The use of hearing protection devices (HPDs) in a group of South African musicians

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INTRODUCTION

Music induced hearing loss (MIHL) is a form of noise induced hearing loss (NIHL) caused by exposure to music that is at an intensity considered dangerous to the auditory system (Chesky 2008). NIHL, an acquired hearing loss, refers to the damage to or death of the inner hair cells due to exposure to noise. The high frequencies are affected first, regardless of the frequency of the noise source (Schulz 2008). Musicians are at risk for MIHL due to extended periods of noise exposure (Deatherage 2003), which may lead to threshold shifts, tinnitus and reduced dynamic range (Dawson 2007). Threshold shifts caused by noise exposure result in a temporary threshold shift, however, repeated exposure results in a permanent shift were the damage is irreversible (Serra et al. 2007). The effect of MIHL on an individual may include an adverse emotional effect and stress as a result of communication difficulties (Torres 2008). Furthermore, hearing loss may prevent a musician from creating music due to a reduction of the quality of the sound they hear (Noonan 2005). Symptoms of MIHL include reduced hearing acuity, hyperacusis, tinnitus, pain and distortion (Bogoch et al. 2005; Chesky 2008; Chung et al. 2005), all of which may affect a musician's performance.

As a permanent threshold shift is irreversible, prevention of NIHL is critical. Current literature indicates a lack of regulations in the music industry with regard to intensity level limits and hearing conservation programs at entertainment venues to protect musicians from hearing loss (Petrescu 2008). Due to the lack of hearing conservation at live music venues, individuals who are at risk for NIHL should use HPDs during the time of noise exposure (Feuerstein 2002). Three main types of HPDs are available, namely ear muffs, canal caps and ear plugs (Ross 2007). The use of ear muffs and canal caps in the musical industry is not noted in the literature. Ear plugs are the most popular type of HPD used in the music industry and come in three variations; premoulded ear plugs, formable ear plugs and custom ear plugs (Ross 2007). Musicians should preferably make use of custom ear plugs as they reduce distortion and increase attenuation. However, due to availability and funding, many musicians make use of premoulded or formable ear plugs instead (Reid 2005).

It is evident from the paucity of information in the literature reviewed that in South Africa insufficient research has been conducted with regards to NIHL and use of HPDs by musicians. This research aimed to determine if South African musicians are making use of HPDs and the reasoning for their behavior. The sub-aims included to (i) determine to what extent a group of South African Rock and Heavy Metal musicians are currently making use of HPDs, and (ii) determine what affects the musicians' choice to make use of HPDs.

METHOD

A non-experimental, cross sectional survey design was used for this study. Cross-sectional surveys are used when the data is collected at a particular point in time and when studying attributes of different people (Maxwell & Satake 2006). Surveys are

used in research to sample the participant's beliefs and opinions (Maxwell & Satake 2006). Thus a survey was a practical method of obtaining information with regard to musician's beliefs, opinions and practices with regard to NIHL and HPDs.

Twenty four male participants (n = 24) were included in this study. All the participants were a member of either a Rock (n_1 = 12) or Heavy Metal (n_2 = 12) band (See Table 1). They were all exposed to loud music, greater or equal to 85 dBA, on a regular basis, a level that is classified as dangerously loud, thus placing the participants at risk for NIHL (NIOSH 1998).The average age of the participants was 22.4 years (range 19-34 years; standard deviation [SD] - 3.82 years).

Table 1: Descriptive information on participants (n = 24)

Type of band	**Age in years**		
	Mean	**Range**	**SD**
Rock (n = 12)	23.6	19-34	8.06
Heavy Metal (n = 12)	21.2	19-25	2.17
TOTAL (n = 24)	22.4	19-34	3.82

A self-developed questionnaire was used to collect the data. The questionnaire had a total of 27 questions categorized into four categories. The categories include demographical information, personal perception of current hearing ability, HPDs, and noise and music as a health hazard. These categories were used to determine what may affect the musicians' choice to make use of HPDs or not.

The data was analyzed using inferential statistics. Inferential statistics are used to determine whether relationships observed in the sample are likely to occur in the larger population (Irwin et al. 2008). Non parametric inferential statistics are used when the data being analyzed refers to the frequency of occurrence, while parametric inferential statistics are used when the data being analyzed are measures such as age (Irwin et al. 2008).

RESULTS

The results were analyzed to determine the use of HPDs by the group of South African musicians and to determine what affects the musicians' choice to make use of HPDs according to the categories presented in Table 2.

Following data-analysis, participants were divided into two groups (G1 & G2) to compare the results of the musicians who make use of HPDs (G1) to those who do not (G2).

Table 2: Categories of the questionnaire correlating to the results sub-categories

Questionnaire Categories	Sub-Categories
Demographical information	Age Number of years playing an instrument Hours exposed to noise per week Genre Instrument
Personal perception of current hearing ability	Self-rating of hearing Experience of ear fullness Experience of tinnitus
HPDs	Knowledge of HPDs and their availability to musicians Cosmetic Aspects of using HPDs Effects of HPDs on the clarity of the music
Noise and music as a health hazard	Belief that noise can damage the auditory system Belief that music is noise Belief that music may damage the auditory system

Age

The average age of the participants in G1 was 23.06 years (range 20 – 34 years; SD - 4.53 years). In G2 the average age was 21.22 years (range 19 – 24 years, SD - 2.28 years). The results indicate that the majority of participants make use of HPDs as G1 consisted of 15 participants (63 %) and G2 consisted of 9 participants (27 %) (see Table 3).

Table 3: Participant demographical information

	Group 1: Use HPDs (n = 15)			Group 2: Non-use of HPDs (n = 9)		
	Mean	Range	SD	Mean	Range	SD
Age (in years)	23.1	20 – 34	4.53	21.2	19 - 24	2.28
Musical instrument experience (in years)	7.7	1 - 20	5.41	8.4	3 - 19	5.29
Noise exposure per week (in hours)	23.3	6.7 – 56.8	18.06	19.9	4.3 – 84.3	24.93

The two sample t-test was used to analyze the data, t = 1.3621, p<0.05 and df = 22, thus the critical value is 2.0739. As the t value was less than the critical value, it is indicated that the use of HPDs is not influenced by the age of the participant.

Musical experience and exposure to noise

The *musical experience* in G1 was on average 7.7 years (range 1 – 20 years, SD - 5.41) and in G2 8.4 years (range 3 – 19 years, SD - 5.29) (see Table 3). The two sample t-test was used to analyze the data, t = 0.31117, p<0.05 and df= 22, thus the critical value is 2.0739. As the t value was less than the critical value, the use of HPDs is not influenced by the number of years the musicians have played for.

The *hours exposed to noise per week* for each participant was calculated by adding the hours they practiced each week, hours they played live each week and other hours per week where they were exposed to noise such as watching other live bands

or teaching music. G1 averaged at 23.3 (range 6.7 – 56.8; SD - 18.06) while G2 averaged at 19.9 hours of exposure per week (range 4.3 – 84.3; SD - 24.93). The Mann-Whitney test was used to analyze the result U= 77.5, p<0.05, with $n2$=15 and $n1$=9 thus the critical value was 34. As the U value is required to be less than or equal to the critical value the results indicated that the use of HPDs is not influenced by hours of noise exposure per week experienced by the musicians.

It was also found that only 60 % of participants in G1 made use of the HPDs during all noise exposure periods. Seven percent of the participants in G1 only made use of HPDs during practice sessions and not during gigs, while the remaining 33 % reported that they sometimes use HPDs but did not specify when. This indicates that although a majority of the participants are making use of HPDs, they are not all using the HPDs during all exposures to noise.

Use of HPDs by genre and instrument type

Of the 15 participants in G1, eight were Metal musicians and nine were Rock musicians. In G2 four participants were Metal musicians and five were Rock musicians. Chi square was used to analyze the results. χ^2 = 0.17777, p<0.05 and df =1 thus the critical value was 3.841 indicating that the use of HPDs is not influenced by the genre. The participants in this study played a variety of *instruments*. These instruments included six vocalists, nine guitarists, six bassists and five drummers. In G1 there were two vocalists, eight guitarists, four bassists and two drummers while G2 consisted of four vocalists, one guitarist, two bassists and three drummers. One participant from each group played two instruments. Chi square was used to analyze the results. χ^2 = 5.194593, p<0.05 and df = 3 thus the critical value was 7.815 indicating that the use of HPDs is not influenced by the instrument played.

Personal perception of current hearing ability

The participants were asked to rate their own hearing, as well as their experience of aural fullness and tinnitus after noise exposure. When asked to rate their *current hearing ability*, of the participants in G1, four stated their hearing was perfect, six felt their hearing was normal, five believed it was slightly worse than when they were younger and none believed it was noticeable worse than when they were younger or had a known hearing loss. In G2, four believed their hearing was perfect, four thought it was normal and one believed their hearing to be noticeably worse than when younger. Chi square was used to analyze the results. χ^2 = 5.226667, p<0.05 and df= 4 thus the critical value was 9.488. Thus the results indicated that the use of HPDs is not influenced by the musicians' perception of their hearing abilities.

The participants were asked to rate their experience of *aural fullness* after exposure to noise. Of the participants in G1, four stated they never experienced aural fullness, none stated they experienced aural fullness after practice sessions, seven stated they experienced aural fullness after gigs and three stated they experience aural fullness after practice and gigs. Of the participants in G2, one stated they never experienced aural fullness, one stated they experienced aural fullness after practice sessions, one stated they experienced aural fullness after gigs and three stated they experience aural fullness after practice and gigs. Chi square was used to analyze the results. χ^2 =8.259378974, p<0.05 and df=4 thus the critical value was 9.488. Thus the results indicated that the use of HPDs is not influenced by the musicians' experi-

ence of aural fullness after noise exposure. Seventy eight percent of the participants experienced ear fullness after noise exposure.

The participants were asked to rate their experience of *tinnitus* after exposure to noise. Of the participants in G1, five stated they never experienced tinnitus, two stated they experienced tinnitus after practice sessions; six stated they experienced tinnitus after gigs and two stated they experience ear fullness after practice and gigs. Of the participants in G2, three stated they never experienced tinnitus, none stated they experienced tinnitus after practice sessions; one stated they experienced tinnitus after gigs and three stated they experience tinnitus after practice and gigs. Chi square was used to analyze the results. χ^2 =7.147857143, p<0.05 and *df*=4 thus the critical value was 9.488. Thus the results indicated that the use of HPDs is not influenced by the musicians' experience of tinnitus after noise exposure.

HPDs

The participants' *knowledge of HPDs* was determined as they were asked what types of HPDs are available and where they may be purchased from. All of the participants in G1 and G2 knew what HPDs were and could give examples of different types of HPDs. All the participants in G1 and six of the participants in G2 knew where to purchase HPDs. Chi square was used to analyze the results. χ^2 =10.04464286, p<0.05 and *df*=1 thus the critical value was 3.841. Thus the results indicated that the use of HPDs is influenced by the musicians' knowledge of where HPDs may be purchased from. The comparison of the two groups, those who make use of HPDs and those who do not indicated that the main contributing factor to the use of HPDs is knowledge of HPDs specifically where they may be purchased. All of the musicians in G1 were able to list places such as audiologists, pharmacies and hardware stores, where HPDs may be obtained.

The participants were asked if the *cosmetic aspects of HPDs* would affect them from using them. In G1 two participants stated they would be affected and 13 stated they would not be affected. In G2 three participants stated they would be affected and six stated they would not be affected. Chi square was used to analyse the results. χ^2 =1.364210526, p<0.05 and *df*=1 thus the critical value was 3.841. Thus the results indicated that the use of HPDs is not influenced by the cosmetic aspects of HPDs.

The participants were asked to describe the *effects of HPDs* on the quality of the music. In G1, one participant stated that the HPDs had no effect on the quality of the music, nine stated they improved the quality, six stated they distort the signal and one stated he did not know. In G2, none participants stated that the HPDs had no effect on the quality of the music, three stated they improved the quality; four stated they distort the signal and two stated they did not know. Chi square was used to analyze the results. χ^2 =2.509368194, p<0.05 and *df* = 3 thus the critical value was 7.815. Thus the results indicated that the use of HPDs is not influenced by the musicians' perception of the effects of HPDs on the quality of the music. It should be noted that although 53% of the musicians in G1 felt that HPDs improve the quality of the music compared to the 33% of those in G2. However, this difference is not significant.

Noise and music as a health hazard

The participants were asked if they believed that exposure to loud noise may damage the auditory system. All of the participants in G1 and G2 believed that noise is harmful to the auditory system. Thus, indicating that the knowledge of the effects of noise on the auditory system does not influence the use of HPDs. This indicates that as all the participants are aware that noise may damage the auditory system, education programs should focus on the long-term effects of such as the effects of hearing loss on daily living.

The participants were then asked if they believed that music may be considered as noise. In G1, ten participants believed that music is a form of noise while five believed that it is not. In G2, seven participants believed that music is a form of noise while two believed that it is not. Chi square was used to analyze the results. χ^2 =0.336134453, $p<0.05$ and $df=1$ thus the critical value was 3.841. Thus the results indicated that the use of HPDs is not influenced by the musicians' belief that music may be considered noise.

The participants were asked if they believed that exposure to music may damage the auditory system. In G1, 14 participants believed that music exposure may damage the auditory system and one believed that it could not. In G2, eight participants believed that music exposure may damage the auditory system and one believed that it could not. Chi square was used to analyze the results. χ^2 =0.145454545, $p<0.05$ and $df=1$ thus the critical value was 3.841. Thus the results indicated that the use of HPDs is not influenced by the musicians' belief that music may damage the auditory system. These results indicate that the majority of the participants are aware that music may damage the auditory system and thus they are at risk of NIHL.

DISCUSSION

Demographical information

This study indicated that the demographical attributes of the musicians (age, number of years of musical experience, genre of music, instrument played and weekly hours of noise exposure) did not affect their use of HPDs. As the majority of participants' in this study are under 25 years of age, this may explain why age is not a contributing factor to the use of HPDs, as compared to previous studies which indicate that age does affect HPD use (Goodman 2001; Laitinen 2005). The results indicating that HPD use is not affected by years of musical experience, was not unexpected as previous research on this topic has had conflicting results, Goodman (2001), found that individuals' who had more musical experience were less likely to make use of HPDs as they experience more distortion as a result of hearing loss. While Laitinen (2005), found that musicians are more likely to make use of HPDs after they have developed a hearing loss. This study found that although a majority of the participants are making use of HPDs, they are not all using the HPDs during all exposures to noise. These results correlate to a study conducted by Laitinen & Poulsen (2008) who found that the musicians who do make use of HPDs generally use them inconsistently and not during all times of noise exposure.

Personal perception of current hearing ability

The study indicated that the musicians' perception of hearing ability (self-rating of hearing, experiencing aural fullness and experiencing tinnitus after music exposure)

did not affect their use of HPDs. As discussed above, hearing loss has conflicting results on the use of HPDs (Goodman 2001; Laitinen 2005), which may have counterbalanced each other out in this study. Twenty five percent of all participants feel that they have some degree of hearing loss, 78 % experience aural fullness and 79 % experience tinnitus after noise exposure; however none of the participants have been to an audiologist for a hearing assessment. This may reflect the musicians' knowledge regarding the role of audiologists in hearing assessment and management.

HPDs

This study indicated that the cosmetic aspects of HPDs and the effects of HPDs on the perceived quality of the music did not affect the musicians' use of HPDs. However, the comparison of the two groups, those who make use of HPDs and those who do not indicated that the main contributing factor to the use of HPDs is the knowledge of HPDs specifically where they may be purchased. All of the musicians in G1 were able to list places where HPDs may be obtained whereas 40% of the participants in G2 did not know where HPDs could be purchased. These results correlate with previous research that indicates increased awareness of HPDs increases the use of HPDs (Wilton 1999). This is an important consideration for awareness programs in the music industry. Furthermore, musicians require an adjustment period to be accustomed to the HPDs before they experience the benefits of HPDs (Laitinen & Poulsen, 2008). Thus awareness programs in the music industry should highlight that an adjustment period is required and that once musicians have become accustomed to the HPDs they perceive the HPDs as beneficial and feel that the HPDs improve the quality of the music.

Noise and music as a health hazard

This study indicated that the knowledge of the effects of noise on the auditory system, the musicians' belief that music may be considered noise and the musicians' belief that music may damage the auditory system did not affect their use of HPDs. This does not correlate to previous studies that have indicated that musicians' are unwilling to make use of HPDs as they do not consider music noise and aim to produce the high intensity sounds (Everton 2004). As all the participants were aware that noise may damage the auditory system, education programs should focus on the long-term effects of such as the effects of hearing loss on daily living.

CONCLUSION

The use of HPDs is affected by the musicians' knowledge of HPDs; however, no other single factor contributes to the musicians' choice to make use of HPDs. It is thus evident that musicians require general education regarding the importance of hearing conservation. The audiological community should become involved in education programs in the music industry regarding the effects of hearing loss, the signs and symptoms of NIHL and the steps that should be followed for assessment and treatment of hearing loss. This is imperative for the prevention and early identification of hearing loss which will lessen the burden on the health care system (Ross 2007). It is also proposed that a change of legislation is required in South Africa to include the music industry in future Occupational Health and Safety Acts.

Recommendations for future research include that this study be replicated on a larger sample size as this may provide more information regarding the factors that affect the use of HPDs in South African musicians. It is also recommended that the research be replicated with musicians from different genres to compare the use and awareness of HPDs across the different music genres. A further study should be performed to determine the effectiveness of educational programs in the music industry. Finally a study comparing the use of HPDs in musicians who received formal music training and those who have not to determine if music colleges in South Africa are promoting hearing conservation.

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