

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Noise induced hearing loss in a longitudinal study of Norwegian railway workers
AUTHORS	Lie, Arve; Skogstad, Marit; Johnsen, Torstein; Engdahl, Bo; Tambs, Kristian

VERSION 1 - REVIEW

REVIEWER	<p>Ryan Lewis, PhD, CIH Exponent, Inc., USA</p> <p>I work for a scientific and engineering company that provides consultation on the potential health effects related to exposure to environmental agents, including noise. However, I currently have no projects concerning noise.</p>
REVIEW RETURNED	10-May-2016

GENERAL COMMENTS	<p>Title</p> <ul style="list-style-type: none"> • You might consider rephrasing the title of your paper as follows, “A longitudinal evaluation of noise induced hearing loss among Norwegian railway workers”. The inclusion of your study’s sample size in the title is not necessary. <p>Abstract</p> <ul style="list-style-type: none"> • Recommendations provided below should be reflect accordingly in the Abstract. <p>Introduction</p> <ul style="list-style-type: none"> • Page 3, lines 8-16: The sentence that begins with “Studies from the period 1950 to 1970...” and ends with “...lower noise exposure level”. Please consider revising this text to make it specific to Norway. You might consider rephrasing the first part as “Historically, the magnitude of exposure to noise in Norwegian workplaces was high and associated severe hearing loss independent of other known risk factors”. Without discussion of the relevance of dB, LAeq, and kHz, it may be difficult for the readership to grasp the importance of this additional information given the broad readership of this journal (i.e., this is not a noise-specific journal). • Page 3, lines 18-20: Please move the first two sentences of this paragraph to right after the first sentence of the first paragraph. This information belongs with the general discussion of hearing loss in workplace settings. • Page 3, lines 20-24: These sentences on age, sex, and genetics as risk factors for noise-induced hearing loss are not relevant here. However, you may consider incorporating this information in your
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	<p>first paragraph in the general discussion of hearing loss. For example, my recommended rephrasing in first paragraph could be "...independent of other known risk factors, such as age, sex, and genetics".</p> <ul style="list-style-type: none"> • Page 3, lines 26-40: The justification for this study is not well described. Please provide a reference for the claim that Norwegian railway workers have been perceived to be at risk for developing hearing loss. Also, please provide clarification as to why these workers are perceived to be at risk? Are these two cross-sectional studies the only two that have been published on Norwegian railway workers? Sure, selection bias may have biased the results of these studies, but, more importantly, they are cross-sectional studies, which have known limitations. If it is true that only cross-sectional studies have been conducted, then a longitudinal study would address any potential issues of temporal ambiguity between noise and hearing loss. Are there any other advantages? For example, what additional data gaps are addressed? What does your study add to the current state-of-the-science on noise induced hearing loss in railway workers or workplaces in general? <p>Methods</p> <ul style="list-style-type: none"> • Page 4, lines 3-4: How many railways workers were excluded due to missing audiograms? How does these excluded subjects compare with those that were used in the present study? Please elaborate on the potential for selection bias. • Page 4, line 8: Please elaborate on the methods used to characterize exposure to noise using dosimetry. What dosimeters were used? Were they calibrated? What settings were used (e.g., exchange rate, criterion level, threshold)? Also, please describe the distributions of the noise exposures in the Results section, not the Methods sections. • Page 4, lines 37: Did you consider classifying the groups according to similar noise exposure instead of simply by job title? • Page 4, line 42: What do you mean by the "better ear"? Why were these frequencies selected? In other words, what is their relevance to noise-induced hearing loss? • Page 4, line 50: It seems to me that you would not only look at the results by occupational group but also by exposure level. Do you have justification to use occupational group as a surrogate for noise exposure? Please justify, or re-run the results by exposure level, which I think will be more informative to the broader readership. • Page 4, line 53-54: What do you mean by "ISO norms"? Please elaborate on the algorithms that given in ISO 1999 that were used. <p>Results</p> <ul style="list-style-type: none"> • Page 11, Table 1: Please consider more detailed distributions for daily noise exposure. • Page 12, Table 2: How did you decide that "Traffic controller" should be the referent? <p>Discussion</p> <ul style="list-style-type: none"> • Page 7, line 8-9: You state that "Their noise exposure is probably too low to give any noise-induced hearing loss". What do you mean by "too low"? Can you quantify this? In other words, what level of noise exposure is necessary to have noise-induced hearing loss? • Page 8, line 3: What evidence do you have that the audiometry data is of "good quality"? Please be specific.
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	<ul style="list-style-type: none"> • Page 8, line 19-20: There is evidence that contradicts the statement, “With the exception of shooting, most evidence suggests that the impact of leisure noise exposures is of minor importance to hear”. For example, please see paper by Lewis et al. (Estimation of permanent noise-induced hearing loss in an urban setting. Environ Sci Technol. 2013 47(12):6393-9) • Page 8, lines 24-25: How do smoking, CVD, HT, diabetes, and high cholesterol relate to hearing loss? How do you expect missing data on these variables to affect your results? A statistical explanation is needed. • Page 8, lines 31-32: The proper term is “African-American”, not “Afro-American”. Also, what has been proposed as the reason why there are differences by race? • Page 8, line 40: What do you mean by a “good” work environment? Please elaborate. • Page 8, lines 40-41: What is your support for the statement that “The Norwegian State Railways has traditionally had a high focus on work, environment and safety and on occupational health”? • Can you please elaborate as to why the ISO 1999 algorithms slightly overestimated hearing loss? Are there any papers that discuss the validity and expected bias from using these algorithms?
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REVIEWER	Pernilla Videhult Pierre Karolinska Institutet, Sweden
REVIEW RETURNED	13-May-2016

GENERAL COMMENTS	<p>I have reviewed a manuscript entitled "Noise induced hearing loss in a longitudinal study of 9640 Norwegian railway workers" by Arve Lie et al. It is a well-written manuscript that shows that Norwegian railway workers are at low risk of developing noise-induced hearing loss.</p> <p>I recommend a minor revision of the manuscript. All my comments can be found in the attached pdf-file. They mostly deal with language issues. The most important other comments are:</p> <ul style="list-style-type: none"> - Page 3, line 8-10: If reference 4 is not a review article, either the word "studies" on line 8 should be changed to "study" or at least one additional reference should be added. - Page 3, line 19: A reference should be added in support of the statement that there is a higher percentage of hearing loss in developing countries. - Page 4, line 7-20: If the numbers derive from the OHS, a reference should be added. If the numbers are a result of the present work, a more appropriate place for them would be in the result section. - Page 4, line 49: Throughout the manuscript, the authors use the expression permanent threshold shifts (PTS). However, as I understand it, the used method does not allow discrimination between permanent and transient shifts. Therefore, I suggest that the word permanent is removed, even though the shifts surely are permanent in most cases. - Page 4, line 56-57: Not all readers (including I) know by heart what ISO 1999:2013, Annex B2 stands for. Therefore, I suggest a clarification. Is it the mean of 3, 4, and 6 kHz? - Page 5, line 39: The authors should clarify if they mean the other groups or the group called the others when writing "compared to the others". - Page 6, line 10: I suppose that a two-sided statistical test was
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	<p>performed, as is always recommended? If that is the case, I think "different hearing loss" would be a better expression than "greater hearing loss".</p> <ul style="list-style-type: none"> - Page 6, line 26-35: It should be clarified whether any of the differences were significant. - Table 1: An explanation to the abbreviations train d., train c., train m., track m., and traffic c. should be added below the table. Moreover, the SD for age is missing. - Figure 1: The lines in the graph suggest that the authors used age as a continuous and not as a categorical variable. Is that true? If not, bar graphs might be a more appropriate graph type to use. - Legend of figure 1: For clarity, An explanation to ISO 1999 should be added. <p>The reviewer also provided a marked copy with additional comments. Please contact the publisher for full details.</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Reviewer Name: Ryan Lewis, PhD, CIH

Institution and Country: Exponent, Inc., USA Competing Interests: I work for a scientific and engineering company that provides consultation on the potential health effects related to exposure to environmental agents, including noise. However, I currently have no projects concerning noise.

Title

- You might consider rephrasing the title of your paper as follows, “A longitudinal evaluation of noise induced hearing loss among Norwegian railway workers”. The inclusion of your study’s sample size in the title is not necessary.

Comment: Done

Abstract

- Recommendations provided below should be reflect accordingly in the Abstract.

Introduction

- Page 3, lines 8-16: The sentence that begins with “Studies from the period 1950 to 1970...” and ends with “...lower noise exposure level”. Please consider revising this text to make it specific to Norway. You might consider rephrasing the first part as “Historically, the magnitude of exposure to noise in Norwegian workplaces was high and associated severe hearing loss independent of other known risk factors”. Without discussion of the relevance of dB, LAeq, and kHz, it may be difficult for the readership to grasp the importance of this additional information given the broad readership of this journal (i.e., this is not a noise-specific journal).

Comment: Text has been adjusted.

- Page 3, lines 18-20: Please move the first two sentences of this paragraph to right after the first sentence of the first paragraph. This information belongs with the general discussion of hearing loss in workplace settings.

Comment: Done.

- Page 3, lines 20-24: These sentences on age, sex, and genetics as risk factors for noise-induced hearing loss are not relevant here. However, you may consider incorporating this information in your first paragraph in the general discussion of hearing loss. For example, my recommended rephrasing in first paragraph could be “...independent of other known risk factors, such as age, sex, and

genetics”.

Comment: This paragraph has been modified.

- Page 3, lines 26-40: The justification for this study is not well described. Please provide a reference for the claim that Norwegian railway workers have been perceived to be at risk for developing hearing loss. Also, please provide clarification as to why these workers are perceived to be at risk? Are these two cross-sectional studies the only two that have been published on Norwegian railway workers? Sure, selection bias may have biased the results of these studies, but, more importantly, they are cross-sectional studies, which have known limitations. If it is true that only cross-sectional studies have been conducted, then a longitudinal study would address any potential issues of temporal ambiguity between noise and hearing loss. Are there any other advantages? For example, what additional data gaps are addressed? What does your study add to the current state-of-the-science on noise induced hearing loss in railway workers or workplaces in general?

Comment: The Norwegian studies on railway workers and hearing are the only studies on this topic in Norway. The perception of high risk of NIHL was discussed in ref. # 14 and this reference has been added to the text. Since the two studies (#14 and #15) were cross sectional we decided to try to obtain longitudinal data to add to the scientific knowledge on NIHL in railway workers. The paragraph has been modified.

Methods

- Page 4, lines 3-4: How many railways workers were excluded due to missing audiograms? How does these excluded subjects compare with those that were used in the present study? Please elaborate on the potential for selection bias.

Comment: 118 incomplete audiograms, 243 with an observation period of < 1 year. This has been added to the text.

- Page 4, line 8: Please elaborate on the methods used to characterize exposure to noise using dosimetry. What dosimeters were used? Were they calibrated? What settings were used (e.g., exchange rate, criterion level, threshold)? Also, please describe the distributions of the noise exposures in the Results section, not the Methods sections.

Comment: The Casella dBadge CEL-350 dosimeter was used by a certified occupational hygienist and calibrated according to the instrument specifications . The measurements were done by a 1 minute log, mean daily exposure level (dBA) and peak level (dBC). Since the main focus of this study was on hearing in railway workers and not on details of exposure measurements we would prefer not to include these data in the methods section.

- Page 4, lines 37: Did you consider classifying the groups according to similar noise exposure instead of simply by job title?

Comment: Yes, but since we do not have detailed exposure data on an individual level of almost 10.000 subjects we decided to do the analysis on job title.

- Page 4, line 42: What do you mean by the “better ear”? Why were these frequencies selected? In other words, what is their relevance to noise-induced hearing loss?

Comment: The better ear refers to the best result of the right or left ear at each frequency from 500 to 8000 Hz and is commonly used by the WHO in classifying hearing loss and in the Norwegian reference values given in ISO 1999. The mean of the frequencies 3-6 kHz are commonly used in studies as this one and represent the most vulnerable area of NIHL. The mean of 0.5 to 4 kHz is used by the WHO in the assessment of hearing loss since this is more clinically relevant.

- Page 4, line 50: It seems to me that you would not only look at the results by occupational group but also by exposure level. Do you have justification to use occupational group as a surrogate for noise exposure? Please justify, or re-run the results by exposure level, which I think will be more informative to the broader readership.

Comment: The noise exposure measurements have been done in order to characterize noise exposure of various occupational groups. We do not have access to individual noise exposure levels of close to 10.000 workers.

- Page 4, line 53-54: What do you mean by “ISO norms”? Please elaborate on the algorithms that given in ISO 1999 that were used.

Comment: The term ISO norm has been changed to ISO standard. The reference given (#11) gives more details on how you may calculate expected hearing threshold (HT) for men and women of a certain age. $HT=c*(age-18)^2$ with different constants, c, for men and women for each frequency.

Results

- Page 11, Table 1: Please consider more detailed distributions for daily noise exposure.

Comment: The noise exposure of train drivers and conductors may vary to some extent depending on the type of train and the conditions of the track which may vary, but since they are not working on the same type of trains and drive the same lines all the time the exposure levels cannot be given more precisely.

- Page 12, Table 2: How did you decide that “Traffic controller” should be the referent?

Comment: Because the traffic controllers have the same health requirements as train drivers and conductors and are working in a office like control room with a low noise exposure level.

Discussion

- Page 7, line 8-9: You state that “Their noise exposure is probably too low to give any noise-induced hearing loss”. What do you mean by “too low”? Can you quantify this? In other words, what level of noise exposure is necessary to have noise-induced hearing loss?

Comment: Daily noise exposure below 85 dBA. The text has been modified.

- Page 8, line 3: What evidence do you have that the audiometry data is of “good quality”? Please be specific.

Comment: As stated in the methods section the audiometric examinations were performed by special trained nurses using a soundproof booth and using the standard procedure of the the Labour Inspection Authority which is equivalent to the ISO 8253-1.

- Page 8, line 19-20: There is evidence that contradicts the statement, “With the exception of shooting, most evidence suggests that the impact of leisure noise exposures is of minor importance to hear”. For example, please see paper by Lewis et al. (Estimation of permanent noise-induced hearing loss in an urban setting. *Environ Sci Technol.* 2013 47(12):6393-9)

Comment: This is based on a systematic review, ref # 7. Since the evidence is conflicting, I have included the reference given by the reviewer and two other references and modify the text of the paper.

- Page 8, lines 24-25: How do smoking, CVD, HT, diabetes, and high cholesterol relate to hearing loss? How do you expect missing data on these variables to affect your results? A statistical explanation is needed.

Comment: The text has been modified to give a better explanation of our assessment.

- Page 8, lines 31-32: The proper term is “African-American”, not “Afro-American”. Also, what has been proposed as the reason why there are differences by race?

Comment: Pigmentation of the cells of the cochlea has been mentioned as a possible protective factor, but my opinion is that this is not well understood. The text has been corrected.

- Page 8, line 40: What do you mean by a “good” work environment? Please elaborate.

Comment: Obligatory occupational health services for the railway companies, a well developed Labour Inspection Authority with a high focus on noise exposure and the prevention of NIHL and a long tradition of cooperation between the social partners on work environment issues.

- Page 8, lines 40-41: What is your support for the statement that “The Norwegian State Railways has traditionally had a high focus on work, environment and safety and on occupational health”?

Comment: Same as above.

- Can you please elaborate as to why the ISO 1999 algorithms slightly overestimated hearing loss? Are there any papers that discuss the validity and expected bias from using these algorithms?

Comment: The ISO 1999, Annex A, is identical with the ISO 7029, and was based on a number of studies from the 1950es to the 1970es. The algorithms are widely in use in studies on noise-induced hearing loss. Some population studies reveal that the ISO 7029 may be too restrictive (too low hearing thresholds) for the youngest ones and this may partly explain the differences. I do have some opinions on this standard, but this is beyond the scope of this paper.

Reviewer: 2

Reviewer Name: Pernilla Videhult Pierre

Institution and Country: Karolinska Institutet, Sweden Competing Interests: None declared.

I have reviewed a manuscript entitled "Noise induced hearing loss in a longitudinal study of 9640 Norwegian railway workers" by Arve Lie et al. It is a well-written manuscript that shows that Norwegian railway workers are at low risk of developing noise-induced hearing loss.

I recommend a minor revision of the manuscript. All my comments can be found in the attached pdf-file. They mostly deal with language issues. The most important other comments are:

- Page 3, line 8-10: If reference 4 is not a review article, either the word "studies" on line 8 should be changed to "study" or at least one additional reference should be added.

Comment: This a review of several studies.

- Page 3, line 19: A reference should be added in support of the statement that there is a higher percentage of hearing loss in developing countries.

Comment: Two references are givens at the end of the sentence, 7 and 8.

- Page 4, line 7-20: If the numbers derive from the OHS, a reference should be added. If the numbers are a result of the present work, a more appropriate place for them would be in the result section.

Comment: A reference has been added

- Page 4, line 49: Throughout the manuscript, the authors use the expression permanent threshold shifts (PTS). However, as I understand it, the used method does not allow discrimination between permanent and transient shifts. Therefore, I suggest that the word permanent is removed, even though the shifts surely are permanent in most cases.

Comment: We believe that PTS is most correct since the audiometric procedure equivalent to the ISO 8253-1 was used.

- Page 4, line 56-57: Not all readers (including I) know by heart what ISO 1999:2013, Annex B2 stands for. Therefore, I suggest a clarification. Is it the mean of 3, 4, and 6 kHz?

Comment: Mean value. Has been adjusted. Some explanations of the ISO 1999 is given later in the text.

- Page 5, line 39: The authors should clarify if they mean the other groups or the group called the others when writing "compared to the others".

Comment: Adjusted

- Page 6, line 10: I suppose that a two-sided statistical test was performed, as is always recommended? If that is the case, I think "different hearing loss" would be a better expression than "greater hearing loss".

Comment: Correct. Adjusted

- Page 6, line 26-35: It should be clarified whether any of the differences were significant.

Comment: The reference values are obtained from the tables in ISO 1999 which make significance testing difficult. That is why we have compared 50 and 90 percentiles with the reference values in figure 1.

- Table 1: An explanation to the abbreviations train d., train c., train m., track m., and traffic c. should be added below the table. Moreover, the SD for age is missing.

Comment: Corrected

- Figure 1: The lines in the graph suggest that the authors used age as a continuous and not as a categorical variable. Is that true? If not, bar graphs might be a more appropriate graph type to use.

Comment: Line diagrams is the most common way of presentation of such data in the literature since a bar diagram will become more “messy”.

- Legend of figure 1: For clarity, an explanation to ISO 1999 should be added.

Comment: The figure legend has been expanded

VERSION 2 – REVIEW

REVIEWER	Ryan Lewis, PhD, CIH Exponent, Inc., USA I work for a scientific and engineering company that provides consultation on the potential health effects related to exposure to environmental agents, including noise. However, I currently have no projects concerning noise.
REVIEW RETURNED	26-May-2016

GENERAL COMMENTS	Thank you for taking the time to address my comments.
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REVIEWER	Pernilla Videhult Pierre Karolinska Institutet, Sweden
REVIEW RETURNED	07-Jun-2016

GENERAL COMMENTS	<p>This manuscript on hearing threshold shifts in Norwegian railway workers needs only minor revisions. My comments are:</p> <ol style="list-style-type: none"> 1. Keywords: The word “excpsure” should be altered to “exposure”. 2. Abstract, results section. The authors write “adjusted change”. I think they should add information about what the data was adjusted for. 3. Page 3, line 11. A period is missing. 4. Page 3, line 13. The word “with” is missing after “associated”. 5. Page 3, line 14. A period should be removed. 6. Page 3. I think the second and third sections should be joined by using the word “However”, like this: “However, there is still a widespread perception”... 7. Page 3, line 29. The word “studies” should be altered to “study”. 8. Page 3, line 30. The word “a” should be removed. 9. Page 4, line 45-46. The authors write: “The average hearing threshold (HTL) for the better ear of 0.5, 1, 2 and 4 kHz and of 3, 4 and 6 kHz for both the first and the last audiogram were calculated.” Does this mean that if different ears were best at the different occasions, these were compared with each other to calculate the threshold shift? And how did the authors treat the data when the average of 0.5-4 kHz was best in one ear and the average of 3-6 kHz was best in the other ear? Or did that never happen? These issues should be clarified. 10. Page 4, line 49–50. I do not understand the sentence “The better ear refers to the best result of each frequency for the left and right ear”. It sounds as if the authors looked at each frequency separately when determining the better ear, which they did not based on what they write on line 45. 11. Page 5, line 45. The word “is” should be altered to “was”. 12. Table 1. The units used to express the daily noise exposure and the hearing thresholds need to be added. Since the unit for age and sex are given within parantheses, the same should be used for noise exposure and thresholds. Then, brackets could perhaps be used for
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	expressing SD. 13. Table 2. The unit used to express PTS needs to be added.
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VERSION 2 – AUTHOR RESPONSE

Reviewer: 1

Reviewer Name: Ryan Lewis, PhD, CIH

Institution and Country: Exponent, Inc., USA

Competing Interests: I work for a scientific and engineering company that provides consultation on the potential health effects related to exposure to environmental agents, including noise. However, I currently have no projects concerning noise.

Thank you for taking the time to address my comments.

Reviewer: 2

Reviewer Name: Pernilla Videhult Pierre

Institution and Country: Karolinska Institutet, Sweden

Competing Interests: None declared.

This manuscript on hearing threshold shifts in Norwegian railway workers needs only minor revisions.

My comments are:

1. Keywords: The word "excpsure" should be altered to "exposure". Authors comment: Corrected
2. Abstract, results section. The authors write "adjusted change". I think they should add information about what the data was adjusted for. Authors comment: Corrected
3. Page 3, line 11. A period is missing. Authors comment: Corrected
4. Page 3, line 13. The word "with" is missing after "associated". Authors comment: Corrected
5. Page 3, line 14. A period should be removed. Authors comment: Corrected
6. Page 3. I think the second and third sections should be joined by using the word "However", like this: "However, there is still a widespread perception"... Authors comment: Corrected
7. Page 3, line 29. The word "studies" should be altered to "study". Authors comment: Corrected
8. Page 3, line 30. The word "a" should be removed. Authors comment: Corrected
9. Page 4, line 45-46. The authors write: "The average hearing threshold (HTL) for the better ear of 0.5, 1, 2 and 4 kHz and of 3, 4 and 6 kHz for both the first and the last audiogram were calculated." Does this mean that if different ears were best at the different occasions, these were compared with each other to calculate the threshold shift? And how did the authors treat the data when the average of 0.5-4 kHz was best in one ear and the average of 3-6 kHz was best in the other ear? Or did that never happen? These issues should be clarified. Authors comment: The better ear refers to the best result for the right or the left ear for each frequency. Therefore the mean of 3,4 and 6 kHz may be a combination of the results from both the left and the right ear. The text has been modified.
10. Page 4, line 49–50. I do not understand the sentence "The better ear refers to the best result of each frequency for the left and right ear". It sounds as if the authors looked at each frequency separately when determining the better ear, which they did not based on what they write on line 45. Authors comment: See my explanation above.
11. Page 5, line 45. The word "is" should be altered to "was". Authors comment: Corrected
12. Table 1. The units used to express the daily noise exposure and the hearing thresholds need to be added. Since the unit for age and sex are given within parantheses, the same should be used for noise exposure and thresholds. Then, brackets could perhaps be used for expressing SD. Authors comment: Corrected
13. Table 2. The unit used to express PTS needs to be added. Authors comment: Corrected

VERSION 3 – REVIEW

REVIEWER	Pernilla Videhult Pierre Karolinska Institutet, Sweden
REVIEW RETURNED	05-Jul-2016

GENERAL COMMENTS	Second section of introduction, row 7: The word "studiy" should be altered to "study".
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