page 5, line 46: Some justification of the inclusion criteria (normal TMs) is warranted; leaving it to the discussion appears to be a bit late.

Author's Response: We added the reason why we included participants with normal TMs in this study.

# Line 27: The sentence should start with 'A'; and 'microphone' should be substituted with 'headphones'.

Author's Response: As reviewer's comment, we added "A" and substituted to "headphone".

# Line 31: conditions.

Author's Response: Thank you for your careful observation. We revised it.

# Line 33: query only: where Otolaryngologists used to operate the automated audiometers?

Author's Response: If the reviewer's query means where the otolaryngologists operated this audiometer during the survey, the survey unit of KNHANES contains a double-walled audiometric sound booth, and a otolaryngologists operated audiometer outside the booth.

# Line 40: does this mean that the stimulus was 1 to 2 seconds, or the space between presentations was 1 to 2 seconds? The following sentence is (i) not clear (does it mean the starting point for the next frequency to be tested?), and (ii) not needed. The next two sentences are not really needed either.

Author's Response: The reviewer's comment is well taken and we removed the unnecessary sentences.

# Line 44: Why? Please give a reference or two. Did anyone have thresholds that reached the limit of the audiometer? If so, how was the value handled? And was there a way to identify unreliability in participants?

Author's Response: As you pointed out above, we removed the unnecessary sentences.

# Page 7, line 33, and 40: "Within the past years" is obviously the translation from the Korean phrase used in the study. However, has this translation lost something? In English this phrase is quite vague, and one normally would expect it to include a number e.g. 'Within the past 2 years'. Without this the phrase has no meaning to the English hearer/reader. Even 'In recent years' is a bit better, which people may interpret as the past 3 years, or past 5 years.

Author's Response: Thank you for your careful observation. There was a typo. We changed as follows: During the past year, did you ever hear a sound.

# Line 50: 'never smoked'?

Author's Response: Thank you for your careful observation. We revised it.

# Line 52: and what was the categorisation for alcohol consumption?

Author's Response: The reviewer's comment is well taken and reviewer #1 also commented about this. Alcohol consumption was divided into two groups according to their drinking frequency: non-drinker and drinker. A non-drinker was defined as participant who had never drunk during the last year.

# Page 8, line 5: is a reference warranted. I am not familiar with this method of categorisation (although I am now – it incorporates economy of scale into the calculation of socio economic status). The authors have not explained why they selected these variables to include in the analysis. It may be too much to provide a reference to each, but an overall rationale would be useful to include.

Author's Response: Levels of income and occupation were chosen as economic status indicators. Monthly income indicates equalized monthly household income and was calculated by dividing total family income by the square root of the number of household members. Monthly income was classified into quartiles to determine monthly income level; lower, lower middle, upper middle, and upper.

# Page 9, line 16: Why were self-reports of any other medical condition grouped as one, regardless of how many condition were reported? The list is incomplete. Can the reader find the full list of conditions that were included?

Author's Response: The survey list of diseases can be also found through the official website of KNHANES (<http://knhanes.cdc.go.kr>). Among these, histories of hearing-related diseases such as obesity, hypertension, myocardial infarction, angina, asthma, depression, renal failure, and diabetes mellitus were selected as variable. (See reference 13-15)

# Line 24: ...while sitting...

Author's Response: Thank you for your careful observation. We revised it.

# Page 10, Line 22: "except for some serologic data" does that mean they were all included? Or they were not? The way the sentence is constructed the latter is suggested.

Author's Response: The reviewer's comment is well taken. Serologic data was not entered into the multivariable analysis model due to significant missing data.

# Lines 37 and 40: 'the' to precede both instances of P-value

Author's Response: We added "the".

# Page 11 line 7: The word 'within' is not helpful. Although it may be read as less than 25dB. The definition of HL is that the PTA>25 in the better ear. That means the other one is also >25. So I would use the words "...of these participants was at least 25dB HL in one or both ears."

Author's Response: Thank you for your careful observation. We changed it.

Line 16: PTA is used only once, and never defined.

Author's Response: Thank you for your careful observation. We reworded it to "mean hearing thresholds >25dB HL at 0.5, 1, 2, and 4 kHz).

Line 24: first use of 'restricted use of medical services'; what does it refer to?

A whole list of medical conditions is listed; earlier it is stated that these were grouped together.

Author's Response: We described about 'restricted use of medical service' in Methods. Restricted use of medical service was defined as if the patients had been unable to use the medical service (except for dentistry) during the past year.

Please be consistent with the terms HI and HD and HL.

Author's Response: The reviewer's comment is well taken and we reviewed the whole sentence again.

Discussion:

# Line 40: the term 'hearing discrepancy' does need revising.

Author's Response: We revised as follows: discrepancy between their self-reported HD and audiometrically-measured HL.

# Page 13, Line 9: "showed significant decrease in age" wording needs revising. ...were significantly younger"? The next sentence is redundant.

Author's Response: We revised as follows: For demographic factors, participants who underestimated or overestimated their HI were significantly younger compared to participants who had concordant HI (tables 2 and 3).

And we deleted the next sentence.

# Line 31: Replace 'natural' with 'not surprising' and 'advanced' with 'increasing'

Author's Response: Thank you for your careful observation. We rewording two words as the reviewer recommended.

# Line 44: the association between over-estimated HI and depression is dealt with a little too simplistically. At least a reference would be useful. And can hypertension and depression be considered together? Depression is also linked to increasing severity of HL.

Author's Response: The reviewer's comment is well taken. We tried to explain more in detail the possible mechanisms associated with overestimated HI in hypertension and depression. And we deleted the sentence that hypertension and depression may also lead to an increased anxiety about their health, thus increasing overestimated HL in non-auditory way. We thought that hypertension may related with cochlea damage that might be caused the pre-clinical hearing loss. Unlike the hypertension, depression may influence the self-reported HD in relation to neuroticism.



# Line 53: “participants who had tinnitus reported their hearing status accurately” This implies all of them; reword this to be more nuanced.

Author’s Response: Thank you for careful observation. We revised this as follows: For auditory factors, tinnitus and occupational noise exposure were associated with concordant HI (Tables 2 and 3).

# Line 55: The wording is awkward. Suggestion: It is possible that these participants had an audiometric assessment for their tinnitus and been informed about their hearing status.

Author’s Response: Thank you for careful observation. We revised this as follows: It is possible that these participants had an audiometric assessment for their tinnitus or occupational health screening program and had known about their hearing status.

# Page 14, Line 5: “noise hardly underestimated their HI” what does this mean?

Author’s Response: Thank you for careful observation. We revised this as follows: And participants who had been exposed to occupational noise tended to have less underestimated HI regardless of tinnitus.

# Table 2 (Page 27 line 12): what that ‘Occupation’ refer to?

Author’s Response: Thank you for careful observation. Because we did not present the types of occupation, the expression of ‘occupation’ changed to ‘employment status’. Employment status was divided into employed and unemployed groups.

# Page 14, Line 12: The wording is awkward. Suggestion: “... in South Korea sourcing data from the same dataset has been recently reported, this present study has some significant variations in approach.”

Author’s Response: Thank you for careful advice. We revised this as follows: Although hearing discrepancy in South Korea from same dataset has been recently published, our study has some significant differences in inclusion criteria and methods of analysis.

# Line 20: It is true that using 40dB as a cutoff means that people should more accurately a hearing impairment than if it was 25dB. But why is one the correct cutoff to use and not the other? I do not see this as a limitation of the earlier study, and strength of the current study. They are different. What is the clinical value of knowing someone has a better ear  $PTA > 25dB$  rather than  $> 40dB$ ?

Author’s Response: The reviewer’s comment is well taken and we deleted this paragraph. Previously, Kim et al.<sup>5</sup> (2017) categorized the self-reported hearing into three categories (no difficulty, a little difficulty, and much difficulty) and classified the mean pure-tone threshold of the better ear into three groups ( $< 25dB$ ,  $\geq 25dB$  and  $< 40dB$ , and  $\geq 40dB$ ). The difference of classification was mentioned in Discussion. Instead of this, we added the difference of reference group. We referenced the concordant HI group which showed both self-reported HD and audiometric HL, and Kim et al.<sup>5</sup> set a reference as concordance group whose self-reported hearing assessment was matched to their audiometric thresholds. Since most participants in concordance group of Kim et al.<sup>5</sup> (93%) had no self-reported HD and normal pure-tone thresholds ( $< 25dB$ ), it is likely that the analysis result may have a bias depending on pure-tone thresholds. Sub-group analysis according to pure-tone thresholds provided in supplementary data showed similar result only in the participants with  $< 25dB$  HL. Therefore, we expected that this study could provide more reasonable analysis to investigate the factors related to discrepancy between self-reported hearing and audiometry.

# Line 37: “not only relies...” and “also depends on...” and “The contribution...” These imply causation. This study has found only associations.

Author's Response: Thank you for careful advises. We reworded this as follows: Non-auditory factors (age and medical histories) as well as auditory factors (tinnitus and noise exposure) were associated with such inconsistent result between self-reported hearing assessment and audiometric hearing. Understanding the factors related to self-reported hearing will assist clinicians in interpreting subjective reports of hearing and researchers to use self-reported hearing data as a surrogate measure of audiometric hearing.

# Acknowledgements: Are these 150 people those who collected the data? The word participating is used; participating normally means those who are tested and examined, not those testing and examining.

Author's Response: Thank you for careful advice. We reworded 'collecting data' instead of 'participating'.

# Tables: the key indicates that  $p < 0.05$  is used to indicate significance. Is this after Bonferroni corrections?

Author's Response: Bonferroni's correction was applied to the P-values and the corresponding confidence interval due to multiple testing. Statistical significance was considered when adjusted P-value was less than 0.05.

# Table 2, Line 24 (and Table 3): reword to "Drinking alcohol in past year"

Author's Response: We reworded.

### VERSION 2 – REVIEW

<b>REVIEWER</b>	Pernilla Videhult Pierre Karolinska institutet, Sweden
<b>REVIEW RETURNED</b>	28-Aug-2018

<b>GENERAL COMMENTS</b>	<p>Thank you for giving me the opportunity to revise the manuscript by Choi et al on self-reported and audiometrically assessed hearing impairment a second time. The authors have improved the manuscript. However, I think that the manuscript still requires major revision. Please find my comments below.</p> <p>Page 5, line 9: The expression "audiometrically-measured hearing loss (AHL) diagnosed by audiometry" needs to be altered to "audiometrically-measured hearing loss (AHL)" or "hearing loss diagnosed by audiometry (AHL)".</p> <p>Page 5, line 20-23: I suggest that the authors include mean or median age as well as information on gender.</p> <p>Page 6, line 9: "Therefore," needs to be removed. A more appropriate wording would be "The results suggest that".</p> <p>Page 6, line 9: The word "older" should be removed.</p> <p>Page 8, lines 23-28:</p>
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	<p>I would like the authors to specify at bit how the survey data is collected. Is it an online survey, a paper survey, a telephone survey, are examiners coming to the homes of the participants...?</p> <p>Page 9, line 32: The word "answers" should be "answer".</p> <p>Page 9, line 55: When writing "on both ears", do the authors mean in each ear, i.e. that the measurement was performed on one side at a time? This needs to be clarified in the text.</p> <p>Page 10, line 34: The expression "with both normal TMs" needs to be changed, e.g. to "with normal TMs on both sides".</p> <p>Page 11, line 14: The authors need to give more information on how smoking status was assessed. What question was asked? Was it a closed-ended question, and, if yes, what fixed response categories were there? Most variables used in the manuscript lack this kind of information. Perhaps it could be given in a supplement file?</p> <p>Page 11, line 16: The authors need to give more information on how alcohol consumption was assessed (see previous comment on smoking).</p> <p>Page 11, line 23: I am definitely not an expert, but I think that marital status is not considered to be a socioeconomic factor.</p> <p>Page 11, line 25: The authors need to give more information on how monthly income was assessed (see previous comment on smoking).</p> <p>Page 11, line 39: The authors need to give more information on how education level was assessed (see previous comment on smoking).</p> <p>Page 11, line 41: The authors need to give more information on how employment status was assessed (see previous comment on smoking).</p> <p>Page 12, line 20: The authors need to give more information on how self-reported health status was assessed (see previous comment on smoking).</p> <p>Page 12, line 23: The authors need to give more information on how body shape perception was assessed (see previous comment on smoking).</p> <p>Page 12, lines 46-55: The information about physical activity needs to be improved. The authors state that weekly frequency in the past seven days was inquired; however in the tables, a dichotomized answer is given (Do not practice/Practise). When exactly was a subject classified as practicing vigorous physical activity, etc?</p> <p>Page 13, lines 4–9:</p>
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	<p>The authors need to give more information on how restricted use of medical service was assessed (see previous comment on smoking).</p> <p>Page 12, lines 9–11: The authors need to give more information on how health screening was assessed (see previous comment on smoking).</p> <p>Page 12, lines 11–14: The authors need to give more information on how current disease was assessed (see previous comment on smoking).</p> <p>Page 15, line 39: I believe that in the expression "of more than 25 dB HL", the word "more" should be changed to "not more".</p> <p>Page 16, lines 4 and 37: The word "occupation" should be altered to "employment status".</p> <p>Page 17, line 11: "1.771" should be "1.772" to be consistent with Table 3.</p> <p>Page 17, line 23: The expression "A cross-sectional survey" should be altered to "This cross-sectional survey", "The present cross-sectional survey", or similar.</p> <p>Page 17, line 27: The expression "overestimated their hearing status" should be altered to "underestimated their hearing status" or, preferably, "overestimated their HI".</p> <p>Page 17, lines 27-32: The authors write: "The accuracy of hearing assessments in the present study (81.8%) was higher than that reported in elderly population (71.8%)<sup>3</sup>, but similar to that reported in the general population (80-82%)<sup>5,6</sup>." Since cultural aspects may influence self-assessment of health (see e.g. Jylha et al. J Gerontol B Psychol Sci Soc Sci 1998, 53: S144-152), I suggest that the authors add information on where these studies were carried out.</p> <p>Page 17, line 41: "≥15 dB" should be altered to "≥25 dB".</p> <p>Page 17, lines 34-37 and page 18, lines 16–46: On page 17, the authors write that young adults generally perceive their hearing status more accurately than the elderly but give no references in support of that statement. However, the results of the authors' own study contradict that statement, which also other studies do, as the authors discuss on page 18. This needs to be revised. I also find the discussion on page 18 confusing. The authors write that audiometric HL and SHD both increase with age and then conclude that "it is therefore nor surprising that younger participants were less likely to have SHD among participants with audiometric HL (Table 2) and had fewer audiometric HL among participants with SHD (Table 3)." The authors need to elaborate this. Several studies have shown that self-reported hearing is much less sensitive to age than audiometric hearing, two of which are Kiely et al (Kiely et al 2012, J Aging Health 24: 439-458) in</p>
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	<p>elderly and Videhult Pierre et al (Videhult Pierre et al 2015 PLoS ONE 10: e0123290) in younger subjects.</p> <p>Page 18, line 4 When the authors write about "abnormal TM", do they mean that subjects with abnormal TM may have been included in the study by Kim et al (2017)? This needs to be clarified.</p> <p>Page 18, lines 23–27: The authors only mention central changes as causes of SHD increasing with age. They ought to mention peripheral changes as well.</p> <p>Page 18, lines 36–37: Bad language in the sentence starting with "This difference".</p> <p>Page 18, lines 50–55: The authors explain why subjects with hypertension may overestimate their HI: "Because hypertension is known to increase the risk of cochlea damage possibly through malfunction of the stria vascularis,<sup>21</sup> 26-28 it might be related to early development of pre-clinical HL in auditory way." Self-reported health is complicated and dependent on many factors (see e.g. Baker et al 2004 J Human Resources 39: 1067-1093). Another explanation that the authors should consider, which also perhaps is a more likely explanation than malfunctioning stria vascularis, is that subjects with hypertension have worse overall health than subjects without hypertension, which in turn has been shown to be associated with an increased likelihood of reporting bad hearing (see e.g. Chang et al 2009, Ear Hear 30: 576-583). Moreover, as the present study is cross-sectional, it cannot be excluded that hypertension is a result of bad SHD.</p> <p>Page 18, line 50–55: References 21, 26, 27, 28 should support the statement "hypertension is known to increase the risk of cochlea damage possibly through malfunction of the stria vascularis". However, only reference 28 is a suitable reference. I suggest that the authors reformulate.</p> <p>Page 19, line 4–11: The authors write "Unlike the hypertension, depression may influence the SHD in non-auditory way". The sentence must be revised as hypertension may also influence the SHD "in non-auditory way", as discussed in my previous comment.</p> <p>Page 19, lines 9–11: The authors write: "Accordingly, depression may lead to an increased perception of HD". Depression may also be a result of bad SHD, just like hypertension.</p> <p>Page 19, lines 32–33: The authors write that they "excluded normal hearing population with normal audiometry and without SHD in the analysis". If this was really the case, it must be described in the material and methods section.</p> <p>Page 20, lines 16–21: The authors write: "Non-auditory factors (age and medical histories) as well as auditory factors (tinnitus and occupational</p>
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	<p>noise exposure) were associated with inconsistent results between self-reported and audiometrically-measured hearing assessment.” I think that this is a confusing summary of the results and therefore suggest that the authors revise it.</p> <p>Page 27, Table 2: I have some difficulties interpreting the information given in Table 2 and I therefore suggest that the authors help me and other readers by adding some more details to the table legend or table footnote. According to the table legend, Table 2 presents underestimated hearing impairment, i.e. subjects with AHL but without SHD. Does the column entitled "Total" give the estimated number of inhabitants in Korea with AHL? Does the column entitled "Without self-reported HD" give the estimated number of inhabitants in with AHL that do not have SHD, that is the prevalence of underestimated hearing impairment? What does "62.0" and "64.9" stand for on line 14? Is "62.0" the mean age of those with AHL? Is "64.9" the mean age of those who have underestimated HI and, if yes, how can it be higher than that of the total group when increasing age is associated with a decreasing prevalence of underestimated HI?</p> <p>Page 33, Table 3: Please see my comments on Table 2.</p> <p>Page 34, line 14: The p-value is 0.000.</p> <p>Page 37, line 7: The p-value is 0.000.</p> <p>General: I know that the authors have revised the language. However, I suggest that additional language revision be made.</p>
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<b>REVIEWER</b>	Christopher Spankovich University of Mississippi Medical Center USA
<b>REVIEW RETURNED</b>	21-Aug-2018

<b>GENERAL COMMENTS</b>	<p>The authors have in general addressed my concerns.</p> <p>There remain a few minor grammatical issues. For example in the Abstract an OR is missing the punctuation : On page 5 there is a space in the middle of SHD, on page 6 otolaryngologists should be otolaryngologist and you need a reference for the ANSI statement. ON page 16 there is a space between they and are.</p>
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<b>REVIEWER</b>	Robert Eikelboom Ear Science Institute Australia
<b>REVIEW RETURNED</b>	20-Aug-2018

<b>GENERAL COMMENTS</b>	The authors have systematically gone through the comments and feedback of the reviews. There is still a need for some editorial
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	<p>attendance to the writing. I have pointed out some instances of errors below, but it is likely that I have not seen them all.</p> <p>Page 5, line 23: “membranes on both ears” – should be “membrane in both ears”; It could also be “..who had normal tympanic membranes” – which I would prefer, as it is on the next page, line 21.</p> <p>Page 6, line 9: delete the word “Therefore”</p> <p>Line 25: I am not convinced that most studies have used &gt;40dB as a cutoff, and furthermore, &gt;40dB is either ear? Worse ear? Better ear? In any case, the word “comprehensive” is not correct; the 25dB is a just another level for the cutoff. You could say it’s a stricter measure if you want.</p> <p>Page 7, line 18: “to understand frequency” – it’s not clear to me what ‘frequency’ means. Frequency of what?</p> <p>Line 32: populations</p> <p>Page 8 line 4: TMs (also line 16 on page 9)</p> <p>Line 11: remove space in SHD</p> <p>Page 9: “correct” not “a correct” ; I would also like to see the word “status” after “hearing” i.e. “on their hearing status”. However, I do have a problem</p> <p>Line 48: otolaryngologist – singular, not plural. Or drop the word “An” (it appears that more than one otolaryngologist was involved)</p> <p>Page 10 line 53: I realise that this is a translation, but when using the word “louder” one expects to be informed that it’s louder with reference to something else. “loudly” may be a better translation; i.e. speak in a loud voice.</p> <p>Page 11 line 16: I wonder why this definition of alcohol drinking was used. Reference?</p> <p>Line 30: reference?</p> <p>Page 12 line 12: is this a report of the findings of this study? Why then are they mentioned here?</p> <p>Page 13 line 11: had, not has</p> <p>Page 15 line 43: “(2,609 out of 14,345)” this should at least be 2,609; but I’d prefer it to be (“n=2,609). “out of” is a bit awkward. Similar comment for line 36.</p> <p>Page 18 line 36: “were” not “had”</p> <p>Line 46: “normal for their age”</p> <p>Page 19, line 36 – 2 sentences. These are awkwardly written. Suggestion: ...had the concordance group (normal hearing and no self-report of HI) as their reference. Since .... their analysis is likely to be biased because of the large number of people in the reference group, rather than focussing on those where there was a discrepancy between audiometry and self-report of HI.</p>
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	<p>Line 50: “was irrelevant to discrepancy...” should be something like “was not associated with the discrepancy...”</p> <p>Line 55: delete the word “comprehensive”; it’s sufficient to say that more variables were included.</p> <p>Page 20, line 11: “reasonable” is not the correct word to use. “comprehensive” could be used.</p> <p>I still miss some discussion on the clinical importance. There is some hint of this in the abstract which is not reflected in the discussion.</p>
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## VERSION 2 – AUTHOR RESPONSE

Reviewer(s)' Comments to Author:

Reviewer: 4

Reviewer Name: Robert Eikelboom

Institution and Country: Ear Science Institute Australia

# Please state any competing interests or state ‘None declared’: No declared

Author’s Response: We have corrected the words to “none declared.”

# Please leave your comments for the authors below

The authors have systematically gone through the comments and feedback of the reviews. There is still a need for some editorial attendance to the writing. I have pointed out some instances of errors below, but it is likely that I have not seen them all.

Author’s Response: We thank you for your valuable time and constructive comments, which have substantially improved the quality of our manuscript. We hope that we have satisfactorily addressed your concerns.

# Page 5, line 23: “membranes on both ears” – should be “membrane in both ears”; It could also be “..who had normal tympanic membranes” – which I would prefer, as it is on the next page, line 21.

Author’s Response: We changed the text to “who had normal tympanic membranes” on both pages. (page 2, line 31 and page 3, line 54)

# Page 6, line 9: delete the word “Therefore”

Author’s Response: We deleted the word “Therefore.”(page 2, line 49)

# Line 25: I am not convinced that most studies have used >40dB as a cutoff, and furthermore, >40dB is either ear? Worse ear? Better ear? In any case, the word “comprehensive” is not correct; the 25dB is a just another level for the cutoff. You could say it’s a stricter measure if you want.

Author’s Response: The reviewer’s comment is well taken. We deleted the word “most” and changed “comprehensive” to “another.” The sentence was changed as follows: Previous studies have defined hearing loss as 40 dB HL or worse in the better ear, but we followed the World Health Organization definition of hearing loss as a mean hearing threshold of > 25dB HL measured at 0.5, 1, 2, and 4 kHz in the better ear (World Health Organization 2014). (page 3, line 56)



# Page 7, line 18: “to understand frequency” – it’s not clear to me what ‘frequency’ means. Frequency of what?

Author’s Response: Thank you. We changed the word “frequency” to “prevalence of those discrepancies.” (page 4, line 76)

# Line 32: populations

Author’s Response: Thank you. We corrected this error. (page 4, line 81)

# Page 8 line 4: TMs (also line 16 on page 9)

Author’s Response: Thank you. We corrected this error. (page 4, line 92)

Line 11: remove space in SHD

Author’s Response: Thank you for your careful correction. We removed the space.

# Page 9: “correct” not “a correct” ; I would also like to see the word “status” after “hearing” i.e. “on their hearing status”. However, I do have a problem

Author’s Response: Thank you for your careful correction. We removed the word “a” and added “status” after “hearing.” (page 6, line 119)

# Line 48: otolaryngologist – singular, not plural. Or drop the word “An” (it appears that more than one otolaryngologist was involved)

Author’s Response: Thank you for your careful correction. We dropped the word “an” because more than one otolaryngologist was involved.

# Page 10 line 53: I realise that this is a translation, but when using the word “louder” one expects to be informed that it’s louder with reference to something else. “loudly” may be a better translation; i.e. speak in a loud voice.

Author’s Response: Thank you for your careful observation. We changed the word “louder” to “loudly.” (page 7, line 160)

# Page 11 line 16: I wonder why this definition of alcohol drinking was used. Reference?

Author’s Response: This study used KNHANES data, which contain the amount and frequency of alcohol consumption during the past year. We selected the frequency of alcohol drinking as the variable for alcohol consumption following a previous study.<sup>1</sup>

1. Park JW, Park JS, Kim S, et al. The association between long working hours and hearing impairment in noise unexposed workers: data from the 5th Korea National Health and Nutrition Examination Survey (KNHANES 2010-2012). *Ann Occup Environ Med* 2016;28:55.

# Line 30: reference?

Author’s Response: Similarly, the KNHANES data define monthly income as equalized monthly household income calculated by dividing the total family income by the squared root of the number of household members. This variable was also used in a previous study.<sup>1</sup>

1. Park JW, Park JS, Kim S, et al. The association between long working hours and hearing impairment in noise unexposed workers: data from the 5th Korea National Health and Nutrition Examination Survey (KNHANES 2010-2012). *Ann Occup Environ Med* 2016;28:55.

# Page 12 line 12: is this a report of the findings of this study? Why then are they mentioned here?

Author's Response: This sentence is not part of the findings of this study. Because the EQ-5D index differs among nations, this report indicates the range of the EQ-5D index for Korean populations. (page 9, line 195)

# Page 13 line 11: had, not has

Author's Response: Thank you for your careful observation. We changed the word "has" to "had."

# Page 15 line 43: "(2.609 out of 14,345)" this should at least be 2,609; but I'd prefer it to be ("n=2,609). "out of" is a bit awkward. Similar comment for line 36.

Author's Response: We changed the expression style "(xx out of xx)" to "(n=xx)." (page 12, line 293)

# Page 18 line 36: "were" not "had"

Author's Response: Thank you. We have rewritten the sentence. (page 15, line 355)

# Line 46: "normal for their age"

Author's Response: We changed the word "in" to "for." (page 15, line 364)

# Page 19, line 36 – 2 sentences. These are awkwardly written. Suggestion: ...had the concordance group (normal hearing and no self-report of HI) as their reference. Since .... their analysis is likely to be biased because of the large number of people in the reference group, rather than focussing on those where there was a discrepancy between audiometry and self-report of HI.

Author's Response: We changed the following two sentences to reflect your comments: Since they included the normal hearing population (93% of the sample) in the reference group, their analysis is likely to be biased by factors related to SHD or AHL, rather than focusing on the discrepancy between subjective hearing assessment and audiometry itself. (page 16, line 390)

# Line 50: "was irrelevant to discrepancy..." should be something like "was not associated with the discrepancy..."

Author's Response: We changed the sentence as the reviewer suggested. (page 16, line 393)

# Line 55: delete the word "comprehensive"; it's sufficient to say that more variables were included.

Author's Response: We deleted the word "comprehensive."

# Page 20, line 11: "reasonable" is not the correct word to use. "comprehensive" could be used.

Author's Response: We changed the word "reasonable" to "comprehensive." (page 17, line 399)

# I still miss some discussion on the clinical importance. There is some hint of this in the abstract which is not reflected in the discussion.

Author's Response: We have added the following sentences about the clinical importance of our study: Understanding the factors related to self-reported hearing will assist clinicians in interpreting and using subjective reports of hearing as a surrogate measure for audiometry. Also, these factors need to be considered when deciding to conduct a hearing test in clinics, even if patients have no SDH. (page 18, line 418)

Reviewer: 3

Reviewer Name: Christopher Spankovich

Institution and Country: University of Mississippi Medical Center, USA

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

Author's Response: We have corrected the words to "none declared."

Please leave your comments for the authors below

The authors have in general addressed my concerns.

# There remain a few minor grammatical issues. For example in the Abstract an OR is missing the punctuation :

Author's Response: Thank you for your careful correction. We added the punctuation after 95% CI.

# On page 5 there is a space in the middle of SHD, on page 6 otolaryngologists should be otolaryngologist and you need a reference for the ANSI statement. ON page 16 there is a space between they and are.

Author's Response: Thank you for your careful correction. We deleted the space in the middle of SHD and after the words "they are" on page 16. Also, we dropped the word "an" because more than one otolaryngologist was involved. We added the reference for the ANSI statement.

Reviewer: 1

Reviewer Name: Pernilla Videhult Pierre

Institution and Country: Karolinska institutet, Sweden

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

Author's Response: We have changed the word to "none declared."

Please leave your comments for the authors below

Thank you for giving me the opportunity to revise the manuscript by Choi et al on self-reported and audiometrically assessed hearing impairment a second time. The authors have improved the manuscript. However, I think that the manuscript still requires major revision. Please find my comments below.

Author's Response: We thank you for your valuable time and constructive comments, which have substantially improved the quality of our manuscript. We hope that we have satisfactorily addressed your concerns.

# Page 5, line 9:

The expression "audiometrically-measured hearing loss (AHL) diagnosed by audiometry" needs to be altered to "audiometrically-measured hearing loss (AHL)" or "hearing loss diagnosed by audiometry (AHL)".

Author's Response: Thank you for your careful correction. We deleted the words "diagnosed by audiometry." (page 2, line 26)

# Page 5, line 20-23:

I suggest that the authors include mean or median age as well as information on gender.

Author's Response: Due to word-count limitations, we have added only the mean age.

# Page 6, line 9:

"Therefore," needs to be removed. A more appropriate wording would be "The results suggest that".

Author's Response: We deleted the word "Therefore."

# Page 6, line 9:

The word "older" should be removed.

Author's Response: We removed the word "older."

# Page 8, lines 23-28:

I would like the authors to specify at bit how the survey data is collected. Is it an online survey, a paper survey, a telephone survey, are examiners coming to the homes of the participants...?

Author's Response: The surveyors came to the public spot close to homes of participants at each survey. Based on the National Health Promotion Act, the surveys are conducted by the Korean Centers for Disease Control and Prevention. This nationally representative, cross-sectional survey includes approximately 10,000 individuals each year.. The health interview and health examination are conducted by trained staff members, including physicians, medical technicians, and health interviewers, at a mobile examination center, with dietician visits to the homes of the study participants following afterward. Most studies using this dataset do not describe how the survey data are collected because the method is described in another references.

# Page 9, line 32:

The word "answers" should be "answer".

Author's Response: We corrected the error. (page 6, line 126)

# Page 9, line 55:

When writing "on both ears", do the authors mean in each ear, i.e. that the measurement was performed on one side at a time? This needs to be clarified in the text.

Author's Response: We deleted the words "on both ears." The pure-tone thresholds were measured in each ear.

# Page 10, line 34:

The expression "with both normal TMs" needs to be changed, e.g. to "with normal TMs on both sides".

Author's Response: We changed "both normal TMs" to "normal TMs on both sides."(line 152)

# Page 11, line 14:

The authors need to give more information on how smoking status was assessed. What question was asked? Was it a closed-ended question, and, if yes, what fixed response categories were there? Most variables used in the manuscript lack this kind of information. Perhaps it could be given in a supplement file?

Author's Response: The reviewer's comment is well taken. Similar to previous articles using the Korea National Health and Nutrition Examination Survey (KNHANES) data, we did not describe in detail how the variables were assessed. We added the following sentences: The participants were asked to self-report to question "Do you smoke now?". If the participant smoked in the past but did not smoke now, it was classified as a past smoker. (page 7, line 166)

# Page 11, line 16:

The authors need to give more information on how alcohol consumption was assessed (see previous comment on smoking).

Author's Response: We changed the sentences about alcohol consumption as follows: Alcohol consumption was divided into two groups according to their drinking frequency during the last year: non-drinker and drinker. The question was "How often do you drink alcohol in the last year?". The participants who had never drunk at all during the last year were classified as non-drinker, while others were classified as drinker. (page 7, line 168)

# Page 11, line 23:

I am definitely not an expert, but I think that marital status is not considered to be a socioeconomic factor.

Author's Response: We reclassified marital status from a socioeconomic factor to a personal factor.

# Page 11, line 25:

The authors need to give more information on how monthly income was assessed (see previous comment on smoking).

Author's Response: We added the following sentence: Participants answered an open-ended question on income: "What is your average monthly income including salaries, property income, pension, government subsidies, and allowance?". (page 8, line 178)

# Page 11, line 39:

The authors need to give more information on how education level was assessed (see previous comment on smoking).

Author's Response: We added the following sentences: With regard to educational level, the participants were asked the level at which their education was completed, which was classified into four educational categories: completion of elementary school, middle school, high school and post-secondary school. For analysis, it was re-grouped as less than high school and high school or more. (page 8, line 180)

# Page 11, line 41:

The authors need to give more information on how employment status was assessed (see previous comment on smoking).

Author's Response: We added the following sentence: The participants answered either "yes" or "no" to the question "Have you ever worked more than one hour for the last week for income, or worked as unpaid family worker for over 18 hours? (The temporary leave status is also included if you have worked)". (page 8, line 184)

# Page 12, line 20:

The authors need to give more information on how self-reported health status was assessed (see previous comment on smoking).

Author's Response: We added the following sentences: Self-reported health status was evaluated using a question "What do you usually think about your health?", and the answer was categorized into good, fair, and poor.. (page 9, line 201)

# Page 12, line 23:

The authors need to give more information on how body shape perception was assessed (see previous comment on smoking).

Author's Response: We added the following sentences: Participants were asked to report their body shape perception as "too thin", "just right, or "too fat". The question was "What do you think of your body weight status?". (page 9, line 202)

# Page 12, lines 46-55:

The information about physical activity needs to be improved. The authors state that weekly frequency in the past seven days was inquired; however in the tables, a dichotomized answer is given (Do not practice/Practise). When exactly was a subject classified as practicing vigorous physical activity, etc?

Author's Response: We added the following sentences: The intensity of the physical activity was categorized as vigorous, moderate, and light. Examples of vigorous intensity physical activities were soccer, basketball, aerobics, running, fast cycling, and fast swimming. Moderate physical activities included cycling at a regular pace, swimming at a regular pace, slow swimming, noncompetitive volley ball, and doubles tennis. Walking slowly or at a moderate pace for the use of public transportation were included in the light physical activity. We used the guidelines suggested by Kim to divide the participants into exercising and non-exercising categories based on the number of days and hours spent for their physical activity. The intensity of the physical activity was based on the physical activity recommendations of the Centers for Disease Control and Prevention and the American College of Sports Medicine, and these activities were categorized as follows: those who perform vigorous-intensity activity for a minimum of 20 minutes at least in three days each week; those who perform moderate-intensity physical activity for a minimum of 30 minutes at least in five days each week; and those who light-intensity activity for a minimum of 30 minutes for at least in five days weekly. Individuals who did not exercise regularly were placed into the non-exercising group. (page 9, line 213)

# Page 13, lines 4–9:

The authors need to give more information on how restricted use of medical service was assessed (see previous comment on smoking).

Author's Response: We added the following sentences: The participants were asked to answer either "yes" or "no" about the restricted use of medical service. The question was "Have you ever been unable to go to the clinic (except for dentistry) during the past year?". (page 10, line 229)

# Page 12, lines 9–11:

The authors need to give more information on how health screening was assessed (see previous comment on smoking).

Author's Response: We added the following sentences: To assess the health screening status, the participants answered either "yes" or "no" to the question "Have you ever had a health checkup for health during the last two years?". (page 10, line 230)

# Page 12, lines 11–14:

The authors need to give more information on how current disease was assessed (see previous comment on smoking).

Author's Response: We added the following sentences: Participants were also asked about their current disease diagnosed by a medical doctor. They answered either "yes" or "no" to questions about current disease. Among the various disease lists, histories of hearing-related diseases such as obesity, hypertension, myocardial infarction, angina, asthma, depression, renal failure, and diabetes mellitus were selected as variables. (page 10, line 232)

# Page 15, line 39:

I believe that in the expression "of more than 25 dB HL", the word "more" should be changed to "not more".

Author's Response: Thank you for your careful correction.. We changed the sentence as follows: On the other hand, 733 (39.5%) of 1,858 participants with SHD had no AHL (mean audiometric thresholds  $\leq$  25 dB HL in the better ear). (page 12, line 291)

# Page 16, lines 4 and 37:

The word "occupation" should be altered to "employment status".

Author's Response: Thank you for your careful correction. We changed the word "occupation" to "employment status." (page 12, line 300)

#Page 17, line 11:

"1.771" should be "1.772" to be consistent with Table 3.

Author's Response: We corrected the error.

#Page 17, line 23:

The expression "A cross-sectional survey" should be altered to "This cross-sectional survey", "The present cross-sectional survey", or similar.

Author's Response: We changed the word "a" to "this": This cross-sectional survey of the Korean population aged  $\geq$  19 years found that 18.2% of participants had a discrepancy between their SHD and AHL. (page 14, line 330)

# Page 17, line 27:

The expression "overestimated their hearing status" should be altered to "underestimated their hearing status" or, preferably, "overestimated their HI".

Author's Response: We changed the expression as follows: Most (71.9%) of these participants had AHL but no SHD (underestimated their HI) while the rest (28.1%) had SHD but no AHL (overestimated HI, Table 1). (line 331)

# Page 17, lines 27-32:

The authors write: "The accuracy of hearing assessments in the present study (81.8%) was higher than that reported in elderly population (71.8%)<sup>3</sup>, but similar to that reported in the general population (80-82%)<sup>5,6</sup>." Since cultural aspects may influence self-assessment of health (see e.g. Jylha et al. J

Gerontol B Psychol Sci Soc Sci 1998, 53: S144-152), I suggest that the authors add information on where these studies were carried out.

Author's Response: The reviewer's comment is well taken. We added information about where these studies were conducted. And we removed a reference because one of them analyzed the same dataset as ours.. (line 334)

# Page 17, line 41: "≥15 dB" should be altered to "≥25 dB".

Author's Response: Thank you for your careful correction. We changed the text in the figure from "15" to "25." (line 338)

# Page 17, lines 34-37 and page 18, lines 16–46:

On page 17, the authors write that young adults generally perceive their hearing status more accurately than the elderly but give no references in support of that statement. However, the results of the authors' own study contradict that statement, which also other studies do, as the authors discuss on page 18. This needs to be revised. I also find the discussion on page 18 confusing. The authors write that audiometric HL and SHD both increase with age and then conclude that "it is therefore not surprising that younger participants were less likely to have SHD among participants with audiometric HL (Table 2) and had fewer audiometric HL among participants with SHD (Table 3)." The authors need to elaborate this. Several studies have shown that self-reported hearing is much less sensitive to age than audiometric hearing, two of which are Kiely et al (Kiely et al 2012, J Aging Health 24: 439-458) in elderly and Videhult Pierre et al (Videhult Pierre et al 2015 PLoS ONE 10: e0123290) in younger subjects.

Author's Response: The reviewer's comment is well taken. First, the accuracy of the hearing assessments was higher in the general population than in the elderly population. Therefore, we thought that young adults perceived their hearing status more accurately than the elderly population. We agree that our support for this statement is weak, so we deleted that sentence. Second, to clarify our position, we added the following sentence: Our reference group was defined as participants who had both SHD and AHL (concordant HI), so it is highly likely that older participants will have both SDH and AHL. (line 356)

# Page 18, line 4

When the authors write about "abnormal TM", do they mean that subjects with abnormal TM may have been included in the study by Kim et al (2017)? This needs to be clarified.

Author's Response: Thank you for your comment. Participants with abnormal TMs were excluded from our study but included in Kim et al. (2017). We have clarified this point. (line 344)

# Page 18, lines 23–27:

The authors only mention central changes as causes of SHD increasing with age. They ought to mention peripheral changes as well.

Author's Response: We added "synaptic loss" (with a reference) to the sentence. (line 354)

# Page 18, lines 36–37:

Bad language in the sentence starting with "This difference".

Author's Response: We have rewritten the sentence.(line 360)

# Page 18, lines 50–55:



The authors explain why subjects with hypertension may overestimate their HI: "Because hypertension is known to increase the risk of cochlea damage possibly through malfunction of the stria vascularis,<sup>21 26-28</sup> it might be related to early development of pre-clinical HL in auditory way." Self-reported health is complicated and dependent on many factors (see e.g. Baker et al 2004 J Human Resources 39: 1067-1093). Another explanation that the authors should consider, which also perhaps is a more likely explanation than malfunctioning stria vascularis, is that subjects with hypertension have worse overall health than subjects without hypertension, which in turn has been shown to be associated with an increased likelihood of reporting bad hearing (see e.g. Chang et al 2009, Ear Hear 30: 576-583). Moreover, as the present study is cross-sectional, it cannot be excluded that hypertension is a result of bad SHD.

Author's Response: We agree with your comment. We added another explanation and reference. Also,, we now mention that depression could be a result of SHD. (line 369)

# Page 18, line 50–55:

References 21, 26, 27, 28 should support the statement "hypertension is known to increase the risk of cochlea damage possibly through malfunction of the stria vascularis". However, only reference 28 is a suitable reference. I suggest that the authors reformulate.

Author's Response: We deleted references 21, 26, and 27.

# Page 19, line 4–11:

The authors write "Unlike the hypertension, depression may influence the SHD in non-auditory way". The sentence must be revised as hypertension may also influence the SHD "in non-auditory way", as discussed in my previous comment.

# Page 19, lines 9–11:

The authors write: "Accordingly, depression may lead to an increased perception of HD". Depression may also be a result of bad SHD, just like hypertension.

Author's Response: As you suggest, we changed these sentences as follows: Also, hypertension and depression may influence the SHD in non-auditory way. Subject with hypertension have worse overall health than subjects without hypertension, which in turn has been shown to be associated with an increased likelihood of reporting HD. Studies have suggested that personality traits of neuroticism had a more adverse perception of their HD, and it is widely known as an important factor that influences depression. Accordingly, hypertension and depression may lead to an increased perception of HD. Moreover, as the present study is cross-sectional, it cannot be excluded that hypertension and depression may be a result of SHD. (line 369)

# Page 19, lines 32–33:

The authors write that they "excluded normal hearing population with normal audiometry and without SHD in the analysis". If this was really the case, it must be described in the material and methods section.

Author's Response: We excluded the normal hearing population from the reference group when we were evaluating the factors associated with hearing discrepancies between audiometry and the self-reported questionnaire. We have clarified this exclusion in the statistical analysis section by changing the words "in the analysis" to "in the reference group." (page 12)

Page 20, lines 16–21:

The authors write: "Non-auditory factors (age and medical histories) as well as auditory factors (tinnitus and occupational noise exposure) were associated with inconsistent results between self-reported and audiometrically-measured hearing assessment." I think that this is a confusing summary of the results and therefore suggest that the authors revise it.

Author's Response: As you suggest, we changed the sentences as follows: Age, and medical histories of hypertension and depression, ) as well as auditory factors (tinnitus, and occupational noise exposure) were associated with inconsistent results between self-reported and audiometrically-measured hearing assessment in multivariable analysis. (line 403)

# Page 27, Table 2:

I have some difficulties interpreting the information given in Table 2 and I therefore suggest that the authors help me and other readers by adding some more details to the table legend or table footnote. According to the table legend, Table 2 presents underestimated hearing impairment, i.e. subjects with AHL but without SHD. Does the column entitled "Total" give the estimated number of inhabitants in Korea with AHL? Does the column entitled "Without self-reported HD" give the estimated number of inhabitants in with AHL that do not have SHD, that is the prevalence of underestimated hearing impairment? What does "62.0" and "64.9" stand for on line 14? Is "62.0" the mean age of those with AHL? Is "64.9" the mean age of those who have underestimated HI and, if yes, how can it be higher than that of the total group when increasing age is associated with a decreasing prevalence of underestimated HI?

# Page 33, Table 3: Please see my comments on Table 2.

Author's Response: We changed the title as the reviewer suggested. "62.0" indicates the mean age of participants with AHL, and "64.9" indicates the prevalence of participants who had AHL and no SHD. We added footnote to describe this below Table 2 and 3.

#Page 34, line 14: The p-value is 0.000.

#Page 37, line 7: The p-value is 0.000.

Author's Response: We changed it to 4 decimal places.

# General:

I know that the authors have revised the language. However, I suggest that additional language revision be made.

Author's Response: We revised the language as the reviewer suggested.

### VERSION 3 – REVIEW

<b>REVIEWER</b>	Robert Eikelboom Ear Science Institute Australia
<b>REVIEW RETURNED</b>	04-Feb-2019

<b>GENERAL COMMENTS</b>	The authors have carefully responded to the comments and suggestions from myself and the other reviewers.  Remaining comments: Page 4, line 56: I am not 100% satisfied with this. Most of the recent reports have used >25dB in the better ear to define hearing
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	<p>loss. Others may use alternative cutoffs, but &gt;40dB would not be one used frequently. I suggest dropping this whole statement. I think it's a strength that &gt;25dB was used.</p> <p>Page 8 line 158 (and elsewhere): This may be pedantic, but should it be stated somewhere that the quotes e.g. of questions, are translated from Korean?</p> <p>Line 222: This is in the middle of a very long sentence; may I suggest that "...Medicine, and these..." be replaced with "...Medicine. These..."</p> <p>Line 386: Subjects (not Subject).</p> <p>Line 405: That should be something like. However, Kim et al. ...</p> <p>Line 406: This needs rewording: Because a large number of normal hearing people (93%) were included in their reference group,...</p> <p>Line 422: Rephrase to: These factors need to be considered when determining whether to conduct a hearing test, even if the patient does not report a hearing impairment.</p>
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### VERSION 3 – AUTHOR RESPONSE

Reviewer(s)' Comments to Author:

Reviewer: 4

Reviewer Name: Robert Eikelboom

Institution and Country: Ear Science Institute Australia

# Page 4, line 56: I am not 100% satisfied with this. Most of the recent reports have used >25dB in the better ear to define hearing loss. Others may use alternative cutoffs, but >40dB would not be one used frequently. I suggest dropping this whole statement. I think it's a strength that >25dB was used.

Author's Response: The reviewer's comment is well taken. We dropped the statement about previous study and revised the sentence.

# Page 8 line 158 (and elsewhere): This may be pedantic, but should it be stated somewhere that the quotes e.g. of questions, are translated from Korean?

Author's Response: All questionnaires were Korean. For reporting, they were translated from Korean.

# Line 222: This is in the middle of a very long sentence; may I suggest that "...Medicine, and these..." be replaced with "...Medicine. These..."

Author's Response: Thank you for your careful correction. We corrected it.

# Line 386: Subjects (not Subject).

Author's Response: Thank you for your careful correction. We corrected it.

# Line 405: That should be something like. However, Kim et al. ...

Author's Response: Thank you for your careful correction. We corrected it.

# Line 406: This needs rewording: Because a large number of normal hearing people (93%) were included in their reference group,...

Author's Response: Thank you for your careful correction. We corrected it.

# Line 422: Rephrase to: These factors need to be considered when determining whether to conduct a hearing test, even if the patient does not report a hearing impairment.

Author's Response: Thank you for your careful correction. We corrected it.