ABSTRACT

MUSIC LISTENING BEHAVIOR, HEALTH, HEARING AND OTOACOUSTIC EMISSION LEVELS

by Brittany Sproat

The purpose of this study was to examine the relationship between hearing levels, otoacoustic emission levels and listening habits related to the use of portable listening devices (PLDs) in adults with varying health-related fitness. Duration of PLD use was estimated and volume level was directly measured. Biomarkers of health-related fitness were co-factored into the analyses. In total, 115 subjects ages 18-84 participated in this study. Subjects were divided into two subgroups; PLD users and non-PLD users. Both groups completed audiological and health-related fitness tests. Due to the mismatch in the mean age of the PLD-user versus the non-PLD user groups, age-adjusted ANOVA statistics were performed on the data to match the groups for age. Results were analyzed to determine trends of variables contributing to hearing sensitivity. Age was the most significant predictor across hearing and health-related fitness variables. PLD user status did not impact hearing acuity, yet PLD users who limited their duration to less than 8 hours per week and intensity to less than 80 dB A in silence were found to have better hearing. Other variables found to be associated with hearing levels included: years listening to PLD, number of noise environments and use of ear protection. Finally, a healthy Waist: Hip ratio, was a significant predictor of better hearing, while body mass index approached, but did not reach statistical significance.
MUSIC LISTENING BEHAVIOR, HEALTH, HEARING AND OTOACOUSTIC EMISSION LEVELS

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Introduction

Hearing loss is the third most prevalent chronic health condition within the adult population in the United States (Hull & Kerschen, 2010). In the past 30 years, the prevalence of hearing loss has almost doubled and is expected to double again by 2050 (Hull & Kerschen). Although the public generally attributes sensorineural hearing loss to presbycusis, hearing loss is becoming a growing concern for younger generations. This is due to noise exposure during recreational activities, including listening to music on Personal Listening Devices (PLD) (Punch, Elfenbein, James, 2011). The ability of PLDs to cause permanent hearing damage is particularly alarming, because PLD users tend to be unaware that Noise Induced Hearing Loss (NIHL) can result from excessive PLD use (Punch et al, 2010).

NIHL is a preventable sensorineural hearing loss which begins with a high frequency deficit and occurs gradually as the result of chronic noise exposure (Petrescu, 2008). The increasing prevalence of NIHL can be attributed to several factors including occupational and leisure noise exposure. Sources of leisure noise exposure include concerts, fireworks, construction sites, firearms, and the subway (Center for Disease Control and Prevention, 2010). Another source of leisure noise that has become particularly popular in the last twenty years is the PLD (Henry & Foots, 2012). Excessive use of PLDs with earbuds has the capability of causing both temporary and permanent hearing loss by inflicting damage to the cochlea (Fallon, 2010). Although The Occupational Safety and Health Administration (OSHA) guidelines limit noise exposure in the occupational setting, few, if any, such restrictions exist in the non-occupational or leisure setting (Dalton et al, 2001).

The impact of PLD use on hearing must be examined in the context of the intensity of sound as well as the duration of listening. While individual susceptibility exists, higher intensities and longer durations of noise exposure damage ears more than lower intensities and shorter durations (Fligor & Cox, 2004). Given the capability of PLDs to store excessive quantities of music, the long battery life and the ability of these devices to play music at hazardously high sound pressure levels, the possibility of increased hearing loss due to PLD use has become an ever-present concern (Fligor & Cox, 2004; Punch et al., 2011; Worthington et al., 2009). A study by Meyer Birsch (1996) found that young adults who used their personal music system for more than 7 hours a week had poorer hearing thresholds compared with other young adults with less PLD use. Personal listening devices also have the potential of producing output
levels as high as 128 A-filter frequency weighting decibels (dB A), with typical PLD users listening at levels between 75 dB A and 110 dB A (Daniel, 2007; Fligor & Cox, 2004). These typical listening levels may fall outside of the NIOSH stated guidelines of safe listening, as sounds exceeding 85 dB A for 8 hours or more are considered to be hazardous to an individual’s hearing (Daniel, 2007).

Although the majority of PLD users listen within the safe listening range, 15%-25% of PLD users exceed safe listening levels (Berger et al, 2009). While preferred listening levels often fall within the acceptable range, listening levels may increase anywhere from 6 to 10 dB A when background noise is introduced in the listening environment (Hodgetts, et al., 2007). This indicates that given the presence of background noise, PLD-users may adjust their volume to unsafe listening levels. Furthermore, although the majority of listeners may be listening at a level or duration that is not significant to cause hearing loss, it is unlikely that music is PLD-users only source of recreational noise exposure. The cumulative effects of recreational noise exposure may lead to an increase in the prevalence of hearing loss (Torre, 2008).

Moreover, NIHL is not the only cause of hearing loss. There are several uncontrollable factors leading to hearing loss including genetics, age, gender, and race (Daniel, 2007; Fausti et al., 2005). Many factors increase the risk for developing age-related hearing loss including non-modifiable factors such cochlear aging and genetic predisposition (sex, race, specific genetic predisposition). Modifiable factors contributing to hearing loss may include environmental factors (occupational and leisure noise, ototoxic medication, socioeconomic class) and health comorbidities (hypertension, cigarette smoking) (Yamasoba et al, 2013). Despite efforts to improve modifiable behaviors linked to hearing acuity, physiological changes to parts of the ear including the inner and outer hair cells, the stria vascularis and afferent spiral ganglion neurons may lead to inevitable sensory, neuronal or metabolic age-related hearing loss (Yamasoba, 2013)

Despite the fact that the prevalence of hearing loss is increasing, preventative measures such as noise exposure reduction, use of ear protection and increased health and fitness may have a positive impact on preserving hearing acuity, particularly with age (Alessio et al., 2002). In adult cohorts, high cardiovascular fitness, as measured with maximum oxygen consumption (VO2 max), has been shown to protect hearing, possibly due to increased internal auditory artery and cochlear blood flow (Cristell et al, 1998). This increased blood flow can in turn increase the availability of oxygen and nutrients to the structures of the inner ear, potentially rendering the ear
less susceptible to the detrimental effects of noise and loud music (Hull & Kerschen, 2010). The beneficial impact of high cardiovascular fitness on hearing acuity can be observed in terms of both preserved hearing acuity with age and resistance to Temporary Threshold Shift (TTS).

Research by Hutchinson and Alessio has consistently demonstrated that individuals with high cardiovascular fitness, measured by VO2 max levels, have the best hearing sensitivity (Hutchinson & Alessio, 2002). It is hypothesized that a healthy cardiovascular system attenuates the effects of age on hearing processes, thus inhibiting presbycusis and maintaining hearing sensitivity (Alessio et al., 2002). What’s more is that high levels of cardiovascular fitness are even more significant for older individuals. The same study by Alessio and Hutchinson found that after age 50, persons with moderate cardiovascular fitness displayed better hearing at most frequencies than persons of the same age with lower cardiovascular fitness levels (Alessio et al., 2002). Cardiovascular fitness also appears to provide protection against TTS caused by noise exposure (Manson et al., 1994). A study conducted by Ismail et al. (1973) found that following an 8-month cardiovascular fitness training program, subjects suffered less (TTS) and recovered hearing faster than an untrained control group (Ismail et al., 1973). Furthermore, high-fit individuals also tended to exhibit less TTS after exercising during noise exposure than low-fit individuals (Manson et al., 1994).

The objectives of the current study were to (1) determine if PLD users have worse hearing than non-PLD users (2) to determine if PLD-users who listen to music louder than 80 dB A free field equivalent levels have worse hearing than PLD-users who listen to music at levels less than 80 dB A (3) to determine what additional factors such as audiological history, hearing protection use, exposure to noise and amount of time listening to PLDs influence hearing acuity and (4) to examine which health-related fitness variables have a positive influence on hearing acuity.

Methods

Subjects

A total of 115 subjects, ages 18-84, were recruited from the Oxford, Ohio area via flyers posted at locations throughout Oxford. Participants were scheduled to complete the Kinesiology and Audiometric portions of the study via email. At this time, participants received an email detailing expectations for each part of the study. Upon arrival to the first part of testing, participants
completed an informed consent form approved by the Miami University Institutional Review Board (Figure 1).

**Acoustic Testing**

Participants were categorized into two groups, earbud PLD users and non-PLD users. PLD users were instructed to bring their most frequently used PLD and headphones with them to testing. Both PLD users and PLD non-users began by completing a hearing health questionnaire (Figure 2) investigating hearing health as well as past and present noise exposure. After completing the questionnaire, participants underwent otoscopy to examine health of the outer ear and tympanic membrane. Participants with visible cerumen occlusions or external ear abnormalities were excluded from the study. Participants were then screened for middle ear disease using tympanometry.

All audiometric testing and OAE testing occurred in double-walled sound-attenuating booths. After confirming the physical health of the ear, the Hughson-Westlake method was used to obtain pure-tone thresholds on a Grason-Stadler 61 diagnostic audiometer at frequencies of .25 kHz, .5 kHz, 1 kHz, 2 kHz, 3 kHz, 4 kHz, 6 kHz and 8 kHz. Pulsed pure-tones were delivered through Etymotic Research-5A insert earphones. Annual calibration of the equipment was performed according to the American National Standards Institute (ANSI) guidelines (ANSI, 2004).

Distortion Product Otoacoustic Emissions (DPOAE) were measured using the Biologic Systems Scout OAE software version 3.45 system with two intensity levels from 2 kHz-8 kHz. Testing was completed at f1/f2 ratio expressions of 1.20 from 2 kHz-8 kHz at 45/55 dB SPL (moderate level) and 55/65 dB SPL (high level; \( L_1 - L_2 = 10 \) dB). Research has shown that Otoacoustic Emission (OAE) testing may be a possible predictor of future NIHL and that OAEs may decrease in amplitude prior to changes in audiometric thresholds (Marshall & Miller, 2007; Miller et al., 2006). Due to the possibility that changes in OAEs may be early indicators of hearing loss, 43 of the 115 participants completed OAE testing in addition to the other audiologic testing. These participants included random participants from January-May 2013, as well as all new participants tested between June and December of 2013. Otoacoustic emission testing was completed on one ear for each subject. The test ear was selected on the basis of the results of the imittance testing including: presence of an acoustic reflex at 100 dB SPL, normal maximum
peak compliance, and better pure tone thresholds. If both ears displayed equal selection criteria, then one ear was selected at random. Following completion of Otoacoustic Emission testing, the non-PLD users completed final questionnaires regarding listening habits (Figure 5) and potential risks of hearing loss (Figure 6), and testing was completed. Seventy-six participants were not available for DPOAE testing and thus were not included in subsequent analyses.

The Audioscan Verifit VF-1 equipment was utilized to obtain probe microphone measurements for listeners who used PLDs. Calibration of the instrument occurred Monday of each week. A reference microphone was placed over the participant’s ear with a probe microphone tube inserted into the ear canal. The probe tubing was inserted at 28 mm for females and 30 mm for males (Audioscan, 2006) using otoscopy. A baseline measure was taken by recording an on-ear-measure of ambient background levels to ensure accurate placement and function of the microphone. An earbud was then placed over the probe microphone on the test ear to secure the position of the tube, and the opposite earbud was also placed into the non-test ear. Each participant was instructed to select a song of his/her choice and set the volume at the most frequently used listening level. An on-ear-measure of this volume level was taken to determine the SPL output at the participant’s tympanic membrane. After the selected song played for 2-minutes, a 15-second long-term average speech spectrum (LTASS) run provided dB SPL data in 1/3 octave intervals from .25 to 6 kHz. The final on-ear measure was obtained when the participant listened to a song in the presence of background noise. A pink noise stimuli (Mazer & Rush, 1983) was selected on the basis of similarity in frequency response and amplitude to stimuli recorded from a New York subway, used by Worthington et al., 2009. Pink noise was directed at the participant’s test ear at 75 dB SPL using a Hewlett Packer L2045W Computer and Altec Lansing speaker model number AS90. Following initiation of background noise, participants were instructed to adjust their volume to meet their needs in the listening environment. The background noise was then removed, and the final volume measurement was completed. Data was displayed on graphs and tables, saved to a secure USB drive and reviewed at a later time.

Upon completion of audiological testing and Verifit probe tube measurements, the PLD user participants were asked to complete the “Listening Habits Survey” (Figures 3 & 7) and the “Knowledge of Potential Risks of Hearing Loss Survey” (Figure 4). These questionnaires were adapted from Worthington et al. (2009) and were used to examine participant’s self-reported
listening patterns as well as knowledge and education regarding noise exposure and hearing. These questionnaires were completed following audiological testing to prevent education regarding noise exposure from impacting selected listening level.

*Health Related Fitness Testing*

Specific markers of health related fitness included resting blood pressure and heart rate, blood lipids, body mass index (BMI), Waist-to-Hip ratio (W: H), hand grip strength, daily activity assessments via pedometer, and cardiovascular fitness using a sub-maximal VO₂ test. All instrumentation was calibrated daily and tests performed by a trained technician. Blood pressure and heart rate were measured on the left arm of all subjects after they had been sitting for ten minutes using an Omron Intellisense Digital Blood Pressure Monitor, Model HEM-907xL. Two readings were recorded, and averaged. If more than a 5% difference occurred between readings, the protocol called for a third reading to be taken after ten minutes. Blood lipid readings were collected using a Cholestech LDX analyzer, catalog number 02111239 (Cholestech Corporation, Hayward, CA 94545). Participants were instructed to fast for 12-hours prior to the blood lipid tests. Specific markers measured were total cholesterol (TC), high-density lipoproteins (HDL), low-density lipoproteins (LDL), triglycerides, non-HDL, TC/HDL and glucose.

Body composition was measured using a Tanida body composition analyzer, Model TBF-300A. Participants were instructed to remove their shoes and socks and step on the electrode plates on the scale portion. For all participants, weight of clothes was entered as 1.0 lb. and body type entered was “Athletic” for their gender. A SECA 210cm. stadiometer was used to measure height. Specific markers recorded from the Tanida scale were weight, body fat percentage (FAT%), fat mass (FM) and fat free mass (FFM). Hip and waist measurements were taken using a Gulick II Tape, model 67020. Measures were taken around the umbilicus and widest area around the buttock. Handgrip strength was measured using a Takei physical fitness test grip strength dynamometer, model number 68812 (Japan). Participants were instructed to stand, hold the dynamometer at their side and to squeeze as hard as they could for approximately 2 seconds. Right hand and left hand were measured twice and the best score was taken. Daily activity estimates were made by means of pedometer step data using the Yamax pedometer model SW-200. Participants were instructed to reset the pedometer each morning, wear the pedometer for all
activities and record their daily steps at night for 14 days. The collection of pedometer steps was used not only to gain objective data for daily activity, but also to validate self-reported exercise and daily activity routines.

Cardiovascular fitness was assessed by submaximal exercise tests whereby participants achieved a steady heart rate while walking for 3 minutes on a flat treadmill at a personally selected walking speed and 4 minutes at a five-degree incline. During this time, heart rate was measured with a Polar chest strap (T31) and a wristwatch and the well-known relation between heart rate and VO$_2$ max ultimately predicted VO$_2$ max. Minimum speed was no less than 4.3 mph and maximum speeds for men and women were 7.5 and 6.5 mph, respectively. According to the protocol, steady state heart rates were not to exceed 180 bpm for either gender. The protocol was modified slightly by having the participants ‘warm-up’ by walking at 3 mph for the first minute. Heart rate was measured with a Polar chest strap (T31) and wristwatch. At the completion of the test, the subject’s body weight in kilograms (BW), speed (mph), HR at termination (bpm) and gender (0=Female, 1=Male) were used to calculate an estimated VO$_2$ max. All subjects successfully completed the single-stage submaximum test and a reliability measure between VO$_2$ max values predicted from this submaximal test and a true maximal test in a subsample (n=20) was very strong (r = .86).

Equation is shown below:

Predicted VO$_2$max = 54.07 - 0.1938(BW) + 4.47(speed in mph) - 0.1453 (HR on bpm) + 7.062 (gender: female=0, male=1)

Statistics

Descriptive statistics were performed on the data set using SAS Software Version 9.2 for Windows. The data were first summarized and examined for outliers and consistency. Several preparatory steps were taken to ready the data for analysis. Usage times were calculated by multiplying self-reported hours per day by days per week of PLD usage. All samples of Verifit SPL values were converted to A-weighted free field equivalents for comparison to noise exposure standards. The Microphone in Real Ear technique (MIRE) calibration tables were used to determine a coupler to free-field correction factor to report free-field equivalent levels for
individual frequencies produced by the Verifit VF-1 (transfer function of the outer ear [TFOE] of the Verifit VF-1 measurements). Pure tone thresholds in HL were analyzed in two ways as dependent variables: traditional frequency range (0.25-8 kHz) and high frequency (HF) range (4-8 kHz).

Results

Participant Information
A total of 119 participants aged 18-84 participated in this study, including 72 females and 43 males. 4 participants were excluded for failing to complete all portions of audiologic and health-related fitness testing leaving a total of 115 participants. The mean age of participants was 45 years with a SD of 16.5. Subjects were divided into two groups (Table 1) PLD users (n=75) and non-PLD users (n=40). The mean age of PLD non-users (52.78 years) was 12 years higher than the mean age of PLD users (40.71 years). For participants under age 50, the traditional frequency range mean was 10.97 dB HL, while the HF mean was 13.76 dB HL. Mean hearing thresholds between 0.25-8 kHz were poorer for participants over age 50, who had a mean of 14.58 dB HL and a HF band mean of 22.81dB HL (Table 2). Twenty-three participants reported a history of ear infections, while 30 participants reported a family history of hearing loss. Thirty-one participants reported past or present tinnitus. Despite these reports, 100 of the participants presented with pure-tone averages ≤25 dB HL for octave frequencies from 0.25-8 kHz (within normal limits) and normal middle ear function determined by compliance and pressure measures. In the High Frequency (HF) band means (4 kHz-8 kHz) an additional 12 participants were classified as having abnormal hearing (pure tone averages >25dB HL).

Acoustic Variables
Due to the mean age mismatch of the PLD user group versus the non-PLD user group, age-adjusted ANOVA statistics was performed on the data to match the groups for age and rule out audiological changes that were the result of presbycusis rather than PLD user status or noise exposure. No differences were found between the PLD-user group and the non-PLD user group in the traditional frequency band range (0.25-8 kHz), the HF band range (4-8 kHz) or DPOAEs. When examining the traditional frequency band means, age was found to be statistically correlated (p <0.001), while PLD listening status was insignificant (p=. 7403). In the HF band
means, age was again the only significant variable contributing to hearing levels (p=\(<0.001\)), while PLD status was insignificant (p= .4787). A similar trend was observed when comparing the DPOAEs of PLD users and non-PLD users at both low and high intensity levels from 2-8 kHz. Age was a significant indicator of DPOAE levels at the low (p= < .0001) and high (p= < .0001) intensity levels, while PLD user status was deemed insignificant (p = .9479).

The listening levels of the PLD-user group were then examined in relation to hearing acuity. A total of 49 PLD-users were included in this analysis. 36% of PLD-users were excluded for failing to bring their most frequently used PLD to testing, or for failing to complete all portions of audiologic testing. Of these 49 users, 94% were considered to have normal traditional frequency band means (pure tone levels < 25 dB HL), while 6% were found to have abnormal levels (pure tone levels > 25dB HL). In the HF range (4 kHz- 8 kHz), 86% were found to have HF means in the normal range, while 14% of participants HF means were considered abnormal. Age (p= < .0001) and listening level in silence (p= 0.0288) were the only two variables found statistically related to traditional frequency means. For the HF band means, only age (p < .0001) was found to be significant.

DPOAEs of the PLD-user group were then examined. For the 27 participants who completed DPOAE testing, probe-microphone and PT testing, age was the only variable significant at the moderate (p= .0002) and high (p= .0007) intensity levels. Listening at harmful levels in silence had no significance on DPOAEs at the moderate 2-8 kHz (p= .2051) or loud 2-8 kHz (p= .0912) intensity levels. The second measurement in the presence of 75 dB SPL background noise revealed that age was again the only significant influence on the traditional frequency range means (p < .0001) as well as HF band means (p < .0001). Participants who listened at levels above 80 dB A in noise showed no difference in hearing levels or DPOAE values at the moderate or high intensity levels.

Finally, survey responses for the 51 PLD-users and 45 PLD non-users were analyzed. These surveys examined variables contributing to hearing acuity such as age, audiology history, hearing protection use, and presence of tinnitus. Isolated questions targeted information specific to PLD users including exposure to noise and duration and frequency of listening to PLDs. Nineteen participants were excluded for failing to complete all parts of the survey. As seen in Table 3, variables found to be a significant association for traditional frequency band means for PLD-users included age, years listening to PLD and hours listening to a device per week.
Participants with increased age or those who listened to PLDs for more than 8 hours per week were found to have worse hearing \((p = 0.0111)\). Contrary to our hypothesis, those who had used a PLD for a greater amount of years were more likely to have better traditional frequency band means when matched for age. However, for HF band means of PLD-users, variables found to significantly influence hearing levels included age, the use of hearing protection, and years listening to device (Table 4).

For non-PLD users, age was the only contribution found to impact traditional frequency band means. For HF band means, significant influences included age \((p<0.0001)\) and consistent use of hearing protection. Participants who “always” used hearing protection were found to have better thresholds in the high frequency range \((Pr > |t|= 0.0213)\) while those who inconsistently wore ear protection had no significant effect.

**Health-Related Fitness Variables**

A total of 105 participants completed both the audiologic and health-related fitness portions of the study. Ten participants were excluded for failing to complete both portions of the study. For the traditional frequency band means, age was found to be a significant contributing factor \((p < 0.0001)\). Body Mass Index (BMI) was found to have a marginal positive correlation with traditional frequency band means \((p= 0.0944)\). For the HF band means, age \((p <0.0001)\) and W: H ratio \((p= 0.038)\) were found to be contributing factors to hearing thresholds. W: H ratio was found to have a significant positive correlation with pure tone HF band means \((b=43.07)\) after adjusting for age.

**Discussion**

This study examined the dynamic relation between measures of hearing acuity, personal listening behaviors and biomarkers of cardiovascular health and fitness. Our results support the conclusion that age is the most significant factor contributing to hearing loss. Presbycusis, or age related hearing loss, is the most common sensory deficit in the elderly, and may occur as a result of various types of physiological degeneration in addition to the effects of noise exposure, medical disorder and genetics (Huang & Tang, 2010). Presbycusis frequently begins as a high frequency hearing loss and presents with clinical features of threshold shifts and decline of speech understanding (Huang & Tang, 2010). This increase in high frequency hearing loss as a result of
aging is consistent with the finding that 12 participants showed traditional frequency band mean hearing loss, while 24 showed hearing loss in HF band means. Furthermore, participants over age 50 had traditional frequency band means that were an average of 3.67 dB HL higher and HF band means an average of 9.05 dB HL higher compared to their younger counterparts (Table 2). This supports the conclusion that older individuals have worse hearing, particularly in the high frequencies.

As seen in Table 1, traditional frequency band means for PLD-users were better (11.98 dB HL) than the means for non-PLD users (15.23 dB HL). Despite these findings, no significant differences in hearing were found between the group of PLD users and the group of non-PLD users when analyzing the traditional frequency band means, HF band means and DPOAE values. These findings are consistent with reports from Berger et al. (2009) who reported that few people are at substantial risk of developing hearing loss from PLDs and instead are at greater risk of developing hearing loss secondary to recreational noise exposure including hunting, power tools, operating motorized vehicles, attending sporting events and concerts and firing guns. Contrary to Berger’s report, our data supports a correlation between exposure to leisure noise (bars, clubs, concerts, sporting events, fireworks) and better traditional frequency band means (p = 0.0502). In this case, individuals that exposed themselves to more different types of noisy environments tended to have better hearing. One hypothesis for this finding is that this study examined the relationship between total number of environments and hearing acuity, rather than examining individual environments and their relationship to mean amplitude levels. Furthermore, frequency and duration of exposure in each environment was not co-factored into the analysis. Future research should examine the link between hearing acuity and individual noise environments, while considering the frequency, intensity and duration of the noise exposure within each context.

Superior HF Pure Tone Thresholds (PTT) were observed for the 5 PLD users that protected themselves from noise damage through consistent use of hearing protection. No changes were observed for participants that “sometimes” or “rarely” wore hearing protection. The most common environments for the use of hearing protection included during construction, at concerts and at shooting ranges. Future research should continue to explore the possibility of DPOAE values as indicators of future NIHL. Nonetheless, no differences in mean DPOAE values at moderate and loud intensity levels were observed between those with frequent noise
exposure, and those with limited noise exposure in the current study. This is contrary to the results of Seixas (2004) who found that DPOAEs parallel deteriorations in PTTs and may worsen as a result of noise exposure (Seixas, 2004).

When discussing the impact of PLD use on hearing, one must always consider both the intensity and duration of listening. The National Institute for Occupational Safety and Health (NIOSH) determined that sounds exceeding 85 dB A for 8 hours or more are considered to be hazardous to an individual’s hearing (Daniel, 2007). For this study, the value of 80 dB A was selected to parallel current international recommendations for duration of noise exposure (SCENHIR, 2008).

Consistent with the belief that intensity levels above 80 dB A are harmful to hearing, participants in the current study who listened at levels above 80 dB A in silence had worse hearing thresholds than those who listened at safe levels (Table 5). No differences were observed between those that listened at dangerous levels in the presence of noise and those that did not (Table 6). The mean intensity of listening level in silence and in noise was also considered according to gender. As seen in Table 5, participant’s volume level in silence was extremely variable. Although the majority of participants listened at “safe” levels, males were more likely to listen at dangerous levels in silence than females. In the presence of background noise, (Table 6) nearly all groups increased their mean intensity. Furthermore, an additional 15 participants listened at levels deemed dangerous in the presence of background noise, including approximately equal amounts of males and females.

A similar correlation between duration/week of PLD use and hearing acuity was established. Our findings indicate that PLD users who listen for greater than 8 hours per week are at an increased risk for hearing loss. This suggests that that duration rather than intensity may increase subsequent risk of developing NIHL. This is consistent with the findings of Meyer Birsch (1996) who found that young adults who used their personal music system more than 7 hours a week had poorer hearing thresholds compared with other young adults with less PLD use. Contrary to our hypothesis, PLD-users who had been listening to their devices for a greater amount of years had better traditional frequency band means and HF levels than PLD-users who had been listening to their devices for less time, despite being matched for age. Opposing findings were reported by Hua Peng, et al. (2007) who found that 14.1% of young adults with long-term history of PLD use had hearing impairment. Of those participants with NIHL,
incidence was highest in the subgroup that had been listening for 5 years, revealing that the risk of damage to hearing is increased as the duration of noise exposure increases (Peng, 2007). A possible explanation for this finding is that traditional frequency band means were examined within the context of number of years listening alone. Future research should cofactor hours/week and intensity of listening along with years listening to obtain a more accurate representation of the relationship between PLD use and hearing health.

Although researchers claim that high cardiovascular fitness positively influences the auditory system and in turn protects hearing sensitivity (Loprinzi et al., 2012), the current study demonstrates that age is the ultimate predictor of hearing health. In the traditional frequency band means, a marginal correlation was found between hearing acuity and BMI (p=0.0944). BMI is an indicator of body fat composition taken from a person’s weight and height. It is calculated by dividing weight in pounds (lbs.) by height in inches (in) squared and multiplying by a conversion factor of 703. BMI values in the range of 18.5-24.9 are considered “normal” while values above 25 are associated with being overweight or obese (CDC). While BMI is commonly used as an indicator of obesity, it is also correlated with other measures of health including cholesterol. In this case, those with higher BMIs tend to have unfavorable lipid profiles including elevated triglycerides, and total cholesterol values (Brenner et al, 2010). With increased values of cholesterol and triglycerides in the blood comes increased likelihood of blockages in blood vessels. This can result in excessive stress that can damage the heart in its effort to circulate blood and oxygen throughout the body, including to parts of the ear (Alessio & Marron, 2014). As seen in Table 7, mean BMI for participants in the current study was 25.21 with a SD of 4.62. This mean is considered to be on the border between “normal” and “overweight.” Nonetheless, Table 8 demonstrates that BMI for participants under age 50 was 24.39 (normal range) while mean BMI for individuals over age 50 was 26.31 (overweight). This indicates that in the current study, older individuals were more likely to have BMIs considered overweight than their younger counterparts. Furthermore, individuals who had lower (superior) hearing thresholds were also more likely to have lower BMI values. This is consistent with the finding that those with better overall health tend to have better hearing acuity.

In the HF band means, a significant correlation was found between hearing acuity and W/H ratio. Normal W/H ratio measurements are: ≤0.8 for women and ≤0.9 for men (Noble, 2001). As seen in Table 6, mean W/H ratios were .839 with a SD of 0.089. Nonetheless, mean W/H
ratio was .875 for participants above age 50 while it was .813 for individuals below age 50. This signifies that younger individuals were more likely to have healthier W: H ratios than their older counterparts (Table 7). Furthermore, individuals who had lower (superior) hearing thresholds from 4-8 kHz also had smaller W: H ratios, indicating that they carried more of their weight on their hips (pear shaped) than around their waist (apple shaped), as seen in Figure 8 (Mayo Clinic). Research has shown that individuals who carry their weight on their hips rather than their waist have a lower risk of developing diabetes, heart disease and other complications of metabolic syndrome. A study by Balkau (2007) which explored the relationship between waist circumference (WC), cardiovascular disease (CVD) and diabetes mellitus (DM) in a sample of 168,000 patients ages 18-80 in 63 countries found that abdominal obesity, measured by WC, showed a graded relationship with both CVD and DM at all levels of BMI. In this case, both men and women with larger waist circumferences were more likely to develop CVD and DM than those with smaller waist circumferences (Balkau, 2007).

Therefore, these findings support the conclusion that improved health-related fitness is correlated with superior hearing in the high frequency band. Exposure to excessive noise affects the high frequency sounds first. Nonetheless, the impact of high intensity noise on blood flow may be minimized through regular exercise. It is believed that high levels of health-related fitness reduce susceptibility to TTS by increasing blood flow and oxygen delivery throughout the body, including the ear (Cristell, Hutchinson, & Alessio, 1998). By improving the circulation of oxygenated blood, the cochlea is less susceptible to the onset of vasoconstriction brought on by loud noise (Hull & Kerschen, 2010). Finally, despite the fact that VO2 max, was lower in the group of participants over the age of 50, compared with <50 year-old group, no significant correlation between increased VO2 max values and improved hearing acuity were observed in the current study. This is inconsistent with previous findings of Alessio and Marron (2014) who reported that individuals with VO2 max values greater than 31 ml/kg/minute for women, and greater than 34 ml/kg/minute for men, reduced their susceptibility to metabolic and cardiovascular disease and also had better hearing acuity. This suggests that despite the possible benefits of cardiovascular fitness on hearing acuity, non-modifiable behaviors discussed previously may make age-related hearing loss inescapable.
Conclusion

This study examined the relationship between hearing levels, listening habits of PLD-users and cardiovascular health and fitness variables within adults aged 18 to 84. Age was found to be a significant predictor for traditional frequency band thresholds, HF thresholds and DOPAEs. PLD user status did not impact hearing acuity. Nonetheless, PLD users who used their devices for longer than 8 hours/week were more likely to have worse hearing levels than PLD users who listened with limited duration. Furthermore, PLD users who listened at safe (<80 dB A) rather than dangerous (>80dB A) intensities in silence had better traditional frequency band threshold levels than those who listened at dangerous volumes. Finally, all health related fitness variables declined with age. However, specific indices of health behavior appeared to influence hearing levels more than others. A healthier (e.g. lower) BMI was marginally associated with improvements in traditional frequency band levels, while a healthier (smaller) W: H ratio was strongly correlated with improved hearing in the high frequencies. Cardiovascular fitness, represented by VO₂ max, was lower in the group of participants over the age of 50, compared with <50 year-old group. In conclusion, the risk of developing NIHL over time is mediated by several audiological and non-audiological behaviors. One non-audiological behavior is health related fitness, which may influence hearing thresholds. Although PLD use alone is not a major predictor of hearing thresholds, intensity and duration of listening may be significant indicators of hearing acuity.
INFORMED CONSENT FORM

Title of Investigation: Factors that influence hearing sensitivity in adults who listen to music with ear bud headphones

Investigators: Helaine Alessio, Ph.D¹, Danielle Ross¹, Brittany Sproat², Melanie Frost², Justin Chu¹, Jack Trusler¹ Kirthi Jetti¹, Bobbi Mills¹, Migle Staniskyte¹, Candra McDonald¹, and Kathleen Hutchinson Marron, Ph.D²

Department of Kinesiology and Health¹ (513-529-2707) and Department of Speech Pathology and Audiology²

Date:__________________

This is to certify that I, ____________________________, hereby agree to participate as a volunteer in a scientific investigation as an authorized part of the education and research program of the Miami University under the supervision of Helaine Alessio, Ph.D.

The investigation and my part in the investigation have been defined and fully explained to me by the investigators and I understand the explanation. A copy of the procedures of this investigation and a description of the study has been provided to me and has been discussed in detail with me.

I have been given the opportunity to ask whatever questions I may have had and all such questions and inquiries have been answered to my satisfaction. A copy of this form will be given to me.

I understand that I am free to deny any answers to specific questions in interviews of questionnaires. I further understand that I am free to withdraw my consent and terminate participation at any time.

I understand that participation does not change the availability of Clinic services at Miami University.

I understand that in the event of physical injury resulting from the research procedures, financial compensation is not available and medical treatment is not provided free of charge.

I have rights as a volunteer subject and if I have any questions about those rights I may contact:
The Office for the Advancement of Scholarship and Teaching (529-3714)
107 Rutherford Hall, Oxford, Ohio 45056

____________________________________________________________________________________
Date Subject’s or Parent Signature

I, the undersigned, have defined and fully explained the investigation to the above subject.

Date Investigator’s Signature

16
**Figure 2: Health History Survey**

Name: __________________________
Subject ID#: ________________ Date: ____________ Tester Initials: ____________

**Subject Demographics:**
Age: ____________
Sex: ____________
Level of education: ____________

**Hearing History:**
1. Do you have any concerns with your hearing?
   a. Yes (please elaborate)
   b. No
2. Do you listen to music?
   a. Yes
   b. No
3. Have you had a history of ear infections?
   a. Yes (please elaborate)
   b. No
4. Please circle all of the following environments in which you may have been exposed to loud noise in the context of employment, home, or recreation. For chosen environments, specify how often and for what duration you are exposed in these specific environments:
   a. Construction Yes / No
   b. Transportation (air planes/trains etc.) Yes / No
   c. Concerts/bands Yes / No
   d. Bars/Clubs Yes / No
   e. Sporting Events (car shows, airplane shows, baseball, basketball, hockey, etc.) Yes / No
   f. Fireworks Yes / No
   g. Shooting Ranges/Hunting Yes / No
   h. Fire Alarms Yes / No
   i. Other
5. Do you wear hearing protection when in noise?
   a. Yes
   b. No
6. How often do you wear hearing protection?
   a. Always
   b. Sometimes
7. In what situations do you wear hearing protection?
   a. Construction
   b. Transportation (air planes/trains etc.)
   c. Concerts/bands
   d. Bars/Clubs
   e. Sporting Events (car shows, airplane shows, baseball, basketball, hockey, etc.)
   f. Fireworks
   g. Shooting Ranges/Hunting
   h. Fire Alarms
   i. Other ______________________

8. Please list any medications (Aspirin, etc.) that might influence your hearing:

9. Have you experienced any ringing in your ears (past or present)?
   a. Yes (please elaborate: ________________________________)
   b. No

10. Have you had any head or neck injuries or surgeries within the last year?
    a. Yes (please elaborate: ________________________________)
    b. No

11. Do you have a family history of hearing loss?
    a. Yes (please elaborate: ________________________________)
    b. No

12. When not using speakers to listen to music, what brand of headphones do you use most often?
    a. Apple
    b. Skull Candy
    c. Sony
    d. JVC
    e. Generic Brand (Wal-Mart, etc.)
    f. Other ________________________
    g. Not applicable (skip Q# 13)

13. Is this brand of headphones a type of:
    a. Earbud
    b. Over-the-ear
    c. Noise-cancelling
    d. Both a & c
    e. Both b & c
1. What is the name of the listening device you currently use majority of the time?
   a. iPod Classic  
   b. iPod Shuffle  
   c. iTouch  
   d. iPhone  
   e. iPod Nano  
   f. Zune  
   g. Phone/Blackberry  
   h. Other: ________________

2. How many years have you been using this particular device? ________________

3. How many years have you been using headphones to listen to music? ________________

4. On average, how many hours per week do you listen to music with headphones?
   a. 0 – 2 hours/week  
   b. 2 – 5 hours/week  
   c. 5 – 8 hours/week  
   d. 8 – 11 hours/week  
   e. Greater than 11 hours/week

5. In what situation do you listen to the device under headphones the majority of the time?
   a. Home  
   b. Transportation (bus/cab)  
   c. While exercising  
   d. Other: ________________

6. Do you listen with headphones more often than with speakers?
   a. Yes  
   b. No

7. With which devices do you use to listen to music through speakers? Circle all that apply:
   a. Computer (built in speakers)  
   b. Stereo system  
   c. iHome/Dock  
   d. Other: ________________  
   e. I do not use speakers

8. Have you previously owned any of the following Portable Listening Devices (PLDs)? Circle all that apply:
   a. Personal cassette player  
   b. Portable compact disk  
   c. Personal AM/FM radio  
   d. Other: ________________

9. What genres of music do you generally listen to a majority of the time under headphones? Check all that apply:
   a. Pop/Rock  
   b. R&B/Hip-Hop  
   c. Alternative  
   d. Metal  
   e. Country  
   f. Other: ________________
Figure 4: Knowledge of Potential Risks of Hearing Loss (PLD users)

Name: ____________________________

Subject ID#: ____________________________ Date: ____________________________ Tester Initials: ______

1. At what sound level do you typically keep your listening device for comfortable listening? Reference Figure 6 on the laminated sheet and select a number rating:
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

2. Have you ever been educated on the risks of hearing from loud sounds? If so, when?
   a. Middle School
d. College – Elective
   b. High School
e. Work conference
   c. College – Required course
f. Other: ____________________________

3. Can loud sounds cause damage to your hearing?
   a. Yes
   b. No

4. What volume level do you feel is the beginning point for “too loud” that will begin to harm your hearing? Please reference figure 6 on the laminated sheet and select a number rating:
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5
   f. 6

5. What length of listening time with earbud headphones (in one sitting) do you feel is “too long” and will begin to harm your hearing?
   a. 15 – 30 minutes
d. 3 hours
   b. 1 hour
e. 4 hours
   c. 2 hours
f. 5 hours

6. Do you feel that you listen to your device at harmful levels?
   a. Always
c. Rarely
   b. Sometimes
d. Never

7. If you learned that you were listening to your device at harmful levels, would you turn it down/limit your weekly use?
   a. Yes
   b. No

8. From which of these persons would you be most likely to follow given advice, regarding iPod/earbud use and hearing loss?
   a. Doctors
   b. Audiologists
c. Manufacturers  
f. Friends  
d. Celebrities  
g. Other: ____________________  
e. Family

9. Would you like more information regarding iPod/earbud use and potential hearing loss?  
a. Yes  
b. No

10. Would you like an explanation of your hearing test?  
a. Yes (please provide your e-mail: ____________________)  
b. No

11. What song did you select? ____________________________________________

12. Who is the artist? ____________________________________________________

13. What genre would you consider it? _____________________________________
Figure 5: Listening Habits (Non-PLD users)

Name:__________________________  Subject ID#:__________________________  Date:__________________________  Tester Initials:_______

1. Do you use a portable listening device?
   a. Yes  b. No

2. Do you listen to music with speakers?
   a. Yes  b. No

3. With which devices do you use to listen to music through speakers? Circle all that apply:
   a. Computer (built in speakers)
   b. Stereo system
   c. iHome/Dock
   d. Other: ______________________
   e. I do not use speakers

4. Have you previously owned any of the following Portable Listening Devices (PLDs)?
   Circle all that apply:
   a. Personal cassette player
   b. Portable compact disk
   c. Personal AM/FM radio
   d. Other: ______________________

5. What genres of music do you generally listen to a majority of the time under headphones? Check all that apply:
   a. Pop/Rock
   b. R&B/Hip-Hop
   c. Alternative
   d. Metal
   e. Country
   f. Other:______________________
**Figure 6: Knowledge of Potential Risks of Hearing Loss (Non-PLD users)**

Name: ____________________  Date: ________________  Tester Initials: ______

Subject ID#: __________________

1. Have you ever been educated on the risks of hearing from loud sounds? If so, when?
   a. Middle School
   b. High School
   c. College – Required course
   d. College – Elective
   e. Work conference
   f. Other: ____________________

2. Can loud sounds cause damage to your hearing?
   a. Yes
   b. No

3. From which of these persons would you be most likely to follow given advice, regarding iPod/earbud use and hearing loss?
   a. Doctors
   b. Audiologists
   c. Manufacturers
   d. Celebrities
   e. Family
   f. Friends
   g. Other: ____________________

4. Would you like more information regarding iPod/earbud use and potential hearing loss?
   a. Yes
   b. No

5. Would you like an explanation of your hearing test?
   a. Yes (please provide your e-mail: ____________________)
   b. No
Figure 7: Noise Level Reference for PLD Users Surveys

1: 

2: 

3: 

4: 

5: 

6: None of the above – even the maximum volume on personal listening devices are safe because manufacturers make sure they are.
Figure 8: Apple vs. pear body shape

Table 1: Participant Demographics by Gender and User-Status

<table>
<thead>
<tr>
<th>PLD Status</th>
<th>N</th>
<th># of Females</th>
<th># of Males</th>
<th>Mean Age</th>
<th>Pure Tone Wideband Mean</th>
<th>Pure Tone HF Band Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLD-user</td>
<td>72</td>
<td>42</td>
<td>33</td>
<td>40.71</td>
<td>11.98</td>
<td>14.91</td>
</tr>
<tr>
<td>Non-PLD user</td>
<td>43</td>
<td>30</td>
<td>10</td>
<td>52.78</td>
<td>15.23</td>
<td>23.39</td>
</tr>
</tbody>
</table>

Table 2: Traditional Audiometric Frequency Means by Age and Frequency

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Traditional Audiometry Mean (250K 500K 1K, 2K, 3K, 4K, 6K, 8K)</th>
<th>High Frequency Band Means (4K, 6K, 8K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50</td>
<td>10.97 dB</td>
<td>13.76 dB</td>
</tr>
<tr>
<td>50 +</td>
<td>14.59 dB</td>
<td>22.81 dB</td>
</tr>
</tbody>
</table>

Table 3: Variables Contributing to Wideband Pure tone Means for PLD-users

| Parameter                             | Traditional Audiometric Frequency Means | t Value   | Pr > |t| |
|---------------------------------------|----------------------------------------|-----------|------|---|
| Age                                   |                                        | 8.49      | <.0001|   |
| Total Number of Environments          |                                        | -2.01     | 0.0502|   |
| Absence of Tinnitus                   |                                        | -1.70     | 0.0958|   |
| Absence of Family History of Hearing Loss |                                    | 1.95      | 0.0572|   |
| Years Listening to Device             |                                        | -2.31     | 0.0253|   |
| Hours Listening to Device/Week        |                                        | 2.65      | 0.0111|   |
Table 4: Listening Variables Contributing to High Frequency Band Means for PLD-users

| Parameter                        | Parameter | t Value | Pr > |t| |
|----------------------------------|-----------|---------|------|---|
| Age                              | Age       | 9.77    | <.0001|
| Total Number of Environments     | 2.14      | 0.0372  |
| Years Listening to Device        | -2.49     | 0.0164  |
| Hours Listening to Device/Week   | 1.78      | 0.0822  |

Table 5: PLD Listening Levels in Silence

<table>
<thead>
<tr>
<th>Silence Harmful</th>
<th>Gender</th>
<th>N</th>
<th>Wide band Mean</th>
<th>HF band Mean</th>
<th>Mean Listening Intensity (dB)</th>
<th>SD</th>
<th>Min Volume (dB)</th>
<th>Max Volume (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Female</td>
<td>26</td>
<td>8.79</td>
<td>9.82</td>
<td>57.316</td>
<td>12.420</td>
<td>37.463</td>
<td>75.909</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>17</td>
<td>12.08</td>
<td>17.50</td>
<td>63.469</td>
<td>9.757</td>
<td>46.26</td>
<td>76.870</td>
</tr>
<tr>
<td>Yes</td>
<td>Female</td>
<td>2</td>
<td>18.57</td>
<td>27.50</td>
<td>90.130</td>
<td>9.381</td>
<td>83.497</td>
<td>96.763</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>6</td>
<td>14.76</td>
<td>17.22</td>
<td>82.984</td>
<td>2.334</td>
<td>80.097</td>
<td>85.800</td>
</tr>
</tbody>
</table>

Table 6: PLD Listening Levels in Noise

<table>
<thead>
<tr>
<th>Noise Harmful</th>
<th>Gender</th>
<th>N</th>
<th>PT Wide band Mean</th>
<th>HF band Mean</th>
<th>Mean Listening Intensity (dB)</th>
<th>SD</th>
<th>Min Volume (dB)</th>
<th>Max Volume (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Female</td>
<td>17</td>
<td>9.76</td>
<td>11.44</td>
<td>70.867</td>
<td>9.843</td>
<td>40.462</td>
<td>79.795</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>11</td>
<td>12.83</td>
<td>17.77</td>
<td>73.354</td>
<td>7.080</td>
<td>54.381</td>
<td>79.4866</td>
</tr>
<tr>
<td>Yes</td>
<td>Female</td>
<td>11</td>
<td>9.07</td>
<td>10.52</td>
<td>87.149</td>
<td>4.640</td>
<td>81.371</td>
<td>95.070</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>12</td>
<td>12.73</td>
<td>17.11</td>
<td>87.675</td>
<td>6.630</td>
<td>81.556</td>
<td>101.856</td>
</tr>
</tbody>
</table>
Table 7: Mean Measures of Health-Related Variables across Participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>25.211</td>
<td>4.624</td>
<td>18.46</td>
<td>38.92</td>
</tr>
<tr>
<td>Waist-to-hip ratio</td>
<td>0.839</td>
<td>0.089</td>
<td>0.60</td>
<td>1.09</td>
</tr>
<tr>
<td>VO2 Max</td>
<td>34.535</td>
<td>8.763</td>
<td>14.80</td>
<td>63.90</td>
</tr>
</tbody>
</table>

Table 8: Mean Measures of Health Related Variables and Hearing According to Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 +</td>
<td>BMI</td>
<td>26.3</td>
<td>5.1</td>
<td>18.7</td>
<td>38.1</td>
</tr>
<tr>
<td></td>
<td>Waist-to-hip</td>
<td>0.8746</td>
<td>0.083</td>
<td>0.7</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>VO2 Max</td>
<td>30.9</td>
<td>5.4</td>
<td>17.6</td>
<td>42.7</td>
</tr>
<tr>
<td></td>
<td>Pure Tone Mean .25-8 kHz</td>
<td>14.6</td>
<td>8.5</td>
<td>-10</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Pure Tone Mean 4-8 kHz</td>
<td>22.8</td>
<td>6.0</td>
<td>-10</td>
<td>75</td>
</tr>
<tr>
<td>≤50</td>
<td>BMI</td>
<td>24.392</td>
<td>4.060</td>
<td>18.5</td>
<td>38.9</td>
</tr>
<tr>
<td></td>
<td>Waist-to-hip</td>
<td>0.8</td>
<td>0.084</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>VO2 Max</td>
<td>37.2</td>
<td>9.803</td>
<td>14.8</td>
<td>63.9</td>
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<td></td>
<td>Pure tone Mean .25-8 kHz</td>
<td>11.0</td>
<td>2.4</td>
<td>-10</td>
<td>110</td>
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<tr>
<td></td>
<td>Pure tone Mean 4-8 kHz</td>
<td>13.8</td>
<td>.86</td>
<td>-10</td>
<td>110</td>
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</tbody>
</table>
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