Assessment of Exposure to Loud Music Among Young Adults Using A Prototype Device

[1]Deeptaa Prabhakar, [2]Daisy Edwin, [3]Dawson Gladys Prathiba

[1]Deeptaa Prabhakar, Consultant Audiologist and Speech Language Pathologist, Hi tone hearing Pvt Limited, Ashok Nagar, Chennai, India

[2]Daisy Edwin, Assistant Professor, Sri Ramachandra Faculty of Audiology and Speech Language Pathology, SRIHER – DU, Porur, Chennai, Tamilnadu, India

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Research Scholar, The New College (Affiliated to University of Madras), Royapettah, Chennai, Tamilnadu, India.

Corresponding author E-mail id: daisychristofer@sriramachandra.edu.in

[3]Dawson Gladys Prathiba, Assistant Professor, Sri Ramachandra Faculty of Audiology and Speech Language Pathology, SRIHER – DU, Porur, Chennai, Tamilnadu, India.

ABSTRACT - The advancement in high quality sound technology has revolutionized Personal Listening Devices (PLD) like mobile phones, MP3 players, iPods with high intensity levels of music that lead to Music Induced Hearing Loss (MIHL). The aim of the study was to develop and test the functionality of an innovative tool to screen the exposure of loud music and create awareness among young listeners. The study was carried out in two phases. Phase I focused on the development of tab-based device, inbuilt in mannequin. Three ranges of sound intensity levels were categorized based on the standard of Occupational Safety and Health Act (OSHA). The levels were safe intensity range (60-90dB SPL), risk intensity range (90–95dB SPL), danger intensity ranges (above 95 dB SPL) of music, respectively. Phase II focused on exploring the functionality of the newly developed instrument in a sound treated room. Individual preferred listening levels of the study participants were measured using the newly developed tool. Results of the study revealed that 44% of young adults were exposed to loud intensity levels of music greater than 95 dB SPL while using PLDs. The newly developed system is an evaluator model to assess the high intensity levels of music.

KEYWORDS: ***awareness; prototype; music exposure; listening levels; personal listening devices; music induced hearing loss.***

I. INTRODUCTION

The advancements and innovations in sound technology and smart phone technology has led to high quality audio playback at high levels of music for a long period of time, due to low power consumption as well as improvements in storage capabilities[1]. The adolescents and young adults expose themselves to loud music levels for pleasure on a voluntary basis over a period of time[2]. Continuous exposure to loud noise or loud music on a daily basis causes damage to the inner hair cells of the cochlea. It is estimated that 1.1 billion young people could be at risk of developing noise induced hearing problems due to unsafe use of Personal Listening Devices[3]. Music Induced Hearing Loss (MIHL) occurs gradually over time, and the complete impact is not perceived immediately within the first few months of the exposure period. The risk of developing hearing loss due to the use of smart phones and personal music players (PMPs) depend on many variables that include the selected volume level of music, the duration of listening, the sensitivity of the individual's ear and the intermittency of music/noise exposures[4]. In the past, research has indicated increased risk of Music Induced Hearing Loss (MIHL) in college students, general public, particularly among

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adolescents and young adult group is mainly due to listening to loud music for a long duration which exceeds the recommended exposure limits (REL) specified by Occupational Safety and Health[5][6]. The results of several studies have also agreed that exposure to loud noise or music can lead to auditory symptoms such as tinnitus, temporary threshold shifts (TTS), permanent threshold shifts (PTS), hyperacusis, difficulty understanding speech, distortion or abnormal pitch perception and aural fullness[7]. Most of the younger generation are unaware of the detrimental effects of high listening levels and the duration of exposure to music[8]. The present study has categorized the intensity levels of music into three broad ranges and evaluated the listening volume (intensity level) from personal music players for awareness and educational purpose among younger generation. Exposure to loud music leads to hazardous auditory symptoms and effects. This public health intervention model intended to educate the current generation young adults to limit the listening volume and to follow the recommendations suggested by Occupational Safety and Health Act. The key to prevention of Music Induced Hearing Loss (MIHL) among younger generation is primarily awareness and education. However, in a country like India adequate emphasis has not been given to curtail the increasing trend of music exposure in current generation of young adults. Thus, education and awareness on NIHL is necessary to prevent or delay the onset of hearing impairment due to loud music[9][10]. Understanding that the life of teenagers revolves around their phones and technology, development of such tool with few special techniques that can promote the prevention of MIHL more effective and successful is the need of the hour. In an effort to provide such education and awareness to young adults, a prototype device has been developed as part of the study as an evaluator model to assess the music levels of Personal Listening Devices (PLDs).

II. MATERIALS AND METHODS

RESEARCH DESIGN

This is a cross sectional study design and was approved by the Institutional Ethics committee (CSP/18/MAY/70/167). The study was conducted on college students from various faculties inside the university. Participants who gave their consent were included in the study. A brief explanation of the demonstration and procedure was provided for all the participants.

PARTICIPANTS

A total number of 140 college students, both male and female were recruited for the study with appropriate consent. The age range of study participants were between 18 to 25 years. Participants who regularly used PLDs for longer duration (> 2 hours/day) were included in the study. None of the participants had any other associated ear problems such as history of middle ear disorders like infections, ear discharge, history of acoustic trauma or hearing loss.

SPECIFIC OBJECTIVES

- To develop a monitoring tool that measures and detects sound levels.
- To educate and create awareness among the young adults using the demonstration of newly developed device.

III. PROCEDURE

The study was carried out in two phases. Phase I focused on the development of prototype device for evaluating the listening levels of young adults. The innovative tool used in the research as public health intervention model and as a health risk assessment evaluator.

MATERIALS FOR THE PROTOTYPE DEVELOPMENT: Mannequin, sound level meter, Node-MCU (microcontroller), tablet/android phone, acoustic calibrator (microphone calibrator).

The prototype has a user interface comprised of three simple technological components supported by the human head mannequin. The main component, sound level meter (SLM) is a device that continuously measures the sound intensity level and displays the same on the SLM display screen (Figure 1). The free field microphone attached to the SLM measures the sound intensity level continuously. The free field microphone is attached to the mannequin's silicon outer ear to measure the intensity range of the music level that the participants listen to. The second component, NODE MCU which is a microcontroller–equipped board allows the device to connect to the web server. The software used inside the NODE MCU is Ardurino and python. The third component, android tablet was used to display colours as a visual notification deliverer to alert on the levels of listening sound intensity. The three smart components sound level meter, NODE MCU and android tablet were interfaced with each other. The sound level meter continuously sends the sound intensity level in decibels to NODE MCU which is a web server, and this data values gets updated continuously in the android tablet with appropriate colour indication using python software. The (listener's) sound/music intensity levels got updated in the web server fraction of second and continuously displays the sound pressure level with appropriate colour indication.

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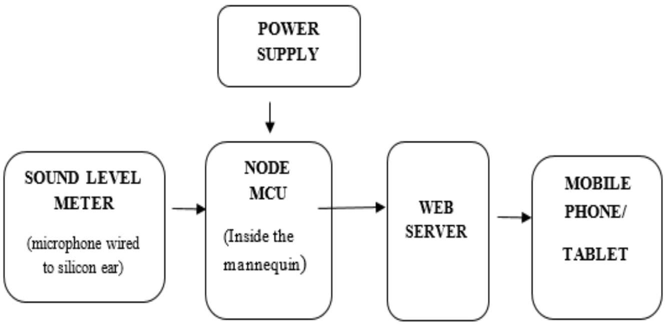
Figure 1: Block diagram of the prototype device



The tool was designed and developed in accordance with the recommendations provided for noise exposure limits by occupational safety and health administration (OSHA). OSHA's permissible noise exposure limit is 90 dB(A) with a 5-dB exchange rate, i.e., 90 dB(A) for 8 hrs and 95 dB(A) for 4 hours. Based on these recommendations, three different colours were chosen to correlate the broad ranges of sound levels. The chosen colours were green, orange and red. Green colour indicates the "safe" range of hearing with 60-95dBSPL. Orange colour indicates the "risk" range of hearing with 90-95dBSPL and red colour indicates the "danger" range with the sound levels above 95 dB SPL. According to the range of sound level received from the earphone, the tablet displays its colour appropriately. The colour change part in the android tablet had been configured using coding process. The purpose of the colour indicators was to create awareness and to cultivate the responsible listening behavior while listening to music.

Figure 2: Prototype device with different sound intensity level and colour indication.

Calibration of SLM was performed by exposing the free field microphone to the standard acoustical calibrator (B&K Type 4231) before and after each measurement procedure. The output sound level of the standard acoustical calibrator produces standard pure tone of 94 decibels in Sound Pressure Level (SPL). The prototype SLM was calibrated before the measurement procedure by presenting the calibrator's tone near the microphone and verified that the measured sound level is acoustically significant.

Phase II explored the functionality of the newly developed instrument and to educate the younger generation adult using the demonstration of the developed prototype device. Prior to phase II of the procedure the functionality of the newly developed instrument was evaluated in a sound treated room and validated by evaluating the responses of 20 participants.

During the measurement procedure, the participants were asked to adjust the volume of the Mp3 player to their regular listening level or preferred listening level. Music was played through the MP3 player for the duration of one minute through the earphones after the participants adjusted the volume to their comfortable level to listening. The participants were asked to keep one end of the earphone in the mannequin's ear and other end of the earphone to their own ear. The tab based device displayed the sound levels as safe, risk and danger with appropriate colour indication. The students self-reported listening levels to music were evaluated using the prototype device. This study emphasized the importance of awareness regarding high level of music exposure. Data were stored on an Excel spreadsheet and used for percentage analysis.

IV. RESULTS AND DISCUSSION

The mobile phone and Mp3 music players has become more common device for listening to music for the adolescent group of students. Many participants often dial the volume of music up to the maximum level as their normal routine. Moreover, the participants showed very less understanding of how to determine which level of volume was too loud. This prototype is a reliable tool with display options that can be used to evaluate the listening levels of young adults to prevent the over exposure of noise or music. Data collected with this tool provided the safe level of listening, risk level of listening and danger level of listening as a warning sign.

The figure 3, summarizes the preferable listening levels of the participants in terms of sound intensity while listening to music through PLDs. The developed tool studied and analyzed the study participants' risk of hearing loss caused due to the exposure to loud music. The earphones used by the participants were mainly commercially available insert earphones with good sound quality. Based on the intensity of the sound exposure and the representation of the respective colour codes the participants were divided into three categories highlighting their risk for developing hearing loss.

Group 1 = Safe levels (n=62)

Group 2 = High Risk (n=42)

Group 3 = Danger (n=36)

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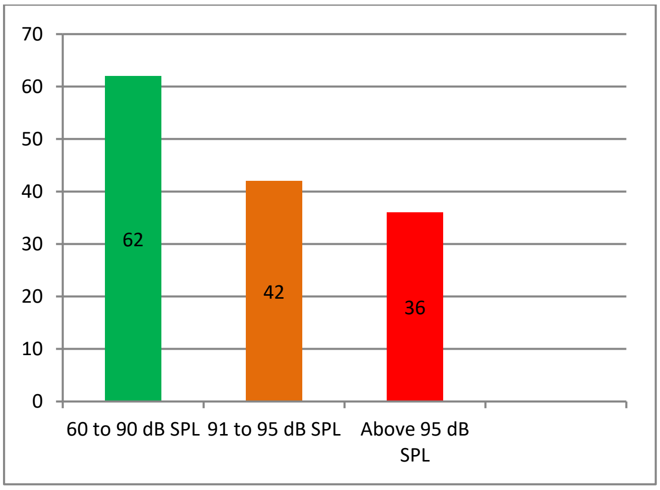
Figure 3: Number of young adults with respect to the level of exposure

NO OF PARTICI PANTS



LEVEL OF EXPOSURE

The assessment of participants listening level showed that, 44% of the participant population listened to music between the sound levels of 60-90 dB SPL, indicating the "safe" listening group. Whereas 30% of participants reported that they listened to music between 90-95 dBSPL, indicating the "risk" level of listening group. The remaining 26% of participants reported that they voluntarily listen to high level of music (more than 95 dBSPL) which indicated "high risk" to MIHL.

The current study basically intended to provide awareness on three domains 1) knowledge about the permissible exposure limit 2) perceived risk and understanding 3) self – modification over the listening level of exposure.

V. CONCLUSION

In conclusion, this current study developed a prototype device to create awareness on risk of hearing loss among young adults listening to loud music. This prototype device facilitated to understand the hearing damage that will be caused by prolonged exposure to loud music. The need for awareness on developing responsible listening behaviors in warranted among young adults. The device can be used as a tool to demonstrate and display at universities, schools, health exhibitions and other public events to sensitize the public on hearing conservation. Research on hearing health awareness and education is very essential to inspire change in young adolescent groups to create healthy listening habits.

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CONFLICT OF INTEREST

There is no conflict of interest among authors

VI. REFERENCES

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