



## Recreational Noise and Hearing Loss. Systematic Review and Meta-Analysis

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### ABSTRACT

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**Background:** Noise Induced Hearing Loss is a sensorineural hearing loss caused by exposure to loud noises within a long duration. In 2015, WHO predict that more than 1 billion teenagers and young adults are at risk of hearing loss due to unsafe listening practices. There is yet a concrete conclusion on how recreational noise effect hearing ability. This study aims to discover whether recreational noise can cause hearing loss. **Purpose:** To study the effect recreational activities, have on hearing ability. **Method:** The design of this study is a systematic review and meta-analysis method with a case-control approach. Of the 2072 studies identified, 3 studies passed the Intercollegiate Guidelines Network (SIGN) eligibility test and was proceed to a meta-analysis using the REVMAN MANAGER 5.4 software. **Results:** The result are there is no significant effect of recreational noise on hearing loss (OR 0.99, 95% CI 0.16, 06.26 P = 0.99). **Conclusion:** Statistically, there is no clinical significance of hearing loss caused by exposure from recreational activities, but there is a need for more variety of recreational activates sound exposure outside of the music sphere and need for more homogenous of methods amongst Noise Induced Hearing Loss caused by Recreational Activities.

### KEYWORDS:

noise induced hearing loss, recreational noise, threshold shift

### BACKGROUNDS

Noise Induce Hearing Loss (NIHL) is a sensorineural hearing loss cause by exposure toward loud noises over a long period of time.

<sup>1</sup>Noise hearing loss generally has a great effect on one's quality of life, especially in terms of social relationship and an academic setting. <sup>2</sup>

Noise Induce Hearing Loss has many causes. NIHL can be cause by occupation or more known as *Occupational Hearing Loss* (OHL), a sudden loud noise like an explosion or a shotgun or by prolonged exposure to loud noise. <sup>3</sup>

Noise induce hearing loss are usually view more the lenses on occupational hazard, <sup>4</sup> this is made by the fact OHL is the highest cause of NIHL overall. *World Health Organization* (WHO) declared OHL as the second highest occupational disease after *workplace injuries*, where more than four million of *Disability-Adjusted Life Year* (DALY) come from OHL. <sup>5, 6</sup>

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Yet in the last few years, there has been a downward trend of OHL prevalence from year to year, in turns there has been a risen of NIHL number from other causes. <sup>6</sup> In 2015, WHO predict there is more than one billion youth are in risk to experienced hearing disorder because of their habits of listening to music with high volume for a long time. <sup>5</sup>

Hearing loss generally are caused by damages to hair cell known as stereocilia located at the inner ear. <sup>1, 3</sup> The vibration of noise will shake the liquid inside the ear, who's in turn will bend the stereocilia and create a sensorics signal delivered to the auditory nerve, which will be perceive by the brain as sound. <sup>7, 8</sup>

Loud noise with big amplitude can cause these hair cells to bend longer creating what known as *Temporary Threshold Shift* (TTS), but exposure of loud noises long term can cause stress with in these sensorics cells, which will cause a *Permanent Threshold Shift* (PTS). <sup>3, 9</sup>

World Health Organization advice a strength of around 70-85 decibel (dB) for at most 8 hours to maintain a healthy hearing. <sup>3, 11</sup> because noise louder than 85 dB, with long term exposure will cause a permanent hearing loss. The bigger the noise and the longer the exposure, then the higher the risk to cause hearing damages. <sup>3</sup>

Recreational activities for the last two decade has had share an exposure of loud noises, such as concert, which usually reach

around 90-110 dB, or watching movies in cinema with sound systems that can put out noise that reach around 110 dB. These activities has become popular enough within society at large.<sup>12, 13</sup>

Alongside the improvement of accessibility and usage of personal music player that can play out noise around 120 dB within the last few years, and the rising habit of listening music for a long time, has cause a concern regarding recreational noise induced hearing loss.<sup>10, 4</sup>

Despite that, the potential damage cause by recreational hearing loss has not risen a lot of attention with in the general public compared to occupational hearing loss,<sup>4</sup> this could be cause by a lack of concrete evidences regarding the damage of said hearing loss.

Carter et al (2014) has share that a lot of commentary regarding NIHL fall toward speculation as to opposed concrete evidences, yet Mcalexander et al (2015) and Nietzel et al (2012) has shared that there has been a rise of noise pollution in the living environment that has risk to develop hearing loss.<sup>14, 15, 16</sup>

This review aims to see the relation regarding recreational noise and its effect on hearing loss.

**RESEARCH METHODE**

**Data Gathering**

The data are gathered via search engines according to inclusion and exclusion criteria, which then will be filtered according to its quality, according to table 1.

**Inclusion and Exclusion Criteria**

Studies on hearing ability related to recreational noise with a case-control study model and published between 2010-2020 will be included, while studies with subjects over the age of 75 will be excluded due to the impact of age on hearing function normally.

**Search Strategy**

The online literature search come from PubMed, Science Direct, Springer, Cochrane dan Google Scholar with the keyword used are such: “Personal Music Player (PMP)”, “Music”, “Music Student”, “Recreational Noise” OR “Leisure Noise” AND “Threshold Shift” OR “Tinnitus”.

**Table 1. PICO**

<b>Problem</b>	Hearing Loss
<b>Exposure</b>	Recreational Noise
<b>Comparison</b>	-
<b>Outcomes</b>	Tinnitus or Hearing Threshold (HTL) shifts.

**Quality Review**

The quality review are done according to the Scottish Intercollegiate Guidelines Network (SIGN) Methodology Checklists 4: Case- Control, while the evaluation are done independently by the writers.

**Data Analyst**

Data analysis will be conducted using the Review Manager 5.4 software (The Cochrane Collaboration, Oxford, UK). The Odds Ratio (OR) is used to analyse the presence or absence of a relationship between two variables. The confidence interval (CI) is set at 95%. A p-value of less than 0.05 indicates statistically significant data.

**RESULT AND DISSCUSION**

Of the 2072 identified pieces of literature from PubMed, Science Direct, Springer, Elsevier, and Google Scholar, 1940 were excluded because they did not fall within the scope of the study, and 5 were excluded because they were duplicates. The remaining 133 pieces of literature were further screened through abstracts, with 76 excluded for not being related to the research topic and 8 for being reviews.

Of the remaining 49 pieces of literature, a full reading was conducted, and 30 were excluded for not meeting the inclusion criteria. Additionally, 7 were excluded for lacking diagnostic criteria, and another 7 were excluded for not having clear exposure criteria.

The remaining 5 pieces of literature were then tested for eligibility using the SIGN checklist for case-control studies. Two were found to have low scores, and three had high or adequate scores. Therefore, the 3 pieces of literature that passed the eligibility test were included in the meta-analysis process for hearing impairment due to recreational noise exposure.

**Recreational Noise Induced Hearing Loss**

From the three pieces of literature that passed the eligibility test, the results of the meta- analysis on the impact of recreational noise exposure on hearing ability can be seen in Figure 2.

Having a high heterogeneity between all three literatures, the total odd ration is calculated using a random effect model to unsure less bias. The meta-analysis results itself found that there is no significant impact of recreational noise exposure on hearing impairment (OR 0.99, 95% CI 0.16, 6.26, P = 0.99).

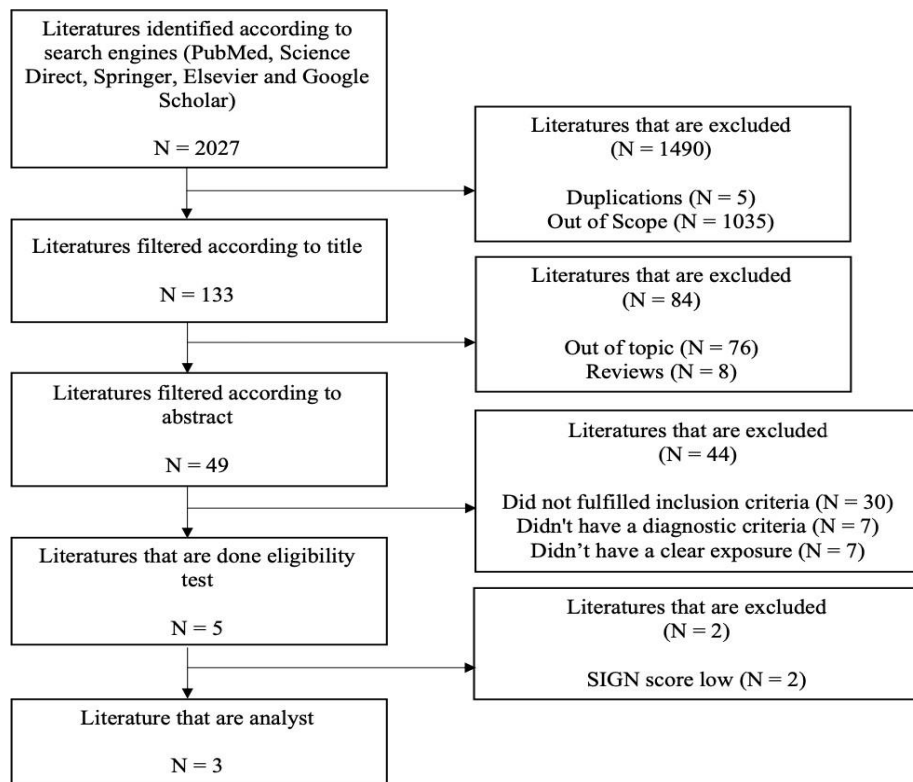


Figure 1. Flowchart of the study

Table 2. Journal Characteristic 1 \*Subjects are students

Journal	Year	Design	Skor SIGN	Subjects	Age Mean
<b>Clercq et al</b>				2275	
Case	2018	Case Control	+	40.04%	10
Control				59.9%	
<b>Rhee et al</b>				2333	
Case	2019	Case Control	++	49.9%	N.A*
Control				50.06%	
<b>Pawlaczyk et al</b>				235	
Case	2016	Case Control	+	71%	22.8
Control				28.5%	

Table 3. Journal Characteristic 2

Journal	Year	Exposure	Diagnostic Criteria
<b>Clercq et al</b>	2018	Usage of <i>Personal Music Player (PMP)</i> more than 3 times a week	<i>High-Frequency Hearing Threshold Shift</i> dan <i>Hearing Loss Questionnaire</i>
Rhee et al	2019	Usage of PMP more than 4 years	Tinnitus and <i>Hearing Loss Questionnaire</i>
Pawlaczyk et al	2016	PMP Usage Hobby	Tinnitus and <i>Hearing Loss Questionnaire</i>

Table 4. Rough Data of Overall Result

Journal	Year	Sick	Not Sick
<b>Clercq et al</b>		<b>258</b>	<b>1817</b>
Exposed	<b>2018</b>	31	800
Not Exposed		227	1017

<b>Rhee et al</b>		<b>398</b>	<b>1935</b>
Expose	<b>2019</b>	239	926
Not Exposed		159	1009
<b>Pawlaczyk et al</b>		<b>22</b>	<b>213</b>
Exposed	<b>2016</b>	20	148
Not Exposed		2	65

Of the three analysed pieces of literature, two indicate a no significant relationship (Rhee et al., 2019 and Pawlaczyk et al., 2016). With Pawlaczyk et al having (OR 4.39, 95% CI 1.00, 19.34.) and Rhee et al, 2019 (OR 1.64, 95% CI 1.32, 2.04). While only one literature pieces (Clercq et al, 2019 OR 0.17 95% CI 0.12, 0.26) showing a significant effects. The findings of all three analyses are not very surprising, considering that, unlike occupational noise exposure, noise from recreational activities does not always occur

consistently. Recreational activities are more frequently done during one's leisure time, whereas noise-induced hearing loss (NIHL) requires consistent and routine exposure.<sup>17, 18</sup> This is clearly shown even in the Clercq et al. (2018) literature, which states that although there were 254 subjects listening to music through personal music players more than 3 days a week, only 83 subjects were recorded listening for more than 1 hour.

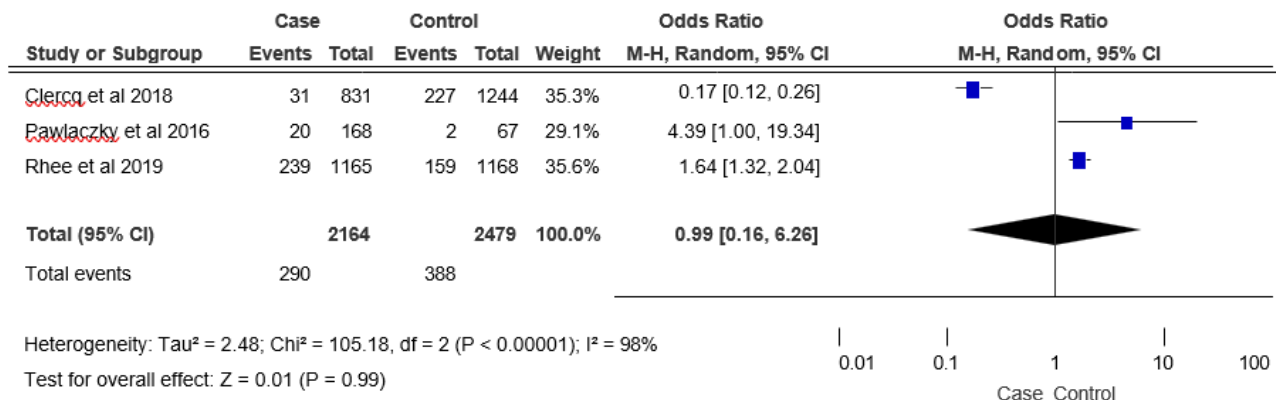


Figure 2. Metanalysis Result of Recreational Noise Induced Hearing Loss

This is also considering the volume level used, with only 43 subjects using personal music players at high to very high volumes (ranging from 85-100 dB). According to the WHO, using a personal music player at 70% volume or around 82 dB is still considered safe as long as the exposure is below 8 hours per day. At 80% volume or around 89 dB, it is only safe for up to 90 minutes per day. Exposure at 100% volume for more than 10 minutes poses a risk of hearing damage.<sup>5, 10</sup>

It is also important to note that the exposure criteria in the analysed studies vary in terms of duration and intensity, which can explain the high number of heterogeneity. If the duration and intensity of exposure were the same, the results of the meta-analysis might differ, as it has been proven that excessive noise exposure can lead to hearing impairment.<sup>1, 3</sup> Another factor to consider is the difference in diagnostic criteria, as tinnitus is more subjective compared to threshold shift. Although tinnitus is a symptom of hearing loss, not all cases of tinnitus indicate significant hearing impairment.<sup>17, 20</sup>

**CONCLUSION AND RECOMMENDATIONS**

Based on the meta-analysis of three studies on noise-induced hearing loss from recreational activities, it can be concluded that there is no statistically significant clinical effect of noise exposure from recreational activities on hearing ability. However, further research is needed on noise-induced hearing loss from recreational activities beyond just music-related activities. Future studies should conduct systematic reviews and meta- analyses of noise-induced hearing loss from recreational activities using similar exposure types and diagnostic criteria, or criteria that are more closely aligned, to achieve more consistent results.

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