Article

Health Education Journal
1–16

DOI: 10.1177/0017896911422780
hej.sagepub.com

Music exposure and hearing health education: A review of knowledge, attitude, and behaviour in adolescents and young adults

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Abstract

Introduction: Adolescents and young adults have been shown to be the age group most at risk of music-induced hearing loss (MIHL), which is already evident and increasing among this group.

Objective: The purpose of this review is to provide further insight into the effectiveness of education programmes on attitude and behaviour towards loud music exposure in adolescents and young adults, and to suggest positive and influential ways of delivering hearing health education.

Methods: Literature searches were conducted using various databases, including PubMed, Google Scholar and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Authors went through the abstracts of these articles to identify those which were potentially relevant; subsequently the full articles were retrieved.

Results: This review highlights the dangers of significant exposure to music on hearing mechanics in adolescents and young adults, and shows that this danger continues to increase with modern music culture. Because the consequences are not immediate, it is difficult for the young to perceive the seriousness of a problem that may not present itself for many years. Conventional education may go a little way in helping to raise awareness but a raised awareness of consequences does not, in itself, change behaviour. There is a significant gap in literature regarding effective methods of education that will inspire attitude change, and have a bearing on actions.

Conclusion: This review has concluded that there is a lack of understanding of how to best influence and educate adolescents and young adults in a way that will motivate and encourage a change in listening habits. It is of vital importance that these groups are made aware of the immediate and future dangers, and how changes in listening behaviour do not necessarily lower their enjoyment.

Keywords

attitude, behaviours, knowledge, music exposure, noise induced hearing loss

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Introduction

Noise can be described as sound at an intensity that can interfere with verbal communication and may cause discomfort of the ears or reduction of hearing sensitivity, defined as hearing damage.[1] Any exposure to noise of significant intensity and duration increases the risk of ear damage and causes permanent hearing affection, known as noise induced hearing loss (NIHL).[2] Noise exposure is one of the major causes of avoidable permanent hearing loss throughout the world.[3–6]

There are several common sources of noise exposure. Industrial noise is estimated to be the cause of 16% of the disabling hearing loss in adults worldwide.[7] In the short-term, Seixas et al.[8] found that three years' exposure to under 90dBA left previously-healthy construction apprentices with measureable loss of hearing function. In the long-term, the onset and extent of presbycusis was found to be earlier and greater in occupational noise-damaged ears than those without a history of exposure.[9] Kumar et al.[10] described noise as the major occupational hazard for industrial workers, and it is also among the most common reasons for seeking compensation.[11]

Noise in leisure and other environments is also a significant factor in the development of hearing symptoms. Temporary threshold shift (TTS) and tinnitus were experienced after one hour of motorcycle riding[11] and recorded in the audience of an ice hockey match,[12] while Neitzel et al.[13] found that noise levels on the New York subway frequently exceeded safe levels. Recreational firearm use has been shown to result in TTS,[13] and Smith et al.[14] showed a permanent threshold shift (PTS) in a long-term study of military personnel.

Loud music exposure has been generally accepted as one of the main recreational noise sources, and acquired hearing loss due to loud music exposure has recently been referred to as music-induced hearing loss.[15] Exposure to music at high intensity and for long periods of time is likely to induce several hearing symptoms, such as TTS, tinnitus, hyperacusis, recruitment, distortion or abnormal pitch perception, eventually resulting in permanent hearing loss.[4,11,15–21] Numerous early studies have explored music-induced hearing loss primarily in professional musicians and people working in music venues. However, there is substantial evidence in literature showing an increasing potential risk of music-induced hearing loss in the general public, particularly adolescents and young adults.

With a drastic change in music listening culture in recent decades, there is an increase in the number of people exposed to louder sounds at a much younger age by listening to, performing, or recording music.[22,23] Young people are more likely to expose themselves to potentially-damaging levels of music through various leisure activities,[24–26] and such behaviour will increase the risk of developing NIHL. In the third National Health & Nutrition Examination Survey (NHANES), an NIHL-type audiometric configuration was noticed in about 12.5% of the children in the 6 to 19 age-range.[27] Studies in America, Scandinavia, Germany and China have suggested that hearing loss relating to leisure noise may already be affecting 12–15% of school-age children and young adults.[28]

Adolescents and young adults are exposed to loud music from various sources, but mainly through using personal music players (PMPs, for example MP3 players, Walkmans or other devices), attending concerts and night clubs. With major technological advancements in PMPs in recent years, such devices are becoming far more accessible and popular.[29,30] The latest models are compact, with the ability to store thousands of tracks of music and have greater battery longevity, allowing people to use them in various situations for substantial durations, for example in noisy environments such as aeroplanes or trains.[4] The output of PMPs can reach up to 110dBA, with the averaged sound level exceeding 85dBA, for an average duration of exposure between two and three hours per day.[4] Considering the hearing damage risk criteria of 85dBA with an exposure

duration of eight hours, PMPs would produce a volume loud enough to potentially put the listeners at risk of hearing damage if exposed to it for a substantial time. The other major source of music exposure for adolescents and young adults is through attending music concerts and night clubs. Meyer-Bisch[3] reported that the sound level at a rock concert is always around 100–115dBA. Considering the same hearing damage risk criteria of 85dBA exposure duration for eight hours, the author suggested that exposure duration of 100dBA should be less than 1.25 hours per week if calculated at the equivalent sound energy.

Although substantial evidence has shown that risk to hearing health is strongly associated with exposure to loud music, much more work needs to be done in terms of providing comprehensive regulation and education for the public in order to raise their awareness and prevention of MIHL. Since 1997, when the World Health Organization (WHO) published a document concerning probable increased risks of future hearing damage due to music exposure, particularly in adolescents and young adults,[6] there have been several studies of education programmes relating to leisure noise, indicating varying degrees of success. Comparing with effectiveness on industrial noise and hearing conservation programmes, these studies show that, in contrast to hearing damage from industrial noise, there is less likelihood of protective behaviour in relation to music noise before the onset of hearing symptoms, but that this behaviour increases when symptoms were experienced.[31,32]

A number of factors appear to be important indicators of the success of education towards protective behaviour of music exposure. In a recent review, Vogel et al[33] identified several sociodemographic and psychosocial correlates such as age, gender, school level, ethnicity, music preference, physical activity, social influence and free supply of hearing protection linked to young people's exposure to loud music. In addition, knowledge of the risks, as well as information on, and availability of, protection correlates with an intention to engage in protective behaviour, but not necessarily in the behaviour itself. Hearing loss itself is often an insidious process, and therefore exposure is often not considered a risk until other symptoms appear.[26] The purpose of this review is to provide further insight into the effectiveness of education programmes on attitude and behaviour in adolescents and young adults when they are exposed to loud music, because such preventive education can be more successful if music listening behaviour and attitude towards loud music exposure is better understood. We will also discuss the successes and failures of hearing protection programmes in leisure settings, and the reasons behind non-compliance with leisure-related hearing protection programmes. Potential approaches for further developing the education programmes will be recommended on the basis of important issues highlighted in the review.

Search strategy

Literature searches were conducted using various databases, including PubMed, Google Scholar and CINAHL. The following search terms were used for the initial searches in these databases: 'hearing loss AND music' (577), 'music exposure AND hearing loss' (146), 'music exposure AND hearing health education' (15), 'music exposure AND hearing loss in adolescents' (60), 'music exposure AND hearing loss in young adults' (35), 'music exposure AND hearing loss AND knowledge' (10), 'music exposure AND hearing loss AND attitude' (11), and 'music exposure AND hearing loss AND behaviour' (12). The numbers in parentheses indicate the number of papers identified. Authors went through the abstracts of these articles to identify those which were potentially relevant; subsequently the full articles were retrieved. In addition, we also used manually-searched references in audiology textbooks and proceedings of some major international conferences.

Music exposure and hearing health education programmes in adolescents and young adults

There has long been an awareness of the effects of industrial type of noise on hearing.[34–36] Both legislation and hearing protection training programmes have been put in place to protect workers from noise damage. However, noise from leisure activities has not been considered in as much detail, either legislatively or in terms of education, nor has it been the subject of such intensive research.[37]

In general, leisure noise falls into several categories, including motor sports, shooting, indoor and outdoor music concerts and exposure to PMPs. A study by Smith et al.[38] indicated that the noise exposure relevant to various social activities had tripled in adolescents and young people in the United Kingdom (UK) since the early 1980s. The incidence of significant noise exposure from various social activities in young adults was approximately 18.8%. It was much higher than that from occupational noise and gunfire noise, which were 3.5% and 2.9% respectively.

Of leisure noise, music exposure currently appears the most common problem among adolescents and young adults because music has been a significant source of noise exposure due to digital technology development in the last few decades.[15] The first studies showing that rock music amplification had become sufficiently loud to cause TTS and other hearing symptoms were carried out in the late 1960s, and audiometric tests on rock musicians by Reddell and Lebo[39] showed a 'notch' typical of noise-induced hearing loss, as well as tinnitus reported in all cases. Along with amplified live music, PMPs have also been studied as a source of potential hearing damage since shortly after the introduction of the first Sony Walkman in 1979, with several studies in the late 1980s indicating levels of exposure commonly above safe levels, and up to 126dBA.[3]

Given that music can now be experienced at volumes which would be considered unacceptable in an industrial setting, similar education and protection programmes should be put in place to protect consumers. Unfortunately, there have been only a limited number of studies of the effectiveness of these programmes, and even fewer follow-up studies. Folmer et al.[40] reviewed several programmes across the United States (US), and found that they increased students' knowledge and intention to engage in protective behaviour. However, they also point out that it would take many years to establish whether or not these programmes were successful in the long-term. The reported success of hearing conservation programmes for occupational noise exposure has shown how a raised awareness of consequences can lead to an effective change in attitude.[6]

Lee et al.[41] conducted an experiment in Hong Kong to discover if a holistic approach to health care in schools would be beneficial. The study involved a training course for not only teachers, but also other health sectors, social services, and parents. Post-training it was reported that the participants felt that they had a change of attitude, and they no longer felt that being 'healthy' was merely absence of present disease, but a lifestyle that leads to future good health. This research could be utilized when educating adolescents about hearing health, considering there is no immediate effect to music exposure, but future hearing health is at risk.

In line with the findings from Lee et al., Peters[42] suggests that an approach to hearing education which focuses on the future consequences of current behaviour may be the most effective in changing participants' attitudes, as it has been in industrial settings. Vogel[25] carried out a study on visitors to discotheques and found a large proportion seemingly more concerned with immediate benefits, rather than consideration of future health effects, again indicating the importance of addressing attitude change in hearing conservation education.

However, hearing health and music exposure education still appears under-represented in the UK curriculum. Currently, in the UK, information on hearing health is not administered through health education, but under the subject of science. It is one of 35 units in Key Stage 3; there are 11 objectives within this unit; only one objective covers noise exposure.[43] When considering popular music culture amongst this age group, and the importance of hearing health, the current provision seems severely inadequate and slightly misplaced; it may be more appropriate under the subject of personal, social and health education (PSHE), and it needs to be expanded to incorporate a comprehensive view of hearing conservation.

Considering the ever-decreasing age of acquired NIHL,[44] hearing health education should be deemed of equal importance to dental health, eyes and vision, and personal hygiene. However, there is currently no plan to introduce hearing conservation programmes into the national education curriculum as part of the PSHE subject within the UK (Qualifications and Curriculum Authority, 2006). This lack of parity with other health issues in schools (smoking, drugs and sexual health for example) may be one of the reasons for the increasing rate of NIHL at an early age,[6] and why this continues to escalate.

Recently, in the UK and in the US, several non-governmental and non-education based organizations have launched campaigns providing information on the dangers of leisure noise to school-age children, such as the Royal National Institute for the Deaf (RNID) in the UK and the National Institute on Deafness and other Communication Disorders (NIDCD) in the US. However, these campaigns and the information provided by these organizations have been the subject of very little follow-up research. Dangerous noise intensity has yet to publish results, and an internal evaluation of the NIDCD's 'Wise Ears!' campaign indicated that a lack of promotion, information and an overly-broad scope within provided materials hampered the campaign's success. In terms of school education programmes, Folmer et al.[40] provided a snapshot of a number of disparate school programmes across the US, but concedes that it would take years to establish the success or otherwise of any of these programmes. Despite the number of programmes discussed, their study points out that hearing conservation is not taught in most schools, and they suggest legislation should be implemented to ensure its funding and provision in parity with programmes dealing with smoking or drug use.

Knowledge, attitude and behaviour towards music exposure

The importance of hearing health education programmes in influencing people's attitude towards music exposure, together with listening habits and protective listening behaviours, is clear. It is therefore essential to understand whether hearing health education methods are suitable and effective in terms of raising awareness, increasing knowledge and consequent changing attitude and behaviour.

Knowledge of music exposure in adolescents and young adults

Various studies have investigated how knowledge of the dangers of amplified music can affect attitudes towards music exposure in adolescents and young adults, together with their listening habits and protective listening behaviours. A survey carried out by Lass et al.[45] focused on the awareness and knowledge of 101 high school students regarding hearing health issues. The results showed several areas in which the students' knowledge was very poor or misinformed. Although 90.1% knew that exposure to noise could cause hearing damage, 88.1% thought this was due to damage to the tympanic membrane, 38.6% thought that damage was caused purely due to intensity

and not related to duration, and 48.5% thought that NIHL could be corrected by medical treatment. The survey discovered that, although 96% of the students often used stereo systems or PMPs, severe deficits were found in their knowledge of hearing health and mechanisms. Particular concern must be expressed over the large percentage of subjects that believe that NIHL while young could be medically corrected at a later stage.

Chung et al.[46] conducted a similar study using an internet-based survey. This questioned adolescents and young adults about general health matters, and whether hearing health was of any concern. A substantial 9,693 people took part in three days, with a mean age of 19 years. Results showed that hearing health was of least concern when compared with sexually-transmitted diseases, depression, drug and alcohol use, smoking, nutrition, weight issues, and acne. Only 16% reported having ever heard, read, or seen anything publicly related to hearing loss with only 9% receiving education at school; significantly, those who did express concerns regarding hearing health were among this small percentage. Only 20% of respondents reported an intention to use ear protection at any future concerts or club events but, importantly, when made aware of the potential hazards of amplified music this number escalated to 66%. This is highly significant when considering the importance of hearing health education.

Relation between knowledge and attitude towards music exposure in adolescents and young adults

Evidence of the association between knowledge and attitude is valuable. Chung et al.[46] showed a substantial change in attitude when knowledge of hearing health is increased. Gallagher[47] reported on a study where 1,529 students were informed about the dangers of loud music and, after education on the dangers, found a 15–20% boost in the number of students prepared to wear ear protection at a concert, clearly showing the benefits of awareness. An alarming factor concerning concerts was uncovered by Mercier and Hohmann[48] when interviewing 700 young adults. The authors discovered that 65% believed concerts not to be too loud, even though 71% reported suffering tinnitus following attendance. Therefore, it could be suggested that, if these young adults perceive the music not to be too loud, they assume it to not be harmful, even in the presence of hearing symptoms. An awareness of the potential harmful effects could prove significantly beneficial to this group.

The association between knowledge and attitude is reinforced in a study by Widén et al.[49] which investigated the use of hearing protection at music events amongst young adults from two different countries: the US and Sweden. The study discusses how, in Sweden, informational campaigns highlighting the dangers of loud music have been in place for many years, and the fact that earplugs are commonly available free of charge at music events in Sweden. In contrast, until recently the campaigns within the US have been aimed more at occupational noise. Significantly, different results were gained from each country. In Sweden 61.2% wore earplugs at music events in contrast to only 9.5% in the US; this vast difference is deemed to be due to increased awareness and an acceptance of earplugs. Widén et al.[49] conclude that the increased awareness is equal to the change in attitude, which in turn leads to a change in listening habits.

Furthermore, in their recent study,[26] they investigated possible association between attitudes, risk-taking behaviours, measured threshold shift and self-reported hearing symptoms experiences in college students. Their sample included 258 students between the age 17 and 21 years. The findings suggest that the attitude towards exposure to loud music was significantly related to self-experienced hearing symptoms, but not the threshold shifts recorded.

Changes in music listening habits and protective listening behaviour in adolescents and young adults

Evidence of the association between knowledge and behaviour is plentiful, but acquiring this knowledge does not necessarily lead to a change in behaviour. Rawool and Colligon-Wayne[31] referred to a study of American students which indicated that, while 85% were aware that no cure exists for sensorineural hearing loss, 72% also reported never using hearing protection devices (HPDs). The 2008 study itself found that 90% of 238 students were aware that hearing loss could occur through exposure to loud music. However, over 75% believed that they would not be affected by hearing loss until they were older, and although 66% had experienced temporary tinnitus, 58% were not concerned by it. The danger of this attitude is pointed out by Widén et al.[26] who believe that temporary threshold shift and temporary tinnitus may in fact be a stronger predictor of hearing loss than permanent tinnitus. As discussed earlier, there appears to be a link between the knowledge of dangers and the attitude to noise, and consequently the intention to engage in protective listening behaviour exists in leisure environments, for example, reducing listening volume and using HPDs.

Chesky et al.[50] found that music students were both more likely than other students to perceive sound which may affect hearing as negative, and to use HPDs. Another survey of Swedish and American students showed a 12.45 times higher likelihood of HPD use among those who had a negative attitude towards noise.[31] Shah et al.[51] concluded that young people in general would be more willing to wear hearing protection if they were aware of both the physical and psychosocial aspects of hearing loss and other hearing symptoms. Vogel et al.[25] showed that the general level of education may affect PMP listening volumes, as those 12–19 year-olds in pre-vocational education were more likely to listen louder than those attending pre-university courses.

Knowledge of the dangers of exposure to loud music has also been linked to increased use of HPDs and, conversely, a lack of knowledge is correlated with failure to use protection in risky noise environments. A study of visitors to the MTV.com website indicated that, while only 20% of respondents had a general intention ever to use HPDs, this rose to 59% if advised by a medical professional, and 66% if made aware that unprotected exposure may result in permanent hearing loss.[46]

Another major contributing factor to attitudes towards leisure noise and the use of HPDs is among individuals with hearing symptoms (tinnitus and hyperacusis) either in addition to, or without, hearing loss. A significant link between tinnitus and/or hyperacusis and negative attitude to noise was made by Widén et al.,[26] with the strongest negative connection to noise being those who experienced both of hearing loss and hyperacusis. They suggest that self-experienced symptoms may therefore themselves be a factor leading to preventative behaviour, including HPD use, while non-experienced symptoms like threshold shift are not. Bohlin and Eriandsson[52] reported that adolescents with persistent tinnitus judged loud music to be more risky than those with no hearing symptoms, and also that they listened less to loud music than those with occasional tinnitus. Therefore, the hearing symptoms such as tinnitus or noise susceptibility may act as a 'trigger' mechanism for the development of health-related behaviour towards exposure to loud noise or music.[53]

However, Weichbold and Zorowka[54] investigated whether a hearing education campaign would have any bearing on the attendance and earplug use of 163 secondary school students who attended discotheques. The results were very poor; attendance at discotheques reduced from only 34% to 24% and earplugs use was increased from 0% to only 3.7%. The authors suggest that education programmes for secondary schools are ineffective. Based on these findings it seems that, in terms

of actual protective behaviour, experience of hearing symptoms resulting from leisure noise is much more likely to result in a negative attitude to loud music than education.

General discussion

Adolescence is a critical time of learning, growth, and development; learning and adopting a healthy lifestyle at this stage has shown to be a strong determinant for future health.[41] The WHO[55] recommends that, when it comes to the methods and delivery of health education, young people should have a role in the decision-making. Further research into this area may discover improved methods of delivering hearing health education. It is possible that the music industry itself could prove more influential than conventional methods. For example, as shown in the study by Widén et al.,[49] earplugs in Sweden are available free of charge at concerts, and this proved enormously influential in the protection of hearing at these events. A study into what adolescents and young adults feel would be an effective method in which to educate them may show that information from the music industry itself (perhaps via magazines, television, websites, and at concerts) could in fact prove more powerful. Further investigations into the opinions and influential factors of this group could prove to be invaluable when instigating and evaluating effective hearing conservation.

The key to successful hearing protection education in relation to leisure noise appears to be through attitude change, rather than solely through information and/or HPD provision. Widén et al.[26] suggest that the change in self-perception from 'non-vulnerable' to 'vulnerable' is vital to this process, and that hearing symptoms other than hearing loss may have a more powerful impact on changing this attitude. They also describe these symptoms as more 'experienced' than hearing loss, which is generally a more insidious process. Rawool and Colligon-Wayne[31] also call for tinnitus and temporary threshold shift (more immediately 'experienced' reactions to loud noise) to be used as the basis for education programmes. Peters[42] points out that industrial education programmes make regular use of hearing tests, therefore allowing participants to maintain awareness of their hearing status, and that a similar approach in leisure noise education would go some way towards making hearing loss an 'experienced' symptom.

Maturity may also have an effect on the success of education programmes, as Goggin et al.[56] found that over-25s were more likely to wear HPDs than younger participants, and to have more positive attitudes to others wearing them. This change of attitude to the 'acceptability' of HPDs indicated as one of the reasons for the success of metal workers, reported by Zohar et al.,[57] where modification of the work environment led to a change to a more respectable image of HPDs, and a connected change in the expectations of peers and supervisors to their use. Vogel et al.[25] state that more research is needed into the specific factors which form barriers to protective listening behaviour in different age and social groups with regard to leisure noise.

Rawool and Colligon-Wayne[31] found a correlation between students who listened loudly through headphones and those who reported sitting close to speakers in concerts. Vogel et al.[25] showed that there was a link between frequent use of PMPs and other generally more risky behaviours, as well as less protective behaviour. In a sample of 1,687 Dutch 12–19 year-olds, frequent PMP users were between two and five times more likely to also engage in risky listening behaviour (listening louder, and being more likely to increase volume after a period of listening), and were two to three times less likely to use hearing protection. Given this link, they suggest that frequency of PMP use may be used as a screening test for those at most risk of hearing loss, and to target education and protection.

Although those who are more likely to engage in risky behaviour in other aspects of life may not be susceptible to education regarding the risks of loud music exposure, it may well be possible that a shift in general perception of loud music from 'safe' to 'risky' may have an overall effect on protective behaviour. Loud noise in industry is now subject to legislation, and is considered a risk to health, although noise at work regulations only came into force in the UK in 1990, while in the US the Occupational Safety and Health Administration introduced legislation in 1972. Prior to this legislation (and the associated possibility of compensation for injured workers) hearing protection was not obligatory, and the 2002 study by Palmer et al.[58] states that the resulting burden of hearing difficulties is substantial.

The change in attitude of the general public to smoking is a clear example of a change in the assessment of a leisure activity from 'risk-free' to 'risky'. An Australian study of attitude change in young people from 1999–2005 (the period of a Smarter than Smoking campaign) towards smoking found significant changes in their negative view of smoking in some key areas: smell, cost and fitness.[59] Farrelly et al.[60] also found a long-term effect of well-executed anti-smoking campaigns, although it is interesting to note that tobacco company-sponsored anti-smoking advertising was associated with a slightly more positive attitude towards smoking.

The experience of hearing protection education in industry could also be valuable to music noise protection training in terms of the best approach (both practically and cost-effectively) to get the information to those who require it. A comprehensive hearing health programme is introduced into schools that will influence pupil's attitude and behaviour towards music exposure. However, consideration of the influence of cultural, regional and socioeconomic factors related to attitudes and risk behaviours towards music exposure is crucial for determining an effective music exposure education programme. Evidence has shown that an inadequately administered hearing education programme has little influence on behaviour and attitude. Folmer[61] examined a programme where, although adequate materials and space within the curriculum were available for educating school children about the exposure to loud noise and its effects, they had not been implemented effectively. Chesky[62] also found that there was very little or no information and/or education towards health risks associated with music exposure, even in music education schools and colleges. Currently no studies have been carried out to determine the best way in which to influence and modify behaviour in this context, and in a document by the WHO[6] it was reported that, to date, knowledge of how to implement effective education plans that will inspire and change attitudes and habits towards music exposure is very poor.

Assessment on the scientific quality of key references in hearing health education of adolescents and young adults

Within this comprehensive review, a scientific quality assessment has been conducted to evaluate strengths and limitations in literature, so that gaps in research can be identified relating to the effectiveness and efficiency of hearing health education on attitude change, and resulting behavioural change. Table 1 shows the summary of the evaluation in terms of strengths and limitations of key references associated with music exposure and hearing health education in adolescents and young adults. Of those studies, various scales for attitude and behaviour evaluation have been used, for example, the youth attitudes towards noise scale (YANS) for measuring attitudes towards noise, and the adolescents' habits and use of hearing protection scale (AHH) as a tool for investigating the use of hearing protection. In addition, the Health Belief Model and the Theory of Planned Behaviour have been applied to the research associated with music induced hearing loss. However, some important influencing factors (e.g. socioeconomic status, educational background and cross cultural perspective) should be further explored.

Table 1. Summary of scientific evaluation of key references associated with music exposure and hearing health education in adolescents and young adults

Author	Aim	Study design	Scientific quality evaluation
Vogel et al. (2010)[25]	To estimate the risk of developing permanent hearing loss as a result of voluntary exposure to high-volume music.	Sample: 1,512 adolescents (aged 12–19 years, mean = 14.7; M:F = 1:1) in 68 classrooms at 15 Dutch secondary schools. Methods: (1) A semi-structured and self reported questionnaire about music listening behaviour and hearing-related symptoms after listening to high-volume music. (2) Estimating the level of noise exposure based on the self-reported music exposure data.	Strengths: (1) Appropriate sample size with a wide range of age band and equal distribution between male and female participants; (2) The self-reported questionnaire used in this study provides detailed information for a rapid assessment. Limitations: (1) Self-reported questionnaires have certain weaknesses in terms of reliability and validity with, for example, a risk of both over- and under-reporting; (2) Unreliable and inaccurate estimation of music exposure level and risk, based on self-reported data (3) Relationship between demographic factors and other variables should also be analyzed.
Widén et al. (2009)[26]	To investigate associations between college students' attitudes, risk-taking behaviour related to noisy activities, and self-experienced hearing symptoms.	Sample: 258 students (aged between 17 and 21, mean = 19.0; M:F = 72:186) enrolled at an American University. Methods: (1) Three questionnaires to measure attitudes towards noise (the youth attitudes towards noise scale, YANS); use of hearing protection (the adolescents' habits and use of hearing protection scale, AHH) and self-reported hearing symptoms (the hearing symptom description scale, HSD);	Strengths: Comprehensive study design including more questionnaires and audiological measurements. Limitations: (1) Disproportion of male and female participants; (2) No measured levels of noise exposure to which the adolescents were experienced.

Table 1. (Continued)

Author	Aim	Study design	Scientific quality evaluation
		(2) Audiological measurements included Otoscopy, Tympanometry and Screening Audiometry (from 500 Hz to 6000 Hz).	
Rawool and Colligon-Wayne (2008)[31]	To evaluate the listening behaviours and beliefs of college students with reference to exposure to loud sounds in the context of the health belief model	Sample: 238 (40 men, 198 women) recruited from one large class consisting mostly first year college students in an American university. Methods: a self-developed questionnaire to address the various questions, including noise exposure, hearing symptoms and elements of the Health Belief Model.	Strengths: The first study applying Health Belief Model to music-induced hearing loss. Limitations: (1) Some important influencing factors on the Health Belief Model (e.g. socioeconomic status and educational background) should be explored; (2) The current findings cannot be generalized to other populations due to the sample quality; (3) Disproportion of male and female participants.
Chung et al. (2005)[46]	To evaluate awareness of music induced hearing loss and perceptions of hearing protection among young adults.	Sample: 9,693 MTV website visitors (aged between 13 and 34, mean = 19.2; M:F = 3,310:6,148) Methods: A self-designed online survey containing questions about views toward general health issues; specific hearing music exposure and hearing protection-related items, together with demographic data (e.g. age, gender, occupational and socioeconomic status).	Strengths: (1) The self-designed online survey including general health issues as important control factors; (2) A large sample size recruited using web-based survey technique to gather hearing health information. Limitations: (1) Not real a random sample taken from the population because of the sole website and short data collection duration; (2) Common disadvantages related to online survey; for example, excluding people who have no access to a computer or to the Internet, as well as self-selection bias due to the voluntary nature of website survey. (4) Disproportion of male and female participants.

(Continued)

Table 1. (Continued)

Author	Aim	Study design	Scientific quality evaluation
Widén et al. (2006)[49]	To compare attitudes toward music exposure and hearing protection held by young people in Sweden and the USA	Sample: a total of 382 participants (179 Swedish students, 57 M, 122 F) and 203 American students (90 M, 113 F), aged between 17 and 21. Methods: Two questionnaires to measure attitudes towards noise (the youth attitudes towards noise scale, YANS) and self-reported hearing symptoms (the hearing symptom description scale, HSD), together with demographic data (e.g. age, gender, choice of educational program, and country).	Strengths: The first study of its kind to compare differences in attitudes and the use of hearing protection between two western countries. Limitations: (1) Specific information related to the cultural factors should be investigated. (2) Disproportion of male and female participants in the Swedish sample.
Chesky et al. (2009)[50]	To compare the attitudes toward noise exposure between students with music majors and students not majoring in music.	Sample: 467 participants (mean = 19.85 years, *SD* = 3.63, M:F = 280:187) Methods: a 12-question questionnaire adapted from the Youth Attitudes to Noise Scale (YANS) to assess attitudes toward noise in youth culture (7) and attitudes toward influencing sound environment (5).	Strengths: The Theory of Planned Behaviour was investigated and discussed in relation to the attitudes towards music-induced hearing loss. Limitations: (1) The current findings cannot be generalized to other populations due to the sample quality; (2) Specific information closely related to students with music majors as co-variables should be investigated.
Bohlin et al. (2007)[52]	To analyze the relationship between music exposure, risk behaviours and risk judgements.	Sample: 310 Swedish adolescents (aged 15–20, M:F = 167:143) recruited from three schools in the west of Sweden. Methods: A modified 'The Adolescent Risk-Taking Questionnaire' to assess risk behaviours and risk judgements to hearing, in combination with eight Questions on hearing protection use and hearing status selected from the	Strengths: The modified questionnaire included risk behaviours and risk judgements relevant to general risk situations as important control factors; Limitations: (1) The questionnaire used in this study is long and complicated (79 items in total); (2) The risk situations listed in 'The Adolescent Risk-Taking Questionnaire' may not have the same

Table 1. (Continued)

Author	Aim	Study design	Scientific quality evaluation
		scale Hearing Symptoms Description (HSD) and Youth Attitude to Noise Scale (YANS).	meaning in a different cultural context.
Weichbold and Zorowka (2003)[54]	Aim: to investigate whether a hearing education campaign would prompt adolescents to display hearing-protective behaviour when attending a discotheque.	Sample: A sample of 169 high school students participated in the pre-campaign interview (aged between 15 and 19, mean = 16.9; M:F = 54:115), whereas only 136 (aged between 16 and 20, mean = 17.9; M:F = 49:93) took part in the post-campaign interview. Methods: Two questions exploring music exposure behavioural aspects before and one year after the campaign, asking for the frequency of discotheque attendance within the past six months, and whether they used earplugs in the discotheque.	Strengths: A longitudinal study to compare the impact of a hearing education campaign on hearing protection behavior. Limitations: (1) High attrition: just over 80% sample where seen for post campaign interview; (2) Did not code respondents so that matched comparison in terms of behaviour changes appeared impossible; (3) Disproportion of male and female participants.

Conclusion

This review highlights the dangers of significant exposure to music on hearing mechanics in adolescents and young adults, and shows that this continues to increase with modern music culture. Legislation has proved insufficient and in fact nonexistent for most recreational music listening even though many exposure levels exceed laws for occupational noise. Because of this lack in government regulations, self-regulation is the only method in which to protect hearing mechanics from music exposure. However, given that research has indicated that much of the population is unaware of the dangers and how to reduce the risks, it is little wonder the problem continues to escalate. It cannot be assumed that the population is instinctively aware of these dangers if no formal education has been provided.

Adolescents and young adults have been shown to be the age group most at risk, and NIHL is already evident and increasing among this group. It is of vital importance that this group is made aware of the immediate and future dangers, and how changes in listening behaviours do not necessarily lower their enjoyment. However, because the consequences are not immediate, it is difficult for the young to perceive the seriousness of a problem that may not present itself for many years. Conventional education may go a little way in helping to raise awareness but a raised awareness of consequences does not, in itself, change behaviour. Future research into the views and opinions of adolescents and young adults may bring forward positive and influential ways to deliver hearing

health education. This group may have ideas that have previously eluded professionals when devising health education; and their opinion of what motivates themselves and their peers may provide vital information that will help in the construction of effective hearing health education.

Acknowledgements

This work was partially funded by the Alumni Foundation and Benjamin Research Trust, University of Bristol, UK.

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