Music Listening Levels and Noise Risk Assessments for Students at the University of Florida
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INTRODUCTION
Noise-induced hearing loss (NIHL) is caused by long-term exposure to high-level sound (recruitment or occupation). The higher the sound level, the shorter the “safe” daily listening duration will be. Personal listening devices (PLDs) are popular (Desature et al., 2009; Levy et al., 2011), as some 90% of college student own a PLD, and youth often prefer loud music (Torre, 2008). This raises concerns as to whether PLD users are choosing safe levels and durations that may lead to NIHL (especially when combined with other sources of loud sound, such as concerts, nightclubs, and sporting events). The US Occupational Safety and Health Administration (OSHA) regulates daily noise exposure in the workplace. Employers are required to limit exposure to 90 dB (time weighted average, TWA) the permissible exposure level (PEL). OSHA (1983). The US National Institute for Occupational Safety and Health (NIOSH) is advisory; they recommend the PEL be reduced to 85 dBA TWA. NIOSH and OSHA also differ in that NIOSH recommends a more conservative 3-dB exchange rate, in contrast to OSHA’s 5-dB exchange rate. Although PLD use cannot be regulated in the same way as workplace noise, OSHA and NIOSH PEIs can be used to assess the percent of the population that may be choosing hazardous listening conditions.

The purpose of this study was to determine the percentage of college student PLD users that listen at levels and durations that may place them at risk for NIHL should they continue with their current listening behaviors. Risk was assessed using both OSHA and NIOSH noise risk criteria. Listening location, gender, reported daily listening duration, and previous music player use were all examined, along with previous reports that listeners adjust their free-field equivalent level (following Berger et al., 2009; Levy et al., 2011).

METHODS
Participants
A total of 138 UF college students (n=94 males, 44 females) participated. Participants were 18 years or older (mean=21 years/median=20 years; range: 18-47 years). Participants identified themselves as White (n=70), Hispanic (n=11), Black (n=19), Asian (n=24), or Other (n=14).

Procedure
• A Jolie mannequin was constructed per the Jolene Cookbook (Martin & Martin, 2007). A Digital Sound Level Meter (SLM) (Radio Shack # 2055) was situated inside an artificial ear (Westone T20C) in the mannequin (image 4).
• Participants completed a survey including demographic information (age, gender, race/ethnicity), normal listening habits (hours/day, days/week, number of years of PLD use), earphone type, and attitudes toward hearing health.
• Whichever the participants had last listened to was played, without changing the level, with earphones inserted in the Jolene device. The SLM screen was video-recorded for approximately 30 seconds, and all level measurements were averaged. There were at least 25 participants per participant.
• Participants were recruited at three campus locations: library exit, fitness center exit, and campus square.

RESULTS

Calculating and estimating risk for NHI
OSHA criteria (29 CFR 1910.95; 5-dB exchange rate)
- Daily exposure (D) = L x T = L x (time of exposure/24 hours) x 8 hours/day x 7 days/week

NIOSH criteria (NIOSH 1998; 3-dB exchange rate)
- Daily exposure (D) = L x T = L x (time of exposure/24 hours) x 8 hours/day x 7 days/week x 0.7
- Weekly exposure (W) = [(D x Days/week) x weeks/term] + (D x Days/term) x N

Figure 1. Males and females listened at comparable levels.

The 4-dB difference in measured listening level for males (51.2±11.1) versus females (79.3±11.3) was not statistically reliable (Mann Whitney test, p>0.10). Although average listening levels were <85 dB, NIOSH guidelines state that decreased confidence in the accuracy of the estimated risk is considered at levels of 80 dB or lower. Large deviations in daily listening levels at ≤80 dB are of concern as the measured levels do not reflect the extended exposure periods given by self-reported listening duration.

Figure 2. Listening level varied with campus location.

There were statistically reliable differences in listening levels when listening level was measured in different campus locations. Listeners exiting the library had lower measured listening levels (Figure 2) and lower NIOSH noise doses (Figure 4), while daily noise exposures using OSHA criteria did not differ across locations. We believe the difference in outcomes occurred with more limited use in using the 5-dB exchange rate rather than the smaller 3-dB exchange rate.

Table 1: Daily and weekly noise exposure estimates for Students at the University of Florida

<table>
<thead>
<tr>
<th>Campus Location</th>
<th>Daily Noise Exposure (D)</th>
<th>Weekly Noise Exposure (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library</td>
<td>57.8±17.7</td>
<td>180.2±52.9</td>
</tr>
<tr>
<td>Fitness Center</td>
<td>58.3±17.7</td>
<td>174.6±51.3</td>
</tr>
<tr>
<td>Campus Square</td>
<td>58.2±17.9</td>
<td>174.6±51.3</td>
</tr>
</tbody>
</table>

Figure 2. NIOSH dose varied with location and gender.

Participants exiting the library had a higher NIOSH dose than those exiting the fitness center (daily: p=0.011, weekly: p=0.003). There was no difference for gender for libraries vs. campus square (daily: p=0.086, weekly: p=0.096, unadjusted p=0.05). There was no statistical difference in NIOSH dose criteria for daily listening levels reported by participants using devices at the library had <100% dose. Participants recruited at the fitness center and campus square had higher average daily listening levels, and there was more variability across participants. With regards to gender, male participants had a higher NIOSH dose than females; this difference was not statistically reliable for weekly listening levels (p=0.053). Comparison of the NIOSH dose criterion for daily listening levels (p=0.234, weekly: p=0.251).

Summary and Conclusions
The average listening level across participants and locations was 82 dB, the conservative 3-dB exchange rate was 79 dB. Regardless of listening duration and frequency of use, the average listener would not be at risk for noise-induced hearing loss solely as a function of music player use. Music player use does add to other sound exposures; data on other sources of exposure were not collected. Although the average levels measured here were “safe,” there was significant variability in daily listening levels, and we assumed there was no potential for risk. Risk was specifically assessed using both OSHA and NIOSH criteria, and we explored effects of gender and campus location on listening level.

Gender
There are multiple reports that male participants prefer higher listening levels than female participants when listening level as a function of gender is assessed. The average listening levels measured in these participants were consistent with previous reports, although the differences measured here were not statistically significant (p=0.069, Figure 1). While there was no statistically reliable effect of gender on listening levels measured, male participants had a significantly higher weekly NIOSH dose than females (daily: p=0.058, weekly: p=0.09).

Campus Location
There were statistically reliable differences in listening levels when listening level was measured in different campus locations. Listeners exiting the library had lower measured listening levels (Figure 2) and lower NIOSH noise doses (Figure 4), while daily noise exposures using OSHA criteria did not differ across locations. We believe the difference in outcomes occurred with more limited use in using the 5-dB exchange rate rather than the smaller 3-dB exchange rate.

Research/Background
There was not a statistically reliable effect of race/ethnicity on listening level.

Future Directions
Most of the available data on listening level fail to support the “hype” regarding an “epidemic of hearing loss” as a function of music player use. While the location and context of listening levels are important dimensions, data from Levy et al. (2011) suggests that a majority of college student device users may be at risk. Those data suggest that a noise level is not an easy campus sidewalk near a campus exit. Here, noise estimates varied with campus location. Additional data are needed to define the “typical” listening pattern, as well as the more extreme listening patterns observed for a small but significant subset of the population. The data are consistent with a small but significant subset of users having significant risk for NHL over the longer term. Future research is needed to explore this phenomenon in additional tests. While it is typically not feasible to measure thresholds in participant recruited on the street, risk assessment was statistically reliable for weekly levels. The majority of the levels is influenced by threshold sensitivity. Those with higher thresholds likely listen at higher levels, regardless of whether hearing deficits are related to previous device use.

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