USE OF PORTABLE AUDIO DEVICES BY UNIVERSITY STUDENTS

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ABSTRACT

New digital portable audio devices such as the Apple iPod have caused renewed concerns that recreational noise exposure may pose a danger to the hearing health of young adults. In this study, 150 undergraduates completed a survey about their use of portable audio devices and about other factors that could affect their hearing health. In addition to completing the survey, 24 students also participated in an experimental session. In the experimental session, hearing thresholds up to 14 kHz were measured and objective acoustical measures of output of the iPod were obtained. Participants listened to music and adjusted an iPod to their preferred setting in five conditions: in quiet and in two types of background noise, traffic or multi-talker babble background, at a high and a low level. A Brüel and Kjær dummy head and PULSE sound analysis system were used to measure the output of the iPod at the preferred settings of the students and at predetermined volume and equalizer control settings. It was found that most students use portable audio devices, but the pattern of their usage seems to be potentially hazardous only for a minority. The importance of education about safe usage of this technology is emphasized

SOMMAIRE

De nouveaux appareils audio digitaux, tel le Ipod, ont renouveler les inquiétudes que peut amener le bruit récréatif à l'ouïe de jeunes adultes. Dans la présente étude, 150 étudiants au baccalauréat ont complété un questionnaire concernant leur utilisation d'appareils audio portatifs ainsi que d'autres facteurs pouvant affecter leur santé auditive. En plus de répondre au questionnaire, les 24 étudiants ont également participé à une session expérimentale. Lors de cette session, les seuils auditifs atteignant 14 kHz ont été mesurés et des mesures acoustiques objectives du iPod ont été obtenues. Les participants ont écouté de la musique et ont ajusté leur iPod au niveau qu'ils préféraient dans cinq conditions. L'une de ces conditions était silencieuse et les deux autres avaient un bruit de fond (du traffic ou plusieurs personnes qui parlaient) à des niveaux de sons haut et bas. Une tête de mannequin Bruel et Kjaer ainsi qu'un système d'analyse de son PULSE ont été utilisés afin de mesurer le output du iPod aux réglages de son favorisés par les participants et des niveaux de volume egaux. Il a été trouvé que la plupart des étudiants utilisent des appareils audio portatifs, mais le patron d'utilisation de ces devis ne pose un danger que chez une minorité d'entre eux. L'article met une emphase sur l'importance d'offrir une éducation sur l'usage sûr de la technologie.

1. INTRODUCTION

For decades, noise has been recognized as a hazard that can damage hearing (Clarke & Bohne, 1999). Concerns about industrial and military noise have dominated research and practice regarding the prevention of noise-induced hearing loss. Nevertheless, it is widely held that exposure to noise in recreational activities could affect hearing health (e.g., Chung et al. 2005; Health & Welfare Canada, 1988; Williams, 2005), with youth being vulnerable (e.g., Ciona & Cheesman, 2000; Lees, Roberts, & Wald, 1985).

In modern everyday life, people are continuously bombarded with noise that is potentially detrimental to hearing health. One of the sources of recreational noise that has received media attention is portable audio devices (e.g., Fearn & Hanson, 1989). These devices have been popular for decades, especially among adolescents and young adults. The media drew attention to the potential risks of using the Sony Walkman in the 1980's. In the 1990's, studies investigated headphone/portable CD players (Bly, Keith & Hussey, 1998; 1999, 2001). Very recently somewhat similar coverage has been given to the potential risk of using the Apple iPod (Fligor, 2006; Hawaleshka, 2006; Spencer, 2006). Some fear that the use of digital devices is excessive and more dangerous than older portable audio technology. The purpose of our study was to investigate if this new technology poses a significant risk to hearing health.

Given the newness of digital portable audio technology, little research has yet been conducted to investigate how it is actually used by young adults. A recent study for the American Speech and Hearing Association gauged the potential risk of portable audio devices based on data gathered in a telephone-based survey focused on high school students (Zogby, 2006). Compared to adults, high school students listened to their audio devices for longer periods at higher settings compared to adults, and they reported having more symptoms of hearing loss, including turning up the TV, tinnitus, and difficulty communicating. As in previous studies, factors that resurfaced were the low level of awareness of the risk of loud sound to hearing health, and the low level of worry about hearing health, at least for those not educated about hearing loss prevention (e.g., Williams, 2005; Chung, 2005; Zogby 2006).

The specific aim of the study was to examine the relationship between the use of portable audio devices and hearing health in university students using both subjective and objective measures. Subjective measures were gathered by administering a web-based questionnaire to determine how portable audio devices are used by university students, how their use interacts with other sources of noise exposure, and whether their patterns of use raise concerns about hearing health. Objective measures included audiometric testing of hearing and acoustical measurement of the output produced by an iPod under control conditions and at the preferred settings of users when listening to two types of music in quiet and in different noisy background conditions.

2. METHOD

2.1 Participants

A questionnaire was administered to 150 participants. The participants included 126 undergraduate students who received a credit towards their Psychology 100 course at the University of Toronto at Mississauga (UTM) for their participation. The others were undergraduate students who volunteered to complete the study with no monetary compensation. Participants from PSY 100 were recruited using the course website and they were tested in groups in a computer lab at the university that was reserved for the study. The others, students involved in other projects in the same research facility, completed the survey individually on a computer in the lab. All participants provided informed consent. The survey took less than 30 minutes to complete and was followed by an information session about the effects of noise on hearing and how to conserve hearing. All participants were young adults, most being between the ages of 16 and 20 years (71.3%) or between 21 and 25 years (28%). Just over half (56%) were male. Almost all were single (92%) and still lived at home with family (82%).

Twenty four of the students who had completed the questionnaire volunteered to attend a second one-hour session at which the objective measures were collected. The measures included audiometry and acoustical measurements of output at the preferred iPod settings for listening to music heard in quiet and in two levels of background noise. Most students earned one course credit for their participation in the second session and a few volunteered without compensation because of their interest in the topic. All participants in session two provided informed consent.

2.2 The Survey

A 124-item online survey was designed to probe items that would provide information on users of portable audio devices in the university student population. Items were designed to investigate a number of topics, including: demographic characteristics, transportation usage patterns, work environments, personal and family hearing history, recreational activities (including noisy hobbies, frequency of attendance at bars, concerts, and sporting events), as well as questions on the use of portable devices. A number of items probed the participants' subjective estimations of the volume levels to which they set their own devices, and their subjective perceptions of their hearing abilities. Thus, the survey was intended to aid in establishing trends relating hearing loss to the degree of use of portable audio devices.

Two items were used to identify the participant number and date. In addition, there were 70 main questions and 52 sub-questions. All participants were asked to complete 48 main questions and 12 associated sub-questions. Only respondents who owned an iPod were asked to complete another 19 main questions and 15 associated sub-questions. Only iPod users who usually adjusted the equalizer settings were asked a further 3 main questions and 25 associated sub-questions. All main questions and associated sub-questions and response options are provided in Appendix A.

2.3 Audiometry

Audiograms were measured for the 24 participants who completed session two. Thresholds were tested for pure-tones of .25, .5, 1, 1.5, 2, 3, 4, 6, 8, 10, and 14 kHz. Participants sat in a sound-attenuating double-walled IAC booth. Standard audiological test frequencies were delivered to Telephonics TDH-50P HB7 headphones from a Grason-Stadler GSI-61 audiometer. High-frequency testing (above 8 kHz) was conducted using a special option on the audiometer and Sennheiser HAD 200 headphones. The ear tested was the one that the participant believed to be of lesser ability or if both ears were believed to be equally good then the left ear was tested.

Clinically normal results for hearing thresholds are considered to be between 0-25 dB HL (Mencher, 1997); following the recommendation of Mencher, if the thresholds of any participant exceeded 20 dB HL at 3 kHz or 30 dB HL at 4 kHz, and if the person wished to have a diagnostic hearing test, then a referral to an audiologist would have been made; however, no participant met these criteria.

2.4 Acoustical Measurement of Output

Acoustical measurements of output were obtained under a range of control conditions using a dummy head and at the preferred settings of the 24 participants in session two.

Equipment

All testing was conducted in a 10 x 12 foot IAC double-walled soundbooth. Music was presented to a dummy head and 24 participants from the same black 30-GB Apple iPod Video MP3 player (MA146LL/A), with standard earbuds. At the start of each session, a calibration test was done in which the output was checked with the iPod volume set to maximum and the equalizer set to the default position.

The output from the iPod was measured by placing the headset on a Brüel and Kjær (B & K, 2006) Sound Quality Head and Torso Simulator (HATS) type 4128-C-001 with binaural microphones and Zwislocki couplers. The output to the ears of the dummy head was measured using a B & K PULSE Sound Analyzer 9.0, Labshop version 9.0.0.352.

Stimuli

The same stimuli were used to obtain the output measurements in the control and user preference conditions. Two samples of music were used, each representative of a particular genre, either Hip-Hop or Electronica. These genres were chosen because they are very popular with undergraduates. A typical 30-second segment of each song was presented to calculate the mean dB (L_{eqA}) level output in each condition. Hip Hop songs are known for their strong percussions, thus most of their energy is concentrated in the low-frequency range between 1 and 4 kHz. The particular sample of Hip Hop tested was from the song "Cop that disk" by Missy Elliott and Timbaland and Magoo which includes vocals. In contrast, a typical Electronica song features synthetized sounds with more energy from 1 to 12 kHz. The particular sample used was from the song "Area 51" by Infected Mushroom, with no vocals. Average spectra for these two clips are shown in Figure 1. The time waveform of the Hip Hop clip is shown in Figure 2 and the time waveform of the Electronica clip is shown in Figure 3.

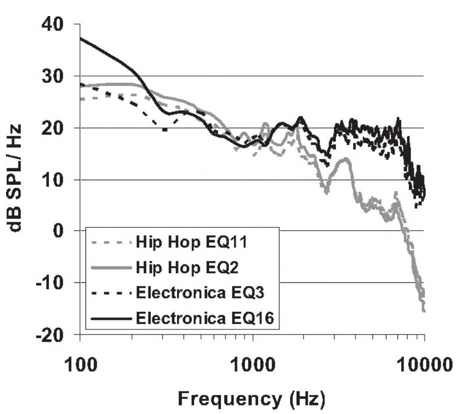

Figure 1. Spectra of Hip Hop clip played at volume 4 with equalizer settings 11 "latin" and 2 "bass booster", and of the Electronica clip played at volume 4 with equalizer settings 3 "bass reducer" and 16 "RNB".

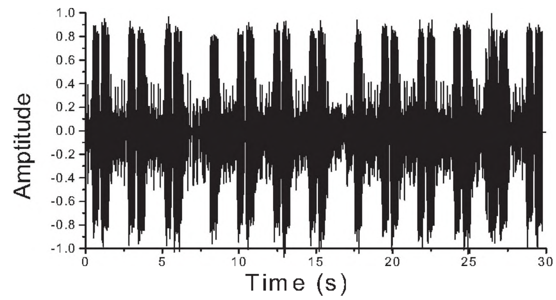

Figure 2. The time waveform of the Hip Hop clip.

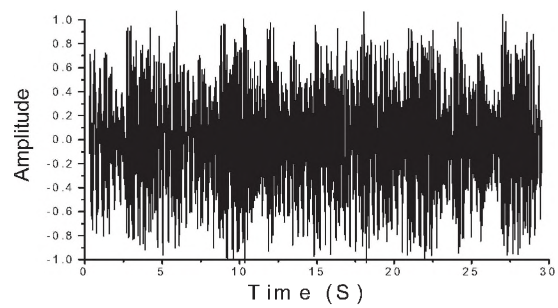

Figure 3. The time waveform of the Elecctronica clip.

2.4.1 Output at Control Settings

The B & K HATS was positioned on a small desk in a fixed location within the booth. There are 23 different equalizer settings options on the iPod and each of them was coded with numbers from 0 through 22. A marker divided into four equal segments was positioned below the iPod's visually displayed volume meter and it was used to divide the volume setting into one of four different ranges: 0-25, 25-50, 50-75 or 75-100%. Thus, the sound level in dBA was recorded at 25, 50, 75, and 100% volume settings for each of the 23 equalizer settings.

The output was measured for three different earbud – style headsets coupled to the iPod, one sold by Apple and two alternatives sold by other companies. The brands of headsets tested and their specifications are as follows:

1. 30-GB iPod Video Earphones with a frequency range of 100Hz - 20kHz, sensitivity of 90 ± -3 dB, impedance of 32 Ω ± -15% and maximum power input of 10mW.
2. Mirai Earphones (MI-SL-730BV-Black) with a frequency range of 20Hz - 20kHz, sensitivity of 113dB ± 3dB, impedance of 32 Ω and maximum power input of 60 mW.
3. Panasonic Earphones (RP-HV288) with a frequency range of 10Hz - 25kHz, sensitivity of 104 dB/mW, impedance of 16 Ω and maximum power input of 50 mW

The standard iPod earphones were the first headset to be assessed. After positioning the earphones in the B & K HATS, a 30-second Hip Hop sound clip was presented to the dummy. The average dBA level was recorded. The initial equalizer and volume setting were adjusted to 0=default and 25%, respectively. The measurements were obtained in the same way for the three other volume levels at the default equalizer setting. Then the next equalizer setting was tested at each of the four volume levels until all 23 equalizers had been tested using the Hip Hop song. The procedure was repeated with the Electronica test stimulus.

For each condition, the average difference in dBA between Hip Hop and Electronica was calculated. The largest and smallest differences at each volume level were used to determine which equalizer settings made the most difference (see Results section). Based on these findings, two equalizer options were selected for further testing with the other two headphones. Specifically, Mirai and Panasonic earphones were tested at the equalizer settings 10=jazz and 13=lounge across the four different volume levels.

2.4.2 Output at User Preference Settings

The 24 participants listened to each sample of music in five background conditions: quiet, multi-talker babble at 50 and 70 dB SPL, and traffic noise at 50 and 70 dB SPL. The levels of noise were chosen to typify mildly and moderately adverse conditions representative of everyday situations.

Participants sat in the center of the booth facing two loud speakers, one in the back left and the other in the back right corner. The background noise was delivered over both loud speakers, positioned at 45^0 on either side of the listener. The delivery of background sound was controlled using a TDT System III. The participants wore the iPod and standard headset in both ears to listen to the music samples.

Participants completed the experiment in one of four orders. In two orders, Electronica was tested first and Hip-Hop second, and the types of music were reversed in the other two orders. Within each music type condition, half of the time traffic noise was tested first and multi-talker babble was tested second, and the types of background noise were reversed otherwise.

Each participant was told he or she would listen to ten music clips, five from each of the two genres. For each clip in each background condition, the participant was asked to adjust the iPod to listen to the song “the way you like it the best”. The participants were shown how to adjust the iPod volume and equalizer controls, but they were not required to do so unless they wanted to. At the start of each condition, the equalizer was set to the default position. After the participant was satisfied with his or her adjustment in each condition, the experimenter noted the volume setting with reference to a pre-marked scale from 0 (minimum, 1-25%) to 4 (maximum, 75-100%). The earbuds were then placed in the dummy’s ears and the 30-second clip was analyzed using the PULSE Sound Analyzer to determine the average output in dBA for each ear at the user’s preferred settings.

3. RESULTS AND DISCUSSION

The main subjective and objective findings will be reported first, and then relationships between the findings in the present study and the study of high school students (Zogby, 2006) will be examined to illuminate whether or not the use of digital portable audio devices poses a risk to the hearing health of university students and how this compares to the findings for high school students.

3.1 The Survey

Portable Audio Device Use

Most (82%) of the participants owned a portable audio device, with the most popular devices being MP3 players (42.7%), iPods (34%), CD players (32.7%), and cell phones (29.3%) (Figure 4). Some students (N=26) listen more often to their device through loudspeakers, but it is more common for students to listen with a headset. About as many (N=51) use standard earbuds as use headphones (N=43), with only 5 students reporting that they use extended range earbuds. About half of the device owners reported using their portable audio device for 5 to 7 days per week, and for a duration of 2 hours or more per listening session. Of the device users, 35 reported listening to their devices as frequently as seven days per week, and 7 listened to their device for as long as 4 to 8 hours in a typical single session. Figure 5 shows the typical length of listening sessions.

The median volume level for students using a headset was 60% on a scale from 0 to 100%, with 100% being the maximum volume; however, there were 17 individuals who reported setting the sound level in the 80-100% range (Figure 6). The median level to which the students using a loudspeaker adjusted their devices was also 60%; however, there were 25 individuals who reported setting the sound level in the 80-100% range when using the device in this fashion. This initial evidence suggests that most students use their devices frequently, but in mid volume ranges, regardless of how frequently the device is used. Nevertheless, there is a minority who may use their devices very frequently for long sessions and at high volumes.

Gender differences were observed (Figure 7). More females than males reported setting the volume in the 25-50% range. Curiously, more males than females preferred the highest ranges, but of those who preferred the lowest volume, more were males.

On average, undergraduates seem to use their devices for less time and at lower levels than high school students. This finding is consistent with age-related trends in frequency and during of participation in other noisy leisure activities (Cheesman, Ciona, Mendoza & Grew, 2001). The most likely explanation seems to be that university students have less leisure time than high school students.

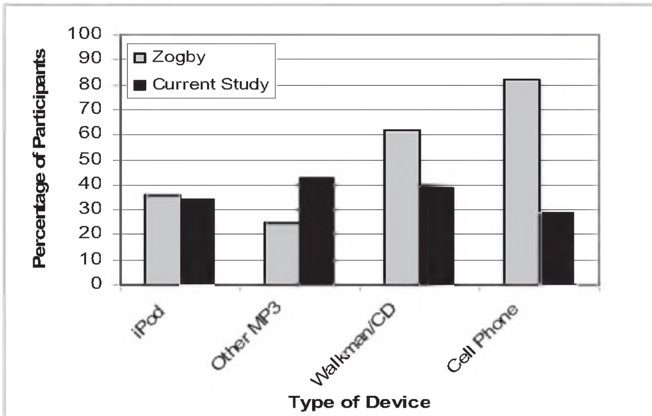

Figure 4. Percentage of respondents in the current study (N = 118) and percentage of 301 high school students (Zogby, 2006) who own various popular portable audio devices.

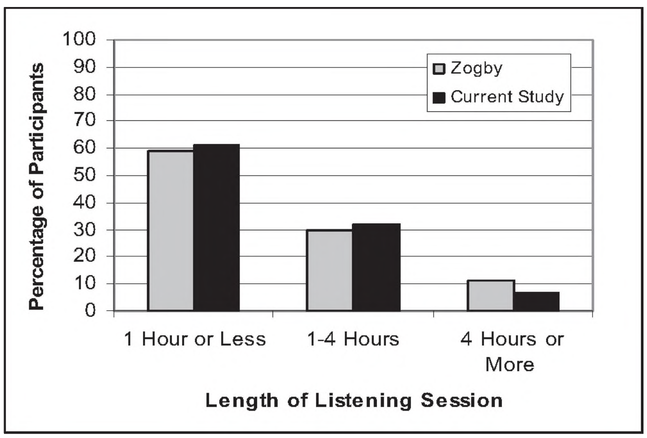

Figure 5. Percentage of respondents owning devices in the current study (N = 118) and percentage of 301 high school students (Zogby, 2006) reporting typical lengths of a listening session.

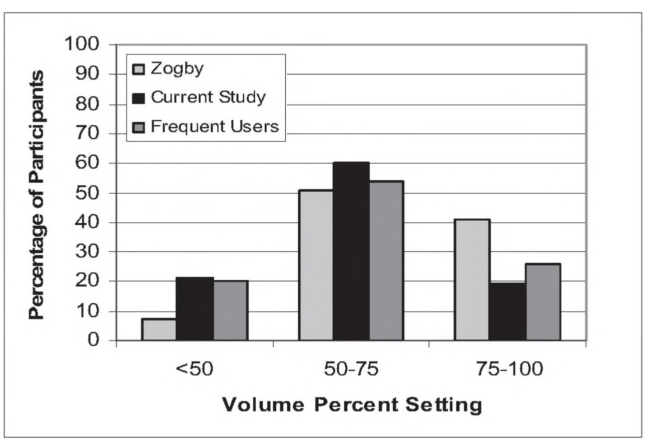

Figure 6. Percentage of students reporting their usual volume setting (in percent of scale) in the study of high school students by Zogby (2006) and in the current study for all respondents who owned a device (N = 121), and for our 35 frequent users who reported using their device 7 days per week.

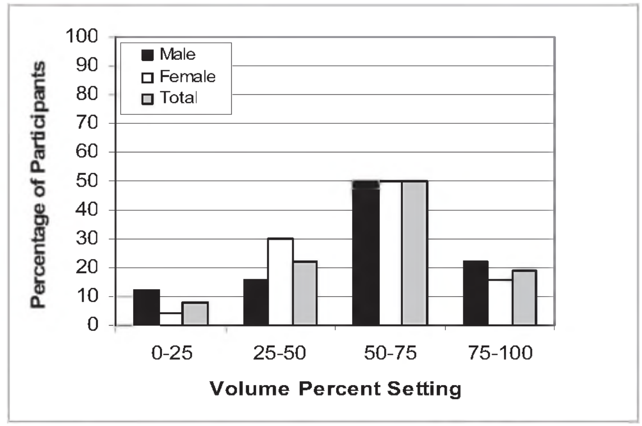

Figure 7. Percentage of male and female respondents owning of portable audio devices (N = 121) reporting volume preferences with volume divided into quadrants.

Work, Transportation, and Recreational Noise

About half of the students (53.6%) were employed at the time of the survey, with about a third of them working less than 10 hours per week, a third working less than 20 hours per week, and a third working more hours per week. About a fifth (21.2%) did volunteer work. The most common work and volunteer settings were community (sports complex, community center, mall, department store) and institutional (library, school, childcare, clinic) locations. Relatively few reported working in recreational settings such as clubs, bars, restaurants, or cinemas (7.9%) or industrial settings such as in factories, manufacturing, or warehouses (6.6%) that would be more likely to be noisy. Nevertheless, almost half (45%) considered their work/volunteer setting to be moderately noisy and another third (32.5%) considered their settings to be more than moderately noisy. The majority (78.2%) seldom or never wear a portable audio device while working or volunteering.

Most students (84.1%) travel to university more than three days per week, with the duration of the trip for most students being less than one hour (88.1%). About half (51%) of the respondents usually travel by car, but many (38.4%) travel by bus, with those using a portable audio device while traveling being distributed bi-modally into those who never listen (36.4%) and those who frequently listen (35.1%). A fifth (20%) reported that commuting was the most common situation in which they used their device.

About half of the students reported going to nightclubs (49.3%) or bars (50%), with about a third going at least once a month to clubs (30.6%) or bars (40.6%). As many as 65 students reported attending a concert once or twice a year, but only 26 students reported attending more than two concerts per year. By comparison, slightly more students (59.3%) attended a sporting event at least once a year, but almost all (98.7%) went to a movie at least once a year.

About a third (34%) play a musical instrument, but few (6.7%) were members of a band. The most popular noisy hobbies were motorcycling/go-karting (17.3%) or ski/sea-dooing (11.3%). However, the majority (76%) reported that they had no noisy hobbies. Regular past times were reported to be watching television (86.7%), sports or exercise (84.7%), reading (64.7%), and playing computer or video games (60%). About a fifth of the students (19.4%) used their portable audio device most frequently during recreational activities, including while exercising (22.7%), walking (14.7%), or during other leisure activities (12%).

Mood seemed to influence device use with frequent use being reported when students were bored (28%), followed by when they were experiencing the common positive or negative emotions of being happy (19.3%) or sad (17.3%), and followed next by when they were experiencing more extreme positive or negative emotions of being excited (15.3%) or depressed (15.3%). Use dropped when they were experiencing feelings such as being angry (13.3%), upset (12.7%), frustrated (10%), tired (9.3%), or hungry (7.3%).

Although some students (11.3%) reported using ear protection, more (N=20) used it while studying or sleeping than the number (N=18) who used it when operating noisy equipment or engaging in noisy hobbies. Only two reported wearing ear protection when attending concerts.

Self-reported Symptoms of Hearing Loss

Self-reports of concerns about hearing (responses 1-3 on question 25) indicated that 31.4% of the university students thought their hearing was worse now than five years ago (Figure 8). Also, 13.3% believed they had a hearing loss (question 26) and 12.7% believed it was noise related. Nevertheless, fewer (8%) reported that difficulty with hearing limited or hampered their personal or social life (responses 6-7 on question 32), and 10% reported that difficulty with their hearing upset them (responses 6-7 on question 33). Importantly, the findings did not differ greatly between the users and non-users of portable audio devices (Figure 9). It is interesting that more non-users than users of portable audio devices rated their hearing as being worse and suspected a hearing loss, yet only frequent users and those who preferred to set the volume high reported negative social or emotional effects of hearing difficulties.

Although our questions and those of Zogby (2006) are not identical, some comparisons can be made regarding self-perceived hearing health. The high school students responded on a scale ranging from "*very concerned*" to "*not at all concerned*" to the question *"How concerned are you about losing your hearing as you age?"*, with responses of "*somewhat"* or "*very concerned*" being taken by Zogby to indicate that the student was concerned.

Zogby (2006) examined three main symptoms of possible hearing loss: turning up the television, tinnitus, and communication problems. Comparisons to similar questions in our study are shown in Figure 10.

Overall, more university students (69%) than high school students (46%) reported no concern about their hearing (Figure 9), but fewer university students (25%) reported none of the symptoms of possible hearing loss compared to the high school students (49%). As shown in Figure 10, about a third (30%) of the university sample reported turning up the TV volume more than they used to (compared to 27% of high school students). Tinnitus following exposure to loud sound was reported by 51.3% of the university students, but 76% reported that usually they never or rarely have ringing. Tinnitus was reported by 17% of high school students.

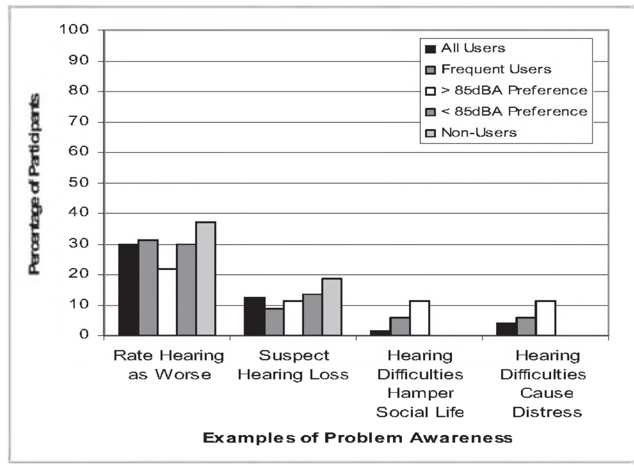

Figure 8. Percentage of students reporting awareness of hearing problems. All users include respondents owning a portable audio device (N = 123). Frequent users (N=35) reported using their device 7 days/week. The >85dBA preference group (N = 9) set the iPod volume at or over 85dBA at least once in session two of the current study. The <85dBA preference group (N = 15) always set the iPod volume below 85dBA in session two of the current study. Non-users (N = 27) are our survey respondents who do not own a portable audio device.

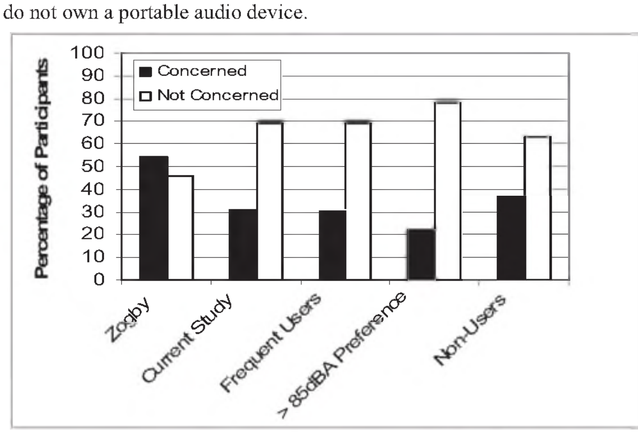

Figure 9. Percentage of students reporting concern about hearing problems for high school students (Zogby, 2006) and university students in the current study.

In terms of communication problems that may be symptoms of hearing loss, our survey probed whether or not students experienced various problems when they were or were not using their device. The responses to two of our items (questions 30 and 64) were averaged to determine an overall communication rating that could be compared to the communication item of Zogby (Figure 10).

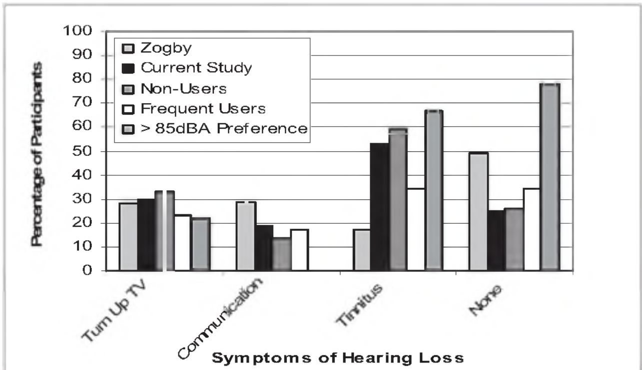

Figure 10. Percentage of students reporting symptoms of hearing loss for high school students (Zogby, 2006), and university students in the current study. Percentages are also shown for non-users (N = 27) and two possibly at risk subgroups, frequent users (N = 35), and those who set the iPod volume at or above 85 dBA in session two (N = 9).

Many aspects of communication are challenged when students are using a portable audio device (Figure 11). Evidence of a problem hearing the doorbell is given by a response of 1-4 on questions 27 or 60; problems in speech communication are suggested by responses of 1-5 on questions 28 or 61 (phone talk), questions 29 or 62 (whisper), questions 30 or 64 (talk in quiet), or questions 31 or 63 (talk in noise). Further comparisons between different types of users without their device (Figure 12) and with their device (Figure 13) suggest that when not wearing the device those who prefer higher volumes experience more problems than those who prefer lower volumes. In contrast, when the device is worn, those who prefer lower volumes experience more problems than those who prefer higher volumes.

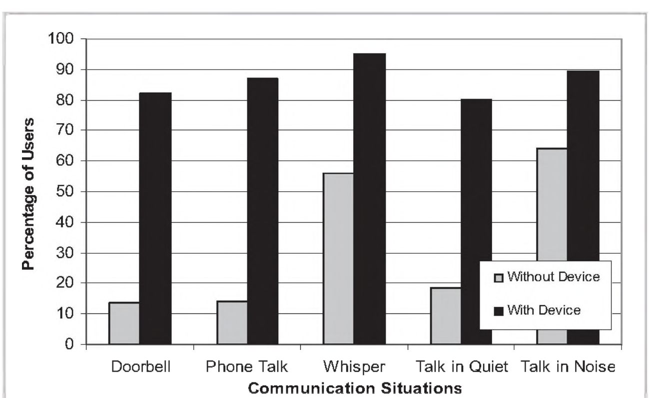

Figure 11. Percentage of students owning devices (N = 123) who report communication problems when wearing or not wearing their own device.

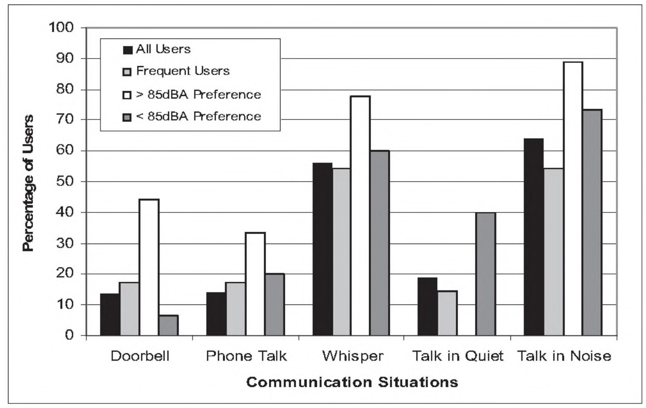

Figure 12. Percentage of students reporting communication problems when NOT wearing a portable audio device for university students in the current study who own a device (N = 123). Percentages are also shown for frequent users (N = 35), and for those who sometimes set the iPod volume at or above 85 dBA (N = 9) or always below 85 dBA (N = 15) in session two of the current study.

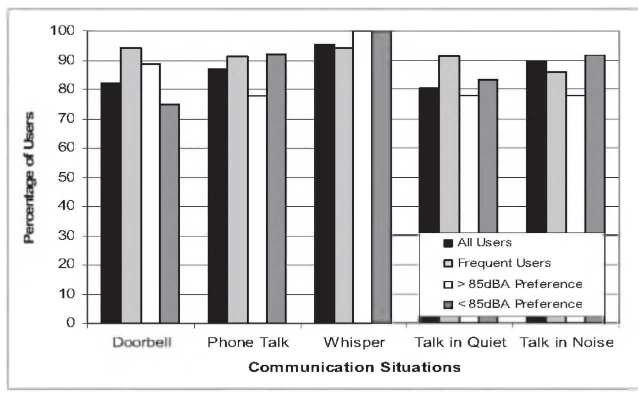

Figure 13. Percentage of students reporting communication problems when they DO wear a portable audio device for university students in the current study who own a device (N = 123). Percentages are also shown for frequent users (N = 35), and for those who sometimes set the iPod volume at or above 85 dBA (N = 9) or always below 85 dBA (N = 15) in session two of the current study.

3.2 Audiometry

The distribution of hearing thresholds (dB HL) measured at each of the test frequencies is shown in Figure 14. All 24 of the students who completed the second session had thresholds less than 10 dB HL at 1, 1.5, and 4 kHz. For all other frequencies, at least ¾ of the students had thresholds better than 10 dB HL, well within the normal range. Only two participants had a threshold falling outside of the range considered to be clinically normal (> 25 dBHL). One of the abnormal thresholds was 30 dB HL for .25 kHz, and the other was 40 dB HL at 14 kHz. Thus, there were no noteworthy early signs of hearing loss, including no suggestion of the classic 4 kHz notch that is usually taken as an early sign of noise-induced hearing loss in industrial hearing conservation programs.

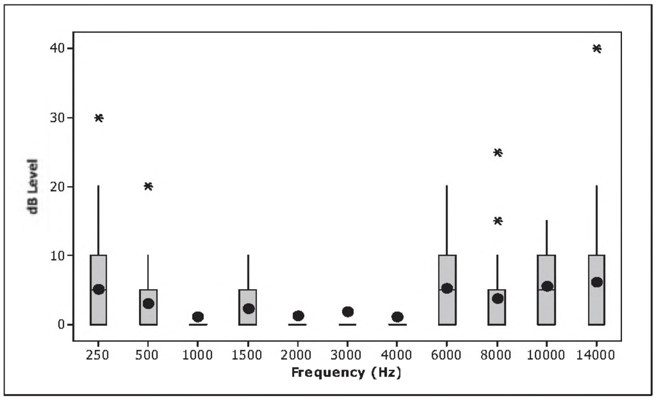

Figure 14. Box and whisker plots showing the mean dB HL threshold (black dots), median (centres of box), inter-quartile range (box ends), and minimum and maximum (ends of whisker lines) thresholds of hearing (dB HL) at each pure-tone frequency tested for the 24 university students who participated in session two of the current study. Outliers are indicated by *.

3.3 Acoustical Measurement of Output

The output of an iPod was measured for two samples of music played at pre-selected volume and equalizer control settings on the B&K HATS dummy head. The output was also measured for the same samples at the preferred settings of the 24 students who completed session two.

3.3.1 Control Settings

For the iPod earphones, the dBA measurements of both ears of the dummy were averaged and plotted for the 23 equalizer settings at four volume levels. Not surprisingly, dBA levels increased with volume. For Hip Hop, the average output (± SD) increased from volume 1 through 4 as follows: 52.5(±5.3), 61.9(±8.2), 77.9(±5.7) and 93.7(±5.7) dBA.

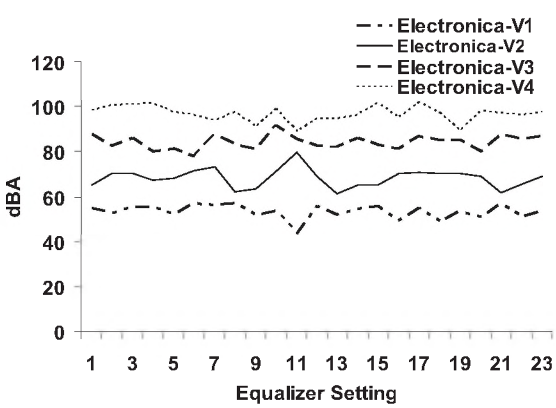

Figure 15. Average of left and right-ear dBA outputs for iPod earphones with the Electronica music at four volumes and 23 equalizer settings.

Interestingly, the average dBA output was greater for Electronica than for Hip Hop for volume levels 1 through 4 respectively: 53.6(±3.2), 68.4(±4.2), 84.3(±3.3), 96.7(±3.6) dBA (Figure 15). The output depended on equalizer and volume settings; however, the variability was greater for Hip Hop.

At each volume and equalizer setting, the difference due to genre was calculated by subtracting the dBA outputs (Hip Hop - Electronica); e.g., at volume 4, the largest negative difference was -19 dB (equalizer 13, "lounge") and the largest positive difference was +8.3 dB (equalizer 10, "jazz"). Thus, it was interesting to examine these two settings more closely because they seemed to illustrate how genre and equalizer settings might interact to affect output at different volume settings. Accordingly, we tested the two alternative transducers, the Mirai and Panasonic earphones, at the default setting and with the equalizer set at 10=jazz and 13=lounge. All tests with the Mirai and Panosonic earphones were conducted at a 50% volume setting because that was assumed to be a typical user setting, but of course, we do not know if a listener would adjust the volume in the same way in all conditions for all headsets.

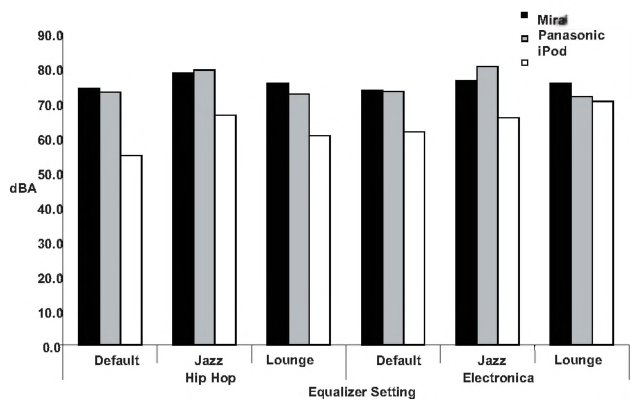

Figure 16. Left and right-ear average dBA outputs for three earphones at 50% volume with default, jazz and lounge equalizer settings for Electronica and Hip Hop.

The dBA output from the Mirai and Panasonic earphones were comparable for each equalizer setting across the two test stimuli (Figure 16). They always yielded dBA output levels between 70 and 80 dBA. The largest difference between them was 4.1 dB in the jazz setting for Electronica. Importantly, the outputs were consistently greater than the outputs from iPod earphones. At the default and lounge settings, the output of the Mirai exceeded that of the Panasonic, and both exceeded the output from the iPod earbuds. This trend, however, was not maintained at the jazz setting where the output of the Panasonic earbuds was slightly greater than that of the Mirai earbuds, but again both alternative transducers produced higher outputs than the standard iPod earbuds. Compatible results were reported by Fligor and Ives (2006) who also found reductions when noise cancellation headsets were tested at lower volumes.

3.3.2 User Preference Settings

On average, listeners adjusted the iPod to 67.6 dBA, but their preferred listening level depended on background noise, and less so on type of music and the ear (Figure 17).

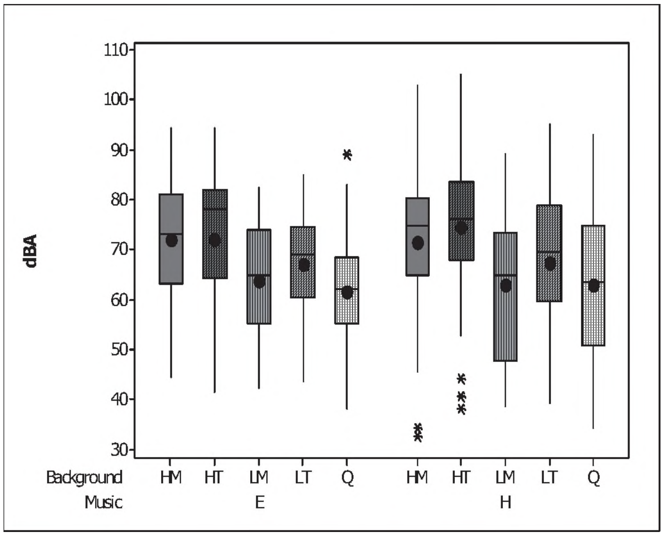

Figure17. Box and whisker plots showing the means (black dots), medians (lines in boxes), inter-quartile ranges (box ends), and minimum and maximum values (ends of whisker lines) for dBA outputs measured when the iPod was adjusted by listeners to their preferred settings for Electronica (E) and Hip-Hop (H) music under five background conditions (HM = high,-level multi-talker babble, HT high-level traffic noise, LM = low-level multi-talker babble, LT = low-level traffic noise, Q= quiet). Results for the two ears are averaged. Outliers are indicated by *.

Output was lowest when there was no background noise (62.1 dBA) or when there was a low level of multi-talker babble (63.4 dBA). Output was greater when there was a low level of traffic noise (67.2 dBA). Output was greatest when there was high level noise, with little difference between multi-talker babble noise (71.7 dBA) and traffic noise (73.3 dBA). Curiously, mean output was 2.7 dB greater for the right than for the left ear.

These descriptions were confirmed by an Analysis of Variance with three within-subjects factors: Ear (right or left), Music (Hip-hop or Electronica), and Background (quiet, low-level multi-talker babble, high-level multi-talker babble, low-level traffic noise, high-level traffic noise). There were significant main effects of ear $F(1, 23) = 35.2$, $p < .01$), and background, $F(4,92) = 21.3$, $p < .01$. A Student-Newman-Keuls test of multiple comparisons confirmed that there was no significant difference between the outputs preferred in the quiet and low-level babble, but that the outputs in these conditions were significantly lower than in low-level traffic noise, and that the outputs in high-level noise conditions were significantly greater ($p = .05$).

3.4 Relationships between Objective and Subjective Measures

3.4.1 Output

Of the 24 students who participated in session two, 20 owned a portable audio device. For the 20 who owned a device, it was possible to compare how they actually set the volume of the iPod when they were listening in session two to their subjective questionnaire responses estimating how they thought they usually set the volume.

Importantly, there were discrepancies between their objective measures and their subjective estimations of preferred volume level. Most participants subjectively estimated that they set the volume above halfway, whereas the objective tests of user preferences indicate that many set the volume above halfway when the background noise level was high, but that more students set it less than halfway when the background noise level was lower (Figure 18). A minority of students (N = 4) underestimated their usual volume settings, reporting that they usually set the volume of their own device to be in the second quadrant (25-50% of the volume scale) while objective measures indicated that they set the volume of the test iPod higher. There were no noteworthy gender differences in either the objective or subjective reports of volume settings for these 24 students.

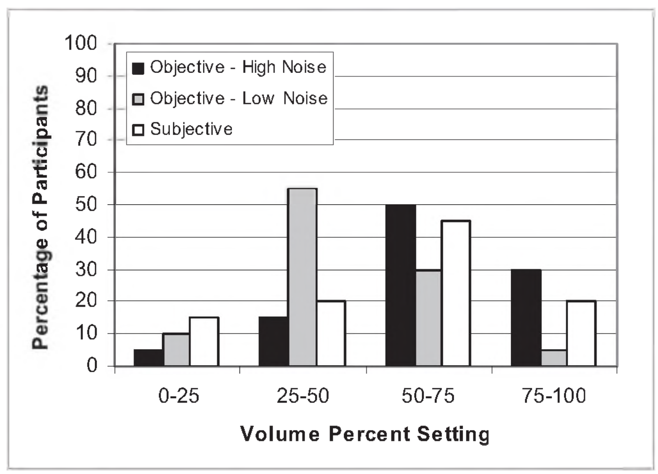

Figure 18. Percentage of participants in the current study who own a portable audio device and who completed both sessions of the current study (N = 20) subjectively estimating their usual volume setting in the survey administered in session one, and objectively adjusting the volume of the iPod in session two in high and low background noise conditions, where volume is divided into four quadrants in terms of percent volume.

Of the 20 device owners for whom both subjective and objective measures of volume setting were obtained, almost half owned more than one portable audio device: 11 owned an MP3 Player, 11 have a CD player and there were 5 iPod owners. It is possible that some of the apparent discrepancy between the subjective and objective measures of how students set the volume might be explained by differences in the specific equipment used by individuals. However, we found no obvious relationship between the objectively measured volume settings and the type of portable audio device and headset owned by the students. Interestingly, 9 students who owned a portable audio device used standard earbuds and 9 used headphones when listening to their devices. Two students used speakers with their device. Only one participant reported using extended-range ear buds that might provide higher actual output than the standard headphones for the same volume control setting.

As seen in the measures of output at predetermined control volume and equalizer settings, the choice of equalizer may also influence the actual output achieved for a given volume control setting. The participants reported adjusting equalizer settings, but not surprisingly they did so less frequently than they adjusted volume settings. About half of the students reported on the survey that they used the equalizer options on their own device, although few students adjusted it during the objective testing.

Even though we did not find significant differences between Electronica and Hip-Hop when measuring output from the test iPod, the majority of the participants reported in the survey that they frequently change volume depending on the genre of music they are playing. Also, the majority of students reported changing the volume of their own device in response to changes in environment, which agrees with the objective output measurements taken in session two in which students increased the volume of the iPod in the high noise conditions. Change in environment was reported to be the most frequent reason for volume adjustments, followed by change in song quality and song loudness. Song genre, environment, and song quality are frequent reasons for use of equalizer settings. Emotions play a role as well, with over half of the students reporting that they adjusted volume and equalizer settings with changes in their mood. They reported listening to their portable audio device mostly when they are bored or when not experiencing extreme emotions.

Thus, the output actually experienced by owners of portable audio devices on a daily basis seems to depend not only on the properties of the device, but also on the settings and the transducer used with the device, and on a variety of non-technical factors. Non-technical factors include stimulus factors such as type of music, personal factors such as mood, as well as environmental factors. Environmental factors range from physical characteristics of the environment (e.g., level of background noise) to social aspects of the environment (e.g., type of activity).

3.4.2 Exposure

The complexity of the factors influencing the actual output experienced by a listener is matched by the complexity of the factors influencing the duration of usage. To determine whether or not the exposure to noise presents a risk to students using portable audio devices, both output and duration must be determined.

It is commonly accepted that 85 dBA for a period of 8 hours is the maximum level of safe exposure (NIOSH). With every 3 dB increase, the duration for safe exposure is halved. The calculations of industrial noise exposure are based on measurements taken in the soundfield rather than measurements taken in the ear canal. The resonances of the outer ear structures effectively amplify the sound, especially in the range from 2 to 4 kHz. Correcting for the head-related transfer function to convert the measurements in the ear canal to corresponding soundfield measurements would yield lower output levels.

In our study, at 100% volume, regardless of type of music or equalizer settings, the sound levels measured in the ear canal exceed 85 dBA, and even after adjusting for the head-related transfer function levels over 85 dBA were found, depending on the equalizer setting and sample of music. Following this logic of using industrial safety limits as a yard stick, guidelines for the safe use of iPods have recently been suggested (Portnuff & Fligor, 2006). The suggested guideline is that there does not need to be a limit on listening time if the volume is set to under 50%. However, for the standard iPod earbuds, a limit of 6 hours per day is suggested if the volume is set at 70%, 1.5 hours if it is set at 80%, 22 minutes if it is set at 90%, and 5 minutes if it is set at 100%. Of course, these guidelines do not take into account differences in output that depend on the equalizer setting and type of music even when the volume is held constant. For example, we examined conditions where extreme differences were observed and discovered that there could be as much as a 27.3 dB difference between the outputs measured for different equalizer settings.

Interestingly, those who set their devices to relatively high levels (at or over 85dBA) during session two are not necessarily more likely to listen to their personal audio devices for longer periods compared to those who preferred lower outputs. About half of the participants who owned a device reported listening to it for up to 2 hours daily for up to 5 days per week. According to the guidelines suggested by Portnuff and Fligor (2006), 2 daily hours of usage would become a problem if the volume were set at 80%, as might be done by about a fifth of our sample.

In addition to noise exposure from portable audio devices, about half of the students were exposed to other sources of high-level noise during commuting, at work or volunteering, or during recreation, but the duration of these exposures is relatively brief and their frequency fairly rare.

For example, about half of the students reported attending nightclubs, bars, and concerts, but the frequency of attendance at such events is usually not more than monthly and few students reported attending more than two concerts a year. Most were exposed to noise during commuting for less than an hour per trip and most of those who worked did so for less than 20 hours per week. Unfortunately, some but not all used ear protection when exposed to potentially hazardous levels of noise. Again, it seems that most university students are not exposed to hazardous levels of noise, but there are a minority who could be at risk.

Overall, within the population of university students, exposure to hazardous doses of noise from the use of portable audio devices or from other noise sources probably does not exceed a "safe" range for the majority of students. Nevertheless, there are individuals whose exposures from these devices, combined with exposures to other noise sources, may pose a risk. To examine the subgroup that seems likely to be at greater risk, we focused on the frequent users of portable audio devices who use their device every day, and on users who prefer outputs at or greater than 85 dBA. We found that frequent users generally seemed to be more cautious about their use of the device and that they expressed more concern about hearing health. The fact that they have begun to experience problems may be prompting them to be more cautious about setting the volume too high.

3.5.3 Evidence of Early Hearing Loss

The estimates of exposures and the reports of concerns about and self-reported symptoms of hearing loss suggest that there may be a subgroup of student owners of portable audio devices who are at risk for noise-induced hearing loss. Nevertheless, there was no audiometric evidence of early signs of hearing loss. Of course, it may take years for the cumulative damage due to noise to cause changes in the audiogram. Thus, the absence of elevated pure-tone thresholds does not prove that the auditory systems of these students have not been damaged by noise. Other kinds of tests such as otoacoustic emissions might provide a more sensitive measure of the health of the outer hair cells which are known to be damaged by noise.

The audiograms were measured on only 24 participants, so the matter of the size of the sample should be considered. In fact, this sample size is not that much smaller than the sample of 60 who were tested in an earlier study that reported a 40% rate of hearing loss in high school and university students (Lees et al., 1985). In their study, the criteria for hearing loss was a 10 dB threshold difference between thresholds at adjacent test frequencies; however, in standard audiometry, test error is considered to be $\pm$ 5 dB, so it is possible that a 10 dB difference could be attributable to test error. In addition, most of the problems they found involved a threshold shift of an average of 20 dB at 6 kHz, not the classic 4 kHz noise notch, and it is common for problems at 6 kHz to result from poor earphone placement. Thus, even though previous studies have reported alarming rates of hearing loss amongst young adults, there does not seem to be a strong enough literature to judge how widespread early noise-induced hearing loss might be or what cohort differences might exist.

Another matter to be considered is whether our self-selected sample might have been biased, especially since they had been given an information session about the dangers of noise after they completed the survey in session one. One possibility is that those who were more worried about their hearing chose to volunteer for session two. Another possibility is that those who were iPod enthusiasts volunteered for session two. The comparison of the subjective measures to the objective measures of iPod use suggest that the participants in session two did respond accurately insofar as their self-reported volume preferences were lower than the settings they selected in session two when the background noise level was high, but their self-reported volume preferences were higher than the setting chosen in session two when the background noise level was low. Furthermore, those who volunteered for session two seemed to be typical of the larger group of 150 students who had completed the survey during session one of the study in terms of their iPod ownership and self-reported use patterns.

4. GENERAL DISCUSSION

Our study confirmed that the majority of undergraduate university students own at least one portable audio device. Therefore, noise-induced hearing loss could be a larger concern now than ever before, especially if the portable audio devices are worn for excessively long durations and/or their wearers are also exposed to other noise sources.

Despite the potential for exposure of these students to hazardous levels of noise, the majority of survey respondents reported that they typically set their device at mid volumes, and only a minority of students reported their work/volunteer places to be loud. The overall 'safe' use of iPods by most undergraduates was confirmed in an experiment to objectively measure the output of an iPod when users adjusted the device to their preferred volume and equalizer setting while listening to music in five different conditions of background ranging from quiet to 70 dB SPL. These findings are consistent with a study of iPod use by 100 graduate students (Filgor & Ives, 2006).

No audiometric signs of early hearing loss were found. Nevertheless, cause for concern is raised by the finding that a third of the participants felt that their hearing had worsened in the past five years, and only 12% of participants ever used hearing protection. Longitudinal studies will be needed to monitor how hearing changes over many years of use of portable audio devices in this cohort.

We also identified subgroups of students who may be at higher risk because of their frequent use of a portable audio device or their preference for setting it to levels exceeding 85 dBA. Thus, our data suggests that although most students tend not to expose themselves to excessive noise (recreational noise, noise at work, or music noise while listening to portable audio devices), there are some individuals who may be at risk. At the same time, those who are at most risk seem to be the least concerned about their hearing. They may simply be not aware that exposure to loud music can result in hearing loss. This assumption was also stated by Chung and colleagues (2005) who conducted an online survey of views on health issues including hearing loss in adolescents and young adults. They concluded that some types of education may be crucial to motivating young people to change their listening habits. In the study by Zogby (2006), respondents indicated that school classes, teen magazines, and TV programs may be effective means for educating young people about hearing. Thus, it seems that, with such widespread use of portable audio devices among young adults, increasing awareness about hearing and early noise-induced hearing loss is essential. Boosting their motivation to protect their hearing may protect this generation from widespread future hearing problems.

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6. ACKNOWLEDGEMENTS

We wish to thank X. Sun and J. Qi for help with the equipment, J. Hu for putting the survey on the web, U. Schimmack, S. delaRosa, and J. Carey for help with PSY100 recruitment, and the UTM Dept of Psychology for funding to program the survey. Six authors (SF, AG, BG, DP, SS, TM) did this project for PSY406S; the others (SA, MK, EZ) were volunteers; student authors are listed in alphabetical order. Parts of this work were presented at the 2006 CAA Conference. We would also like to thank Tracy Moniz for featuring this topic in *Inside UTM.*

6. APPENDIX A

UTM Portable Audio Device Questionnaire

Basic Demographic Information

1. What is your gender?
   - o Male
   - o Female

2. What is your age?
   - o 5-15
   - o 16-20
   - o 21-25
   - o 26-35
   - o > 35 years

3. What is your marital status?
   - o Married
   - o Life Partners
   - o Single
   - o Divorced
   - o Other

4. What best describes your living situation?
   - o Share off-campus accommodation with peers
   - o Share on-campus accommodation with peers
   - o Living with my family
   - o Living alone
   - o Share an accommodation with strangers

Transportation

5. a. Which means of transportation do you use most often when commuting to UTM?
   - o Bus
   - o Walk
   - o Car
   - o Train
   - o Motorcycle
   - o Other, please specify:___________________

   b. Do you listen to a portable audio device while using this means of transportation?

   Never   Occasionally   Frequently
   1   2   3   4   5   6   7

6. On average how often do you commute to UTM in a week? (number of round-trips)
   - o 0
   - o 1-2
   - o 3-4
   - o 5-6
   - o > 7 trips

7. On average what is the duration of your trip to UTM (one way)?
   - o 0 – 30 minutes
   - o 30 – 60 minutes
   - o 60 – 90 minutes
   - o 90 – 120 minutes
   - o > 120 minutes

8. a. What is your primary means of transportation on a daily basis when NOT at UTM?
   - o Bus
   - o Walk
   - o Car
   - o Train
   - o Motorcycle
   - o Other, please specify:___________________

   b. How often do you listen to a portable audio device while using this means of transportation?

   Never   Occasionally   Frequently
   1   2   3   4   5   6   7

Work

9. a. Are you currently employed?

   YES   NO

   b. If yes, how many hours per week do you work on average?
   - o 1 – 10 hours
   - o 11 – 20 hours
   - o 21 – 30 hours
   - o 31 – 40 hours
   - o > 41 hours

10. Are you currently volunteering?

    YES   NO

11. Which best describes the setting of your most frequent work/volunteer place?
    - o Community (e.g., sport complex, community center, mall, departmental stores)
    - o Residential (e.g., university residence, seniors' homes)
    - o Institutional (e.g., library, school, tutoring centers, day care, medical clinics)
    - o Recreational (e.g., clubs, bars, restaurants, movie theaters)
    - o Office
    - o Industrial settings (e.g., factory, manufacturing, warehouse)

12. Do you consider your primary place of work/volunteering to be…?

Very Quiet Moderate Very Loud
1 2 3 4 5 6 7

13. Do you listen to a portable audio device at your place of work/volunteering?

Never Occasionally Frequently
1 2 3 4 5 6 7

Hearing History

14. a. Did a family member have a hearing loss before old age?

YES NO

b. If yes, what is their relationship to you?

- o Father
- o Mother
- o Brother
- o Sister
- o Aunt
- o Uncle
- o Grandmother
- o Grandfather
- o Cousin
- o Other

c. If yes, do you know what type it is?

- o Age-related
- o Noise-induced
- o Present at birth
- o Other (i.e., due to illness, drug side effect)
- o Don't know

15. Do you wear a hearing aid?

YES NO

16. How often do you get ear infections?

Never Occasionally Frequently
1 2 3 4 5 6 7

17. Do you get colds?

Never Occasionally Frequently
1 2 3 4 5 6 7

18. Do you have allergies (e.g., hay fever)?

Never Occasionally Frequently
1 2 3 4 5 6 7

19. Do you take any medication on a regular basis that makes your ears ring?

YES NO

20. Do you have ringing in your ears?

Never Occasionally Frequently
1 2 3 4 5 6 7

21. After being exposed to loud sound, do you experience ringing in the ears?

Never Occasionally Frequently
1 2 3 4 5 6 7

22. Do you experience the feeling of cotton in your ears after exposure to loud sound?

Never Occasionally Frequently
1 2 3 4 5 6 7

23. Do you turn up the TV more than you used to?

YES NO

24. How much do you enjoy listening to loud music?

Not at all Somewhat Very Much
1 2 3 4 5 6 7

25. How do you rate your hearing compared to five years ago?

Much Worse Same Much Better
1 2 3 4 5 6 7

26. a. Do you think you have a hearing loss?

YES NO

b. If so, what do you think is the cause?

- o Age-related
- o Noise-induced
- o Present at birth
- o Other (i.e., due to illness, drug side effect)
- o Don't know

When NOT wearing any portable audio devices…

27. I hear the doorbell…

Never Occasionally Frequently
1 2 3 4 5 6 7

28. I can have a phone conversation with…

Difficulty Some difficulty No difficulty
1 2 3 4 5 6 7

29. I can hear someone speaking in a whisper with

Difficulty Some difficulty No difficulty
1 2 3 4 5 6 7

30. I can carry on a conversation with one other person when in a quiet place (e.g., library) with

Difficulty Some difficulty No difficulty
1 2 3 4 5 6 7

31. I can carry on a conversation with one other person when in a noisy place (e.g., party) with

Difficulty		Some difficulty			No difficulty	
1	2	3	4	5	6	7

32. I feel that difficulty with my hearing limits or hampers my personal or social life…

Never		Occasionally			Frequently	
1	2	3	4	5	6	7

33. Difficulty with my hearing upsets me…

Never		Occasionally			Frequently	
1	2	3	4	5	6	7

Recreational Activities

34. What genre(s) of music do you listen to on a regular basis? (check all that apply)
- o Hip-Hop
- o Jazz
- o Pop
- o Rock
- o Alternative
- o Punk
- o Reggae
- o Other, please specify:___________________

35. How many hours a day do you listen to music?
_____________average hours per day

36. a. Do you go to nightclubs?
YES NO

b. If yes, how often?

Daily	Weekly		Monthly		Annually	
1	2	3	4	5	6	7

37. a. Do you go to bars?
YES NO

b. If yes, how often?

Daily	Weekly		Monthly		Annually	
1	2	3	4	5	6	7

38. a. How many concerts do you attend in a year?
______________concerts

b. If yes, which type do you typically attend?
- o Hip-Hop
- o Jazz
- o Pop
- o Rock
- o Alternative
- o Punk
- o Reggae
- o Other, please specify:___________________

39. How often do you attend professional sporting events in one year?

Never		Occasionally			Frequently	
1	2	3	4	5	6	7

40. How often do you go to the cinema?

Never		Occasionally			Frequently	
1	2	3	4	5	6	7

41. a. Do you play a musical instrument?
YES NO

b. If yes, what kind(s):________________________

42. How many years of formal music training have you had?
______years of training

43. a. Are you a member of a music band?
YES NO

b. If yes, what genre of music do you play?
- o Hip-Hop
- o Jazz
- o Pop
- o Rock
- o Alternative
- o Punk
- o Reggae
- o Other, please specify:___________________

44. Did/do you have any of the following noisy hobbies? (Check all that apply)
- o Activities involving firearms
- o Carpentry
- o Ski/Sea-dooing
- o Motorcycling
- o Go-karting
- o None
- o Other, please specify: ____________________

45. What other past times do you engage in on a regular basis? (Check all that apply)
- o Reading
- o Watching Television
- o Playing computer/video games
- o Does not apply

46. Do you participate in any physical activities (i.e., exercise, sports)?
YES NO

47. a. Do you use hearing protection (e.g., earplugs)?
YES NO

b. If yes, in what situations do you most use hearing protection (Check all that apply)?

- o Attending concerts
- o Playing music
- o Sleeping
- o Studying
- o Operating machinery
- o Other, please specify: _____________

Portable Audio Devices

48. Do you have a portable audio device?

YES NO

IF NO THEN STOP HERE
IF YES THEN PLEASE GO ON

49. If so, what type of portable audio device do you own currently?

- o MP3 Player (Generic)
- o IPod
- o CD Player
- o Portable Cassette Player
- o Mini Disc
- o Cell Phone
- o PSP
- o Other, please specify:__________________

50. Currently, what type of output device do you use most to listen to this portable audio device?

- o Speakers (Portable)
- o Earbuds
- o Headphones
- o Car Stereo System
- o Home Stereo System
- o Other, please specify:___________________

51. Do you use the equalizer settings on your portable audio device?

YES NO

52. On a scale from 0-100 what level would you typically have the volume of your audio device set at while using headphones? (Please mark on scale.)

0 25 50 75 100

Actual Value:__________

53. On a scale from 0-100 what level would you typically have the volume of your audio device set at while using speakers? (Please mark on scale.)

0 25 50 75 100

Actual Value:__________

54. How often do you use your portable device?

________________ days per week

55. If yes, do you ever wear a portable audio device during any recreational activities?

Never Occasionally Frequently
1 2 3 4 5 6 7

56. In which situation do you use your portable audio device the most?

- o Walking
- o Studying
- o Leisure
- o Working
- o Working Out
- o Commuting
- o Other, please specify:_____________

57. When listening to a portable audio device, how long do you wear the headset in a single session?

_________ hours on average (use fractions if < 1 hour)

58. When in the following emotions/moods, rate how often you use your portable audio device

a. Happy
Never Occasionally Frequently
1 2 3 4 5 6 7

b. Sad
Never Occasionally Frequently
1 2 3 4 5 6 7

c. Angry
Never Occasionally Frequently
1 2 3 4 5 6 7

d. Upset
Never Occasionally Frequently
1 2 3 4 5 6 7

e. Frustrated
Never Occasionally Frequently
1 2 3 4 5 6 7

f. Bored
Never Occasionally Frequently
1 2 3 4 5 6 7

g. Anxious
Never Occasionally Frequently
1 2 3 4 5 6 7

h. Excited
Never Occasionally Frequently
1 2 3 4 5 6 7

i. Depressed
Never Occasionally Frequently
1 2 3 4 5 6 7

j. Tired
Never Occasionally Frequently
1 2 3 4 5 6 7

k. Hungry
Never Occasionally Frequently
1 2 3 4 5 6 7

59. a. If you use ear buds, do you share or use other people's ear buds?
YES NO

b. If so how often?
Never Occasionally Frequently
1 2 3 4 5 6 7

When wearing my portable audio device the way I wear it most often....

60. I hear the doorbell…
Never Most of the time Always
1 2 3 4 5 6 7

61. I can have a phone conversation with…
Difficulty Some difficulty No difficulty
1 2 3 4 5 6 7

62. I can hear someone speaking in a whisper…
Never Most of the time Always
1 2 3 4 5 6 7

63. I can carry on a conversation with one other person when in a noisy place (e.g., party) …
Difficulty Some difficulty No difficulty
1 2 3 4 5 6 7

64. I can carry on a conversation with one other person when in a quiet place (e.g., library) …
Difficulty Some difficulty No difficulty
1 2 3 4 5 6 7

65. I feel that difficulty with my hearing limits or hampers my personal or social life…
Never Occasionally Frequently
1 2 3 4 5 6 7

66. Difficulty with my hearing upsets me…
Never Occasionally Frequently
1 2 3 4 5 6 7

67. I most often adjust the volume because of a…

a. Change in environment
Never Occasionally Frequently
1 2 3 4 5 6 7

b. Change in song genre
Never Occasionally Frequently
1 2 3 4 5 6 7

c. Change in song quality
Never Occasionally Frequently
1 2 3 4 5 6 7

d. Change in song loudness
Never Occasionally Frequently
1 2 3 4 5 6 7

e. Change in my mood
Never Occasionally Frequently
1 2 3 4 5 6 7

PLEASE COMPLETE THE FOLLOWING QUESTIONS ONLY IF YOU USE THE EQUALIZER SETTINGS.

68. How often do you adjust your equalizer settings?
Never Occasionally Frequently
1 2 3 4 5 6 7

69. I most often change equalizer settings because of a

a. Change in environment
Never Occasionally Frequently
1 2 3 4 5 6 7

b. Change in song genre
Never Occasionally Frequently
1 2 3 4 5 6 7

c. Change in song quality
Never Occasionally Frequently
1 2 3 4 5 6 7

d. Change in song loudness
Never Occasionally Frequently
1 2 3 4 5 6 7

e. Change in my mood
Never Occasionally Frequently
1 2 3 4 5 6 7

ANSWER THE FOLLOWING QUESTION ONLY IF YOU OWN AN iPod

70. How often do you change the following equalizer settings?

a. Acoustic
Never Occasionally Frequently
1 2 3 4 5 6 7

b. Bass Booster
Never Occasionally Frequently
1 2 3 4 5 6 7

c. Bass Reducer
Never Occasionally Frequently
1 2 3 4 5 6 7

d. Classical
Never Occasionally Frequently
1 2 3 4 5 6 7

e. Dance
Never Occasionally Frequently
1 2 3 4 5 6 7

f. Deep
Never Occasionally Frequently
1 2 3 4 5 6 7

g. Electronic
Never Occasionally Frequently
1 2 3 4 5 6 7

h. Flat
Never Occasionally Frequently
1 2 3 4 5 6 7

i. Hip Hop
Never Occasionally Frequently
1 2 3 4 5 6 7

j. Jazz
Never Occasionally Frequently
1 2 3 4 5 6 7

k. Latin
Never Occasionally Frequently
1 2 3 4 5 6 7

l. Loudness
Never Occasionally Frequently
1 2 3 4 5 6 7

m. Lounge
Never Occasionally Frequently
1 2 3 4 5 6 7

n. Piano
Never Occasionally Frequently
1 2 3 4 5 6 7

o. Pop
Never Occasionally Frequently
1 2 3 4 5 6 7

p. R&B
Never Occasionally Frequently
1 2 3 4 5 6 7

q. Rock
Never Occasionally Frequently
1 2 3 4 5 6 7

r. Small Speakers
Never Occasionally Frequently
1 2 3 4 5 6 7

s. Spoken Word
Never Occasionally Frequently
1 2 3 4 5 6 7

t. Treble Booster
Never Occasionally Frequently
1 2 3 4 5 6 7

u. Treble Reducer
Never Occasionally Frequently
1 2 3 4 5 6 7

v. Vocal Booster
Never Occasionally Frequently
1 2 3 4 5 6 7

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- THX certified

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STC	51-72	52-74	56-80
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Weight	2.7 lbs/sq ft	2.8 lbs/sq ft	5.4 lbs/sq ft
Fire Rating	1 hour	1 hour	

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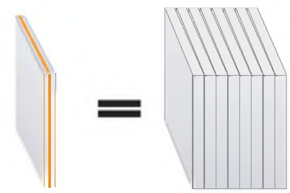

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CAA - Web Master

The Canadian Acoustical Association is seeking a volunteer to take on the duties of webmaster for the CAA website at http://caa-aca.ca/. The main responsibilities of the webmaster are to keep the site up to date, in response to information provided by the CAA secretary, awards coordinator and other members of the CAA board of directors, and to maintain a “Job Advertisement and Job Wanted” page. Recently a system was created for submission of CAA conference abstracts and papers using an on-line MySQL database and PHP programming. This is an ideal opportunity for someone to improve their knowledge and skills for online database programming and to apply these skills to automation of other aspects of the CAA website. For further information please contact Dave Stredulinsky, email: webmaster@caa-aca.ca. ph. (902) 426-3100 ext 352.

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