

LISTENING HABITS OF YOUNG ADULTS DURING COVID-19 PANDEMIC: A SURVEY

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SEPTEMBER, 2021

CERTIFICATE

This is to certify that this dissertation entitled '**Listening habits of young adults during COVID-19 pandemic: A Survey**' is a bonafide work submitted in part fulfilment for degree of Master of Science (Audiology) of the student Registration Number: 19AUD001. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled '**Listening habits of young adults during COVID-19 pandemic: A Survey**' is the result of my own study under the guidance of a faculty at All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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Abstract

Background: People's lifestyles have been severely altered as a result of the Covid-19 pandemic and the methods taken to halt the virus's spread, including confinement orders. Most people to cope with boredom and divert themselves during these times brought on by the Covid-19 condition, employed in leisure activities such as listening to music and watching videos. Further, during the pandemic the global education system underwent a paradigm shift, favoring online learning. Therefore, the duration of usage of Personal Listening Devices (PLDs) has possibly further increased due to this Covid-19 pandemic. A looming risk of compromised hearing acuity comes with increased listening length for pleasure and work/studies.

Aim: The present study aimed to evaluate the effect of Covid-19 pandemic on the listening habits of young adults (duration, volume and listening purpose) using PLDs through a survey.

Method: A cross-sectional descriptive survey design was used to survey undergraduate and postgraduate students between ages of 18-25 years. A descriptive questionnaire was designed in a google form and was shared online through different social media platforms to obtain responses. A total of 116 responses were received from the participants which was then subjected to statistical analysis.

Results: The results showed a significant differences in the total and continuous listening duration after the pandemic in these group of individuals implying an increase in use of PLDs during pandemic. Further, a significant difference was also observed on listening for academic purpose for both duration of listening and the preferred volume of listening. Meanwhile, for recreational purpose the differences between before pandemic and during pandemic listening wasn't significant.

Conclusion: Most people used their PLDs mostly for recreational purposes prior to the Covid-19 pandemic, but due to online classes for students, they also used them for academic purposes during the pandemic. As a result, after the pandemic, the amount of time people spent using their PLD increased significantly. Following the pandemic, those who have been exposed to long listening periods are likely to observe an increase in their daily permissible noise dose. Although it is difficult to say how many people are at risk of hearing loss, the findings of this study suggest that a small subset of young adults is particularly vulnerable.

Keywords: PLDs, Covid-19, Listening Habits.

Chapter 1

Introduction

Easy access and the lower cost of smartphones have increased the use of mobiles remarkably. With built-in personal listening device (PLDs) facilities in smartphones, more people use PLDs than ever (Gupta et al., 2014). Innovations in technology have brought in newer options to improve listening experiences. The newer devices deliver exceptional sounds over a wide range of volume control and play for a much longer duration (Henry and Fooks, 2012). Therefore, paying attention to the volume and time for which people use their devices has become essential.

The World Health Organization (WHO) estimates in 2018 revealed that, "over a billion young people worldwide could be at risk of hearing loss due to unsafe listening practices. Among teenagers and young adults aged between 12 to 35 years in middle and high-income countries, nearly 50% of the population listens to unsafe sound levels through personal audio devices such as MP3 players and smartphones. Approximately 40% have exposure to potentially damaging sound levels in nightclubs, discotheques and bars" (WHO, 2018). Hence, health care experts have been perturbed about the potential effects of exposure to loud sounds in teenagers and young adults in recreational activities like listening through their PLDs, and hence, quite a few research studies have been conducted in this domain (De Santis et al., 2008; Imam and Alam Hannan, 2017; Kaplan-Neeman et al., 2017; Narahari et al., 2017).

The effects of PLD on hearing depends on many variables like duration of exposure, the intensity of the sound (Danhauer et al., 2009; Nagarajan and Narayanamoorthi, 2015), types of earphones (Fligor et al., 2006.), maximum output levels of the PLDs (Fligor and Cox, 2004), etc. The maximum levels of output of portable music players and their potential risk for causing issues to hearing sensitivity were investigated by Fligor & Cox (2004). They found that some music players could

produce outputs over 130 dB SPL and concluded that PLD use with supra-aural headphones should be limited to 60% of maximum volume for 60 minutes per day. The "60-60 Rule" is a popular term for this recommendation. The outputs of PLDs could exceed the safe levels and pose a public health hazard. The tendency to increase the device's loudness to a maximum in background noise or for a better listening experience leads to a further increase in volume levels (You et al., 2020).

Ansari et al. (2014) reported that 36.8% of the participants listened to music without stop, 49.6% of the students said they listened to 'somewhat loud' or 'very loud' music, and 44.3% of the respondents said they had previously had hearing difficulties. The findings of this study corroborated the report by WHO.

The condition has only worsened since Covid-19 pandemic. An unprecedented and unexpected Covid-19 pandemic has had its pervasive impact throughout the world. It has brought the world to a state of vigilance, halt, and lockdown for months. For more than a year, social distancing, working from home, and online classes are the new normal (Dorene et al., 2020). The duration of usage of PLDs has possibly further increased due to this Covid-19 pandemic. Throughout the year, restrictions were imposed on movement to stop the spread of infection. The schools and colleges are conducting online classes, which mandate the use of smartphones and computers throughout the day. A looming risk of compromised hearing acuity arises with increased listening duration for leisure and work/studies.

1.1 Need for the study

Major leisure activities for young individuals constitute listening to music or audio-visual modes of entertainment such as movies, web series, and social media. With the restrictions imposed due to the Covid-19 pandemic, many individuals resort to such

activities more often. This, in turn, has increased listening duration, especially among young adults. Further, for better performance and a popular trend, most individuals connect their headphones with their PLDs, indulging in longer duration listening and potentially damaging sound levels. Also, due to the restrictions, nearly all classes are done in a virtual mode. Individuals are using their PLDs continuously for a longer duration for academic purposes, which poses a risk for hearing loss in listeners who use high volume for a good listening experience and to attenuate the background noise.

Findings from multiple studies have shown PLDs' effect on hearing (Akilarooran et al., 2019; Danhauer et al., 2009; De Santis et al., 2008; Fligor et al., 2004; Jiang et al., 2016; Nagarajan and Narayanamoorthi, 2015; You et al., 2020). It is highly likely that individuals, particularly adolescents and young adults, could be at an increased risk of developing hearing problems in the future due to their unhealthy and incautious listening habits, more particularly during this time of lockdown and online classes. Most individuals that use PLDs are young adults. It has become an indispensable part of their daily life, and therefore it is safe to assume that they could have an increased listening time through their device. Basu et al. (2019) reported a need to develop information, education, and communication activities promoting safe listening behaviour, including listening to lower volumes for a shorter duration. Therefore, a need arises to observe and report any discernible changes in an individual's listening habits post Covid-19 pandemic. The survey approach is one of the most effective means of evaluating whether potentially unsafe listening behaviours exist and whether public outreach activities are needed to address them.

1.2 Aim of the study

Hence, the present study aimed to evaluate the effect of the Covid-19 pandemic on the listening habits of young adults (duration, volume, and listening purpose) using PLDs through a survey.

1.3 Objectives of the study

The objectives of the study are to-

- Compare the total and continuous listening duration_of PLDs in young adults before and during the Covid-19 pandemic
- Compare the duration of usage of PLDs in young adults before and during the Covid-19 pandemic
 - for academic purposes
 - for recreation purposes
- Report the average volume settings in different conditions

Chapter 2
Review of Literature

Occupational and leisure-time sound exposure are some variables contributing to the rising prevalence of noise-induced hearing loss (NIHL). Concerts, fireworks, and watching a movie are some sources of recreational noise (Petrescu, 2008). The personal listening device (PLD) is another form of potential leisure noise that has grown in popularity over the last 20 years (Henry and Foots, 2012).

Personal audio systems consist of a personal music player that can be used with various digital music players, including radios, cell phones, smartphones, cassettes, CDs, MP3 players, with headphones or earphones (Eldracher, 2010). The increasing availability and use of PLD for listening to music or watching videos are accompanied by their use at higher volumes and for a more extended period (Henry and Foots, 2012; Danhauer et al., 2009; DaSilva et al., 2018; Fligor and Cox, 2004). Thus, hearing damage can occur due to the continued exposure to loud sound levels (Kim et al., 2009; Levey et al., 2013; Neitzel & Fligor, 2019). However, the damage can be undetectable at times (Basu et al., 2019). Several occupational noise exposure programs, regulations, and standards have been developed, but no similar standards have been established for recreational noise, which is an emerging contributor to hearing loss (Clark, 1991).

This chapter discusses the studies related to the listening habits through PLDs (Duration, Preferred volume, and Purpose of listening), their maximum output levels, and the effects of these devices on hearing. Since the main aim of the current study is to assess the impact of the Covid-19 pandemic on listening habits, information related to listening habits during the Covid-19 pandemic is also given in this chapter.

2.1 Use of Personal Listening Devices

The listening habits of an individual can be described by the parameters such as the volume that an individual prefers to use, duration of listening, and the purpose of using PLD. More than 90% of young adults, according to many studies, use PLDs with the headphones provided by the manufacturer (Iii, 2008; Kim et al., 2009; Kumar et al., 2009) and the listeners tend to increase the level of volume in the noisy background (Hodgetts et al., 2007; Vogel et al., 2010).

Turning up or down the volume on a personal audio device is a personal choice determined by the audio/audio-visual quality of the file being played (Worthington et al., 2009). Background noise levels, characteristics of attenuation by the head/earphone characteristics in background noise, and the listener's preferred signal-to-noise ratio (SNR) are likely to influence the optimal levels at which a person wishes to set their PLD (preferred level of listening above background noise). The preferred SNR is affected to some degree by music-listening-related behavioural trends (Florentine, 1998). The above-mentioned factors that influence the effect of PLD on hearing are discussed in the following sections.

2.2 Factors related to PLDs that influence hearing sensitivity

There were ample studies done that had documented the influence of the PLDs and the factors related to PLDs. In this section, studies that have assessed the preferred volume settings and preferred duration of usage of PLDs for different purposes and their maximum output levels are discussed.

Singh and Manish (2017) surveyed the trends of personal music player use and listening habits among young adults in India. The results showed 53% use PLDs for

less than an hour, while 27% listened to music between one and two hours. Less than 20% of participants listen to music for more extended periods (>2 hours) a day. More than three-quarters of those polled (76%) listened to music in one or two sessions a day. In contrast, 16% increase the volume settings while at home, in noisy environments, or while travelling, and during leisure activity. The majority of study participants (71%) reported that the most extended music listening session lasted between 30 minutes and 2 hours. Many people (55%) said the shortest session lasted less than 30 minutes. Whereas Torre's (2008) and Hodgetts et al. (2007) reported that the most prolonged sessions lasted up to 4 hours.

Singh and Manish (2017) also reported that 21% of the participants were using PLDs at their full volume. More than half (55%) used the PLDs at a medium volume in noisy conditions, while 16% changed the volume controls regularly. Additionally, 70% of the participants reportedly raise the volume regularly. When a song or music of their choice was playing, 36% of participants increased the volume settings.

Fligor and Cox (2004) measured the sound levels produced by the headphones of commercially available portable compact disc players and provided safety suggestions to hearing healthcare practitioners were evaluated. Results revealed that a maximum allowed noise dose was acquired within 1 hour of listening with the volume set to 70% of the volume setting using supra-aural headphones, based on SPL computed through various listening devices and the noise dosage model established by NIOSH. Though the outputs differed across manufacturers, it was recommended to restrict headphone use to one hour or less each day using supra-threshold headphones at a volume of 60% of the maximum.

Jiang et al. (2016), in a systematic review, found that in the presence of high-level background noise (61–80 dBA), 27.4% of adolescents and students exceeded 100 percent daily noise dose, while 15.9% of those in the presence of low-level background noise (40–60 dBA) did not. However, in a calm situation, only 9.5% of people were at risk of surpassing the 100% noise dose. As a result, lowering the level of background noise appears to be an effective strategy to lower the preferred listening levels and, as a result, reducing the danger of exceeding the daily noise exposure limit when using a PLD (Kaplan-Neeman et al., 2017; Portnuff, 2016).

Azodo and Idama (2018) also recorded the overall output sound intensity values and reported the output levels ranged from 60.30 dBA to 108.30 dBA, with a mean value of 90.49 dBA. Over an indefinite period of exposure, only 14.8% of people were seen using their phones in the safe sound volume level (75 dBA). Similar results have also been reported by many other studies (Catalano & Levin, 1985; Williams, 2005; Singh & Sasidharan, 2016).

Likewise, in a 2018 study, Kim and Han calculated the SPLs of different music genres at volume steps delivered by recent smartphones. The first warning volume of the Galaxy S6 and the LG G2 had the lowest (84.1 dBA) and highest (92.4 dBA) levels of the six smartphones, respectively. The SPLs increased as the volume step was increased. At the maximum volume step, the iPhone 6 was the loudest (113.1 dBA). Dance-pop had the highest processing level (91.1 dBA) of all the music genres for all smartphones. The sound pressure level for all smartphones peaked at 2000 Hz inside the 20-20,000 Hz frequency range. The results revealed that the SPLs of the first volume step and the maximum volume step for various smartphone models and music genres were different. Furthermore, the risk volume steps suggested by the most recent

smartphones were loud enough to trigger NIHL if users listen to music at those levels regularly (Kim and Han, 2018).

Further, Henry and Foots (2012) reported that both headphones and ambient conditions significantly influenced the preferred listening level (PLL). Listeners had higher PLL with earbud headphones than with over-the-ear headphones on average. The average PLL was lower when the noise reduction circuit was used with over-the-ear headphones. PLL in the presence of street noise was on average higher than that of multi-talker babbling.

The summary of all the studies regarding the relation of listening habits and the maximum output levels of PLDs indicates that the PLD is capable of causing damage to hearing when used at high output levels and for a prolonged duration. However, most studies focused on evaluating the outputs from PLDs when listening to music mainly. PLDs are also used for other purposes like watching videos or games and now due to Covid-19 pandemic for studying too in online classes, thereby warranting further research.

2.3 Effects of Loud music through audiological tests

Hearing loss becomes more likely when sounds are heard louder and for more extended periods (Portnuff, 2016). There is a significant concern regarding the potential damage to the auditory structures and hearing while using PLDs to listen to loud music for extended periods (Breinbauer et al., 2012; Hodgetts et al., 2007).

LePage and Murray (1998) used TEOAE to determine the impact of personal listening stereo systems on hearing. Individuals who used personal stereo systems had slightly lower OAE amplitude than non-users. According to the findings, OAEs have a

clear tendency to decline with prolonged use of PLD headsets, with the scale of the decline being proportional to the amount of exposure. A decrease in otoacoustic strength predicts hearing loss in personal stereo users.

Similarly, Keppler et al. (2010) measured the performance levels of a commercially available MP3 player and the changes in hearing after one hour of listening using TEOAE and DPOAE. Significant differences in hearing levels and TEOAEs amplitudes were observed in the noise exposure population before and after noise exposure measurements. DPOAE amplitudes, on the other hand, did not show this pattern

Furthermore, Trzaskowski et al. (2014) investigated if listening to music on a PLD influenced auditory function using OAEs. While there were no apparent changes in OAE parameters or PTA thresholds after 30 minutes of listening to music at 85 dB, it was suggested that exposure to music at similar levels does not impair cochlear functioning in a way that can be detected by PTA, TEOAE, or DPOAE, but can cause subtle changes in the auditory system. More intense exposure could result in more detectable changes in these tests.

The hypothesis that prolonged exposure to PLDs at high volume leads to decreased high-frequency hearing sensitivity was tested by Kumar et al. (2017) by examining changes in hearing thresholds in PLD users using Extended High-Frequency audiometry. PLD users' hearing levels differed significantly at high frequencies between 3 and 6 kHz and extended high frequencies between 9 kHz and 16 kHz. Hearing levels in PLD users were found to be elevated and were directly proportional to the volume and length of use. Based on these results, it is reasonable to assume that

extended high frequencies can be used to detect Music Induced hearing loss (MIHL) in PLD users early.

Similarly, Hussain et al. (2018) studied the subjective and objective evaluation of young adults' hearing capacity and listening habits. Their results revealed that PLLs were substantially associated with hearing thresholds. According to the NIOSH guidelines, the majority of participants engaged in healthy listening conduct. Pure tone audiometry revealed increased hearing thresholds at 4000 and 6000 Hz in a significant high-risk subgroup of PLD users. This may be a sign of NIHL in its early stages. These results indicate that preventive steps might be necessary to avoid a rise in clinically significant NIHL in heavy PLD users in the future.

Therefore, it can be deduced that the effects PLDs have on hearing are subtle, and conventional audiometric tests like PTA cannot detect them. High-frequency audiometry can be a helpful tool in identifying these deficits earlier. However, more research is warranted for this test to be used clinically on noise exposure and to recognize the subtle hearing deficiencies. A common complaint of users who use their PLDs for a long duration and at high volume is tinnitus associated with changes in OAEs. However, similar to the maximum outputs and preferred listening habits, most studies have studied the effects only when listening to music. Further research is warranted to perform audiological tests for listening activities like watching video or games and even online classes that are the everyday norm during this pandemic for students.

2.4 Non-auditory Effects of Loud music through PLDs

Apart from auditory effects, studies have reported some non-auditory effects of prolonged listening through PLD. Gupta et al. (2014) conducted a cross-sectional study

of college students' subjective effects of using PLDs. Headaches (58%), inability to focus (48%), and ringing in the ears were all recorded as side effects of loud noise (41.8%). Only 2.7% of respondents wore ear protection while listening to music at a high volume though 83.8% of respondents were aware that excessive noise is detrimental to their ears.

Basner et al., (2014) reviewed the significance of effective noise avoidance and reduction techniques. According to their findings, excessive noise exposure causes annoyance, disrupts sleep and causes daytime sleepiness, affects patient outcomes and staff performance in hospitals, increases the occurrence of hypertension and cardiovascular disease, and impairs cognitive performance in schoolchildren.

Stošić et al. (2020) examined the subjective sensitivity to noise on their non-auditory health impacts. Noise sensitivity plays a key role in creating non-auditory health impacts in adults, such as night-sleep duration, and daily rest disturbance. Further, subjective noise sensitivity was strongly linked to the negative effects of noise, such as behavioural changes, cardiovascular disease, psychological symptoms, and so on.

2.5 Listening Habits and Covid-19 pandemic

The Covid-19 pandemic and the methods used to slow the virus's spread, particularly confinement orders, have drastically altered people's lifestyles. While confinement has been shown to help spread the disease, it has also been related to a negative impact on people's mental health (Liu, 2020; Wang et al., 2020; Xiang et al., 2020; Yang et al., 2020). Adherence to social distance rules is linked to fewer behavioural possibilities, which can lead to boredom, making adherence more difficult (Bieleke et al., 2020). One of the most remarkable characteristics of music and other

audio-visual modes of recreation, like movies, web series, documentaries, etc., can be highlighted as a valuable resource for mood control (Zatorrea and Salimpoor, 2013). Music and watching videos help people cope with not only boredom but also bad emotions like stress and anxiety brought on by the Covid-19 problem (Ferreri et al., 2021). Thus, most people employ leisure activities to divert themselves during these times to avoid the majority of these side effects (Cabedo-Mas et al., 2021; Vidas et al., 2021).

Further, people can effortlessly listen to music or watch different videos from their PLDs due to the broad availability of streaming services. Therefore, individuals reported an overall rise in the frequency of listening to music or watching videos, during the pandemic, according to the findings (Bieleke et al., 2020; Boylan et al., 2021; Cabedo-Mas et al., 2021; Ferreri et al., 2021; Hurwitz and Krumhansl, 2021; Vidas et al., 2021).

Due to the Covid-19 pandemic, the educational system has faced serious impacts on parts of everyday learning and daily living. During the pandemic, the world witnessed a paradigm shift in the education system, favouring online learning (Shetty et al., 2020). With the Covid-19 pandemic, regular classroom classes closed in all educational establishments for the most part of the last academic year to adhere to the guidelines of social distancing.

Large-scale online classes in many academic setups were launched to continue with the academic programme (Akhter, 2021; Shetty et al., 2020; Sindiani et al., 2020; Tuladhar et al., 2020). Since online classes warrant the use of PLDs for the whole day, individuals could use their PLDs for this for a longer period. As a result, the frequency of PLD might be expected to increase after the pandemic compared to before the

pandemic. In fact, long online classes creating eye difficulties due to prolonged screen time and social media distraction have been documented by several studies (Shetty et al., 2020; Tuladhar et al., 2020; Verma et al., 2020). Since online classes require the use of PLDs and listening to them for a continuous-time, a change in listening habits can be attributed to this shift in the paradigm of classes. When studies have documented the impact online classes had on vision and attention, not many studies have been done to compare the changes in listening habits due to the Covid-19 pandemic.

2.6 Conclusion

There are ample studies that have discussed the listening habits of individuals through PLDs. The maximum output levels, the subsequent SPLs at different volumes and the effects of prolonged listening at those volumes have been extensively studied in lab settings and real-life settings. From the review, it is clear that if PLD is used for a prolonged duration and at high volumes, these devices can cause hearing issues. However, the hearing issues are subtler deficits and cannot be detected from conventional tests like PTA. PLL through PLDs seems to be highly variable and dependent on factors like background noise, content, and the type of outputs.

A common feature among all these studies was that most of these studies discussed the effect loud music can have on hearing and primarily focused on evaluating the impact of music. PLDs can be used to listen for other purposes like watching videos or playing games. There can be a prolonged exposure during these activities too. Very little researches have been done that studied the effects of these listening habits.

Further, due to the Covid-19 pandemic, online classes have been the new norm for students. Additionally, with more leisure time, people are listening for a prolonged duration through their PLDs. There could be an increase in the daily permissible noise

dose in individuals during pandemic with such exposure. Therefore, a need to observe and compare young individuals' before and during pandemic listening habits across different devices and other purposes is warranted.

Chapter 3

Methods

A descriptive questionnaire was designed to survey a group of individuals from 18 to 25 years of age. The research design used was a cross-sectional descriptive survey design. The method included two phases. The first phase consisted of the development of the questionnaire and the second phase included the administration of the questionnaire. The steps involved under these different phases are given in Table 3.1.

Table 3.1: Development of the questionnaire

Phase 1 Development of the questionnaire	Phase 2 Administration of the questionnaire
Step 1: Outlining the framework of the questionnaire	Step 1: Sample selection with the inclusion and exclusion criteria
Step 2: Framing questions under each domain	Step 2: Administration of the questionnaire
Step 3: Validation of the questionnaire	Step 3: Analysis
Step4: Preparation of the final questionnaire	

3.1 Phase 1: Development of the questionnaire

The main objective of this phase was to prepare the questionnaire to carry out the survey. It was carried out in the following steps:

3.1.1. Step 1: Outlining the framework

For identifying changes in listening habits of individuals during the Covid-19 pandemic, a framework of the questionnaire was designed to measure different domains that comprised relevant questions under each of them. Personal Listening Device and Hearing Questionnaire (PLDHQ), an 83 item comprehensive

questionnaire developed by Danhauer et al., (2009), was used as a reference to develop the questionnaire. The domains included were:

- i) Demographics and General Information
- ii) Before pandemic and Post –pandemic listening habits and preferences

3.1.2. Step 2: Framing questions under each domain

In this step, questions were framed under each domain based on the objectives of the study.

- ***Demographics and General information:***

This domain consisted of demographic information such as age, gender and the educational status. General information such as any history of hearing difficulty in order to rule out individuals with hearing issues from the analysis was also included. Further, questions regarding an individual's use of PLDs and the type of device the individual used for listening was also included in this section. Questions such as what devices they were using to listen and what outputs they used to connect to those devices was included. This was done in order to obtain responses about the general patterns of listening habits before the pandemic.

- ***Before and During Pandemic listening habits and preferences:***

This section incorporated the main aim and objective of the study. The questions were divided into three major categories, the purpose of listening through PLDs, duration of listening across different devices for academic and recreational purposes respectively, and the preferred volume across different devices. The responses were obtained for different devices across different listening purposes. Further, to compare the changes in the listening habits before and during Pandemic, each question in all the major sections had the option of selecting before and during pandemic. In the end, the question to obtain the total and continuous listening duration before and during the

pandemic was incorporated into this section to compare the changes in the listening habits during the Covid-19 pandemic.

3.1.3. Step 3: Validation

The questionnaire prepared was given to experts (five audiologists) for content validation. The experts were given a printed handout comprised of the aims and objectives of the current study, the draft questionnaire and the instruction on the task they had to perform. A table with a Likert scale to indicate the response accompanied each question was also included. The response categories in the Likert scale were as follows: 1: strongly agree, 2: agree, 3: neither agree nor disagree, 4: disagree, 5: strongly disagree. Based on the scale, the expert had to rate the questions on a scale of 1-5 in terms of it's:

- a) Relevance
- b) Comprehensibility
- c) Clarity

Furthermore, a comment section was given under each question wherein the experts could add their comments and feedback related to the questionnaire. The experts reviewed the questions who suggested and commented on whether the questions matched the study's objectives. A question was selected if the experts marked the score from 1-3 for each question on a scale of 1-5, and the questions with an average rating of 4 or 5 were omitted. Based on the suggestions given by all the experts, the domains and the questions were modified. In total, 40 questions were framed at the end of this process, as shown in Table 3.2. The questionnaire is given in Appendix.

Table 3.2: Domains and No. of questions

S.No	Domains	No.of questions
1.	Demographic and General Information	21
2.	Before pandemic and during pandemic listening habits and preferences	19
	Total	40

3.1.4. Step 4: Preparation of final questionnaire

Based on the feedback from the experts, the questionnaire was amended and edited, and a final version of the questionnaire was prepared. Therefore, the questions were primarily qualitative and didn't have any correct or incorrect answers, and were used to gather exhaustive information under each domain.

3.2 Phase 2: Administration of the questionnaire

This phase involved the administration of the questionnaire on a group of participants and collecting the data. Following are the steps involved in Phase II:

3.2.1. Sample selection

The targeted population for the survey was 116 young adults from the age group of 18 to 25 years (Mean age = 21.9; SD = 2.1). Following inclusion and exclusion criteria were used to enroll the participants:

Inclusion and Exclusion criteria:

- Individuals in the age range between 18 and 25 years were included in the study.

- All the participants had English as their medium of instructions.
- Undergraduate and postgraduate college students who took online classes during the Covid-19 pandemic were included.
- Individuals who reported a history of ear and hearing-related problems before using PLDs were excluded.

The sample from the population was acquired using convenience sampling. The researcher briefly provided information regarding the aims and objectives of the survey and asked the participant if they were interested in filling the survey. Based on the interest and the response of the participant, the questionnaire was shared. A total of 116 responses were received from the google form distributed through different online platforms. Four individuals who responded to not attending online classes were excluded from the analysis. Two Individuals who reported a history of ear and hearing-related problems before using PLDs were excluded from the data analysis. Out of the 116 participants, 81.8% were undergraduate students, and 18.2% were postgraduate students. The percentage of male and female participants were 44.5% and 55.5%, respectively.

3.2.2. Administration of the questionnaire

The questionnaire was distributed through google forms using online platforms. The google form consisted of precise instructions in each domain on what information is expected to be achieved. To obtain responses from all the questions, the questions in the forms were marked 'required to fill.' Before starting each section, a clear and elaborative description of how to select responses in the respective section was given, which could help in relevant responses for each question.

3.2.3. Statistical Analysis

The percentages of all the responses were cumulated. The data obtained were subjected to statistical analyses using IBM Statistical package social sciences (SPSS) version 25.0 (SPSS Inc., Chicago). The results of the study were analysed descriptively as well as using inferential statistics. The normality of the data was checked using the Shapiro Wilk test. Because the data were not normally distributed, Wilcoxon signed-rank test was done to compare the listening habits of individuals before and during pandemic.

Chapter 4

Results

The study's objectives were to compare the duration of PLD use before and after the Covid-19 pandemic for academic and recreational purposes, and to observe the average volume settings for these listening purposes and the results are listed in the following sub-sections:

4.1 Analysis of Total Listening Duration using PLD

4.2 Duration of PLD usage for academic purpose

4.3 Duration of PLD usage for recreational purposes

4.4 Average volume settings for different listening purposes

4.1 Analysis of Total Listening Duration using PLD

In this section, the number of hours each individual used his or her PLDs, along with the total number of days an individual used their PLDs in a week, was obtained. The mean days of use of PLDs before the pandemic were 4.64 days, while during pandemic, it was 5.98, showing an increase in the use of PLDs during pandemic. With reference to the number of hours of usage per day, the participants had to choose one of seven categories of duration shown in Figure 4.1. For example, if the individual was using the PLD for around 3 hours a day, then they had to choose the '2-4' hours category. The percentage of individuals using PLDs under different categories of overall duration in a day is shown in Figure 4.1.

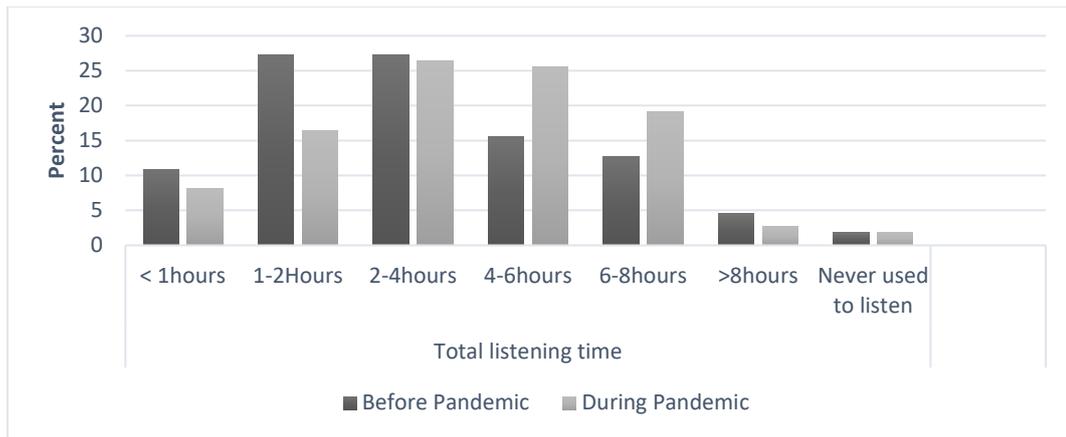


Figure 4.1: Comparison of total listening time between before pandemic and during pandemic

Most individuals' total listening time was 2-4 hours before pandemic, and a marginally lesser percentage of individuals have used PLD for 2-4 hours during pandemic as more individuals have used their devices for 4-6 hours and 6-8 hours. That is, only 15.5% of individuals were using their device for a total time of 4-6 hours before pandemic, and the number increased to 25.5% during pandemic. Similarly, 12.7% of individuals used their device for 6-8 hours before pandemic and 19.1% used for 6-8 hours during pandemic. The Wilcoxon signed-rank test was done to see if there was a significant difference between pre and during pandemic listening times. The results showed a significant difference ($Z = -2.394, p < 0.017$) between the total duration of PLD usage between before and during pandemic situations.

Owing to the fact that individuals had more leisure time during the pandemic and with online classes, the assumption was that during the pandemic, individuals could use their devices continuously with little breaks. The effect of continuous periods of listening without breaks on hearing is well known. Thus, with reference to this, the participant had to choose one of the five different duration categories. The percentage

of individuals using PLDs under different categories of duration continuously without any break in a day is shown in Figure 4.2.

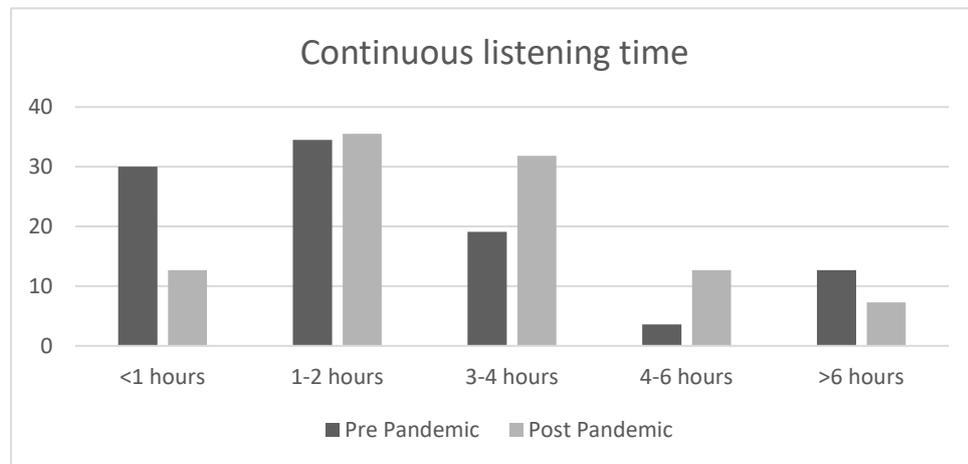


Figure 4.2: Comparison of Continuous listening time of PLDs between before pandemic and during the pandemic.

Figure 4.2 illustrates the comparison of the continuous listening time between before and during pandemic situations. Compared to before pandemic listening time, there is an evident increase in the continuous listening time. When only 19.1% of individuals had a continuous listening time of 3-4 hours before pandemic, 31.8% had a continuous listening time of 3-4 hours during the pandemic. Similarly, when only 3.6% of individuals had a continuous listening time of 4-6 hours, the responses increased to 12.7% during pandemic. Most individuals had a continuous listening period of 34.5% before pandemic that rose slightly to 35.5% during pandemic. The Wilcoxon signed-rank test showed a significant difference ($Z = -2.067, p < 0.036$) between before and during pandemic continuous listening durations.

4.2 Purposes of PLD usage between before and during pandemic

The question "What purpose did you use your headphones/earphones for listening" was framed to assess the purpose of listening to the PLDs. The individuals

had to choose from the options of watching videos, listening to music, and academic purposes. If an individual was using their PLDs for listening to music only before the pandemic, they were expected to select the option ‘before pandemic’, and if they were using it for music only after the pandemic, they were expected to select the option ‘during pandemic’. If listeners were using the PLDs both before and after the pandemic for listening to music or other purposes, both the options of before and during pandemic had to be selected.. The purpose/s for which PLDs were used are given in Table 4.1.

Table 4.1: Purpose of listening to PLDs used before and during pandemic situation

Listening purpose	Before pandemic	During pandemic	Before and after
Watching videos	21.8%	15.5%	62.7%
Listening to music	26.4%	11.8%	61.8%
Academic purpose	5.2%	72.8%	22%

From the table, it is clear that most individuals (72.8%) used the PLDs after the pandemic for academic purpose. The proportion of individuals using the PLDs for academic purpose was substantially lesser before pandemic. There were also a few respondents (22%) who used their devices both before and during pandemic. This could likely be attributed to attending online educational materials and resources before the pandemic.

Similarly, for the recreational purpose of listening, 62.7% of individuals used their PLDs both before and during pandemic. Likewise, 21.8% of individuals used PLDs for recreational purpose before the pandemic only, and the remaining 15.5% used their PLDs after the pandemic only. Unlike academic purposes, use of the device for recreational purpose were similar before and after the pandemic.

4.2.1 Comparison of duration of PLD usage between before and during pandemic for academic purpose

From the Table 4.1, it is evident that, due to online classes, the frequency of using PLDs for academic purposes increased during pandemic. The duration of use of mobile and laptop before and after the pandemic for academic purposes is shown in Table 4.2.

Table 4.2: Duration of usage of mobile and laptop for academic purpose before and during pandemic

	Duration in hours	Before pandemic (%)	During pandemic (%)
Mobile use duration for academic purpose	Less than 1	45.5	10
	1-2	11.8	13.6
	3-4	0.9	28.2
	more than 4	2.7	45.5
	didn't use	39.1	2.7
Laptop use duration for academic purpose	Less than 1	31.89	5.5
	1-2	11.8	9.1
	3-4	1.81	27.3
	>4	0.9	50.9
	Didn't use	53.6	7.3

As shown in Table 4.2, most individuals used their PLDs for a relatively longer duration of greater than four hours during pandemic for academic purposes. The individuals who were not using their devices for academic purposes were significantly greater before the pandemic, with 39.1% and 53.6% responses for mobile and laptop, respectively. Whereas, only 10% (2.7% for mobile and 7.3% for laptop) of individuals did not use PLDs for academic purposes. The Wilcoxon signed-rank test showed a significant difference in the listening duration between before and during pandemic

for academic purpose using mobile ($Z = -2.232, p < 0.026$), and laptop ($Z = -1.281, p < 0.02$).

4.2.2 Comparison of duration of PLD usage between before and during pandemic for recreational purposes

The duration of use of PLDs before and after the pandemic for recreational purposes is shown in Table 4.3 in terms of the percentage of responses. It can be seen from the Table 4.3 that more percentage of individuals used PLDs for recreational purpose for a prolonged duration (40.9% used for 1-2 hours and 36.4% used for 3-4 hours) during pandemic than before pandemic.

Table 4.3: Duration of usage of mobile and laptop for recreational purpose before and during pandemic

	Duration in hours	Before pandemic (%)	During pandemic (%)
Mobile use duration for recreation purpose	Less than 1	11.8	13.6
	1-2	40.9	22.7
	3-4	21.8	36.4
	more than 4	24.5	27.3
	didn't use	0.9	0
Laptop use duration for recreation purpose	Less than 1	13.6	15.5
	1-2	40.9	30.0
	3-4	19.1	29.1
	>4	18.2	17.3
	Didn't use	8.2	8.2

In addition, there was a slight increase in the duration of use of the PLDs for more than 4 hours from 24.5% to 27.3% during pandemic. The Wilcoxon signed-rank test showed no significant difference ($Z = -1.688, p > 0.091$) and ($Z = -0.714, p > 0.475$),

for the duration of use of mobile and laptops for before and during pandemic for recreational purpose.

4.3 Comparison of preferred volume across devices and different listening activities before and during pandemic

In this section, a comparison of the preferred listening levels (PLL) was done before and after the pandemic for different listening purposes. The respondents were instructed to select from five options of different preferred volumes for before and during pandemic situation. This was done separately for different listening purpose.

4.3.1 Comparison of preferred volume for recreational purposes before and during pandemic

The preferred volume of PLDs before and after the pandemic for recreational purposes is shown in Table 4.4 in the percentage of responses. For the recreational purpose of listening, the most preferred volume range was 20%-30% in mobile and 30-40% in laptops before pandemic. However, most individuals responded with the preferred volume set at 50%-60% in mobile and 40-60% in laptops during pandemic.

Table 4.4: Preferred volume for recreational purpose in mobile and laptop before and during pandemic

	Volume	Before pandemic (%)	During pandemic (%)
Mobile volume for recreation purpose	<20%	4.5	6.4
	20%-50%	46.4	41.8
	50%-60%	33.6	44.5
	>60%	13.6	6.4
	Didn't use	1.8	.9

Laptop use	<20	5.5	8.2
duration for	20-30	23.6	20.0
recreation purpose	30-40	24.5	27.3
	40-60	22.7	29.1
	> 60	15.5	9.1
	Didn't use	8.2	6.4

Compared to before pandemic volumes, more individuals listened to higher volumes in their mobile and laptops during pandemic showing a change in the listening habit after the pandemic. The Wilcoxon signed-rank test showed no significant difference between before and post- pandemic music listening habits for listening to music or watching videos using laptops ($Z = -1.421, p > 0.155$) and mobile ($Z = -1.908, p > 0.056$).

4.3.2 Listening for academic purposes before and during pandemic

The preferred volume of PLDs before and after the pandemic for academic purposes is shown in Table 4.5 in the percentage of responses. Similar to recreational purposes, the preferred volume was higher during pandemic compared to before pandemic for both mobile and laptop.

Table 4.5: Preferred volume for listening for academic purpose in mobile and laptop pre and during pandemic

	Volume	Before pandemic (%)	During pandemic (%)
Mobile volume for	<20%	5.5	12.7
academic purpose	20%-50%	39.1	40.9
	50%-60%	30.9	35.5
	>60%	16.4	8.2
	Didn't use	8.2	2.7

Laptop use duration for academic purpose	Less than 20	6.4	8.2
	20-30	17.3	20.0
	30-40	19.1	20.9
	40-60	17.3	30.0
	> 60	14.5	9.1
	Didn't use	24.5	9.1

The Wilcoxon signed-rank test showed a significant difference between pre and post-listening habits for mobile ($Z = -2.647, p < 0.008$) and laptop ($Z = -4.014, p < 0.001$) respectively for academic purposes.

Chapter 5

Discussion

The present study aimed to observe the effect of a Covid-19 pandemic on the listening habits of young adults. The preferred volume and the duration of listening across different devices were compared pre and during pandemic situations for different listening purposes.

5.1 Comparison of total and continuous listening duration between before and during pandemic.

The study's finding showed a significant increase in the total and continuous listening duration between pre and during pandemic. Most countries enforced a lockdown that confined individuals to their homes, adopted social distancing measures, and closed most workspaces except those critical and emergency services to combat the spread of the Covid-19 epidemic. The new normal are lockdowns, social distancing, working from home, and online classes for students (Dorene et al., 2020).

Throughout the year, movement restrictions were imposed to avoid the spread of infection. While confinement was demonstrated to aid in the spread of the disease, it was also linked to a bad influence on people's mental health (Liu, 2020; Wang et al., 2020; Xiang et al., 2020; Yang et al., 2020). Boredom, annoyance, and confusion were among the impacts studied in those who were confined (Brooks et al., 2020). Adherence to social distancing standards is associated with fewer behavioural options, which leads to boredom (in boredom-prone individuals), which could make adherence more challenging (Bieleke et al., 2020).

Most individuals used recreational activities to distract themselves during these times to evade most of the above effects (Cabedo-Mas et al., 2021; Vidas et al., 2021). Listening to music, as well as audio-visual forms of entertainment such as movies, web series, and social media, are popular among young people's recreational activities. Due to the Covid-19 outbreak and subsequent restrictions, many people opted for these

activities more frequently. In addition, the individuals in the present study were using more than one device and for more than one purpose. When most individuals were using their devices mostly for recreational purposes before the pandemic, during, and after the pandemic, they used it for academic purposes and due to students' online classes (Akhter, 2021; Sindiani et al., 2020). Thus, the total time an individual was using their PLD increased during the pandemic. The majority of individuals were using their PLDs for a total duration of 2-4 hours before pandemic. However, during pandemic most individuals were using it for an increased duration of 4-6 hours. Additionally, the duration of most online classes was for 2 to 4 hours or more. There were 12.7% of individuals attending online classes for more than 6 hours.

One of the most important factors influencing overall SPLs and Recommended Exposure Limit (REL) is the length of noise exposure. Because of the Covid-19 pandemic, the duration of use of PLD grew even further, which the findings of the present study corroborate. Exposures from individual activities on a particular day are summed together to calculate a total noise dosage, a cumulative measure. Usually, there are very few breaks between classes. Thus, the continuous listening period is higher for this listening purpose, evident from the significant difference observed in the present study. Not all individuals might surpass the 100% dose, but the risk is higher for those using their PLDs for multiple purposes and individuals using it for greater than 6 hours (Oms, 2015; Punch et al., 2011). Further, those individuals who listened for more than 3 hours through their PLDs were more likely to have tinnitus and have more subjective hearing issues, too (Jiang et al., 2016; Twardella et al., 2017; Widen et al., 2017). Further, adding listening times for other purposes further increases the total duration beyond the REL, increasing the possibility of hearing damage in the future.

5.2 Comparison of total and continuous listening duration between before and during pandemic for academic purpose

A significant difference was found between before and during pandemic listening duration for academic purposes, indicating greater use of PLDs during pandemic for academic purposes. Covid-19 pandemic had an impact on education around the globe, causing lectures, practical classes, clinical placements, and exams to be either delayed or cancelled. Online classes in many academic streams were carried out (Tuladhar et al., 2020). Schools and colleges are offering online classes and hence, students had to use their smartphones and computers throughout the day (Akhter, 2021; Shetty et al., 2020; Sindiani et al., 2020; Tuladhar et al., 2020). Individuals used their PLDs continuously for a longer duration for academic purposes. Therefore, the frequency of use of PLDs during pandemic increased compared to before pandemic, which was evident from the study's findings.

As the duration of usage of PLDs increases, the noise dose also increases. Thus, the longer the duration, the chances are higher for reaching or exceeding 100% dose. This could pose a risk for hearing loss in individuals in the present study who use their devices for an extended period and fail to attenuate the background noise (De Santis et al., 2008; Gilliver et al., 2017; Jiang et al., 2016; Reddy and Thenmozhi, 2018; Widen et al., 2017). Further, since individuals were using one or two devices for listening, the total listening duration might even be greater than that reported in the findings. Further, OAEs showed a clear tendency to decline with prolonged use of PLD headsets, with the scale of the decline being proportional to the amount of exposure (LePage and Murray, 1998b). Likewise, Keppler et al. (2010a) observed significant differences in hearing levels and TEOAEs amplitudes between before and after noise exposure measurements of one hour in the noise exposure population. Marron et al. (2014)

reported that PLD users who listened less than 8 hours a week with intensities of less than 80 dBA were found to have better hearing. The hearing levels in high-frequency audiometry is found to be elevated, and that was directly proportional to the volume and length of use (Kumar et al., 2017; Kumar & Deepashree, 2016; Philip et al., 2017; Silvestre et al., 2016).

5.3 Comparison of total and continuous listening duration between before and during pandemic for recreational purposes

Though for recreational purposes, no significant difference was observed between before and during pandemic listening durations for recreational purposes, most individuals used PLDs for more than 3-4 hours whereas most people used their PLDs for 1-2 hours before pandemic. Major recreational activities for young adults involve listening to music or watching different videos. As mentioned in the above sections, due to Covid-19, individuals had more time to listen to their PLDs when compared to before pandemic times. Further, these activities were used by individuals as coping strategies from the psychological impacts of the Covid-19 pandemic (Cabedo-Mas et al., 2021; Cuiyan et al., 2020; Vidas et al., 2021). Due to the Covid-19 outbreak and subsequent restrictions, many people opted for these activities more frequently.

In the present study, it is clear that individuals use their devices for a much longer duration than that for only a single purpose. When the durations of other listening purposes are added, the safe listening limits could easily be exceeded, which will risk their hearing (Kaplan-Neeman et al., 2017; Worthington et al., 2009).

5.4 Preferred volume across devices and different listening activities before and post- Pandemic

Most individuals (46.4%) used their devices at a volume of 20%-50% for recreational purposes; there were a substantial number of them using it for a volume of 50%-60% and greater than 60%. For academic purposes, most individuals (35.5%) used it for a volume of 50%-60%. Fligor & Cox (2004) reported that some music players could produce outputs over 130 dB SPL and concluded that PLD use with supra-aural headphones should be limited to 60 percent of maximum volume for 60 minutes per day. In addition, as the amount of background noise grows, participants prefer greater ear canal levels for all headphone designs. When evaluating exposure from PLD use, the actual exposure assessed overtime must be taken into account. When a device's output levels surpass the recommended exposure limit (REL) for a given damage-risk criterion (DRC), users may be concerned that they are putting themselves at risk of hearing loss.

Thus, in the context of REL and DRC, with an increased duration of hearing and noise adding up cumulatively, individuals listening to volumes greater than 60% (6.4% and 8.2% individuals respectively for recreational and academic purposes) could be at potential risk for MIHL. When listening to music with a background noise level of more than 65 dB and the use of earbuds, a large number of young individuals using PLDs are already at danger of noise-induced hearing damage (Danhauer et al., 2009; Fligor et al., 2006; Jiang et al., 2016; Portnuff, 2016b). When used for long periods, the current generation of digital PLDs can create output levels that could raise the risk of MIHL. Current devices yield maximum levels ranging from 97 to 107 dBA, with average levels of 101.5 dBA for earbud-style earphones and 97 dBA for supra-aural-style earphones (Fligor et al., 2011). Kim and Han (2018) compared different smartphone models, and

the SPLs of the first volume step and the maximum volume step for different music genres found that the risk volume steps suggested by the most recent smartphone models were high enough to trigger NIHL if users listen to music at those levels on a regular basis. Vogel et al. (2010) found that occupational noise sensitivity was surpassed by about half of the adolescents. Just listening to MP3 players caused about a third of the respondents to violate safety requirements. Exposure to high-volume music was linked to hearing symptoms after using an MP3 player or visiting a discotheque. Given the high possible output levels described for digital PLDs, some of these young individuals are expected to be exposed to more than 100 percent noise exposure.

The newer generation of smartphones gives warning notification whenever a certain volume range is crossed. This makes it easy to monitor listening levels in these devices. Unless individuals use their devices purposely above these levels, they would be listening to safe listening levels. However, such a warning signal is not present in laptops or PCs. Without any monitor or warning similar to smartphones, an individual could surpass the safe listening levels in these devices without even being aware of it. Since individuals used laptops mostly for online classes, and with continuous listening in this device without a monitor, they could be exceeding the REL and not even be aware of it.

.The findings of the present study shows that a small but significant number of PLD users, 8.2% (for academic purposes) and 6.4% (for recreational purposes), are at risk of NIHL as a result of their daily listening habits following the pandemic, which included listening at greater than 60% volumes and for a duration of greater than 6 hours. Overall, the findings of the study corroborate with the existing research that not all individuals could be at risk of reaching 100% noise dose but some are particularly

vulnerable(Ansari et al., 2014; Kim and Han, 2018; Portnuff, 2016; Warner-Czyz and Cain, 2016).

Chapter 6

Summary and Conclusion

Listening to music, as well as audiovisual forms of entertainment such as movies, web series, and social media, are popular among young individual's leisure activities. Due to the restrictions established because of the Covid-19 outbreak, many people are turning to such activities more frequently (Cabedo-Mas et al., 2021; Hurwitz and Krumhansl, 2021; Vidas et al., 2021). Further, due to the constraints, practically all classes are taught in a mode. Individuals are also using their PLDs for academic purposes for extended periods (Akhter, 2021; Shetty et al., 2020; Sindiani et al., 2020). Thus, the need was identified to discern the changes in the listening habits of young individuals during the pandemic.

Hence, a survey was carried out among undergraduate and post-graduate students in the age range of 18 to 25 years. A questionnaire was designed for the survey which included two main sections: i) Demographic and General Information that consisted of 21 questions and, ii) Pre pandemic and Post Pandemic listening habits and preferences.

In this study, a comparison was done between the total and continuous listening duration before and during pandemic. Further, before and during pandemic listening duration was compared for recreational and academic purposes. In addition, the preferred volume across these devices was also compared before and after the pandemic. Wilcoxon signed rank test was done to compare between the aforementioned parameters. The results showed significant differences in the total and continuous listening duration between before and during pandemic. Similar result was obtained for the duration of listening for academic purpose as well as for preferred volume. For recreational purpose there was a difference observed before and after the pandemic but it wasn't significant.

.From the findings of the present study it was evident that prior to the pandemic, most people used their PLDs mostly for recreational purposes; but, due to online classes for students, they also used them for academic purposes during and after the pandemic. In fact, individuals are using their PLDs continuously for a longer duration for academic purposes. As a result, the amount of time people spent using their PLD soared after the pandemic, particularly among young individuals evident from the findings of the study. Those exposed to such prolonged listening durations are likely to see an increase in their daily permitted noise dose following the pandemic.

To conclude, Covid-19 pandemic has altered the lifestyles of everyone globally. This has had its pervasive impact on the listening habits of young adults too as evident from the findings of the present study. The findings of the present study suggests that a small but considerable proportion of young PLD users are at risk of NIHL as a result of their daily listening habits during the pandemic.

Implications

- The comforts and conveniences provided by PLDs may be offset in some cases by few individuals. This implies particularly for teens and young adults in the present study who are unaware of or unwilling to recognize potential risks and who disregard them safe practice guidelines especially during this time of lockdown and online classes.
- Although it is difficult to say how many people are at risk for hearing loss due to PLD usage, the findings of this study implies that a small group of young adults may be particularly vulnerable.
- Since MIHL or hearing issues due to PLD use can be prevented with awareness and knowledge on safe listening habits, young adults need to be well versed

about the potential effects of exposure to noise in listening activities like listening through their PLDs.

Future directions

This study has highlighted the change in listening habits of young adults after the covid-19 pandemic for academic and recreational purposes. The following future directions can be suggested based on the findings of the present study.

- Various audiological tests like OAEs (TEOAE, DPOAE, and DPOAE fine structure) and high-frequency audiometry can be done in this group of individuals in order to observe the changes in the auditory system due to these listening habits, particularly in those who were listening at loud volumes and prolonged duration in this study.
- Study comparing these individuals' attitudes and awareness to safe listening habits can be done and correlated with the findings of the present study.
- Likewise, since smartphones are an integral part of the daily lives of all individuals, a study that compares the listening habits of these individuals and their addiction to smartphones or any gadgets can be compared in future studies.

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Appendix:

Listening habits of young adults during pandemic: A survey

Personal listening devices (PLDs) are portable devices designed to be worn on the body or in a pocket for listening purposes. Examples are headphones and earphones.

This survey aims to observe the listening habits of young adults before and after the Covid-19 pandemic. It takes nearly 10 minutes to be filled.

The questions in this survey has 3 primary domains that has further sub domains in each of them.

The questions are directed to get relevant details regarding the listening habits of an individual.

The results obtained will be used to compare the duration of usage of **Personal Listening Devices (PLDs)** in young adults before and during the Covid-19 pandemic for academic purpose and recreation.

If you are a student aged 25 or less please proceed to fill the survey.

I. Demographic information and General Information regarding Hearing and listening habits

A. Demographic info:

1. Name:
2. Email Id:
3. Age.....
4. Gender Male Female other
5. Are you a student? Yes No
 - a) If yes, mention whether you are pursuing
 Under-graduate post-graduate
 - b) Mention the course and in which year you're studying currently.....

B. General Information regarding listening habits and preferences before pandemic

1. How long has it been since you started using Personal Listening devices (PLDs)?
 >10 years 5-10 years 2-5 years 1-2 year less than a year
2. Which device do you use currently? (Mention model using currently)
 Mobile
- Laptop/Desktop.....
- Tablets/I-pad.....
3. Which of the audio output do you prefer for listening from your device? (Select the one that you use the most)
 Headphones Earphones Speakers

4. a) If you have chosen headphones/earphones in the previous question, why? Mention in the order of the following choices based on which you selected headphones/earphones to be a better choice for listening.

A - Comfort,

B - Reduced background noise,

C- Better audibility and listening experience

D- More privacy,

E- Better aesthetics,

F- Portability.

For e.g. If privacy is the main reason for headphone choice then type D at first, then if comfort is the second reason of your choice of headphones type A and so on.

-
-
-
-
-
-
-

b) Which one of the following device do you use for listening?

 <input type="radio"/> ear-buds	 <input type="radio"/> ear earphones
 <input type="radio"/> Bluetooth earphones	<input type="radio"/> AirPods 
<input type="radio"/> Headphones	<input type="radio"/> Noise cancelling headphones 



No connection to any Bluetooth devices or wired earphones, listening through the PLDs speaker alone None

C. General information regarding hearing status before pandemic (before Covid-19 pandemic)

1. Do you think you have any hearing difficulties?
 - Yes
 - No
 - Maybe
 - I don't know

2. How often do you say "huh," "what," or ask for repetitions because you do not hear others clearly?
 - Never
 - Rarely
 - Sometimes
 - Frequently
 - Always

3. Do you have to turn up the volume of your **Personal listening devices (PLDs like mobile, tablets, MP3 players etc.)**, laptop, PC or TV to hear better even in silent background?
 - Never
 - Rarely
 - Sometimes
 - Frequently
 - Always

4. a) Have you ever had a hearing test?
 - Yes Nob) If yes, what was the result of the test?

5. If you have hearing difficulties, since when do you have it?
 - >5 years
 - 2-5 years
 - Less than 2 years
 - Less than a year

- don't have hearing difficulty
6. What caused your hearing difficulties? Select from the options below.
- Ear infections
 - Fever
 - Noise Exposure (Including listening at high levels through your PLDs)
 - Trauma
 - Drugs
 - Birth defects
 - Unknown
 - Other (please specify).....
 - do not have any hearing problems
7. If your hearing difficulty is due to noise exposure, is it due to listening to high levels of sounds in your Personal Listening devices (PLDs)?
- Yes No Maybe don't know
8. How often are you in noisy environments (e.g., concerts, disco, noisy home or work environments etc.)?
- Never
 - Rarely
 - Sometimes
 - Frequently
 - Always

II. Listening Habits and preferences before Pandemic and restrictions:

The questions in this section aim to collect information regarding the listening habits and preferences that you had before the Covid-19 pandemic i.e. before March, 2020 and during the covid-19 pandemic particularly during lockdown, in which time period you'd attended online classes and used your PLDs for recreational purpose more often. Select the most appropriate options based on your habits and preferences before and during the Covid-19 pandemic.

1. What purpose did you use your headphones/earphones for listening? Based on the following choices,

**A- Study B- Music C- Videos (movies, series, documentaries etc.) D-Gaming
E- Others (specify).....**

Starting from the choice with the highest frequency of use, (For e.g. Music> Study> Gaming and so on) mention in order of use the purpose you used your earphones/headphones for. E.g. If you use your earphones/headphones for study most frequently type A first, then if gaming was the second frequent purpose, type D and so on.)

Before pandemic	During Pandemic
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>

2. How many days a week did you usually use your earphone/headphone for listening the activities that you've selected in the former question?

Before pandemic.....

During Pandemic.....

A. Listening preferences before and During Pandemic

1. a) Did you attend online classes during the pandemic?

Yes No

b) If yes, for how long each day?

1-2 hrs

2-4 hrs

4-6 hrs

>6hrs

c) From when did your online classes start? Mention month.....

d) Until when did your online classes continue? Mention month.....

1. What device you'd connect your headphones or earphones with mostly. If using more than one device select more than one device.

	Before pandemic	During Pandemic
For recreational purpose (listening to music/ watching videos)	<input type="radio"/> Laptop	<input type="radio"/> Laptop
	<input type="radio"/> Mobile	<input type="radio"/> Mobile
	<input type="radio"/> Desktop computers	<input type="radio"/> Desktop computers
	<input type="radio"/> Tablets	<input type="radio"/> Tablets
	<input type="radio"/> iPads	<input type="radio"/> iPads
	<input type="radio"/> didn't use earphones	<input type="radio"/> didn't use earphones
For academic purpose (online classes/studies)	<input type="radio"/> Laptop	<input type="radio"/> Laptop
	<input type="radio"/> Mobile	<input type="radio"/> Mobile
	<input type="radio"/> Desktop computers	<input type="radio"/> Desktop computers
	<input type="radio"/> Tablets	<input type="radio"/> Tablets
	<input type="radio"/> iPads	<input type="radio"/> iPads
	<input type="radio"/> didn't use earphones	<input type="radio"/> didn't use earphones

For mobile devices and Tablets:

2. What volume did you set your device on while listening through earphones/headphones?

	Before pandemic	During Pandemic
For recreational purpose (listening to Music/videos)	<input type="checkbox"/> Less than 20%	<input type="checkbox"/> Less than 20%
	<input type="checkbox"/> 20%-50%	<input type="checkbox"/> 20%-50%
	<input type="checkbox"/> 50%-60%	<input type="checkbox"/> 50%-60%
	<input type="checkbox"/> greater than 60%	<input type="checkbox"/> greater than 60%
For academic purpose (online classes/studies)	<input type="checkbox"/> Less than 20%	<input type="checkbox"/> Less than 20%
	<input type="checkbox"/> 20%-50%	<input type="checkbox"/> 20%-50%
	<input type="checkbox"/> 50%-60%	<input type="checkbox"/> 50%-60%
	<input type="checkbox"/> greater than 60%	<input type="checkbox"/> greater than 60%

3. How many hours did you usually use your mobiles, tablets with earphones/headphones it in total for the day?

	Before pandemic	During pandemic
For recreational purpose	<input type="radio"/> Less than 1	<input type="radio"/> Less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4
	<input type="radio"/> didn't use	<input type="radio"/> didn't use
For academic purpose	<input type="radio"/> Less than 1	<input type="radio"/> Less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4
	<input type="radio"/> didn't use	<input type="radio"/> didn't use

4. How many hours did you use your earphones continuously in a single session per day in mobile device?

	Before pandemic	During pandemic
For recreational purpose	<input type="radio"/> Less than 1	<input type="radio"/> Less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4
For academic purpose	<input type="radio"/> Less than 1	<input type="radio"/> Less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4

For laptops/PCs

5. What volume did you set your Laptop/PCs on while using earphones/headphones?

For recreational purpose	Before pandemic	During pandemic
	<input type="radio"/> Less than 20	<input type="radio"/> Less than 20
	<input type="radio"/> 20-30	<input type="radio"/> 20-30
	<input type="radio"/> 30-40	<input type="radio"/> 30-40
	<input type="radio"/> 40-60	<input type="radio"/> 40-60
	<input type="radio"/> Greater than 60	<input type="radio"/> Greater than 60
For academic purpose	<input type="radio"/> Less than 20	<input type="radio"/> Less than 20
	<input type="radio"/> 20-30	<input type="radio"/> 20-30
	<input type="radio"/> 30-40	<input type="radio"/> 30-40
	<input type="radio"/> 40-60	<input type="radio"/> 40-60
	<input type="radio"/> Greater than 60	<input type="radio"/> Greater than 60

6. How many hours did you usually use it in total for the day?

For recreational purpose	Before pandemic	During Pandemic
	<input type="radio"/> less than 1	<input type="radio"/> less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4
	<input type="radio"/> didn't use	<input type="radio"/> didn't use
For academic purpose	<input type="radio"/> less than 1	<input type="radio"/> less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4
	<input type="radio"/> didn't use	<input type="radio"/> didn't use

7. How many hours did you use your earphones continuously in a single session in your laptops/PCs per day?

For recreational purpose	Before pandemic	During Pandemic
	<input type="radio"/> less than 1	<input type="radio"/> less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4
For academic purpose	<input type="radio"/> less than 1	<input type="radio"/> less than 1
	<input type="radio"/> 1 to 2	<input type="radio"/> 1 to 2
	<input type="radio"/> 3 to 4	<input type="radio"/> 3 to 4
	<input type="radio"/> more than 4	<input type="radio"/> more than 4

8. What was your total listening time in your PLDs per day? Includes all the listening activities.

Before pandemic	During Pandemic
<input type="radio"/> Less than 1 hour	<input type="radio"/> Less than 1 hour
<input type="radio"/> 1-2 hours	<input type="radio"/> 1-2 hours
<input type="radio"/> 2-4 hours	<input type="radio"/> 2-4 hours
<input type="radio"/> 4-6 hours	<input type="radio"/> 4-6 hours
<input type="radio"/> 6-8 hours	<input type="radio"/> 6-8 hours
<input type="radio"/> >8 hours	<input type="radio"/> >8 hours
<input type="radio"/> I never used to listen	<input type="radio"/> I never used to listen