The Relationship between Listening Habits and Knowledge- Attitude-Practice Regarding Acoustic Exposure: A Study through Ecological Momentary Assessment

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CERTIFICATE

This is to certify that this dissertation entitled **"The Relationship between Listening Habits and Knowledge- Attitude-Practice Regarding Acoustic Exposure: A Study through Ecological Momentary Assessment"** is a bonafide work submitted as part of fulfilment of the degree of Master of Science **(Audiology)** of the student with Registration Number **P01II24S023004**. 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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CERTIFICATE

This is to certify that this dissertation entitled **"The Relationship between Listening Habits and Knowledge- Attitude-Practice Regarding Acoustic Exposure: A Study through Ecological Momentary Assessment"** has been prepared under my supervision and guidance. It is also being certified that this dissertation 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 **"The Relationship between Listening Habits and Knowledge- Attitude-Practice Regarding Acoustic Exposure: A Study Through Ecological Momentary Assessment"** is the result of my own study under the guidance of **Dr. Indira C. P., Assistant Professor of Audiology**, 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.

Mysuru
June, 2026

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To my Amma....

Without whom none of this would exist.
For your love, your sacrifices, and for giving me everything without ever asking for anything in return.
You never said no to me even once.
This work is the fruit of your endless yes. With all my love, always.....

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ABSTRACT

Background: *The widespread use of personal listening devices (PLDs) among young adults has emerged as a significant public health concern, with excessive volume and prolonged usage identified as primary risk factors for noise-induced hearing loss (NIHL). College-going students represent a particularly vulnerable population due to their habitual and often unregulated PLD use. Traditional questionnaires to study the listening practices and impact are limited by recall bias, underscoring the need for ecologically valid assessment approaches.*

Objectives: *The study aimed to (1) characterise listening habits of young adults using Ecological Momentary Assessment (EMA), (2) measure objective PLD output levels and examine their relationship with self-reported volume settings, (3) assess participants' Knowledge, Attitude, and Practice (KAP) regarding safe listening and hearing conservation, and (4) explore the correlation between listening behaviour and KAP scores.*

Method: *Twenty-five college-going young adults were monitored over seven days using a 27-item EMA questionnaire administered daily via smartphone, yielding 175 daily responses. A 19-item KAP questionnaire was also administered. Objective PLD output levels were measured using a Kemar. Pearson's and Spearman's rank correlation analyses were used to examine the relationships between measured output, self-reported volume, and KAP scores.*

Results: *Earphones connected to smartphones were the predominant transducer type. The mean self-reported volume usage was 6.19/10 (SD = 1.68) and mean daily listening duration was 136.18 minutes (SD = 77.59), exceeding WHO safe listening recommendations for a substantial proportion of participants. Both volume and duration preferences were stable within individuals across the monitoring period. Short-form social media videos and movie album music were the most consumed content, with Instagram and music streaming apps as dominant platforms. Mean objectively measured PLD output was 67.80 ± 6.41 dB. No significant correlation was found between measured output and self-reported volume ($r = 0.182$, $p = 0.385$). KAP scores showed good general awareness of hearing risks but no significant correlation with average volume ($\rho = 0.14$, $p = 0.51$) or duration ($\rho = 0.04$, $p = 0.84$).*

Conclusion: *PLD use among college-going young adults is characterised by extensive earphone use, prolonged listening durations, and diverse content consumption across digital platforms. Listening habits represent stable personal routines not significantly influenced by hearing health awareness. Self-reported volume estimates do not reliably reflect actual acoustic exposure. The findings highlight the need for behaviour-focused hearing conservation strategies that go beyond knowledge-based interventions to promote safer listening practices among young adults.*

Keywords: Personal listening devices, ecological momentary assessment, noise-induced hearing loss, listening behaviour, young adults, knowledge attitude and practice, safe listening, earphones.

Chapter 1

INTRODUCTION

Noise-induced hearing loss (NIHL) has become one of the most common problems associated with various occupational environments, such as manufacturing, construction, military service, traffic, etc. (Ranga et al., 2014). Chronic noise exposure adversely affects not only the auditory system but also the physiological systems including the cardiovascular, gastrointestinal, and neuropsychological systems. High blood pressure, increased secretion of stress hormones, disrupted gastrointestinal function, and increased anxiety and depression have all been associated with chronic noise exposure. (Gopal et al., 2019; Levey et al., 2011).

In recent decades, a distinct and increasingly prevalent category of NIHL has emerged - Recreational Noise-Induced Hearing Loss (RNIHL). RNIHL is the hearing loss that is primarily the consequence of exposure to noises originating from voluntary, leisure-oriented behaviours rather than workplace conditions. Unlike occupational NIHL, RNIHL occurs largely outside the institutional control, making its prevention efforts considerably more challenging (Henderson et al., 2011). Studies have shown that a substantial proportion of individuals with documented exposure to hazardous levels of recreational noise are experiencing clinically significant auditory symptoms, with 56.15% reporting tinnitus and one or more symptoms of hearing impairment, and these includes individuals who are already know about the dangers associated with the exposure to the high noise levels (Upreti et al., 2025).

According to the World Health Organization (WHO), around 1.1 billion individuals between the age range of 12-35 are currently at risk of developing hearing loss as a direct consequence of hazardous exposure to noise through vocational and recreational modes (Gopal et al., 2019; WHO, 2019). The alarming statistics reflect not merely an audiological concern but a multidimensional public health crisis that warrants urgent scientific and clinical attention. One important reason for this projected rise in the incidence of NIHL is the widespread use of Personal Listening Devices (PLDs).

PLDs have become a common part of everyday life, used for extended durations, often at high volumes exceeding internationally recommended safety standards. Despite the observation that it can result in significant auditory injury, it has become embedded within ordinary recreational behaviour (Mayes & Fink, 2021). The voluntary and pleasurable nature of personal music/recreational listening means that individuals will not initially notice the consequences of their behaviour. With increased duration and high level of exposure, this behaviour can result in hearing loss over a period of time.

The regulation of noise exposure within various occupational settings has been governed by various organizations in order to protect the workers from the serious effects of prolonged sound exposure. Many Regulatory bodies such as the National Institute for Occupational Safety and Health (NIOSH) guidelines limit exposure to noises of 85 dBA to 8 hours has prescribed permissible exposure limits (U.S CDC, 1998). Industries should be compliant to the standards as per the laws of the land they are operational in through engineering controls, administrative measures, and use of personal protective devices. These occupational modifications safeguard the workers from the serious consequences of the noise exposure, and prevent the workers from the permanent risk of sensorineural hearing loss.(CDC, 2026; U.S CDC, 1998).

For the use of PLDs, however, there are no regulatory standards. There are certain guidelines for safe recreational music exposure which are mainly given by organizations such as the WHO and other various national health authorities (Chadha, 2021).

In addition to a lack of regulatory standards for recreational noise exposure, most individuals are also unaware about the risks of exposure to high levels of noise. Studies report that individuals who listen to high levels of music are unaware of the consequences of the behaviour (Trimmis et al., 2025).

One of the major concerns of RNIHL is the higher prevalence of hazardous listening behaviours among young adults. Adults aged between 18 to 40 represent a population that exceeds the particular regulatory standards of safe listening habits, not more than 4hours per day if the volume level is at 70% and for 80% volume levels only for a duration of 90 minutes (Berg et al., 2016)

Mostly through the over usage of various PLDs at high volumes and involvement in very high intensity sound environments such as clubs, party, DJ etc. Studies show that up to 58.2% of young adult groups exceed safe levels while using PLDs (Jiang et al., 2016). Studies also show that 22% of adults sometimes exceeded safe listening doses (Kaplan-Neeman et al., 2017). Much of the research on the use of PLDs has focused on the listening habits and risks for teenagers and young adults, but the unregulated use of PLDs may have a more significant impact on adults too. This is due to the effect of exposure to high levels of sounds for work or entertainment, which are compounded by the normal age-related hearing issues.

It should also be noted that the individuals vary in their usage patterns of their PLDs, in terms of the levels, duration, the genre, etc. this means to say that they vary in their 'listening habits'. Actual listening habits vary greatly, with individuals preferring different sound levels, and content to listen to. This could be due to their usage of these devices for work-related aspects also. This variability will make it difficult to create a single guideline and furthermore, intentions to adopt safer practices, like lowering volume or cutting back on listening time, are also related to individual attitudes, social norms, and self-control behaviours (Shim et al., 2018).

Understanding the awareness of individuals regarding the effects of high levels of noise exposure through the PLDs, noting their self-reported listening habits, and correlating that with actual objective measurements that has been attempted to study the risk indicators among PLD users. However, self-reported listening habits after a period of time do not match well with these objective measurements. This suggests that relying solely on self-assessment of risk indicators among PLD users is unreliable (Paping et al., 2021).

This complex situation highlights the urgent need to monitor real-world listening behaviours. Effective monitoring of noise exposure levels, coupled with assessing their knowledge regarding effects of noise exposure will provide the evidence needed to develop personalized risk assessments, improve safety standards, and create targeted interventions to reduce preventable hearing loss among adults.

1.1 Need for the study

The use of PLDs is consistently on the rise and poses a significant health concern due to the associated noise exposure. Hearing loss acquired as a consequence of listening to high levels of noise predominantly recreational in nature is called Recreational Noise Induced Hearing Loss (RNIHL). The World Health Organization (WHO) projected that around 1.1 billion individuals between the age range of 12-35 are currently at risk of developing hearing loss as a direct consequence of hazardous exposure to noise through various personal listening devices and others (Gopal et al., 2019; WHO, 2019). Multiple studies have shown that hearing loss, tinnitus, and other non-auditory issues are reported among individuals with RNIHL (Ilić Živojinović et al., 2023; Trimmis et al., 2025).

Attitudes and knowledge regarding a particular topic are expected to predict the intention to adopt safe practices – and NIHL is no exception (Gopal et al., 2019). Therefore, individuals with favourable views towards safe listening are more likely to express a willingness to modify their behaviour to minimize exposure to unsafe levels of recreational noise. In terms of the knowledge regarding the impact of exposure to recreational noise, (Torre & Reed, 2019) reported that while young adults can accurately report risky listening behaviours, many still listen at higher intensity levels above 85dBA, even in quiet settings. These findings indicate a probable gap between understanding of a concept and the appropriate action to implement it. In other words, being aware of the consequences of a particular behaviour is not enough to change it.

There are certain guidelines pertaining to safe recreational noise exposure given by various organizations. However, the scope and specificity of these guidelines fall considerably short of what is required to meaningfully address the complexity of real-world listening behaviour (Torre & Reed, 2019). The existing guidelines are largely extrapolated from the standards of the occupational noise and modified based on laboratory based acoustic measurements. These guidelines tend to operate on the assumption of a relatively uniform listening scenario- that is, a fixed volume level sustained over a defined duration. These guidelines are often too generalized and do not account for differences in individual listening habits, device types, and environments.

There are laboratory based studies and retrospective self-report measures that are informative, but are limited in their ability to reflect the true nature of everyday listening behaviour, as there are context driven variability that characterises PLD use across different times, places, and situations. So, there is a clear cut need for the methodological approach that is capable of documenting listening behaviours in the day to day life. There is a clear need for research that fills this gap by gathering real-world usage patterns of PLDs as well as measures the actual levels of exposure to sounds from PLDs. This can help create personalized risk assessments and also develop focused educational outreach that can effectively address the rising concern of RNIHL in the present society.

Ecological Momentary Assessment (EMA) offers a particularly well suited and structured framework for recording behaviours over a period of time. It involves the repeated collection of data from various participants at multiple time points over an extended period of time, collecting information about behaviour, context, and psychological state as it occurs in real time rather than through retrospective recall. In the context of recreational PLD use, EMA enables researchers to document listening habits and contexts, details such as volume levels, duration of use, listening environment, device type, etc. It can help establish a longitudinal picture of an individual's listening behaviour that reflects actual patterns of use rather than approximations.

The influence of an individual's knowledge/attitude regarding noise exposure on their listening patterns are also not clearly established (Khoza-Shangase, 2025). A study that attempts to understand usage patterns of PLDs must also gather information regarding a participant's knowledge and attitude regarding noise exposure and their perception regarding safe listening. Comparison of their perceptions and their actual behaviour may help us draw an understanding regarding possible intervention plans to improve listening behaviours.

Findings from an investigation that reveals any possible association between an individuals' knowledge and attitudes towards noise-induced hearing loss and their observed patterns of PLD use will have considerable implications for public health practice.

College-going young adults are the demographic group that is the most vulnerable yet insufficiently studied populations in the context of RNIHL. They are the most high risk population, exposed to noise as part of their personal, social, academic, and recreational aspects of the campus life. Thereby focusing on this population, the study helps to generate information that may require changes through targeted interventions.

1.2 Aim of the study

The aim of the study is to explore the relationship between listening habits and KAP of noise exposure among college-going young adults.

1.3 Objectives of the study

Objectives of the study are;

1. To document the listening habits of young adults over a period of one-week through EMA method.
2. To measure the sound exposure levels generated by their personal listening devices during typical usage.
3. To evaluate the knowledge and attitude of the adults with the usage of personal listening devices.
4. To examine the association between the listening habit and KAP towards noise exposure personal listening devices.

Chapter 2

REVIEW OF LITERATURE

The increase in the prevalence of personal listening device (PLD) usage among young adults has been become a significant public health concern. A number of research studies have therefore been conducted to study the nature, patterns, and impact of PLDs on their users.

2.1 The Patterns of Personal Listening Device Usage

The age range of PLD usage and listening levels, duration, device type, and context of usage of PLDs among individuals is reported in literature. Reports from large scale survey studies indicate that PLD usage begins as early as at age three, and that the by age six, nine, and twelve to nineteen, the prevalence of usage increases from 29% to 59% to 80% (Mayes & Fink, 2021). In the United States, young individuals use PLDs for an average duration of 4.5 hours a day, and some report listening for as many as 12 hours per day, including during sleep (Mayes & Fink, 2021). These reports indicate that PLDs are a source of sustained and cumulative auditory risk for Recreational Noise Induced Hearing Loss (RNIHL) throughout the formative years of development. Therefore, it is important to understand the specific characteristics of PLD usage across different population groups, including college-going young adults.

At present, smartphones function as multipurpose PLD's capable of delivering audio content across a wide range of various platforms and services. In a large scale survey of 1,009 Korean college students, You et al. (2020) found that 97.6% of respondents currently used a PLD, of whom 93.8% identified their smartphone as their primary device. Smartphones provide virtually unlimited media storage and continuous connectivity to various streaming services, increasing opportunities for prolonged listening among their users. A similar pattern was documented by Lee and Jeong (2021) among Korean adolescents, in which 97.1% used smartphones as their primary PLD. Most participants had started the use of PLDs during grades four to six of elementary school, suggesting that the foundations of risky listening behaviour are laid well before young people enter tertiary education. Sulaiman et al. (2013) reported that mobile phones are the most frequently used PLDs among urban high school students in an age range of 13 to 16 years. These studies indicate that smartphones are the predominantly used devices for recreational audio consumption across diverse geographic and cultural settings.

Jiang et al. (2016), in a systematic review of 26 studies, found that PLDs are capable of producing sound output levels exceeding 125 dBA at maximum volume, and that the average listening levels reported across studies ranged from 71 to 105 dBA. Up to 58.2% of participants in certain studies exceeded the recommended 100% daily noise dose based on the NIOSH criterion of 85 dBA for eight hours, particularly in the presence of background noise.

Levey et al. (2011) measured the free-field equivalent sound levels from the earphones of 189 college students using a calibrated the mannequin. They found average listening levels of 92.6 dBA, considerably above the NIOSH threshold. The results showed that 58.2% of participants exceeded daily exposure limits and 51.9% exceeded weekly exposure limits.

Almeida et al. (2020) in a Brazilian university used the microphone-in-real-ear (MIRE) technique and found a mean equivalent music listening level of 84.7 dBA, with 38% of participants exceeding the NIOSH daily time allowance. The studies indicate that PLDs pose a sustained auditory risk and that usage patterns among the participants were indicative of possible RNIHL.

In a study by Lee and Jeong (2021), approximately one quarter of 416 Korean middle and high school student participants reported a perceived decrease in hearing following the usage of various PLD's, with high school students reporting such changes at more than twice the rate of their younger counterparts (32.2% vs. 14.2%). The preferred mean listening level across both the groups was 70.13 dB, with a third of participants selecting levels above this threshold. The authors attributed the increase in perceived hearing loss among older students to cumulative exposure, consistent with the dose-dependent nature of NIHL.

Tung and Chao (2013) similarly found that among 1,878 Taiwanese university students 90.9% reported regular earphone use, with a mean session duration of 1.6 hours and an average volume level of 4.6 on a 10-point rating scale. Their study also revealed that recreational noise exposure was not limited to PLDs alone: 80.9% of participants had engaged in at least one other loud recreational activity in the past years, including singing at different venues for a mean duration of about 3.53 hours, indicating that cumulative auditory risk among college students arises from not only from a PLD exposure.

The listening environment is an important contextual factor that shapes PLD usage patterns. Almeida et al. (2020) found that 92% of their university participants used PLDs in noisy environments, and that listening levels in these contexts were substantially higher than those measured in quiet settings. Preferred listening levels are consistently reported to be higher in the presence of background noise and correlated to background noise levels (Jiang et al., 2016;

Torre & Reed, 2019). Levey et al. (2011) found that in New York City, subway noise levels averaging 85.7 dBA on platforms created an acoustic environment that drove listeners to increase their PLD volume. Skånland (2013) reported through qualitative interviews with 12 adults in Norway that PLD use is driven largely affected by various reasons including the intention to enter desired emotional states, to create psychological privacy in public spaces, and to buffer themselves against environmental stressors. This psychologically driven dimension of PLD use has critical implications for risk. The reports indicate that the listening volume is not determined solely by the acoustic necessity but also by personal emotional goals. The earphone type is another variable factor in the PLD usage patterns.

Hoover and Krishnamurti (2010) studied the patterns of transducer usage and found that among 428 US college students, 91.8% used earbuds as their primary listening accessory indicating a dominance of earbud style transducers among college going young adults. You et al. (2020) reported that 66.2% of their participants (college students) used earbuds, while Lee and Jeong (2021) found that 82% of adolescents used in-ear earphones. Shim et al. (2018) found in a controlled laboratory setting that earbuds generated an output levels approximately 10 to 12 dBA higher than that of over-the-ear earphones under equivalent volume settings, and that over-the-ear earphones were associated with lower preferred listening levels because their superior passive isolation reduced the need to compete with the background noise. The reports indicate that ear buds are the most commonly used transducer in conjunction with the PLDs, which is associated with lower background noise attenuation compared to in-ear canal and over-ear configurations. This is therefore a predisposing factor leading the users to increase listening volume in order to overcome the ambient noise.

The auditory consequences of habitual PLD usage extends well beyond conventional audiometric thresholds. Mayes and Fink (2021) reported that the incidence of tinnitus is approximately 28% among the PLD users compared to that of 8% among non-users, and that fewer than five years of PLD exposure is associated with signs of hidden hearing loss including impaired otoacoustic emissions and extended high-frequency threshold shifts. Mokhatrish et al. (2025) reported that in a Saudi Arabian sample of 428 participants that 47.9% reported tinnitus, and that those who preferred listening levels above 70 dB were more than twice as likely to exhibit higher hearing loss scores, with the relationship between volume level and hearing impairment.

Divya et al. (2025) provided electrophysiological evidence of subclinical auditory dysfunction in habitual PLD users with clinically normal standard audiograms. In their study of 35 young adults aged 18 to 35 years, PLD users demonstrated significantly elevated extended high-frequency audiometric thresholds compared to controls, as well as reduced Auditory Brainstem Response (ABR) Wave I amplitudes across all stimulus conditions — a pattern consistent with cochlear synaptopathy or hidden hearing loss. There were preserved Wave V amplitudes alongside reduced Wave I amplitudes resulting in elevated V/I amplitude ratios under masking conditions, which the authors proposed as a sensitive electrophysiological marker of subclinical auditory neural dysfunction. These findings suggest that the conventional pure tone audiometry underestimates the impact of auditory recreational noise exposure in young PLD users. The auditory damage is accumulating silently in a population that considers itself to have normal hearing.

2.2 How PLD Usage is Being Studied

The impact of PLD usage on audition is studied using objective acoustic measurements and subjective self-report measures, each with certain distinct advantages and limitations. The approaches in the literature can be broadly categorized as self-report questionnaires, objective acoustic measurement in laboratory or field settings, combined hybrid methods, biological outcome measures, and app-based or technology-mediated monitoring. The choice methodology also influences the conclusions drawn about listening risk, and several studies have specifically examined the degree to which self-report measures approximate objective data.

Self-report questionnaires is the most widely used tool in large-scale surveys of PLD use due to the practicality and their ability to capture contextual and habitual dimensions of behaviour across extended time periods. Hoover and Krishnamurti (2010) reported from a 30-item online survey to 428 US college students, that two-thirds of respondents used PLDs for three or more days per week, and over one-third reported occasionally listening at maximum volume a finding with direct implications for hearing risk. Mokhatrish et al. (2025) used a structured questionnaire comprising of 37 items across six different categories such as demographics, medical history, PLD usage patterns, hearing symptoms, knowledge and beliefs, and protective measures. They conducted a cross-sectional study of 428 Saudi adults, using a 4-point rating scale to quantify symptom severity the findings revealed that the awareness towards the noise induced hearing loss was moderate and participants who have used more than 70% of the volume levels are having higher chances of getting hearing loss. Khoza-Shangase and Mokhethi (2025) also used an eight-item open-ended online survey administered to 154 South African undergraduate students, applying thematic analysis to explore the psychosocial determinants of unsafe usage of PLD the findings suggest that the knowledge alone will not be insufficient to change those listening behaviours. Lee and Jeong (2021) used the Listening Habit Questionnaire that is a validated tool developed from the Health Belief Model in order to assess perceived susceptibility, severity, benefits, barriers, and self-efficacy relating to music-induced hearing loss among Korean adolescents. While these type of questionnaires allow large samples to be reached efficiently, social desirability effects, and limited accuracy in translating subjective volume impressions into objective equivalents are their caveats. For example, Jiang et al. (2016) identified that individuals frequently underestimate their actual listening volumes in self-reports, with the study documenting that there is a significant difference between self-reported and objectively measured preferred listening levels.

Objective acoustic measurement of the PLD output levels represents a more accurate but resource-intensive approach to studying PLD usage patterns. The microphone-in-real-ear (MIRE) technique, that has been standardized under ISO 11904-1:2002, involves placing a probe microphone within the ear canal at a point close to the tympanic membrane, providing ecologically valid estimates of noise exposure. Almeida et al. (2020) used this approach, placing the probe at a standardized depth of 28 mm, and found a mean equivalent listening level of 84.7 dBA with substantial inter-individual variation ranging from 65.1 to 97.5 dBA.

The acoustic manikin approach, in which a standardized head-and-torso simulator fitted with a calibrated ear simulator is used to measure the output of participants' own earphones at their habitual volume setting, has been widely adopted as a practical field-based alternative.

Levey et al. (2011) used a calibrated mannequin constructed according to a particular validated protocol to measure free-field equivalent sound pressure levels directly from earphones at the point of use among college students in New York City. Park et al. (2017) employed a Jolene mannequin to measure chosen listening levels from 138 university students across three campus locations. The latter study found a significant variation in listening levels among the participants, depending on environmental context. For example, gym users listened at substantially higher levels (mean 79.7 dBA) than library users (mean 70.4 dBA). The results indicate that single-location measurements fail to capture the full range of an individual's exposure profile across daily contexts. Divya et al. (2025) used an Aurical Free Fit real-ear measurement system with a probe microphone that is positioned at the tympanic membrane to objectively verify participant's self-reported habitual listening levels, confirming their group allocation as PLD users or controls based on real-ear sound pressure levels exceeding or falling below 80 dB SPL.

Audiometric testing and otoacoustic emissions have also been employed to move beyond exposure estimation toward direct physiological assessments. Lee et al. (2014) combined self-report along with the objective sound level measurement using a well calibrated MP3 player and 2cc coupler. They then assessed inner ear function through both distortion product otoacoustic emissions (DPOAEs) and transient-evoked otoacoustic emissions (TEOAEs), finding significant reductions in OAE amplitudes in the high-risk listening group, particularly at 4 kHz indicating the cochlear frequency region most vulnerable to noise damage. Divya et al. (2025) had extended this approach by means of incorporating Auditory Brainstem Response (ABR) testing with ipsilateral masking paradigm at multiple masker levels, demonstrating that masked ABR paradigms reveal subclinical neural dysfunction in PLD users that the conventional audiometry cannot detect. Divya et al. (2025) also used extended high-frequency audiometry testing at frequencies from 9 to 16 kHz beyond the standard clinical range. These thresholds were found to be significantly more sensitive in detecting early cochlear changes in PLD users than standard pure tone audiometry, with mean threshold differences reaching 12.5 dB HL at 16 kHz. These biological measurement approaches provide certain evidences for damage to the auditory system but require specialized equipment and expertise that limits their applicability in large-scale population studies.

App-based technology to monitor PLD usages offers real-time data capture with good ecological validity. Kim et al. (2021) measured the actual listening levels and duration of usage in 34 Korean college students over a four-week period using a custom smartphone application that recorded listening level at one-second intervals and transmitted the data to a secure server every five seconds. The application measured the Z-weighted equivalent sound pressure levels (LZeq) and C-weighted peak levels (LCpeak), constituting a comprehensive longitudinal dataset of 952 participant-days of listening behaviour. The mean preferred listening level was 68 to 70 dB SPL across the four-week monitoring period, with large individual differences ranging from 57.32 to 83.43 dB SPL. This study identified that when listening data were applied to three internationally recommended noise exposure standards, the proportion of participants exceeding safe limits varied dramatically from 0% under the NIOSH 85 dBA/8-hour standard to 56.72% under the WHO 60-60 rule thereby highlighting the profound impact that standard selection has on risk classification. Paping et al. (2021) had similarly used a smartphone application in order to monitor PLD listening habits in 311 Dutch adolescents over a period of 35-days as part of the 'Generation R' longitudinal cohort study in which the listening frequency, duration, and level across diverse daily contexts were recorded. This study found a median listening frequency of 2.1 days per week and a median listening time of 21.1 minutes per day – substantially lower than figures reported in survey-based studies. This demonstrated that only slight to fair agreement is observed between the data that are obtained by objectively measured and self-reported listening habits, with weighted kappa coefficients ranging from 0.179 to 0.364. These findings confirm that the self-report measures are insufficient as standalone tools for characterizing actual listening behaviour and underscore the need for objective and the technology-mediated monitoring approaches.

The heterogeneity among the various methodological approaches across different studies, including different measurement systems, procedures of noise correction, methods of conversion to free-field equivalent levels, and criteria for defining hearing risk, pose significant challenges for cross-study comparison. Jiang et al. (2016) highlighted this as a major limitation in the existing literature, noting that the methodological differences that are likely contributed to the wide variation in the proportion of participants reported to exceed safe listening doses across the studies in which ranging from 0% to 58.2%. This reinforces the need for standardized, ecologically valid methods that can capture the dynamic, context-sensitive nature of real-world listening behaviour i.e. the need that ecological momentary assessment and smartphone-based monitoring approaches are uniquely positioned to address.

2.3 Ecological Momentary Assessment

The Ecological Momentary Assessment (EMA) is a research methodology designed to capture real-world behaviours, experiences, and contexts by collecting repeated measurements from participants as they go about their daily lives, typically delivered via mobile devices at multiple points throughout the day. The method has its origins in clinical psychology and health behaviour research. It is designed to address the fundamental limitations of retrospective self-report by capturing behaviour, symptoms, and experiences close to the moment they occur, thereby reducing recall bias, capturing intra-individual variability across time and context, and producing data that are ecologically valid, i.e., reflective of real-world behaviour rather than behaviour in artificial laboratory conditions. Its application to PLD research represents a methodologically significant advance over the cross-sectional and single-session designs that have dominated the field.

The rationale for EMA in PLD research stems from well-documented discrepancies between listening behaviour in controlled environments and real-world listening contexts. Torre and Reed (2019) highlighted that their laboratory measurements were obtained in a sound-treated room an environment almost diametrically opposite to the noisy everyday contexts in which most PLD use occurs and acknowledged that this likely produced underestimates of habitual listening levels. Almeida et al. (2020) reported that the PLD users typically vary their listening levels based on listening conditions such as environmental noise and others, meaning that static laboratory measurements systematically misrepresent real exposure levels. Skånland (2013) had given a qualitative dimension in to this argument, demonstrating through in-depth interviews that PLD use can be influenced by the emotional state and intention of the user. A listener might select different volume levels in different listening conditions such as high volume during a stressful event, moderate volume while studying, and minimal volume in a social gathering variation that a retrospective questionnaire data cannot capture. EMA's capacity to sample behaviour repeatedly across these varied and acoustically diverse daily contexts makes it uniquely suited to characterising cumulative noise exposure and the factors that influence it.

Kaplan-Neeman et al. (2017) used a custom smartphone application to continuously log listening data including volume settings and session duration over a two-week period in 40 young adults aged 18 to 34. This approach captured the actual behaviour in real time. The logged data were used to calculate daily and weekly noise doses according to NIOSH damage risk criteria. Results revealed substantial intra-individual variability: actual listening days per week ranged from 1.5 to 6.5, mean continuous listening time was 1.56 hours per day, and maximum daily noise doses ranged from 0 to 406% of the permissible dose. Eight participants (22%) had exceeded the 100% daily noise dose at least once during the monitoring period, and five participants (13.5%) exceeded 50% of the weekly noise dose. Crucially, correlations between self-reported listening habits and logged data were only low to moderate, with no significant correlation between self-reported and actual listening days. And these findings make a compelling empirical case for continuous monitoring over retrospective self-report, confirming that listening habits cannot be reliably characterized from a single assessment point.

Kim et al. (2021) extended this approach over a longer four-week monitoring period with 34 Korean college students, using a custom Android application that recorded listening levels at one-second intervals. The study revealed that the first week of monitoring produced significantly higher listening levels than subsequent weeks- a pattern the authors attributed to heightened self-consciousness during initial participation suggesting that the monitoring needs to extend over a sufficient period to capture representative behaviour. After the initial adjustment phase, participants consistently listened at 68 to 70 dB SPL, with large individual variability ranging from 57 to 83 dB SPL. The study found that most participants had adequate break times between listening sessions, with 94% listening continuously for two or more hours per day but taking rest periods of approximately six hours, a behavioural pattern that has important implications for cumulative dose estimation. Critically, the study also demonstrated that the number of participants that are identified as at-risk varied dramatically depending on which noise exposure criterion was applied which ranges from 0% under the NIOSH standard to 56.72% under the WHO 60-60 rule, underscoring that the interpretation of EMA-derived data is profoundly sensitive to the reference standards that has been employed.

Paping et al. (2021) validated the EMA approach in a large scale population based sample of 311 Dutch adolescents monitored over 35 days as part of the Generation R cohort study. Their smartphone application ran continuously in the background, recording each listening session's start and end time and the volume level selected at each point within the session. The study found that the median listening frequency which was 2.1 days per week and median daily listening time was 21.1 minutes which is strikingly lower than figures that are derived from questionnaire-based studies reporting the average listening of one hour or more per day, illustrating how objective monitoring corrects the systematic overestimation inherent in self-report. A key finding which was the only slight to fair agreement between objectively measured and self-reported listening habits across frequency, duration, and level, with kappa coefficients of 0.179, 0.193, and 0.364 respectively. Forty-six percent of participants overestimated their listening frequency, while 44% underestimated their listening time on listening days. These findings provide compelling empirical justification for preferring app-based EMA monitoring over questionnaire-based self-report in future PLD research.

Due to the feasibility of smartphone application-based EMA for PLD research has now been established across multiple studies, with Kaplan-Neeman et al. (2017), Kim et al. (2021), and Paping et al. (2021) all demonstrating that such applications can operate continuously in the background with minimal disruption to participants' normal listening behaviour. The advantages of EMA in PLD research that extend beyond the correction of self-report bias. EMA enables the simultaneous capture of contextual variables such as ambient noise level, listening environment, emotional state, and social context, alongside objective exposure data, thereby making it possible to examine the situational and psychological determinants of moment-to-moment changes in listening behaviour. Technical challenges remain, including the need for individual calibration to account for differences in earphone transfer functions and ear canal acoustics, and the limitation of most current applications to monitoring a single device. Nevertheless, the converging evidence from these studies strongly supports that the EMA as an ecologically valid and data-rich method currently available for characterising real-world PLD use among young adults.

2.4 Knowledge, Attitude, and Practice

The Knowledge-Attitude-Practice (KAP) framework provides a useful conceptual lens through which to examine any possible connect/disconnect between an individual's awareness regarding noise exposure and their everyday practice. The framework recognises that knowledge, attitudinal orientation, and actual protective behaviour could be related but distinct dimensions that do not necessarily translate linearly from one to the next.

Gopal et al. (2019) used the Theory of Planned Behaviour (TPB) framework to investigate predictors of intention to engage in two safe listening behaviours includes lowering volume and shortening listening duration among 92 young adults. Regression analyses showed that attitude was the only significant predictor of intention for both behaviours, with standardized regression coefficients of 0.57 for turning music down and 0.56 for listening for shorter periods. Social norms and perceived behavioural control did not significantly predict intention for either behaviour. About 61% of participants reported experiencing at least one symptom of RNIHL among the symptoms the most commonly tinnitus at 33% and ear pain at 28% and they yet continued to engage in risky listening practices, confirming that symptom experience alone is insufficient to motivate behaviour change. You et al. (2020) similarly found through regression modelling in 1,009 Korean college students that attitude was positively associated with hearing conservation behaviour: respondents who recognized tinnitus or volume escalation as signs of developing hearing loss were more likely to endorse both informational and technical preventive measures. Yet 41.5% of these same students stated they would not change their PLD use patterns even if scientific evidence confirmed that high-volume listening could cause hearing loss this is a finding that powerfully illustrates the limits of knowledge-driven approaches.

Khoza-Shangase and Mokhethi (2025) had done an applied behavioural science lens to this problem, conducting thematic analysis of open-ended survey responses from 154 South African undergraduate students to identify the psychosocial mechanisms that sustain unsafe listening in the presence of known risk. There were Five interrelated themes that emerged including optimism bias and perceived invincibility, whereby students believed hearing loss was unlikely to affect them personally or would only manifest in the distant future; peer influence and social reinforcement, whereby high-volume listening was normalised by group behaviour and social expectation; cognitive dissonance, whereby students rationalised the unsafe habits by minimising the significance of temporary symptoms; environmental barriers, whereby noisy academic and transit settings compelled students to raise their volume in order to hear content or the information; and limited awareness of safer listening alternatives, whereby many students were unaware that volume-limiting features existed on their devices. These findings extend the KAP framework beyond the cognitive variables to encompass the motivational, social, and structural dimensions of unsafe listening habits, and providing an explanation for why awareness-raising campaigns that target knowledge alone have consistently failed to produce meaningful behavioural change in this population domain.

Mokhatrish et al. (2025) had documented the particular research gap in knowledge-practice in their Saudi Arabian cross-sectional study, where 81.1% of participants recognized that loud noise was harmful to hearing, and 77.6% of participants acknowledged that prolonged exposure could worsen hearing loss. Despite this high rate of cognitive awareness, 33% of participants preferred volume levels above 70 dB levels that are associated with significantly elevated hearing loss scores and only 72.9% reported preferring to reduce device volume during most of their listening time. Participants who had preferred intense volume levels above 70 dB during their listening tasks were more than twice as likely to exhibit greater amount of hearing loss scores (OR = 2.55, $p < .01$), confirming that the knowledge-behaviour gap carries direct and measurable audiological consequences. Similarly, Ilić Živojinović et al. (2023) had found that among 431 Serbian medical students, a population with substantially higher health literacy than typical young adult samples that about 91.9% used PLDs and that continuous daily use exceeding one hour was significantly associated with depressive symptoms (47.1% vs. 32.5%, $p = .006$). The negative attitude toward noise, as measured by the Youth Attitude to Noise Scale (YANS), was associated significantly with both anxiety and depression, suggesting that the psychological consequences of noise exposure are themselves attitudinally mediated.

Lee and Jeong (2021) applied the Health Belief Model in order to examine how listening beliefs were associated with perceived hearing change among 416 Korean adolescents. The most consistent finding was that higher perceived barriers to preventing music-induced hearing loss significantly increased the likelihood of reporting decreased hearing, with odds ratios of 2.05 for middle school students and 1.35 for high school students. Students who faced practical or motivational obstacles to safe listening such as uncertainty about maintaining safe volume levels in noisy environments were more likely to report auditory symptoms. Perceived self-efficacy was also significantly associated with perceived hearing change among high school students, with lower self-efficacy predicting greater likelihood of reported hearing decrease. The findings that suggest the key points for attitude and practice change are not general knowledge of risk but rather the specific perceived barriers and the individual's confidence in their ability to overcome them.

Hutchinson Marron et al. (2015) examined that the relationship between knowledge of safe PLD limits and actual listening behaviour in 180 college students. Their findings revealed that the approximately 95% were aware that PLD usage could cause hearing loss, yet 94% of those listening at potentially hazardous intensity levels were unaware that their specific listening level was harmful, illustrating their knowledge about RNIHL risk does not translate into accurate self-assessment of individualized risk level. Torre and Reed (2019) found that while the survey questions could predict objectively hazardous intense listening with the sensitivity values of 88.9% and 83.3%, the specificity for one question was only 70.6%, meaning that many individuals who believed they were listening unsafely were in fact within acceptable limits. The self-knowledge of personal risk level represents a critical gap: interventions that assume individuals accurately understand their own exposure are likely to both under serve genuinely high-risk users and unnecessarily alarm low-risk users.

A consistent finding that comes across the PLD literature is the persistent disconnect between the young participants' knowledge about the risks of loud noise exposure, the attitudes they hold toward hearing conservation, and the listening behaviours they actually engage in. While numerous studies have documented that awareness of the potential for noise-induced hearing loss does not reliably translate into protective behaviour, identifying the factors that mediate and moderate this relationship represents one of the most important research priorities in the RNIHL literature.

A significant research gap that emerges across the KAP literature is the absence of studies that directly and longitudinally examine the relationship between KAP profiles and objectively measured real-world listening behaviour in ecologically valid settings. Most of the studies have relied on cross-sectional designs that capture KAP and behaviour at a single time point, making it impossible to determine whether knowledge and attitude changes precede, accompany, or follow changes in listening practice. Furthermore, most studies have assessed behaviour through self-report rather than objective measurement, the knowledge-behaviour gap with the self-report validity problem. In the Indian population specifically, the studies that are examining the relationship between real world usage of PLD and the KAP among college students are not evident in the literature, representing a further gap that warrants direct investigation.

2.5 Intervention Strategies

The intention of conducting studies on PLD usage patterns is to deliberate on and develop intervention strategies to reduce harmful PLD usage and promote hearing conservation. Approaches include educational programmes, direct measurement feedback, behavioural and motivational approaches, technological solutions, and regulatory and policy measures. These strategies differ markedly in their focus, mechanism of change, and reported effectiveness, and their synthesis points toward the need for multi-level approaches to prevent from the hazardous effects of RNIHL.

Educational and awareness-based interventions are the most frequently proposed approach, given the widespread prevalence of awareness-behaviour gaps documented across the literature. Gopal et al. (2019) argued that large-scale educational campaigns targeting attitudes rather than simply providing information are essential, since attitude was identified as the strongest and only significant predictor of intention to engage in safe listening behaviour. They specifically recommended that focus on volume reduction as the most feasible and acceptable protective behaviour, since participants expressed stronger intentions to lower volume (mean intention 5.22) than to shorten listening time (mean intention 4.11). Social media-based delivery was highlighted as particularly appropriate for young adult populations. Hutchinson Marron et al. (2015) found that 84% of students expressed their willingness to shorten the usage of PLD or reduce the listening levels if given appropriate guidance from audiologists or healthcare providers, suggesting that personalised clinical counselling may be more effective than generic mass-media campaigns in motivating change among at-risk individuals. Henderson et al. (2011) found that as many as 59% of adolescent survey respondents indicated they would be more likely to use hearing protection if encouraged by a doctor or nurse, pointing to an important role for audiological professionals in the delivery of brief motivational interventions at routine clinical hours. Lee and Jeong (2021) concluded that hearing conservation education must commence in elementary school, given that most adolescents begin PLD use at grades four to six. They recommended that programmes prioritize building knowledge and skills to overcome specific barriers to safe listening such as strategies for maintaining safe volume in noisy environments rather than relying on general awareness messaging. This recommendation is grounded in their Health Belief Model analysis, which identified perceived barriers as the most consistent predictor of hearing change across both school-level subgroups. Herrera et al. (2016) similarly recommended the development of Hearing Health Promotion Programmes explicitly designed to actively engage young people, while largely aware of hearing risk, expressed limited motivation to participate in hearing health initiatives. Female students showed significantly greater interest in participation than males, suggesting the value of gender-targeted program design.

Direct measurement feedback is another intervention modality explored. Almeida et al. (2020) carried out a single-session intervention in which each participant's actual PLD listening level was demonstrated using the Jolene manikin, accompanied by oral guidance on safe listening levels and durations. After one-year follow-up, 30 of the original 50 participants revealed that 70% had reduced their listening volume levels and 43.3% had reduced their listening duration, with both changes reaching statistical significance. This approach is notable because it personalizes the risk message: rather than providing abstract statistical information about population-level risk, it shows individuals exactly what level of noise they are subjecting themselves to in their own daily practice. The manikin (Jolene), a low-cost acoustic measurement device which was developed by the Dangerous Decibels program, which represents as an accessible tool for hearing health promotion in settings where specialist real-ear measurement equipment is unavailable.

Technological interventions represent an increasingly prominent and promising strategy for reducing RNIHL risk. Kaplan-Neeman et al. (2017) proposed that the particular smartphone applications that are capable of real-time noise dose monitoring and display could provide users with immediate objective feedback on their cumulative exposure, enabling informed personal decision-making as exposure accumulates rather than after the fact. This represents a fundamentally different approach from education alone: rather than hoping that knowledge will motivate the appropriate behaviour change, technological tools that could create moment-by-moment prompts and warnings that make the consequences of risky listening immediately salient. Park et al. (2017) had suggested that main music streaming applications such as Apple Music or Spotify could incorporate volume-alert features to flag dangerous listening thresholds during playback. Kim et al. (2021) argued that rather than applying uniform population-level exposure standards, technology-mediated monitoring should be used to generate personalized exposure profiles that account for individual listening patterns and suggest customized safe listening guidelines an approach they likened to digital health tools already widely used for heart rate and physical activity monitoring. Paping et al. (2021) proposed that app-based monitoring tools, could be deployed clinically to promote safe listening behaviour by providing individual users with ongoing feedback on their own habits.

Device type modification has been identified as a practical device-level intervention. Jiang et al. (2016) found that the use of isolating or insert earphones significantly reduced preferred listening levels by attenuating background noise, thereby reducing the acoustic need to increase volume in noisy settings. Shim et al. (2018) found that over-the-ear earphones were associated with lower preferred listening levels than earbuds, and recommended their use as a protective measure for habitual PLD users. The use of noise-cancelation headphones has been highlighted across various studies as a they are particularly effective in passive intervention, as these devices allow comfortable listening at lower volumes by eliminating the effect of environmental noise without requiring any change in listening habits on the part of the user. Khoza-Shangase and Mokhethi (2025) reported that the many students are unaware of volume limiting features on their particular devices and had no knowledge about the noise cancelation technologies, suggesting that campaigns for awareness in promoting specific device-based protective options could support educational initiatives in a broader way.

Mayes and Fink (2021) argued that the voluntary behavioural approaches are unlikely to provide sufficient protection at the population level, drawing an analogy to automotive safety legislation and arguing that mandatory engineering controls including required sound output limits on PLD devices, unified volume step output increases, and de

fault startup at low sound levels that are necessary for meaningful population-level impact. Sulaiman et al. (2013) recommended that PLD manufacturers should include cautionary statements in the user manuals, incorporate optional volume limiters, and develop visual warning indicators to be provided for unsafe listening levels. Jiang et al. (2016) argued for the development of standardized, music-specific recreational exposure guidelines that are distinct from the occupational noise standards designed for continuous industrial exposures these guidelines that account for the variable, intermittent nature of recreational listening and provide clearer and more practically relevant guidance to both users and manufacturers. Mokhatrish et al. (2025) recommended that the targeted public health campaigns directed particularly at youngsters who are the most frequent users of PLD's, with hospitals and educational institutions identified as the most effective place for the NIHL awareness dissemination based on participant preferences.

Loughran et al. (2021) provided one of the most theoretically sophisticated analyses of intervention targets, using the particular Capabilities, Opportunities, and Motivations model of Behaviour change (COM-B) to compare individuals who had used hearing protection in recreational settings with those who had not. Their study of 185 UK adults found that while both groups reported similar levels of capability and opportunity to use hearing protection, those who had never used protection scored significantly lower on both reflective motivations the desire and intention to use protection and automatic motivation the habitual impulse to use protection without conscious deliberation compared to ever-users. This finding suggests that previous interventions, which have focused almost exclusively on increasing knowledge and skills, have targeted the components of behaviour that are already adequate, while neglecting the motivational components that actually differentiate protective from non-protective behaviour. The authors had recommended that future interventions specifically target on the motivational deficits using theoretically grounded frameworks, the PRIME theory of motivation, and that they focus particularly on elderly population, women, and those in non-manual occupations and groups identified as disproportionately represented among never-users of hearing protection.

Taken together, the literature points toward a multi-level intervention framework as the most appropriate response to the complex, multiply determined problem of RNIHL prevention. This effective intervention will require the educational campaigns that should target specific attitudes, perceived barriers, and self-efficacy alongside with the general knowledge; technological tools that can provide real-time exposure feedback, device and earphone design modifications that facilitate lower preferred listening levels; certain regulatory frameworks that establish and reinforceable recreational noise standards; and clinical approaches to deliver personalised counselling and brief motivational interventions.

Chapter 3

METHODS

The study aimed to explore the relationship between habits of personal listening devices (PLDs) usage and Knowledge, Attitude and Practice (KAP) regarding noise exposure among college-going young adults. The study was carried out in three phases:

3.1 Development and Validation of Questionnaires
3.2 Data Collection
3.3 Data Analysis

3.1 Development and Validation of Questionnaires

In the first phase of the study, two questionnaires were developed: the EMA questionnaire to collect information regarding participants' listening habits through PLDs, and the KAP questionnaire to study their KAP regarding noise exposure.

3.1.1 EMA questionnaire development

The EMA questionnaire was designed to collect participants' usage and exposure data regarding PLD usage over a period of one week. The questionnaire was developed based on previously published literature, expert input, and expert validation. The steps in the development of the EMA questionnaire, therefore, included:

3.1.1.a Selection of Questions from Existing Questionnaires
3.1.1.b. Expert Validation Process
3.1.1.c Final Questionnaire Construction
3.1.1.d Integration of the PLD Usage Questionnaire into Google forms

3.1.1.a Selection of Questions from Existing Questionnaires. A literature review was carried out with a total number of 31 studies, and finally eight studies were considered for the selection of questions. The questions for the current study were then drawn from these studies of Herrera et al. (2016), Hoover and Krishnamurti (2010), Ilić Živojinović et al. (2023), Lee and Jeong (2021), Mokhatrish et al. (2025), Torre and Reed (2019), Tung and Chao (2013),You et al. (2020). Whenever necessary, the existing items from the selected questionnaires were modified to suit the EMA format and the current study. Additional questions were added to collect data regarding the demographic details of the participants. The investigators finalized on the questions to be sent for expert validation based on discussions.

3.1.1.b Expert Validation Process. After selecting the questions, the questionnaire was sent to experts for validation to establish its content validity. Content validation was conducted by an expert panel comprising of three specialists with adequate knowledge and expertise in hearing loss prevention and noise exposure. The experts were asked to validate the questions based on three aspects: their relevance to the study's objectives, the extent to which they introduce redundancy relative to other items in the questionnaire, and their perceived essentiality to the EMA questionnaire. Only those questions deemed relevant, non-redundant, and essential by all three raters were included in the final questionnaire. This validation process ensured that the EMA questionnaire had the content validity necessary to generate meaningful and interpretable data.

3.1.1.c Final Questionnaire Construction. To construct the final questionnaire, each validated item was presented in one of response formats: Yes/No or multiple-choice. Within the EMA framework, closed-set responses will be more appropriate for quick completion, reduce participant effort, and maintain clarity. In addition to the listening behaviour items, the questionnaire included a section on participants' demographic details.

3.1.1.d Integration of the PLD Usage Questionnaire in to Google forms. To facilitate efficient, user-friendly, and valid data collection over the one-week monitoring period, the finalized EMA questionnaire was integrated into Google Forms. This mobile-based platform was well suited to the EMA methodology, as it enabled participants to receive questionnaire links through messaging applications at randomized intervals throughout the day and provide real-time responses within their natural listening environments. In addition to the validated EMA questions, the forms collected participants' demographic information. Integrating all data collection components into a single platform streamlined the process, reduced the risk of data loss associated with paper-based methods, and enabled automatic timestamping of responses, which was valuable for analyzing listening behaviour across the monitoring period.

3.1.2 KAP Questionnaire Development

The KAP questionnaire was developed to assess the knowledge, attitudinal dispositions, and self-reported behavioural practices of college-going young adults with specific reference to noise exposure arising from the usage of PLDs.

3.1.2.a Selection of Questions from Existing Questionnaires. Questions were drawn from a large set of validated questionnaires employed in studies examining noise exposure, hearing health awareness, and PLD use. A total no 27 studies were referred and for the final questionnaire development six studies were mainly considered Herrera et al. (2016), Hoover and Krishnamurti (2010), Ilić Živojinović et al. (2023), Mokhatrish et al. (2025), Torre and Reed (2019), Tung and Chao (2013).Items were included if they demonstrated relevance to the domains of knowledge, attitudes, and practices pertaining to PLD use and its auditory and non-auditory health effects, and if they had been validated for use in populations that are culturally or contextually comparable to the Indian young adult population. Items relating to noise sources other than personal listening devices that could not be readily adapted to the PLD context were excluded. The investigators finalized on the questions to be sent for expert validation based on discussions. Modifications to the questions were made whenever necessary to preserve their original conceptual content and integrity.

3.1.2.b Expert Validation Process. After selecting the questions, the questionnaire was sent to experts for validation to establish its content validity, a process similar to that of the EMA questionnaire. Content validation was conducted by an expert panel comprising of three specialists with adequate knowledge and expertise in hearing loss prevention and noise. The experts were asked to validate the questions based according to its relevance to the knowledge, attitude, or practice domain. Only those questions deemed relevant, non-redundant, and essential by all three raters were included in the final questionnaire.

3.1.2.c Final Questionnaire Construction. To construct the final questionnaire, each validated item was presented in one of three response formats: Yes/No, multiple-choice, or small descriptive answers. Yes/No responses were employed for the questions that assess the presence or absence of specific knowledge facts, behavioural practices, or attitudinal factors that are conceptually appropriate. Multiple-choice responses were used for questions that required participants to select the relevant option from a defined set of response options, particularly when knowledge items have a specific option or practice items require specifying frequency, duration, or preference from a range of alternatives.

3.2 Data Collection

3.2.1 Participants

A total of 32 college-going young adults were initially recruited through offline data collection from the All India Institute of Speech and Hearing campus. During the monitoring period, two participants had one-day attrition, and data from five participants were excluded due to errors arising from the use of multiple email IDs or shared mobile devices. Consequently, data from 25 participants (22 females and 3 males) were included in the final analysis. The mean age of the participants was 20.3 years.

Prior to enrolment, participants were provided with detailed information regarding the study's purpose, procedures, duration, and any potential risks or inconveniences, and written informed consent was obtained from each participant. The study procedures complied with the ethical guidelines for bio-behavioural research involving human participants and received approval from the Institutional Review Board (Ref. No. SH/IRB/M.4/AUD.19/2025-26). Participants were assured of the confidentiality of their data and their right to withdraw from the study at any time without any consequences.

The following inclusion and exclusion criteria were used for the selection of participants in the study.

Inclusion criteria:

- Individuals in the age range of 18-26 years, young adults

- Individuals with normal middle ear function
- Persons who own a personal listening device and use the device for a minimum of 3 hours/week
- Individuals with Normal hearing to moderate degree of hearing loss (4 frequency PTA of </= 55dBHL) or a score of >8 on HHIA-S
- Individuals who are able to read and comprehend 7th-grade English material

Exclusion criteria:

- Individuals with significant noise exposure by sources other than PLDs, long-standing hearing loss, and family history of hearing loss.
- Individuals with significant history of ototoxicity or trauma.
- Individuals using hearing aids or cochlear implants for hearing loss.
- Individuals with hearing thresholds>55 dB HL in either ear

3.2.2 Data Collection Procedure

The data collection procedure was carried out in multiple stages. The steps thereby include:

3.2.2.a Interview and Pre-Testing

3.2.2.b PLD Output Recording

3.2.2.c Administration of KAP Questionnaire

3.2.2.d Providing integrated questions in to a link

3.2.2.e Monitoring the Behaviour

3.2.2.a Interview and Pre-Testing. Basic information regarding the participants to decide their inclusion in the study were collected through a structured, face-to-face interview in a quiet environment. Demographic and background information was collected from each participant. Questions regarding the participants' self-reported PLD use patterns, including the typical daily duration of PLD use, the types of devices and earphones most frequently used, and the range of environments in which devices are primarily used were also collected during this period. The interview also contained questions that are related to ear related problems such as any otological complaints that the participant may currently be experiencing or has experienced in the recent past, including various symptoms such as tinnitus, ear pain, aural fullness, or perceived difficulty in understanding speech in noise, as well as any relevant medical or surgical history pertaining to the auditory system, including any history of ear infections, noise exposure events, or previous audiological assessments.

After the interview, every participant underwent an audiological test battery assessment to confirm their eligibility for the study in accordance with the inclusion criteria. The audiological test battery used consisted of Otoscopy, Pure Tone Audiometry, Tympanometry, and Otoacoustic Emissions.

3.2.2.b PLD Output Recording. After the completion of the interview and pre-testing session, the output sound pressure levels generated by each participant's personal listening device were objectively measured under standardized acoustic measurement conditions to establish an accurate record of the device-specific noise exposure associated with each individual's typical listening behaviour. Measurements were conducted using a calibrated acoustic manikin fitted with an ear simulator. A well-calibrated sound level meter was used in conjunction with the manikin setup to ensure the accuracy of all acoustic measurements met recognized standards. Before measurements began, the sound level meter and associated equipment were calibrated to confirm that all readings fell within acceptable tolerance limits. Each participant was instructed to connect their personal listening device and earphones or headphones to the manikin and to adjust the volume to the level they would typically select in their everyday listening environment, without any modification or self-conscious alteration in response to the measurement context. This was done to understand each participant's habitual listening behaviour rather than a standardized or idealized volume setting, as participants often report using different volume levels across listening environments, such as lower volumes at home and higher volumes while travelling or in noisy public settings. All recorded output levels were documented in decibels A-weighted (dBA) and retained for subsequent analysis alongside the EMA and KAP data, enabling examination of the correspondence between objectively measured device output and participants' self-reported volume-setting behaviour.

3.2.2.c Administration of KAP Questionnaire. After completing the PLD output recording, the KAP questionnaire was administered to each participant, with the audiological pre-testing and acoustic measurement components completed before asking participants to reflect on their knowledge, attitudes, and practices regarding noise exposure. The KAP questionnaire was administered in a well-structured, formal interview. The interview was conducted in a quiet setting to ensure participants could attend fully to each item without distraction, and responses were recorded on the questionnaire for subsequent scoring and analysis. The investigator presented each questionnaire item verbally to the participant and recorded their responses systematically on the prepared test instrument. The interview-based format was preferred over self-administered completion in this context for several methodological reasons i.e., it ensures that all the participants have an equal opportunity to seek clarification on any item they find ambiguous or unclear, thereby reducing the likelihood of misinterpretation and improving the accuracy and reliability of the data that has been collected; it enables the investigator to maintain a consistent and standardized administration of the questionnaire across all the participants, thereby minimizing the risk of differential item interpretation that could introduce bias into the KAP data.

3.2.2.d Providing integrated questions in to a link. Upon completion of the participants' assessment and with each participant's informed consent, a google forms link that is developed for the EMA component of the study that was provided to each participant's personal smartphone. After providing them the link a standardized orientation to the Google forms was given, during which the investigator provided information about the interface, explained the nature and timing of the prompts they would receive, demonstrated the process for completing a questionnaire entry, and addressed any questions or concerns about using the about the link. Participants were informed that appropriate prompts will be provided through a messaging application and would give them prompts according to a daily schedule for a period of one week, and that the participants are expected to respond to it, reflecting their listening behaviour and context at that specific moment, rather than relying on retrospective recall.

3.2.2.e Monitoring the Behaviour. During one week of EMA monitoring, the participant’s responses to the questionnaire were collected through Google forms. After the monitoring period, the accumulated EMA data was extracted and systematically analyzed characterize each participant's listening behaviour across the full range of variables captured by the instrument, including patterns of daily PLD use, volume-setting behaviour across different environments and various time points, particular device and content type preferences, and the contextual factors that are associated with various episodes of potentially hazardous exposure. These data were examined in conjunction with the objective PLD output measurements and the KAP questionnaire scores obtained during the initial assessment session. This enabled a comprehensive analysis of the relationship between participants' real-world listening habits and their knowledge, attitudinal, and practice profiles with respect to the aspect of noise exposure. These findings, generated through this monitoring and analysis process, will directly address the study's primary aim: to explore the relationship between listening habits and KAP regarding noise exposure among college-going young adults.

3.2.3 Data analysis

Descriptive statistics were carried out for the EMA questionnaire, in which for each question, the frequency of occurrence of particular options was analyzed, and for the correlation analysis, in which inferential statistics were used, in which normality tests were carried out based on the results, appropriate parametric and non-parametric tests were carried out.

Chapter 4

RESULTS

The findings from the study are presented under the following sections according to the four study objectives:

4.1 Listening habits of young adults
4.2 PLD output measurement and reported volume level usage
4.3 Knowledge, Attitude and Practice Regarding PLDs
4.4 Correlation of listening behaviour with KAP score and KP score

4.1 Listening habits of young adults

4.1.a The Ecological Momentary Assessment Questionnaire:

The Ecological momentary assessment questionnaire developed comprised of 27 questions to elicit the information regarding the patterns of personal listening devices (PLDs) usage by the participants. There were five common questions, and the rest of the information was conditionally derived based on whether they chose to listen to Music, Other audio content, or both. Those who listened to music alone responded to seven follow up questions, those who listened to other audio content responded to seven follow up questions and those who listened to both responded to eight follow up questions. The complete questionnaire is given in Appendix 1.

4.1.b The listening habits of the participants:

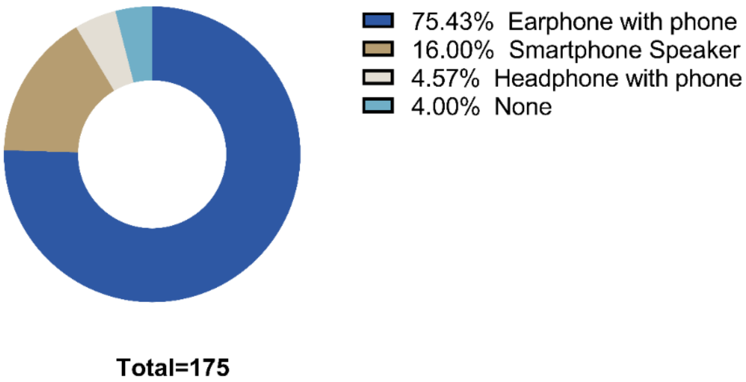
The listening habits of the participants were assessed over a time period of one-week through EMA method using 27 questions. A total of 175 daily responses were recorded per common question from the 25 participants, over a period of 7 days. The number of responses for the other questions based on the conditional branching varied based on the participants' listening preferences. The findings from the participants' reports over the time of the study participation are given below:

Responses to common questions

i. Figure 4.1 shows the usage patterns of transducers by the participants. Majority of daily responses (132/175) indicated that participants predominantly used earphones connected to a smartphone for their daily listening. Smartphone with speakers represented the second most commonly reported type of configuration (28/175). Headphones connected to a phone were reported by a lesser number of participants (28/175), and 8 times there was no usage of PLD reported.

Figure 4.1

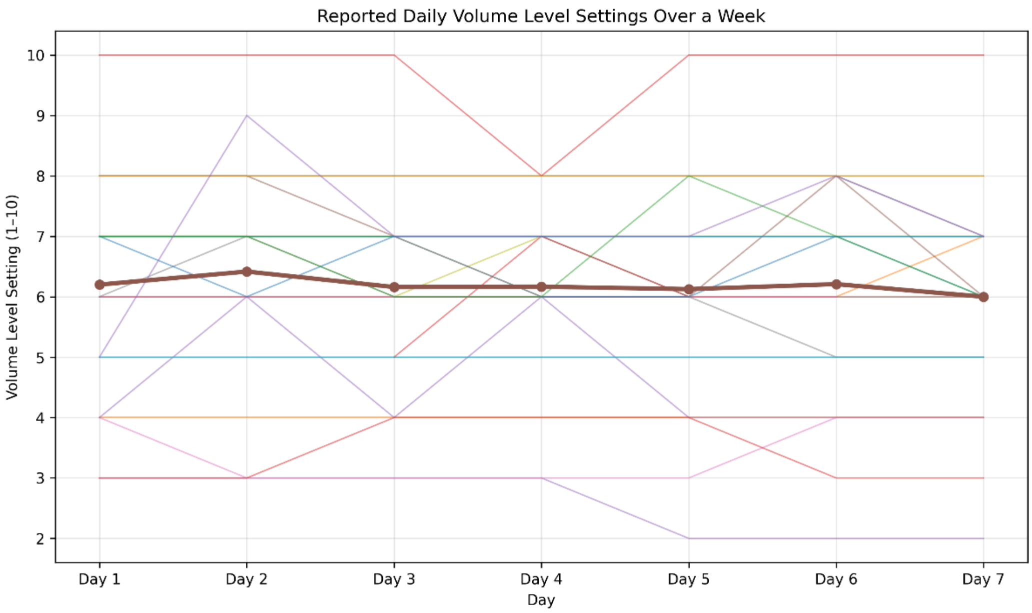
Types of personal listening devices used by respondents



ii. Figure 4.2 shows the volume setting reported by each participant as they listened to their PLD each day separately during the seven-day monitoring period. Participants reported their typical daily volume setting on a scale of 1-10 (considered in percentage varying from 0 to 100%). The volume preferences varied from individual to individual, and the data indicates the individual preferences mostly did not change during the monitoring period.

Figure 4.2

Preferred volume levels for listening to their PLD output by the participants over the 7 day reporting period. The mean value is in dark brown and bold, while the individual preferences are in ligher lines. (Volume settings are in percentages – 1=10% and 10=100%)

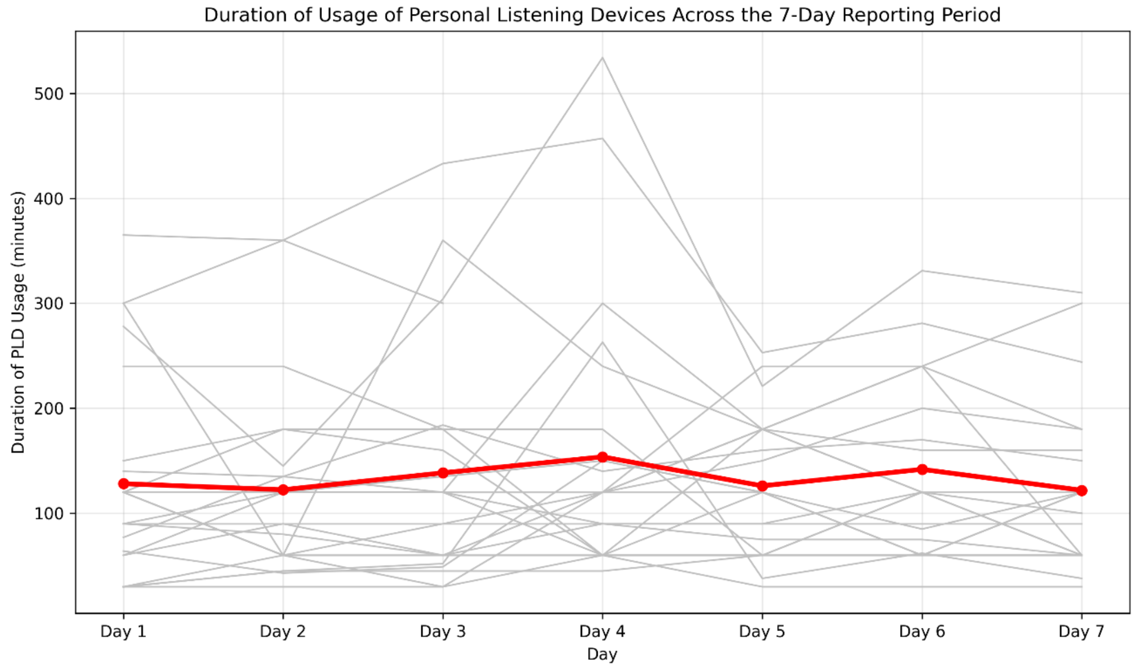


The mean volume setting was calculated for each participant across the days on which they reported PLD use, yielding an individual mean volume score that was used for subsequent analysis. The mean volume setting was 6.19 (SD = 1.68), with individual participant means which is ranging about a minimum of 2.57 to a maximum of 9.71.

iii. Figure 4.3 shows the daily listening duration in minutes reported by each participant across the seven-day monitoring period. The mean daily listening duration was calculated for each participant across the days on which PLD use was reported, yielding an individual mean duration score that was used for subsequent analysis.

Figure 4.3

Duration of usage of personal listening devices across the 7 day reporting period. The mean value is in red, while the individual reports are in grey lines.

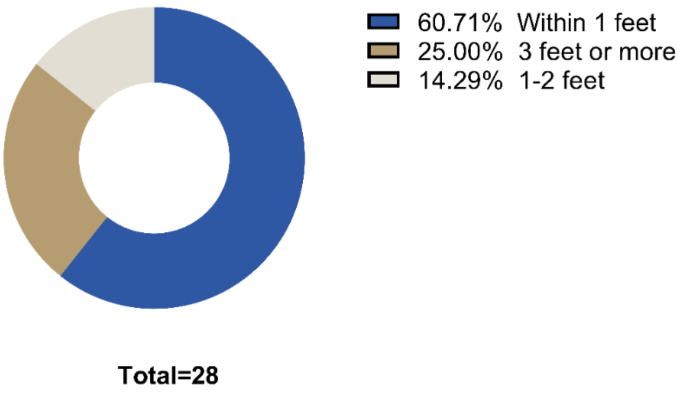


The mean daily listening duration of the PLDs was about 136.18 minutes, which is equivalent to approximately 2 hours and 20 minutes per day with a SD of 77.59 minutes. Individual participant values ranged from a minimum to maximum of 49.29 minutes to 341.86 minutes (5.7 hours approximately) per day.

iv. Figure 4.4 shows the distance from the ears the PLD speaker was kept. This question is applicable only to those entries that reported the usage of speakers or smartphone speakers (28 out of 175 times reported).

Figure 4.4

Preferred distance for placing the speaker during listening to content.

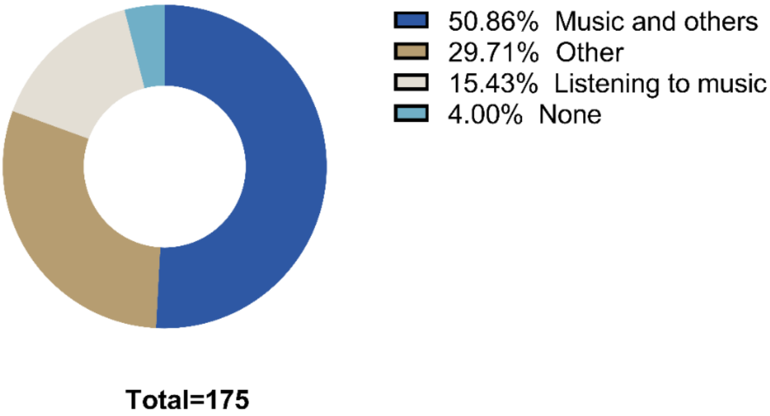


The majority of the responses indicated speaker distance within 1 foot (17 /28). The second most prominent response was the 3 feet or more category having 7 responses, while the 1-2 feet category was the least common, with having only 4 responses.

v. Figure 4.5 shows the nature of the content participants used their PLD to listen to each day of monitoring. Participants were given three response categories that included listening to music only, others, and music and others, where selection of a category resulted in conditional branching (and appropriate follow-up questions based on their selection).

Figure 4.5

The nature of the content participants used their PLD to listen to each day of monitoring



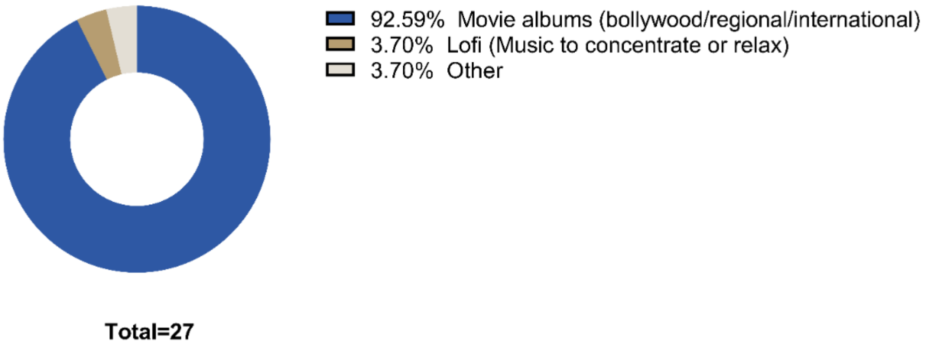
The category 'music and others' was the most frequently reported among the listening activities across the monitoring period, accounting for 89 out of 175 responses. The 'others only' category was the second most common response, accounting for 52 responses, while listening to music exclusively accounted for 27 responses. Days on which no PLD use was reported accounted for 7 responses. Collectively, responses involving music listening whether exclusively or in combination with other activities, accounted for 116 out of 175 daily responses.

Responses to follow-up questions for the participants who chose Listening to music

i. The first question was conditionally administered only to participants who reported listening to music on the particular day of monitoring. Response options for this question included movie albums encompassing Bollywood, regional, and international film soundtracks, lofi music described as music to concentrate or relax, and an open other category for genres not listed. Across the full monitoring period, a total of 175 daily responses were recorded, of which the majority were not applicable owing to the conditional nature of the question. Figure 4.6 shows the genres of music listened to by the respondents.

Figure 4.6

Genre of music listened to by respondents

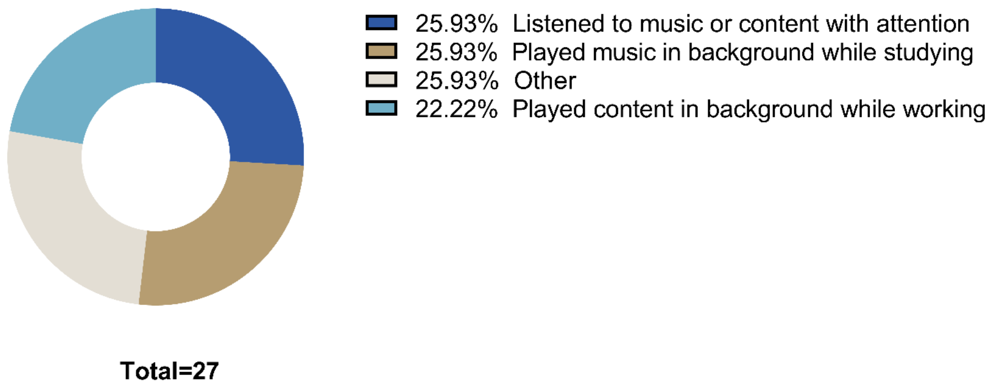


Among the 27 valid responses of the genre that has been recorded during the monitoring period, movie albums encompassing Bollywood, regional, and international film soundtracks were the most frequently reported genre, accounting for 25 out of 27 valid responses. Lofi music was reported on one occasion by a participant, and the other category was reported on one occasion by a Participant, with neither participant specifying an alternative genre further. No other genre categories were reported across the monitoring period.

ii. The second follow up question captured the degree of attentional engagement with the audio content and comprised four categories: listened to music or content with attention, played content in the background while working, played music in the background while studying, and other. Figure 4.7 shows the responses.

Figure 4.7

Level of attention paid while listening to content by respondents

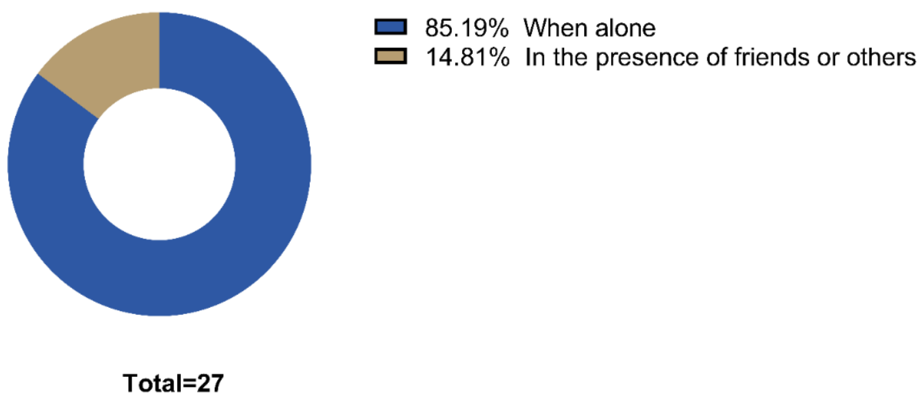


The four response categories were rather equally distributed. Listened to music or content with attention and played music in the background while studying each accounted for 7 responses, and played content in the background while working accounted for 6 responses.

iii. The third question captured the context in which the participant listened to music. The responses options were 'when alone; or 'in the presence of friends or others'. Figure 4.8 shows the responses for the same.

Figure 4.8

The context in which the participants listened to music

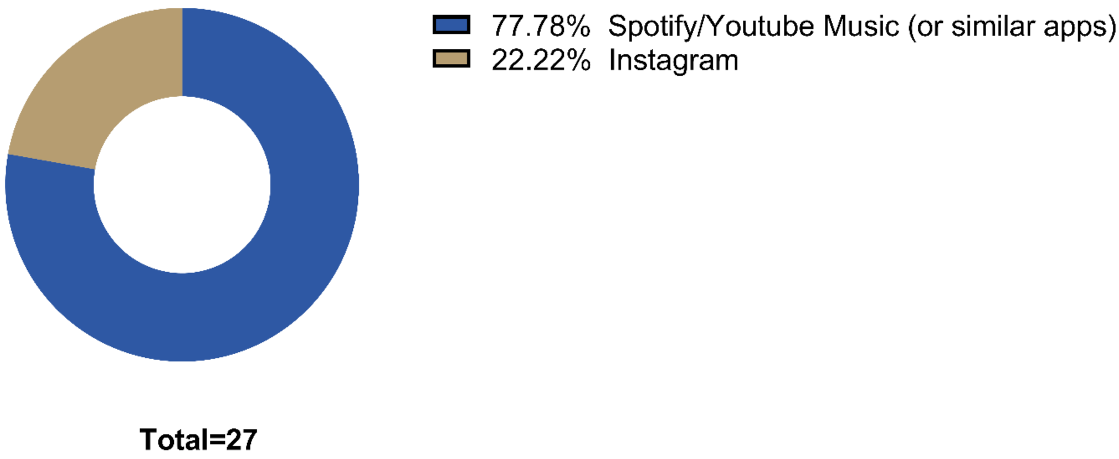


Solitary listening was predominant (23/27). Listening in the presence of friends or others accounted for the remaining 4 valid responses.

iv. The fourth question captured their preferred platforms for listening to music. The response options comprised Spotify or YouTube Music, and social media platforms such as Instagram. The figure 4.9 shows the responses.

Figure 4.9

Most frequently used app for listening among respondents

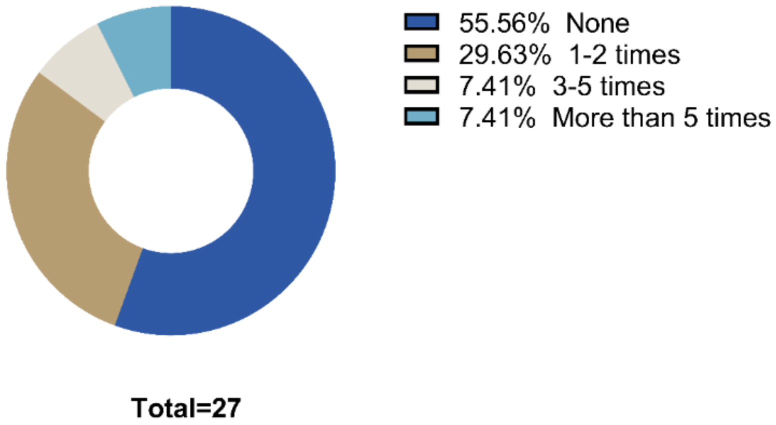


The music streaming applications were the most frequently reported (21/27). Instagram, accounted for the remaining 6 valid responses.

v. The fifth question collected the information on whether the participants noticed the high volume alerts and long duration notifications in smartphone operating systems (Figure 4.10). Response options comprised four categories: none, 1 - 2 times, 3 - 5 times, and more than 5 times. Figure 4.10 shows the responses.

Figure 4.10

Frequency of high volume or long duration warnings noticed by respondents

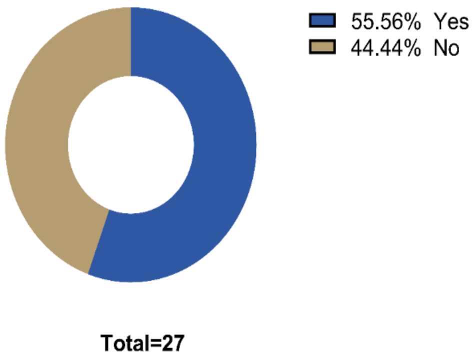


15 out of 27 responses, indicated they did not encounter any device-generated hearing health alerts. Warnings noticed 1 to 2 times accounted for 8 responses, while warnings noticed 3 to 5 times and more than 5 times each accounted for 2 responses respectively.

The question assessed whether participants were listening to music through their PLD in the presence of background noise (Figure 4.11). The reports indicate that 15 out of 27 individuals listened to music in the presence of background noise.

Figure 4.11

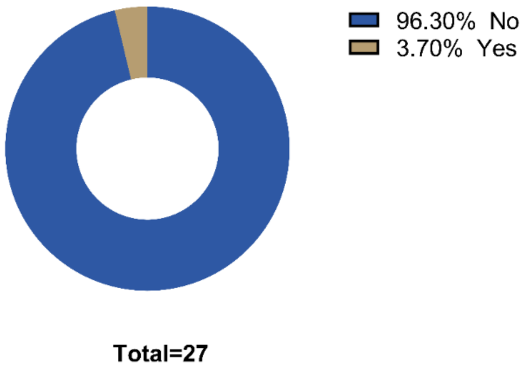
Distribution of presence of background noise during music listening through PLDs



vi. The seventh question was to determine whether participants, upon receiving a high volume alert or long duration notification from their smartphone or music streaming application, chose to override the warning and continue listening. Response options were binary (Yes/No). Across the 27 valid responses 26 out of 27 responses were No. Yes, response was recorded on one occasion. Which is shown in the figure 4.12.

Figure 4.12

Self-reported override of phone listening warnings among respondents



***Responses to follow-up questions for the participants who chose* 'Other audio related content'**

i. The first question tried to characterize the nature of non-music PLD use among participants by identifying the predominant listening activity engaged in during the days of exposure. Response options comprised of Reels, Long videos (movies or web series), podcasts or eBooks, gaming, and Other (Figure 4.13)

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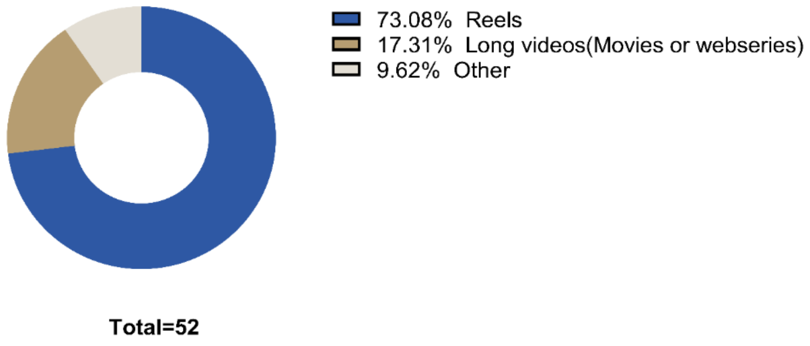
Figure 4.13

Primary listening activity engaged in by respondents who reported listening to 'Other audio content'

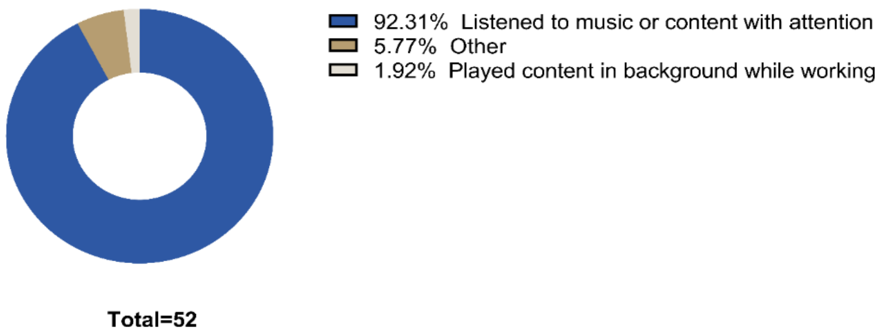


Across the 52 valid responses recorded during the particular days of the monitoring period, Reels was the predominant content (38/52) consumed. Long form content, encompassing movies and web series, accounted for 9 responses, while Other activities accounted for the remaining 5 responses (9.6%).

ii. The second question was to determine the attentional engagement with PLD-mediated content among participants. The responses were shown in the figure 4.14

Figure 4.14

Level of attention paid while listening to content other than music by the respondents

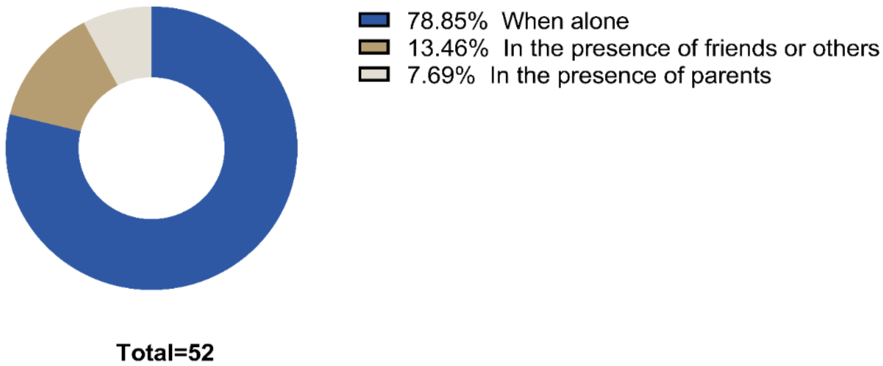


Listened to music or content with attention was the dominant among the category of responses (48/52). Only 3 instances reported played content in background, and while working accounted for only 1 response.

iii. The third question was to characterize the social context in which participants used PLDs for content other than music. Response options comprised the categories: "When alone," "In the presence of friends or others," and "In the presence of parents." The responses are shown in the figure 4.15

Figure 4.15

Distribution of peak phone listening times among respondents for music listening

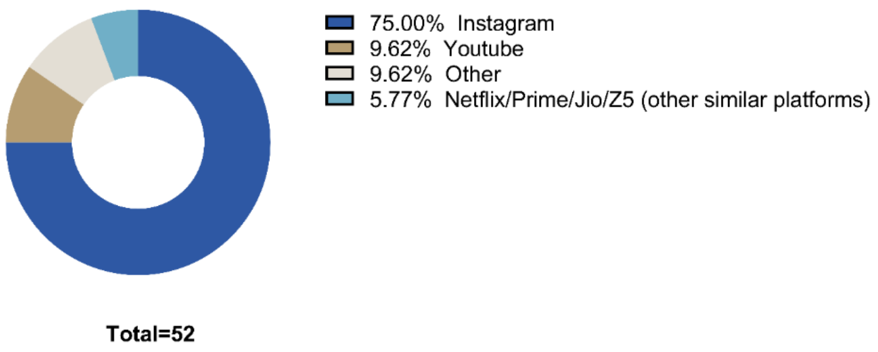


"When alone" was the most predominantly response (41/52), "In the presence of friends or others" accounted for 7 responses, while "In the presence of parents" accounted for 4 responses.

iv. The fourth question tried to identify the platforms or the applications used for consuming content other than music. Response options comprised listed categories including Instagram, YouTube, Netflix/Prime/Jio/Z5 (and other similar streaming platforms), Gaming and an "Other" category. Responses are shown in Figure 4.16.

Figure 4.16

Most frequently used app for listening to non-musical content among respondents

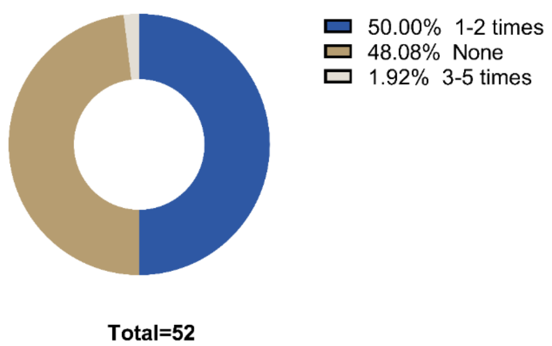


Instagram was the predominantly reported platform (39/52). YouTube accounted for 5 responses, the "Other" category also accounted for 5 responses, and Netflix/Prime/Jio/Z5 (and other similar streaming platforms) accounted for 3 responses. Gaming and No other applications were not reported.

v. The fifth question intended to assess the frequency of exposure to device generated safety warnings when using PLDs for non-music content. Response options comprised four categories: 1-2 times,3-5 times, More than 5 times and None. Responses are shown in the figure 4.17.

Figure 4.17

Frequency of high volume or long duration warnings noticed by respondents while listening to non-music content

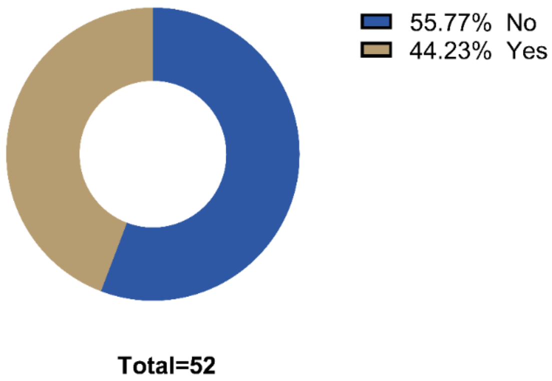


26 out of 52 times the participants reported receiving the warning "1-2 times", while 25 times no warning was reported. Receiving warning "3-5 times" was reported only once, and no responses were obtained for "more than 5 times".

vi. The sixth question assessed whether these participants were listening to the content in the presence of background noise while consuming non-musical content (yes/no responses). Responses are represented in the figure 4.18.

Figure 4.18

Distribution of presence of background noise while consuming non-musical content

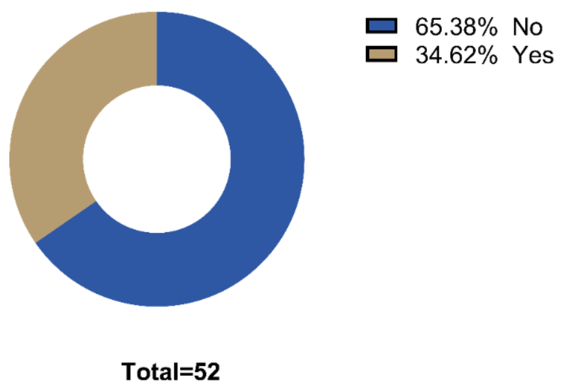


Participants predominantly consumed the content in the absence of background noise as reported (29/52).

vii. The seventh question intended to assess whether the participants chose to override device generated safety warnings related to higher volume or prolonged duration exposure. Response options comprised two categories: "Yes" and "No". Responses are represented in the Figure 4.19.

Figure 4.19

Self-reported override of phone listening warnings among respondents



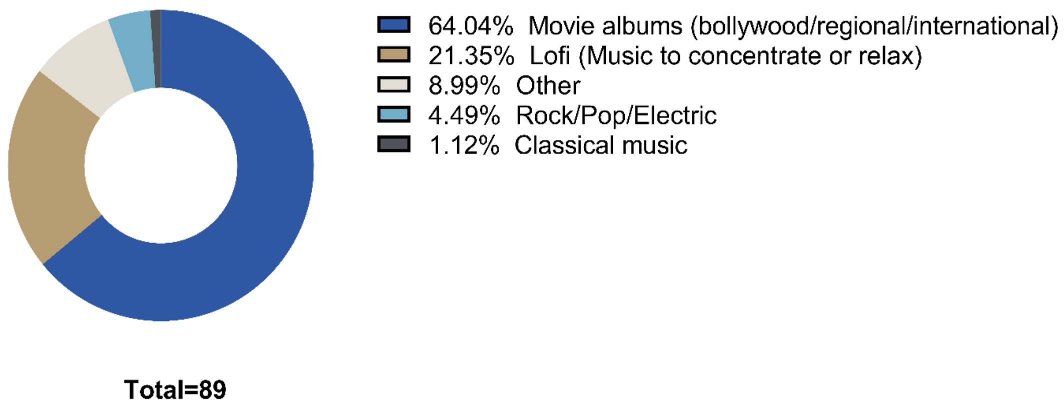
The results revealed that 34/52 times participants did not override warnings, while 18 times they did.

Responses to follow-up questions for the participants who chose Listening to music and other content

i. The first question was designed to characterise the specific genre of music consumed Response options comprised “Movie albums (Bollywood/regional/international)”, “Lofi (Music to concentrate or relax)”, “Rock/Pop/Electric”, “Classical music”, "Metallica" and “Other”. Responses are represented in the Figure 4.20

Figure 4.20

Genre of music listened to by respondents who reported PLD usage for 'music and others'

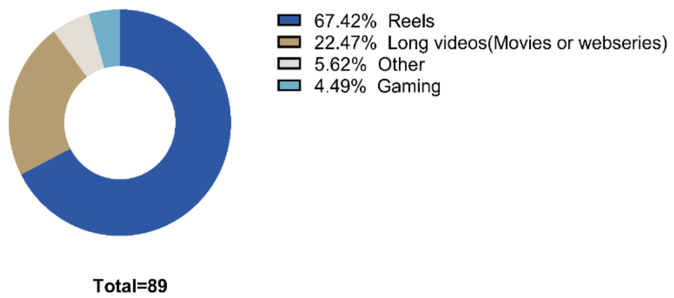


'Movie albums' was the predominantly dominant genre (57/89), 'Lofi' was the second most frequent genre (19/89), 'Other' was reported 8 times, 'Rock/Pop/Electric' 4 times, and 'Classical music' once.

ii. The second question intended to understand the participants' consumption of content other than music. Responses options composed "Reels" (short-form video content typically from social media platforms), "Long videos (Movies or web series)", "Gaming", "podcast or eBook's" and "Other". Responses are represented in the Figure 4.21

Figure 4.21

Primary listening activity engaged in by respondents who reported listening to 'Music and other audio content'

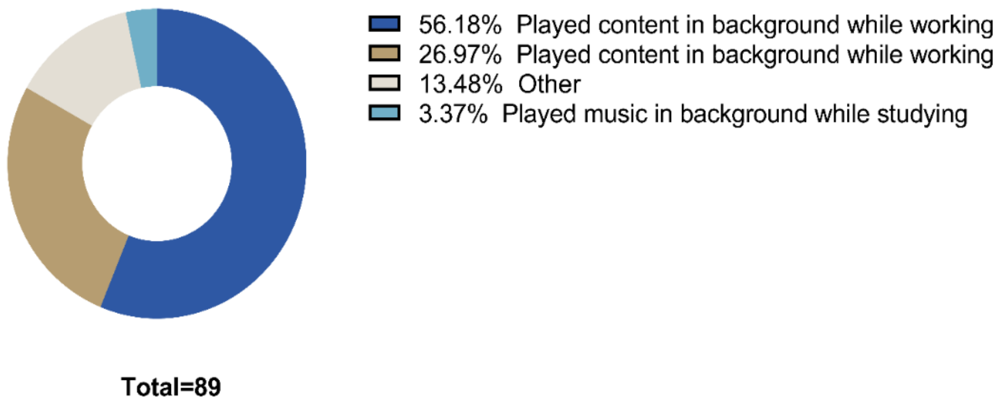


'Reels' was the most reported content type (60/89). Long videos reported 20 times, 'Other' was reported 5 times, and 'Gaming' was reported 4 times.

iii. The third question determined the quality of engagement with PLD-mediated music content, namely "Listened to music or content with attention", "Played content in background while working", "Played music in background while studying", "Played music in background while exercising" and "other". Responses are shown in the Figure 4.22

Figure 4.22

Level of attention paid to listening content by respondents (who reported consuming music and others) while listening to music

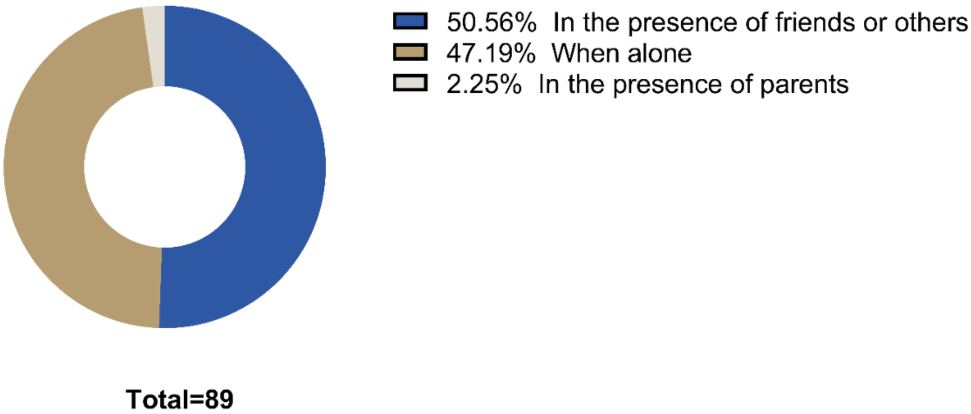


'Listened to music or content with attention' was the most reported (50/89). "Played content in background while working" was the second most common response (24/89), followed by "Other" (12/89). "Played music in background while studying" accounted for only 3 responses.

iv. The fourth question was administered to determine the social context in which participants primarily consumed music content ("When alone," "In the presence of friends or others," and "In the presence of parents"). Responses are shown in Figure 4.23

Figure 4.23

Distribution of peak phone listening times among respondents (who chose music and others) for music listening

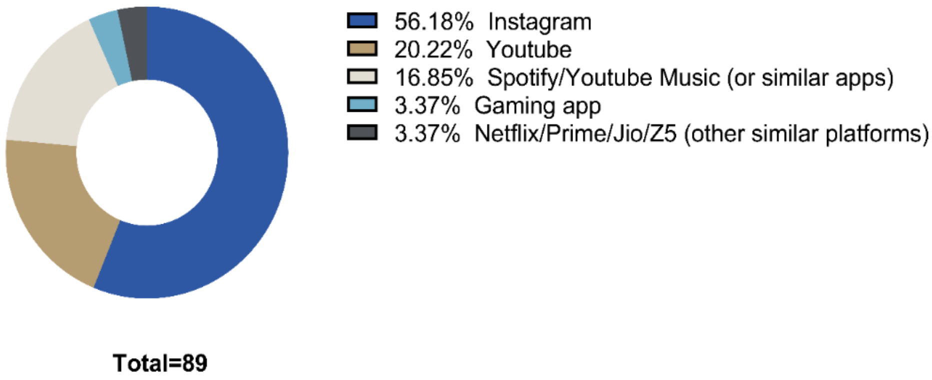


"In the presence of friends or others" was the most frequently reported category (45/89) and "When alone" was the second most common response (42/89). "In the presence of parents" accounted for only 2 responses.

v. The fifth question was administered to identify the platforms or applications that are used for music listening by the respondents. Response options comprised "Instagram", "YouTube", "Spotify/YouTube Music (or similar apps)", "Netflix/Prime/Jio/Z5 (other similar streaming platforms)", "Gaming app" and "others". Responses are shown in the Figure 4.24

Figure 4.24

Most frequently used app for listening among respondents

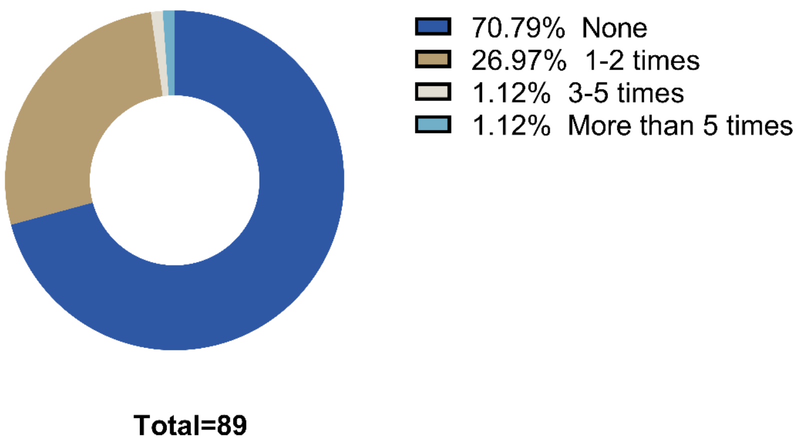


"Instagram" was the most frequently reported application (50/89), "YouTube" was the second most common (18/89), followed by "Spotify/YouTube Music (or similar apps)" (15/89). and "Netflix/Prime/Jio/Z5 (other similar platforms)" and "Gaming app" (3 each).

vi. The sixth question was administered understand the frequency of exposure to device generated safety warnings. Response options comprised: "None," "1-2 times," "3-5 times," and "More than 5 times." Responses are shown in the Figure 4.25

Figure 4.25

Frequency of high volume or long duration warnings noticed by respondents

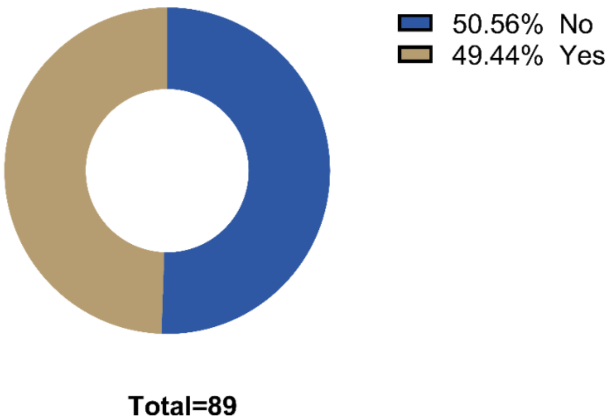


Most of the times no warning were encountered by the respondents (63/89). "1-2 times" was the second most common response (24/89), and "3-5 times" and "More than 5 times" were each reported once.

vii. The seventh question was administered to determine whether participants were exposed to background noise while listening to music on their PLDs, Response options comprised two categories: "Yes" and "No." Responses were shown in the Figure 4.26.

Figure 4.26

Distribution of background noise conditions during listening to music through PLDs

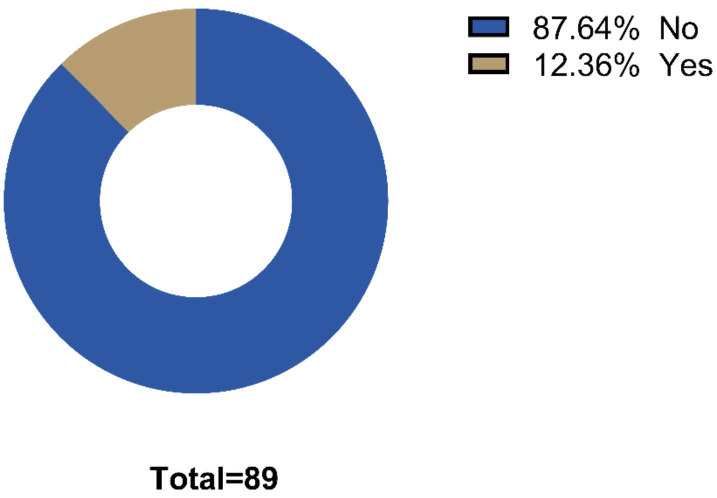


Participants reported not listening in background noise 45/89 times, 44/89 times they responded to listening in the presence of noise.

viii. The eighth question was to determine if the participants chose to override device generated safety warnings for safe listening (Yes/No). Responses are shown in the Figure 4.27.

Figure 4.27

Self-reported override of phone listening warnings among respondents



The participants did not override warnings 78 out of 89 times, and ignored the warning the remaining 11 times.

4.2 PLD output measurement and reported volume level usage

The mean output level recorded from the personal listening devices (PLDs) of the participants was 67.80 ± 6.41 dB. The normality of the data was assessed using the Shapiro–Wilk test, which indicated that the PLD output values were normally distributed ($p > 0.05$).

To examine the relationship between the objectively recorded output levels and the participants' self-reported average volume settings, a correlation analysis was performed. Pearson's correlation coefficient revealed no significant association between the recorded PLD output levels and the average percentage volume levels reported by the participants ($r = 0.182$, $p = 0.385$).

4.3 Knowledge, Attitude and Practice Regarding PLDs

4.3.1 KAP questionnaire

The KAP questionnaire comprised of 18 questions which are mainly determined to know about the knowledge, attitude and practice of the participants in which mainly related to the usage of their PLD's, type of PLD, duration of usage, audio content related, Average usage all those were assessed.

4.3.2 Responses

a. The first question collected information regarding the primary transducer used by the participants, a total of 25 responses were recorded. The majority of participants reported using **earphones**, with 24 out of 25 respondents (96.0%) indicating this as their primary device type. Only one participant had (4.0%) reported using **headphones**.

b. The second question collected information regarding the number of years of smartphone usage. The number of years of smartphone usage ranged from a minimum of three years to a maximum of ten years. The mean duration of the smartphone use was 6.28 years (SD = 2.19). Thus, the modal duration was 10 years (24% of participants), followed by 6 and 7 years (20% each). These findings indicate that the participants, on average, had approximately six years of smartphone experience, suggesting a generally proficient and habituated user base with substantial exposure to smartphone-based audio listening.

c. The third question represents the duration of the smart phone for listening per day. The reported daily listening durations ranged from a minimum of 180 minutes to a maximum of 690 minutes. The mean listening time was 451.8 minutes per day, with a median of 450 minutes. The distribution was relatively centered, with the majority of participants reporting in between 300 and 600 minutes.

d. The fourth question tried to understand their perception of percentage of the hours spent listening through their PLDs. The values ranged from a minimum of 13% to a maximum of 76% of the total duration of device usage. The mean percentage was 39.3% (SD = 16.2), and the median was 40%. The mode was 50%, which was occurring four times (16% of responses), followed by 30% which occurred three times. Only three participants exceeded 60%, and only two fell below 20%.

e. The fifth question collected information on the frequency of music listening. The frequency distribution as follows: “Sometimes” was the most common response, selected by 14/25 participants (56.0%), followed by “Often” with 7/25 participants (28.0%). “Rarely” and “Very often” were each reported by 2 participants (8.0% each).

f. The sixth question collected information about the participant’s exposure to noisy environments. Majority (13/25, 52.0%) of the participants were ‘rarely’ exposed to noise, while (7/25, 28.0%) were sometimes, (4/25, 16.0%) were exposed often, and 1 participant (4.0%) was ‘very often’ exposed to noise.

g. The seventh question collected participants’ information on the average duration of music listening in a week. The reported weekly listening durations ranged from a minimum of 420 minutes (7 hours) to a maximum of 1,600 minutes (approximately 26.7 hours). The mean listening time obtained was 892.8 minutes per week, with a median of 840 minutes.

h. The eighth question collected information on the participants’ online gaming frequency. The reported frequencies ranged from a minimum of 1 time per week to a maximum of 5 times per week. The mean frequency was 1.5 times per week (SD = 1.0), with a median of 1. 8 participants (72%) reported playing once per week, 3 participants (12%) reported three times per week, and one participant each (4%) reported 2, 4, and 5 times per week, respectively.

i. The ninth question examined the participants' self-identification as a professional gamer. The majority of participant, 23 out of 25 respondents (92.0%) answered "No," indicating that they do not identify as professional gamers. Only two participants (8.0%) answered "Yes." No other response options were selected.

j. The tenth question explored whether there were any sources of constant loud sounds where they lived. All 25 participants (100%) answered "No,".

k. The eleventh question assessed whether the participants had any difficulty understanding speech in noisy environments. "No" was selected by 14 participants (56.0%), while "Sometimes" was selected by 11 participants (44.0%).

l. The twelfth question assessed participants' self-perception of their hearing ability (1: the worst hearing level, 10: the best hearing level). The mean rating was 8.9 (SD = 0.6), and the median was 9. The most frequent rating was 9, selected by 16/25 participants (64.0%), followed by 8 selected by 5/25 (20.0%) and 10 selected by 4/25 (16.0%).

m. The thirteenth and fourteenth questions explored whether participants perceived PLD usage as the reasons for their hearing difficulty, if any. "If you have hearing difficulties, what do you think is the cause", a total of 25 responses were recorded. All 25 participants (100%) answered "No," indicating that none of the respondents reported having any hearing difficulties.

n. The fifteenth question assessed whether the participants were aware that loud noise has any other effect on health. All 25 participants (100%) answered "Yes,".

o. The sixteenth question assessed whether the participants were aware that listening to loud music can cause permanent hearing loss even in young people. All 25 participants (100%) answered “YES”.

p. The seventeenth question assessed whether the participants were familiar with volume-limiting (or safe listening) features on their personal music devices. 9/25 participants (36.0%) were familiar, whereas 16/25 participants (64.0%). Were unaware.

q. The eighteenth question assessed the participants’ knowledge of whether noise induced hearing loss can be prevented in advance. 22/25 participants (88.0%), thought that it was possible to do so, while 3/25 participants (12.0%) answered “No” No other responses were provided. The results indicate that the overwhelming majority of participants believe that noise-induced hearing loss is preventable through advance measures.

r. The nineteenth question collected information on whether they were aware that tinnitus (or ringing in the ears) is a symptom of overexposure to hazardous noise. Among the participants, 20 (80.0%) were aware and 5 (20.0%) were unaware.

4.4 Correlation of listening behaviour with KAP score

The relationship between listening behaviour and participants KAP scores was examined by correlating the average volume and average duration of PLD usage with the KAP scores. Spearman's rank correlation analysis revealed no significant correlation between KAP scores and either average volume of PLD usage ($\rho = 0.14$, $p = 0.51$) or average duration of PLD usage ($\rho = 0.04$, $p = 0.84$).

Similarly, the relationship between listening behaviour and KAP scores was assessed using Spearman's rank correlation analysis. The results indicated no significant correlation between KP scores and average volume of PLD usage ($\rho = 0.13$, $p = 0.54$) or average duration of PLD usage ($\rho = 0.06$, $p = 0.76$).

Overall, neither the average listening volume nor the average duration of PLD usage showed a significant association with the KAP or KP scores of the participants.

Chapter 5

DISCUSSION

The present study employed Ecological Momentary Assessment (EMA) to study patterns of personal listening device (PLD) usage among college-going students. Unlike the traditional retrospective questionnaires that are used to study the use and impact of exposure to recreational noise, EMA captures listening behaviour closer to the time of occurrence. This, therefore, reduces recall bias in the participants and helps gather a more representative picture of everyday PLD usage habits of the participants. The findings provide insights into the types of transducers used, listening duration and volume preferences, content consumption patterns, and safe listening behaviours among the participants studied.

5.1 Device Preferences and Listening Configurations

The study participants had preference for earphones over headphones used in conjunction with their mobile phones. Both the EMA responses and the KAP questionnaire demonstrated that nearly all participants primarily used earphones for listening. This finding is clinically relevant because earphones deliver higher sound pressure levels at the tympanic membrane compared to speakers and circumaural headphones (Voss & Herrmann, 2005). The preference of earphones over headphones or speakers is more relevant when we consider the number of hours of PLD usage among the participants. The recommended safe levels of music exposure is not more than 4 hours if the volume is at 70% or 90 minutes if the volume is at 80% (Berg et al., 2016). The mean reported volume levels according to the present study is 6.19 (SD = 1.68), with individual participant means which is ranging about a minimum of 2.57 to a maximum of 9.71. This indicates that the listening practices using PLDs are poor among the participants studied.

Listening to music through speakers is generally considered healthier than while using earphones. In the study, when participants reported listening through speakers rather than earphones, the speakers were generally positioned within one foot of the ears. The distance from the ear also shall play an important role in the SPLs delivered to the ear. According to the inverse square law, in a free field the sound energy decreases by **6dB** for every doubling of distance from the source (“Room Acoustics,” 2020). A preference to place the speaker farther away may also have indicated an inclination towards safe listening practices. However, when participants were not using earphones, listening habits were characterized by a preference for maintaining audio sources close to the listener.

5.1.1 Listening Volume and Duration Preferences

There was substantial variability in the participants’ preferred listening volume levels. Some individuals consistently preferred listening at relatively low volume settings, some others preferred mid-levels, and the rest preferred considerably higher levels. However, it was also observed that volume preferences remained stable within individuals across the seven-day monitoring period. The same pattern was observed for listening duration.

This lack of variability within individuals suggests that their participation in the study did not influence their listening behaviour. That is, the study participants did not demonstrate reactivity (participants modifying their behaviour due to awareness of being under observation) (Portnuff et al., 2013a). Reactivity is a concern in EMA studies since the participants are well aware that their behaviour is being monitored. This however may be ruled out as a confounding factor in the current study. Any influence of participant consciousness in the results may be absent from the study since the study duration was short. As the duration of the particular period of monitoring increases there are larger the number of attrition noted. In the current study, the listening volume level appears to represent an established personal habit that remains relatively constant over time.

51.2. Duration of PLD Usage

Similar to the volume level preferences, reported listening duration also varied substantially across participants. Nevertheless, individual listening durations remained relatively consistent throughout the monitoring period, suggesting stable personal listening routines. The results regarding the duration of listening may be considered from the KAP questionnaire responses as well as the EMA reports.

According to the KAP questionnaire responses, the participants spent an average of approximately 2.25 hours daily on PLDs. The reports from the EMA reports also indicates an average 2.75 hours of PLD usage. These durations exceed the recommended safe levels of exposure (Berg et al., 2016). It also indicates a common practice of gadget usage among the population studied. This is a concerning trend since level of exposure as well as duration can both have hazardous impact on the listener's hearing. Prolonged daily listening may therefore contribute to cumulative auditory stress even when listening levels are not excessively high. It should also be noted that the PLD usage is not restricted to music listening. The audio consumption is spread across different platforms and content types including short and long form contents. The content could be educational, recreational, and social media-related, and consumed throughout the day.

5.1.3 Nature of Content Consumption

While providing responses to the EMA questionnaire, participants reported whether their audio consumption was primarily restricted to music or included other forms of audio content. The follow-up questions were tailored conditional to their response to this question. This enabled comparison between participants who had different listening habits. The majority of participants reported using PLDs for both music and other forms of audio content. This is understandable given the contemporary digital environment, where audio and audiovisual content is available across multiple platforms and devices. The content consumed could be on platforms meant for social media, streaming services, educational applications, and video-sharing websites. The devices could be smart phones, computers, or television sets. Audio consumption has become deeply integrated into individuals' daily activities in the society. It is no longer restricted to traditional music listening. There was a smaller group of participants who reported listening primarily to music. Interestingly, the listening behaviour of the two groups revealed distinct patterns.

Participants who listened exclusively to music preferred movie albums as the predominant genre. They reported of listening to music primarily when alone. They tended to listen to music almost in equal proportions by paying full attention, in the background, as well as while studying. Such behaviour suggests that music may serve multiple functions, including entertainment, mood regulation, concentration, and environmental enrichment. They also predominantly used music streaming applications for listening.

Individuals who listened to music along with other content, listened to other genres (e.g. lofi) too, along with movie albums. They also reported of consuming content with focused attention most of the time. Use of content in the background or while studying was not reported. The source of content was primarily Instagram, and probably this is the reason for more active engagement with the listening material. In addition, participants who consumed both music and other content reported a more diverse listening profile.

The findings suggest that listening behaviour is increasingly shaped not only by the content consumed but also by the digital platforms through which the content is accessed.

5.1.4 Social Context of Listening

Across the groups it was reported that PLD usage primarily happened when the participants were alone. This trend may be exacerbated by the portability and personalized nature of modern listening technologies. Considering that the duration of listening is also high in most instances reported, this reflects considerable lone time among the participants. This could indicate a reduction in opportunities for face-to-face social interaction. However, the present study did not directly assess social outcomes. Nevertheless, previous literature has shown increased solitary media consumption to be associated with reduced social engagement and greater dependence on personal devices (Hall & Liu, 2022). Reduction in social interactions is also associated with poorer mental health (Morina et al., 2021).

In this light, it may be recommended that encouraging activities that involve greater interpersonal interaction may naturally reduce the amount of time spent engaging with PLDs, and positively influence mental health of the population. Creating opportunities for group participation, recreational activities, and social engagement may therefore represent a practical approach to reducing excessive listening exposure.

5.1.5 Compliance to Device Warnings

In an interesting observation, participants who consumed non-musical content and those who listened to both music and other content reported overriding warnings more frequently than participants who listened exclusively to music. The reason for this could be that these individuals spent actively engaging with their devices more than those who listened exclusively to music. Frequent interaction with smartphones increases the likelihood of encountering duration-based listening warnings, which the former group must also have encountered. Repeated exposure to such warnings may gradually reduce their effectiveness, leading users to ignore or override them. Repeated exposure to alerts without any immediate consequence can result in reduced responsiveness over time. This phenomenon is called warning fatigue (Michels et al., 2025). The findings therefore suggest that providing warnings without any evident consequence may be insufficient to promote safe listening behaviour among PLD users.

5.2 Relationship Between Self-Reports, SPL Measurements, and KAP Scores

There was no significant correlation between participants' self-reported volume settings and the objectively measured output levels of their PLDs. Similarly, there was no significant relationship listening behaviours (duration) and KAP scores. This is similar to the reports by Shim et al. (2018), who reported absence of a relationship between listening behaviour and KAP scores. Their findings suggest that awareness and knowledge alone may not be sufficient to influence listening practices. Although participants generally demonstrated good awareness regarding hearing conservation and the potential risks associated with loud listening, this awareness did not translate into safer listening behaviours.

The lack of correlation between reported volume settings and measured output levels suggests that subjective estimates of listening volume may not accurately reflect actual acoustic exposure. Participants may interpret percentage volume settings differently, and identical percentage values may correspond to substantially different sound pressure levels across devices, earphones, and media sources. This finding is in consensus with other reports in literature that indicates lack of correlation between reported and observed behaviours of PLD usage (Portnuff et al., 2013b). This also indicates that monitoring the listening behaviours of individuals through direct input of device usage and controls will serve as a better tool for understanding PLD usage and patterns. For example, Paping et al. (2021), in their study gathered information regarding participants' PLD listening duration and volume through direct input from an application installed for the study.

Together, these findings raise important concerns regarding the reliability of self-reported listening data. While EMA provides valuable real-time information regarding listening habits, self-reported measures remain subject to reporting inaccuracies and estimation errors. Consequently, future studies should incorporate objective monitoring methods, such as direct smartphone-based logging systems, device-generated listening statistics, or real-time acoustic exposure measurements, to obtain a more accurate assessment of listening behaviour.

The present findings demonstrate that PLD use among college students is characterized by extensive earphone use, prolonged listening durations, individualized yet stable listening habits, and substantial engagement with both music and non-musical content. Listening behaviour appears to be strongly influenced by content type, platform characteristics, and social context. Importantly, knowledge regarding hearing conservation did not appear to translate into safer listening practices, and self-reported listening levels did not correspond closely with objectively measured sound levels. These findings highlight the need for objective monitoring approaches and targeted hearing conservation strategies aimed at promoting safer listening habits among young adults.

Chapter 6

SUMMARY AND CONCLUSIONS

The present study investigated the patterns of personal listening device (PLD) usage patterns among college-going young adults using the Ecological Momentary Assessment (EMA) methodology. The study also examined the output levels of PLDs and explored the relationship between listening behaviour, PLD output levels, and Knowledge, Attitude, and Practice (KAP) scores related to safe listening. A total of 25 participants were monitored over a seven-day period, yielding 175 responses i.e., structured through a 27-item EMA questionnaire

The study was structured around four primary objectives: (1) characterizing the listening habits of young adults through EMA, (2) measuring PLD output levels and examining the relationship between measured output and self-reported volume, (3) assessing the KAP of participants regarding PLDs, and (4) exploring correlations between listening behaviour and KAP scores.

With regard to device preferences, the findings revealed a strong and consistent preference for earphones connected to smartphones across both the EMA and KAP questionnaire responses. Listening volume levels showed considerable individual variability, with a mean self-reported volume setting of 6.19 out of 10 (SD = 1.68). Individual participant means ranged from 2.57 to 9.71. The mean daily listening duration as captured by EMA was approximately 136.18 minutes (about 2 hours and 20 minutes), with individual values ranging from 49.29 minutes to 341.86 minutes per day. Both volume and duration levels were found to exceed the WHO-recommended safe listening guidelines in a substantial proportion of participants. Importantly, both volume and duration preferences demonstrated strong intra-individual consistency across the seven-day monitoring period, suggesting the presence of stable personal listening routines rather than reactive behaviour during study participation.

In terms of content consumption, the majority of participants engaged in both music and non-musical audio content. Among music listeners, movie albums were the predominant genre, and music streaming applications such as Spotify and YouTube Music were the primary platforms used. For non-musical content, short-form social media content were the most commonly reported content type, with Instagram being the dominant platform. Participants who consumed both music and non-musical content showed a broader and more diverse listening profile, with Instagram emerging as the most frequently used application overall.

Listening was predominantly conducted in solitary settings across all participant groups. Most participants reported listening when alone, which, combined with the extended durations of daily use, raises concern about the degree of social isolation associated with PLD use. PLD usage was also reported across various attentional contexts, including focused listening, background listening while working, and background listening while studying, indicating its pervasive integration into daily life activities.

With respect to device-generated safety warnings, the majority of participants reported not encountering or overriding alerts. However, a notable proportion of participants who listened to non-musical content or both content types reported overriding warnings more frequently, suggesting a phenomenon of warning fatigue among active device users. The findings indicate that repeated exposure to safety notifications without perceived immediate consequence may diminish their effectiveness as a behaviour change tool.

The objective PLD output measurements yielded a mean sound output level of 67.80 ± 6.41 dB. Pearson's correlation analysis revealed no significant association between the objectively measured PLD output levels and participants' self-reported average volume settings ($r = 0.182$, $p = 0.385$). This indicates that subjective volume estimates are unreliable indicators of actual acoustic exposure, likely due to differences in device characteristics, earphone types, and individual perceptions of loudness.

The KAP questionnaire results demonstrated that participants possessed a generally good level of awareness regarding the risks of loud noise exposure. All participants were aware that loud noise can cause permanent hearing loss and have broader health implications. A large majority were aware that noise-induced hearing loss is preventable, and most were aware of tinnitus as a symptom of excessive noise exposure. Despite this, two-thirds of participants were unfamiliar with volume-limiting or safe listening features on their devices. Spearman's rank correlation analysis revealed no significant association between KAP or KP scores and either average volume (KAP: $\rho = 0.14$, $p = 0.51$; KP: $\rho = 0.13$, $p = 0.54$) or average duration of PLD usage (KAP: $\rho = 0.04$, $p = 0.84$; KP: $\rho = 0.06$, $p = 0.76$). This finding suggests that knowledge and awareness alone are insufficient to modify listening behaviour.

6.1 Conclusions

The following conclusions were drawn from the present study:

1. Earphones connected to smartphones constitute the predominant mode of PLD use among college-going young adults, representing a clinically significant risk factor given the higher sound pressure levels delivered to the tympanic membrane.
2. The mean daily listening duration and volume levels reported by participants exceed the WHO-recommended safe listening guidelines, indicating widespread risky listening practices among the study population.
3. Listening behaviour, both in terms of volume preference and daily duration, exhibits strong intra-individual consistency across a monitoring period, suggesting that PLD usage patterns represent established personal habits rather than context-dependent variations.
4. Audio content consumption among young adults extends beyond traditional music listening to encompass diverse platforms and content types, including social media reels, long-form videos, and podcasts, reflecting the deeply integrated role of PLDs in contemporary daily life.
5. Solitary listening is the predominant social context for PLD use, and the extended durations of solitary listening may have implications for social engagement and mental well-being.
6. Participants who frequently interacted with their devices for non-musical content demonstrated a higher tendency to override device-generated safety warnings, suggesting the presence of warning fatigue as a limiting factor in the effectiveness of current built-in safety features.

7. Objective PLD output measurements were not significantly correlated with self-reported volume settings, indicating that subjective volume estimates cannot be relied upon as accurate proxies for actual acoustic exposure levels.
8. Despite demonstrating adequate general awareness of the risks associated with loud listening and noise-induced hearing loss, participants' KAP scores did not significantly correlate with their listening behaviours. This confirms that knowledge and attitude alone are insufficient to drive behavioural change in PLD usage.
9. The EMA methodology proved to be a feasible and ecologically valid approach to capturing real-time listening behaviour in young adults, providing a more representative picture of daily PLD usage compared to traditional retrospective questionnaires.

6.2 Clinical Implications

The findings of the present study carry significant clinical implications for audiologists, hearing healthcare professionals, and public health practitioners. Given that knowledge alone does not translate into safer listening behaviour, hearing conservation programmes targeting young adults must go beyond awareness campaigns. Interventions should focus on behaviour modification strategies, including counselling on the practical use of volume-limiting features, promotion of the 60/60 rule (listening at no more than 60% volume for no more than 60 minutes at a time), and encouraging the use of noise-attenuating earphones that reduce the need for high-volume listening in noisy environments.

The prevalence of warning fatigue observed in this study highlights the need for more effective and engaging safety alert designs in smartphone operating systems and streaming platforms. Simple volume and duration warnings may be inadequate; personalised and contextually responsive notifications may be more effective in promoting behaviour change. Audiologists working in educational or occupational settings may also consider incorporating device-based objective monitoring as part of hearing conservation assessment protocols, given the demonstrated unreliability of self-reported volume data.

Furthermore, the high degree of solitary listening and the extensive time spent on social media platforms suggest an opportunity for targeted outreach through those very platforms. Public health messaging embedded within popular audio and video streaming applications may reach young adults more effectively than traditional educational formats.

6.3 Limitations of the Study

In the present study, the sample size was relatively small, comprising 25 participants, and they were drawn from a single college setting which may limit the generalizability of the findings to a broader population of young adults.

While the EMA methodology reduces retrospective recall bias, it is not entirely free from self-report limitations. Participants' responses regarding volume settings and content type remain subjective and susceptible to estimation inaccuracies. Additionally, although intra-individual consistency in listening behaviour was observed, the seven-day monitoring period may not fully capture seasonal, academic, or contextual variations in PLD usage that may occur over longer time frames.

6.4 Recommendations for Future Research

Based on the findings and limitations of the present study, the following directions are recommended for future research:

1. Future studies should employ larger and more diverse samples across multiple educational institutions to improve the generalizability of findings.
2. Longitudinal EMA studies spanning several months would provide a more representative picture of habitual PLD usage and its temporal variation in relation to academic schedules, seasons, and lifestyle changes.
3. Objective and continuous monitoring of PLD usage through device-based logging systems or dedicated sound dosimetry applications would overcome the limitations of self-reported data and provide more accurate acoustic exposure estimates.
4. Audiological assessments, including pure-tone audiometry, extended high-frequency audiometry, and distortion product otoacoustic emissions (DPOAEs), should be incorporated in future studies to examine subclinical hearing changes in relation to PLD usage patterns.
5. Intervention studies evaluating the effectiveness of targeted hearing conservation programmes, including smartphone-based feedback tools, personalized safe listening reminders, and educational counselling, should be conducted to inform evidence-based clinical and public health strategies.

6. The role of platform design and notification features in influencing safe listening behaviour warrants further investigation, particularly in the context of reducing warning fatigue and improving user responsiveness to device-generated hearing health alerts.

In conclusion, the present study provides valuable real-time evidence regarding the PLD usage patterns of college-going young adults and highlights the gap between hearing health knowledge and actual listening behaviour. The findings underscore the urgent need for comprehensive, evidence-based hearing conservation strategies that move beyond awareness campaigns toward sustained behavioural interventions, leveraging both clinical and digital platforms to promote safer listening practices among young adults.

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APPENDIX 1

ECOLOGICAL MOMENTARY ASSESSMENT QUESTIONNAIRE

1. Did you use any of the personal listening devices? (Choose all that applies)
☐ Smartphone Speaker
☐ Headphone with phone
☐ Earphone with phone
☐ None

2. At what volume setting did you listen to your phone most of the time?
10% ◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ 8 ◯ 9 ◯ 10 ◯ 100%

3. How many hours or minutes did you use your phone to listen today? (Please mention unit hrs/min.)

4. At what distance do you keep your phone to listen?
☐ Within 1 feet
☐ 1-2 feet
☐ 3 feet or more
☐ Not applicable

5. For which listening activities did you use your phone today? (Select all that applies)
☐ Listening to music
☐ Other
☐ Music and others

Listening to music only

6. Which genre of music did you listen to today?
☐ Classical music
☐ Movie albums (bollywood/regional/international)
☐ Rock/Pop/Electric
☐ Metallica
☐ Lofi (Music to concentrate or relax)
☐ Other

7. How much attention did you pay to the listening content?
☐ Listened to music or content with attention
☐ Played music in background while studying
☐ Played music in background while exercising
☐ Played content in background while working
☐ Other

8. When did you use your phone to listen for most of the time?
☐ When alone
☐ In the presence of parents
☐ In the presence of friends or others

9. Which app did you use to listen most of the time?
☐ Youtube
☐ Instagram
☐ Gaming app
☐ Netflix/Prime/Jio/Z5 (or other similar platforms)
☐ Spotify/Youtube Music (or similar apps)
☐ Other

10. How many times did you notice high volume or long duration warnings on your phone?
☐ 1-2 times
☐ 3-5 times
☐ More than 5 times
☐ None

11. Were you listening to your phone in background noise?
☐ Yes
☐ No

12. Did you override warnings and continued to listen to your phone?
☐ Yes
☐ No

Other audio related content

13. Which listening activity did you engage today mostly?
☐ Reels
☐ Long videos (Movies or webseries)
☐ Podcasts or ebooks
☐ Gaming
☐ Other

14. How much attention did you pay to the listening content?
☐ Listened to music or content with attention
☐ Played music in background while studying
☐ Played music in background while exercising
☐ Played content in background while working
☐ Other

15. When did you use your phone to listen for most of the time?
☐ When alone

☐ In the presence of parents
☐ In the presence of friends or others

16. Which app did you use to listen most of the time?
☐ Youtube
☐ Instagram
☐ Gaming app
☐ Netflix/Prime/Jio/Z5 (other similar platforms)
☐ Spotify/Youtube Music (or similar apps)
☐ Other

17. How many times did you notice high volume or long duration warnings on your phone?
☐ 1-2 times
☐ 3-5 times
☐ More than 5 times
☐ None

18. Were you listening to your phone in background noise?
☐ Yes
☐ No

19. Did you override warnings and continued to listen to your phone?
☐ Yes
☐ No

Music and others

20. Which genre of music did you listen to today?
☐ Classical music
☐ Movie albums (bollywood/regional/international)
☐ Rock/Pop/Electric
☐ Metallica
☐ Lofi (Music to concentrate or relax)
☐ Other

21. Which listening activity did you engage today mostly?
☐ Reels
☐ Long videos (Movies or webseries)
☐ Podcasts or ebooks
☐ Gaming
☐ Other

22. How much attention did you pay to the listening content?
☐ Listened to music or content with attention

☐ Played music in background while studying
☐ Played music in background while exercising
☐ Played content in background while working
☐ Other

23. When did you use your phone to listen for most of the time?
☐ When alone
☐ In the presence of parents
☐ In the presence of friends or others

24. Which app did you use to listen most of the time?
☐ Youtube
☐ Instagram
☐ Gaming app
☐ Netflix/Prime/Jio/Z5 (other similar platforms)
☐ Spotify/Youtube Music (or similar apps)
☐ Other

25. How many times did you notice high volume or long duration warning on your phone?
☐ 1-2 times
☐ 3-5 times
☐ More than 5 times
☐ None

26. Were you listening to your phone in background noise?
☐ Yes
☐ No

27. Did you override warnings and continued to listen to your phone?
☐ Yes
☐ No

APPENDIX 2

KNOWLEDGE ATTITUDE PRACTICE QUESTIONNAIRE

1. Do you use your phone to listen to audio content?
☐ Yes
☐ No
☐ Other: ___________

2. If yes, do you use headphones/earphones to listen to audio content through the phone?
☐ Headphones
☐ Earphones

3. Since how many years have you been using a smartphone (in years)?
____________ years

4. On average, how long do you use phone for listening per day (in minutes/hours)?

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5. Of those hours, how much percentage through earphones/headphones?
____________ %

6. On average, how long do you listen to music in a week (in minutes/hours)?

---

7. How often do you play online games that involve listening to loud sounds in a week?
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐

8. Do you consider yourself a professional gamer?
☐ Yes
☐ No

9. Are there any sources of constant loud sounds where you live (ex: railway track/factories/airport)?
☐ Yes
☐ No

10. Do you think you have difficulty understanding speech in noisy environments?
☐ Yes

☐ No
☐ Sometimes

11. How would you rate your current hearing ability (1: the worst hearing level, 10: the best hearing level)

1 2 3 4 5 6 7 8 9 10

(Circle or tick your rating)

12. If you have hearing difficulties, what do you think is the cause?

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13. If you already have hearing loss, do you think that using PLDs has contributed to it?
