

### **Critical Review:**

## **Effectiveness of hearing protection to minimize the subjective hearing loss experienced after exposure to high intensity music at entertainment venues**

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This critical review examines the relationship between the use of hearing protection by persons exposed to loud recreational music at entertainment venues and the negative consequences that are often experienced after exposure. It also focuses on the views of attendees of these venues towards excessive noise and hearing protection. Study designs include: survey research and a randomized control trial. Overall, research shows that there is a connection between attendees who do not wearing hearing protection and their experiences of negative auditory effects, however most patrons of entertainment venues still choose to not protect their hearing.

### ***Introduction***

Noise induced hearing loss (NIHL) is a common concern among industrial workers and many companies have implemented protocols regarding mandatory hearing protection for their employees when exposed to high intensity noise for extended periods of time. Many musicians are also aware of the potential damage that listening to music at high levels can do to their hearing, and many protect themselves using hearing protection. However, individuals who frequently attend entertainment venues with live bands or loud music are exposing themselves to the same or greater intense levels of sound. If these attendees are repeatedly exposing themselves without hearing protection, they could be putting themselves at risk of permanent deterioration of hearing (Bogoch, House, & Kudla, 2005).

NIHL is often associated with a temporary threshold shift (TTS) which is a decrease in hearing sensitivity immediately following exposure to intense sounds that lasts for a short period of time after the exposure (Opperman, Reifman, Schlauch, & Levine, 2006). If this threshold shift does not return to the pre-exposure threshold, the damage to the cochlea may be irreversible resulting in a permanent threshold shift (PTS) (Opperman, Reifman, Schlauch, & Levine, 2006). Many attendees of concerts and other entertainment venues expose themselves to the effects of NIHL without being aware of the potential harm that extended periods of noise exposure can cause (Goggin et al., 2008). The seemingly obvious solution would be for the patrons to protect their hearing with ear plugs to attenuate the high intensity music when they are going to an entertainment venue and yet most choose to not take the precaution. One possible explanation for failure to protect one's hearing is the associated stigma

with those who choose to wear hearing protection at these types of events. Many people who go to entertainment venues may believe that wearing hearing protection will ruin the sound quality of the music and therefore they are willing to forego the hearing protection so that they do not sacrifice their enjoyment of the music. There is also the belief that the noise reduction when wearing ear plugs will alter or distort the quality of the music (Opperman, Reifman, Schlauch, & Levine, 2006).

NIHL often can occur after prolonged exposure to noise greater than 80 dB(A). It is estimated that sound exposure at entertainment venues can vary anywhere from an average of 90 dB(A) to 122 dB(A) (Opperman, Reifman, Schlauch, & Levine, 2006). Thus, even though attendees of such venues do not expose themselves for the length of time that an industrial worker would during a given day, the intensity that they are exposing themselves to may be just as damaging over the briefer exposure period.

### ***Objectives***

The objectives of this paper are to find out if adults who are exposed to loud music at entertainment venues experience fewer signs of hearing damage when they wear hearing protection, when compared to those who do not wear hearing protection.

### ***Methods***

#### Search Strategy

Computerized databases, including CINAHL, PubMed, and Scopus were searched using the following search strategy:

((hearing protection) OR (ear plug\*)) AND  
((concert\*) OR (entertainment venue\*) OR

(music)) AND ((hearing loss) OR (threshold shift))

The search was limited to articles written in English between 1990 and 2008.

### Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate whether wearing hearing protection devices decreases the likelihood of experiencing of negative auditory effects when exposed to loud music at entertainment venues. A limit on the demographics of the research participants was restricted to individuals 16 years of age or older. No limits were set on subjective outcome measures.

### Data Collection

Results of the literature search yielded three survey research studies and one randomized control trial study in congruence with the previously mentioned selection criteria.

## **Results**

### **Survey Research**

Three articles were identified from the above search comparing the results of various different studies where individuals were exposed to loud music at various different types of entertainment venues and then reported on their hearing protection use (if any) and any negative auditory consequences after the exposure. These articles are survey research which indicates an evidence level of 3.

Mercier, Luy, & Hohmann (2003) had 33 volunteers attend a six day music festival in Switzerland. Each volunteer was equipped with a dosimeter, given a pair of ear plugs and a questionnaire to fill out at the end of the evening. It was the volunteer's choice of whether or not they wore the ear plugs. The questionnaire inquired about basic demographic information, asked where the volunteers prefer to be during the concert, whether they chose to wear the ear plugs, and their view of the sound level and sound quality of the music. Each volunteer's sound level exposure was measured and the equivalent sound level was measured throughout all of the concerts that were attended over the course of the six days. The sound level ranged from 73 to 109.4 dB(A) with an average exposure of 95 dB(A). Each volunteer spent between 4 to 12 hours per day at the festival and several of the individuals volunteered for multiple nights. Volunteers wore the ear plugs in 14% of the 296 concerts that were attended throughout the six days.

Attendees (n=601) at the festival were also questioned regarding where they preferred to stand during the concert, their perceptions of the sound level and quality, their use of hearing protection, and any tinnitus that they

may have experienced after exposure to the music. Only 5% reported wearing ear plugs at all of the concerts and 36% indicated that they had experienced tinnitus immediately after exposure. The investigators wanted to have information on ten volunteers each day across the six days of the festival for a total of sixty separate questionnaires and dosimeter data, however they only had 33 volunteers and therefore several of the volunteers wore the dosimeter and repeated the questionnaire on multiple days. Once a volunteer had been exposed to the sound levels from one day at the festival, there is no way to tell if any negative effects that they experience in subsequent days are due to the previous day's exposure or the present day's exposure. The article also did not mention if there was any statistical analysis of the data that was collected in this study.

Bogoch, House, & Kudla (2005) distributed 204 questionnaires to attendees at four separate rock concerts at a venue in Toronto. Each questionnaire asked about the individual's basic demographic information, how often they attend concerts, where in the venue they prefer to listen during the concert, their knowledge of the potential risks of damage to hearing, any negative effects that were experienced after the exposure to the concert, whether they wore hearing protection, and if they did not, their reasoning for not wearing it. To evaluate the data, multivariate analysis was done using multiple logistic regression for the current use of hearing protection and the willingness to wear hearing protection in the future if it was provided for free. Almost half (48.5%) of the respondents reported that they like to be in the loudest areas during the concerts. 80.2% responded that they never wear hearing protection and only 3% reported that they always wearing ear plugs, however 42.1% reported that they would wear complimentary hearing protection if it was provided. A statistically significant (84.7%) of those who responded to the questionnaire reported that they had experienced tinnitus after the concerts ( $p=0.005$ ), and 37.8% reported a disturbance to their hearing, which the authors infer is likely a temporary threshold shift from the noise exposure. The authors were not given permission to measure the sound levels at these concerts so the actual levels to which the patrons were exposed were not known.

Goggin et al. (2008) surveyed 303 patrons and staff of 12 different entertainment venues to find out if those who attend these types of venues wear hearing protection when exposed to the live bands and loud music played by disc jockeys, and any negative effects that they may experience after exposure to that music. They also measured the sound levels in these venues throughout the evening to find the average noise

exposure levels. The article includes a chart that states that the minimum level of noise was 70 dB and the maximum level was 115 dB, with a mean level of 95 dB. Nowhere in the chart was there a mention of which decibel scale was used. In one sentence in the article it does state that the study showed that the attendees were exposed to an average of 95 dB (A) so the dB values in the chart likely are A-weighted, however it was not clearly stated in the table. The questionnaires were conducted with anyone who was willing to participate, however any questionnaire that was completed by someone who appeared to be under the influence of illicit drugs or alcohol was not included in the data analysis. The questions in the survey asked about how often and for how long the patrons/employees attended the entertainment venues, any experiences of negative auditory or systemic (headache, nausea) effects due to the noise exposure, and attitudes towards and use of hearing protection. The investigators found that a significant number of respondents (64%) reported to have suffered some type of negative effect after exposure to excessive noise at the venue ( $p < .01$ ). Tinnitus was the most common negative auditory consequence with 56% reported experiencing it, and 16% reported experiencing temporary hearing loss. Some of the individuals reported headaches and nausea after exposure to the high intensity music (16% and 4% respectively) however the authors acknowledge that these symptoms could be related to many other factors including environmental stressors or consumption of alcohol or drugs. Of those who were surveyed, 17% reported wearing hearing protection which is much higher than the other studies that have been mentioned. However, when the patrons who did not wear hearing protection were asked if they would consider wearing ear plugs if they were provided, only 7% reported that they would. This is a much different result than the result of 42% that was reported in the Bogoch, House, & Kudla (2005) study. This large inconsistency could possibly be due to the wording in the questionnaire or it may reflect a large difference between motivations of earplug use amongst Canadians and Australian attendees at entertainment venues.

#### **Prospective, Randomized Control Trial**

Opperman, Reifman, Schlauch, & Levine (2006) measured the hearing of 29 volunteers immediately before and after they attended three different rock concerts. The volunteers were randomly assigned to different seats and in each location a sound level meter measured the volunteer's sound exposure. There were slight variations in the sound levels measurements across the different locations and the three different concerts, with the averages ranging from 95.12-106.84 dB(A). For each seat location there were two volunteers, one that was randomly assigned to wear ear

plugs, and one who was assigned to not wear any hearing protection. Hearing thresholds were measured before, and immediately after, and the temporary threshold shift (TTS) of each individual was calculated.

Each audiogram was evaluated for significant shifts in threshold based on the Occupational Safety and Health Act (OSHA) standard threshold shift (STS) criterion, the American Speech and Hearing Association (ASHA) criterion, and a multinomial statistical model. A repeated measures analysis of variance (ANOVA) showed a significant effect for earplugs ( $P = 0.006$ ). 64% (9 of the 14) individuals who were in the group assigned to not wear hearing protection showed a significant TTS based on all 3 criteria. 27% (4 of the 15) individuals who were in the group assigned to wear the hearing protection had a significant TTS. Some of individuals who did not wear hearing protection did not have a significant threshold shift, whereas others who did wear the protection did have a shift in their hearing thresholds.

#### **Discussion**

All of the articles seem to support the question of whether or not there are negative consequences to exposing oneself to high intensity music without wearing ear protection. Opperman, Reifman, Schlauch, & Levine (2006) showed a statistically significant effect for the use of earplugs and the reduction of negative effects associated with exposure. One critique of this study was the small sample size with only 29 participants. Also, the investigators were not able to obtain any follow up audiograms as many of the participants did not want to come in for any further testing without compensation.

Mercier, Luy, & Hohmann (2003) caution that it is not simply one evening of exposure that puts us at risk. In our society, where the population is exposed daily to occupational, residential and leisure noise, it is important to focus on prevention and reduce exposure not only at these types of venues, but also if we are exposed in other areas of our life, especially in the workplace. Opperman, Reifman, Schlauch, & Levine (2006) found that while the majority of people who wore earplugs showed no significant change in thresholds and conversely, the majority of people who did not wear earplugs did show a significant threshold shift, there were still many individuals who did not show these effects. There were some who wore the ear protection and still showed a threshold shift and those who did not wear ear plugs and yet did not show any change in their hearing. This could be due to noise exposure in other areas of the participant's lives, or some individuals might be more susceptible to hearing damage from noise exposure. It was not mentioned in

any of the articles whether the subject's noise exposure at work, or in other areas of their lives, was asked about in any of the surveys.

There are also other confounding factors that could contribute to the experience of negative auditory or systemic effects after noise exposure. In Goggin et al. (2008) it is mentioned that the effects of other stressors in the environment, such as strobe lighting, or the consumption of alcohol or drugs may contribute to, or be the sole cause of these experiences. It is extremely challenging to attempt to measure the effects due to the high intensity music, while excluding all of the other factors.

### ***Conclusion/Recommendations***

All of the articles mention that based on the average noise levels at these entertainment venues are well above the levels associated with risk of noise-induced hearing loss. Although many patrons of these venues are not exposing themselves for the average length of a workday, repeated unprotected exposures at these high intensity levels might put these individuals at risk of permanent deterioration of hearing. The majority of individuals who attend these types of venues do not wear any type of hearing protection, and many of them report experiencing negative auditory effects after exposure (Bogoch et al., 2005; Goggin et al., 2008; Mercier et al., 2003; Opperman et al., 2006).

Bogoch, House, & Kudla (2005) and Goggin et al., (2008) both found that individuals who had experienced hearing disturbances previously, had an increase in willingness to use hearing protection, which suggests that knowledge, through the personal experience of the negative auditory effects, might help to increase the use of hearing protection. There is a need for more research on the reasons behind the motivations of those who do protect their hearing and why others abstain from these practices, in order to find out how to encourage more people to start to regularly wear earplugs when exposing themselves to loud music. Another potentially effective approach to minimizing the high exposure to sound is the regulation of noise levels in venues, however this strategy may be one that is difficult to execute and

sustain (Goggin et al. 2008; Mercier, Luy, & Hohmann, 2003)

### ***Clinical Implications***

Based on the results of these studies, my recommendation would be for individuals who are exposing themselves to the high intensity music at entertainment venues, to always wearing hearing protection. This is especially true if they have ever experienced any adverse auditory effects in the past, or if they are exposed to high level noise in other areas of their life.

In reviewing these articles it is evident that many individuals experience negative effects after high level noise exposure at entertainment venues. Although these effects may be more evident in some listeners over others, and it is not known for certain that these short term effects cause permanent damage, it is better to err on the side of caution and protect your hearing.

### ***References***

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