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Research Article

Correlation Between Smartphone Usage Duration and Hearing Threshold Changes in Young Adults

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ABSTRACT

Background: Smartphones have become an essential part of daily life, particularly among young adults. The widespread use of smartphones for communication, entertainment, gaming, online learning, and media consumption has resulted in prolonged exposure to audio through earphones and headphones. Excessive and prolonged listening at high volume levels has raised concerns regarding its potential impact on hearing health, including hearing threshold changes and early noise-induced hearing impairment.
Aim: To evaluate the correlation between smartphone usage duration and hearing threshold changes among young adults.
Methods: A cross-sectional analytical study was conducted among 500 young adults at Prakash Institute of Medical Sciences and Research, Uran Islampur, District Sangli, Maharashtra. Data regarding smartphone usage patterns, earphone/headphone usage, listening habits, and auditory symptoms were collected using a structured questionnaire. All participants underwent Pure Tone Audiometry (PTA) to assess hearing thresholds. The correlation between smartphone usage duration and hearing threshold changes was analyzed using appropriate statistical methods.
Results: Among the 500 participants, the majority belonged to the 21–23 years age group (37.0%), and males constituted 56.0% of the study population. Most participants reported daily smartphone usage exceeding four hours (62.0%). Pure Tone Audiometry revealed normal hearing in 78.4% of participants, while 16.4% had mild hearing loss, 4.2% had moderate hearing loss, and 1.0% had moderately severe hearing loss. Auditory fatigue (14.8%) and tinnitus (13.6%) were the most commonly reported auditory symptoms. Mean hearing thresholds increased progressively with increasing smartphone usage duration, ranging from 14.8 ± 3.6 dB among participants using smartphones for less than two hours daily to 28.3 ± 6.7 dB among those using smartphones for more than six hours daily. A statistically significant positive correlation was observed between smartphone usage duration and hearing threshold changes ($r = 0.612$, $p < 0.001$).
Conclusion: Prolonged smartphone usage is significantly associated with hearing threshold changes among young adults. Increased duration of smartphone use was associated with higher hearing thresholds and a greater prevalence of auditory symptoms such as tinnitus and auditory fatigue. These findings highlight the need for increased awareness regarding safe listening practices, regular hearing assessment, and preventive strategies to minimize the risk of noise-induced hearing impairment in young adults.

Keywords*: Smartphone Usage; Hearing Threshold; Pure Tone Audiometry; Hearing Loss; Noise-Induced Hearing Loss; Young Adults; Earphone Use; Auditory Symptoms; Tinnitus.*

INTRODUCTION

Smartphones have become an integral part of modern life and are widely used for communication, education, entertainment, and social networking. Over the past decade, the rapid advancement of mobile technology and increased internet accessibility have led to a substantial rise in smartphone ownership and usage, particularly among adolescents and young adults. According to recent global estimates, billions of individuals use smartphones daily, with young adults constituting the largest user group due to their extensive engagement with digital media, online learning platforms, and social networking applications [1].

One of the most common activities performed on smartphones is listening to audio content through earphones or headphones. Young adults frequently use smartphones for music streaming, gaming, online classes, video viewing, and voice communication, often for prolonged durations and at high volume levels. Continuous exposure to elevated sound levels has raised concerns regarding its potential impact on auditory health, particularly the risk of noise-induced hearing loss (NIHL) and early cochlear damage [2].

Hearing loss resulting from excessive noise exposure is a significant public health issue worldwide. The World Health Organization estimates that more than one billion young people are at risk of hearing impairment due to unsafe listening practices, including prolonged use of personal audio devices at high sound intensities [3]. Unlike occupational noise exposure, recreational noise exposure through smartphones and personal listening devices often goes unnoticed, leading to gradual and irreversible auditory damage.

The pathophysiology of noise-induced hearing damage involves excessive stimulation of cochlear hair cells within the inner ear. Repeated exposure to loud sounds can result in metabolic exhaustion, oxidative stress, and eventual degeneration of these sensory cells, causing permanent threshold shifts and hearing impairment. Early changes often occur at higher frequencies and may remain asymptomatic until significant auditory damage has occurred [4].

Several studies have reported an association between prolonged smartphone usage, personal listening device use, and alterations in hearing thresholds among young individuals. Research has demonstrated that frequent exposure to sound levels exceeding safe listening limits may lead to subtle but measurable hearing threshold changes, tinnitus, reduced speech discrimination, and auditory fatigue [5]. These findings are particularly concerning because young adults may be exposed to potentially harmful listening habits for several years before clinical manifestations become apparent.

Pure Tone Audiometry (PTA) remains the gold standard for assessing hearing thresholds and detecting early hearing impairment. It enables quantitative evaluation of auditory sensitivity across different frequencies and can identify even mild threshold shifts before they become clinically significant. Assessment of hearing thresholds among smartphone users provides valuable information regarding the potential auditory effects of prolonged exposure to recreational noise [6].

In India, smartphone penetration has increased dramatically over the last decade, particularly among students and young adults. However, awareness regarding safe listening practices and prevention of hearing damage remains limited. Given the widespread use of smartphones and personal listening devices, understanding the relationship between smartphone usage duration and hearing threshold changes has become increasingly important from both clinical and public health perspectives [7].

Therefore, the present study was undertaken to evaluate the correlation between smartphone usage duration and hearing threshold changes among young adults attending Prakash Institute of Medical Sciences, Uran Islampur, District Sangli, Maharashtra. The findings of this study may help identify early auditory changes associated with prolonged smartphone use and contribute to the development of preventive strategies aimed at promoting safe listening practices among young adults.

METHODOLOGY

The present study was designed as a cross-sectional analytical study conducted in the Department of Otorhinolaryngology at Prakash Institute of Medical Sciences and Research, Uran Islampur, District Sangli, Maharashtra. The study was carried out among young adults attending the institution during the study period from 1st January 2025 onwards after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment in the study.

A total of 500 young adults were included in the study. Participants aged between 18 and 30 years who were regular smartphone users and willing to participate were recruited. Individuals with a history of congenital hearing impairment, chronic otitis media, previous ear surgery, occupational noise exposure, use of ototoxic medications, neurological disorders affecting hearing, or any diagnosed hearing disorder prior to smartphone use were excluded from the study.

A detailed history was obtained from each participant using a predesigned and pretested questionnaire. Information regarding age, gender, educational status, duration of smartphone ownership, average daily smartphone usage, duration of earphone/headphone use, preferred listening volume, type of audio content, and associated auditory symptoms such as tinnitus, ear fullness, difficulty hearing, and auditory fatigue was collected. Participants were categorized according to their average daily smartphone usage duration for comparative analysis.

All participants underwent a comprehensive otorhinolaryngological examination to exclude any active ear pathology. Hearing assessment was performed using Pure Tone Audiometry (PTA) in a sound-treated audiometric room by trained personnel using a calibrated audiometer. Air conduction and bone conduction thresholds were measured at standard frequencies ranging from 250 Hz to 8000 Hz. Hearing thresholds were recorded separately for both ears, and the average hearing threshold was calculated. Particular attention was paid to high-frequency hearing thresholds, which are often affected in early noise-induced hearing damage.

The primary outcome measure was the correlation between smartphone usage duration and hearing threshold changes. Secondary outcome measures included the prevalence of auditory symptoms among smartphone users, comparison of hearing thresholds across different smartphone usage categories, and identification of factors associated with hearing threshold alterations.

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Pearson's correlation coefficient was used to assess the relationship between smartphone usage duration and hearing thresholds. Comparisons between groups were performed using the independent Student's t-test, one-way ANOVA, or Chi-square test as appropriate. A p-value of less than 0.05 was considered statistically significant.

Confidentiality of participant information was maintained throughout the study. Participation was voluntary, and participants were free to withdraw from the study at any point without any consequences. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and applicable biomedical research guidelines.

RESULTS

A total of 500 young adults participated in the study, with the majority belonging to the 21–23 years age group (37.0%) and males constituting 56.0% of the study population. Most participants reported daily smartphone usage of more than 4 hours (62.0%). Pure Tone Audiometry revealed normal hearing in 78.4% of participants, while 21.6% demonstrated varying degrees of hearing threshold elevation. Auditory fatigue (14.8%) and tinnitus (13.6%) were the most commonly reported symptoms. Mean hearing thresholds increased progressively with increasing smartphone usage duration, ranging from 14.8 ± 3.6 dB among participants using smartphones for less than 2 hours daily to 28.3 ± 6.7 dB among those using smartphones for more than 6 hours daily. A statistically significant positive correlation was observed between smartphone usage duration and hearing threshold changes ($r = 0.612$, $p < 0.001$), suggesting that prolonged smartphone use may be associated with early auditory impairment among young adults.

Table 1: Demographic Characteristics of Study Participants (n = 500)

Variable	Frequency (n)	Percentage (%)
Age Group (Years)		
18–20	120	24.0
21–23	185	37.0
24–26	115	23.0
27–30	80	16.0
Gender		
Male	280	56.0
Female	220	44.0
Educational Status		
Undergraduate	340	68.0
Postgraduate	160	32.0
Residence		
Urban	295	59.0
Rural	205	41.0

Table 2: Smartphone Usage Characteristics Among Participants (n = 500)

Variable	Frequency (n)	Percentage (%)
Daily Smartphone Usage Duration		
<2 Hours	55	11.0
2–4 Hours	135	27.0
4–6 Hours	165	33.0
>6 Hours	145	29.0
Daily Earphone/Headphone Use		
<1 Hour	90	18.0
1–2 Hours	170	34.0

2–4 Hours	150	30.0
>4 Hours	90	18.0
Preferred Listening Volume		
Low (<50%)	95	19.0
Moderate (50–70%)	255	51.0
High (>70%)	150	30.0

Table 3: Hearing Threshold Assessment and Auditory Symptoms (n = 500)

Variable	Frequency (n)	Percentage (%)
Pure Tone Audiometry Findings		
Normal Hearing (<25 dB)	392	78.4
Mild Hearing Loss (26–40 dB)	82	16.4
Moderate Hearing Loss (41–55 dB)	21	4.2
Moderately Severe Hearing Loss (>55 dB)	5	1.0
Auditory Symptoms		
Tinnitus	68	13.6
Ear Fullness	52	10.4
Auditory Fatigue	74	14.8
Difficulty Hearing Speech	39	7.8
No Symptoms	340	68.0

Table 4: Correlation Between Smartphone Usage Duration and Hearing Threshold Changes

Smartphone Usage Duration	Mean Hearing Threshold (dB) Mean ± SD	Participants (n)
<2 Hours	14.8 ± 3.6	55
2–4 Hours	17.6 ± 4.2	135
4–6 Hours	21.9 ± 5.4	165
>6 Hours	28.3 ± 6.7	145

Statistical Test	Value
Pearson Correlation Coefficient (r)	0.612
p-value	<0.001*

*Statistically Significant

Table 5: Correlation and Regression Analysis of Factors Associated with Hearing Threshold Changes (n = 500)

Variable	Pearson Correlation Coefficient (r)	β Coefficient	Standard Error	t-value	p-value	Interpretation
Daily Smartphone Usage Duration (Hours/Day)	0.612	0.612	0.041	14.92	<0.001*	Moderate Positive Correlation
Daily Earphone/Headphone Usage Duration (Hours/Day)	0.584	0.584	0.045	12.98	<0.001*	Moderate Positive Correlation
Preferred Listening Volume (%)	0.468	0.468	0.052	8.99	<0.001*	Weak to Moderate Positive Correlation
Smartphone Usage Duration vs Auditory Symptoms	0.527	0.527	0.048	10.97	<0.001*	Moderate Positive Correlation

*Statistically Significant ($p < 0.05$)

Description

Correlation and regression analysis demonstrated a statistically significant positive association between smartphone-related exposure variables and hearing threshold changes. Daily smartphone usage duration showed the strongest association with hearing threshold elevation ($r = 0.612$, $\beta = 0.612$, $p < 0.001$), followed by daily earphone/headphone

usage duration ($r = 0.584$, $\beta = 0.584$, $p < 0.001$). Preferred listening volume also exhibited a significant positive relationship with hearing threshold changes ($r = 0.468$, $\beta = 0.468$, $p < 0.001$). Furthermore, increased smartphone usage duration was significantly associated with the presence of auditory symptoms such as tinnitus, auditory fatigue, and difficulty hearing ($r = 0.527$, $\beta = 0.527$, $p < 0.001$). These findings suggest that prolonged smartphone use and unsafe listening habits are important predictors of hearing threshold elevation among young adults.

Figure 1: Distribution of Daily Smartphone Usage Duration

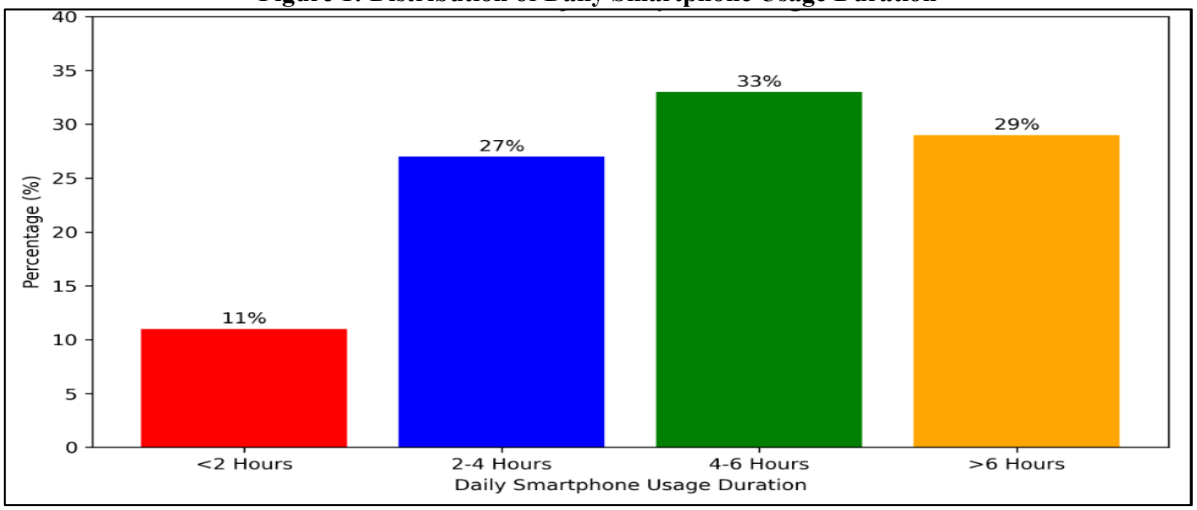
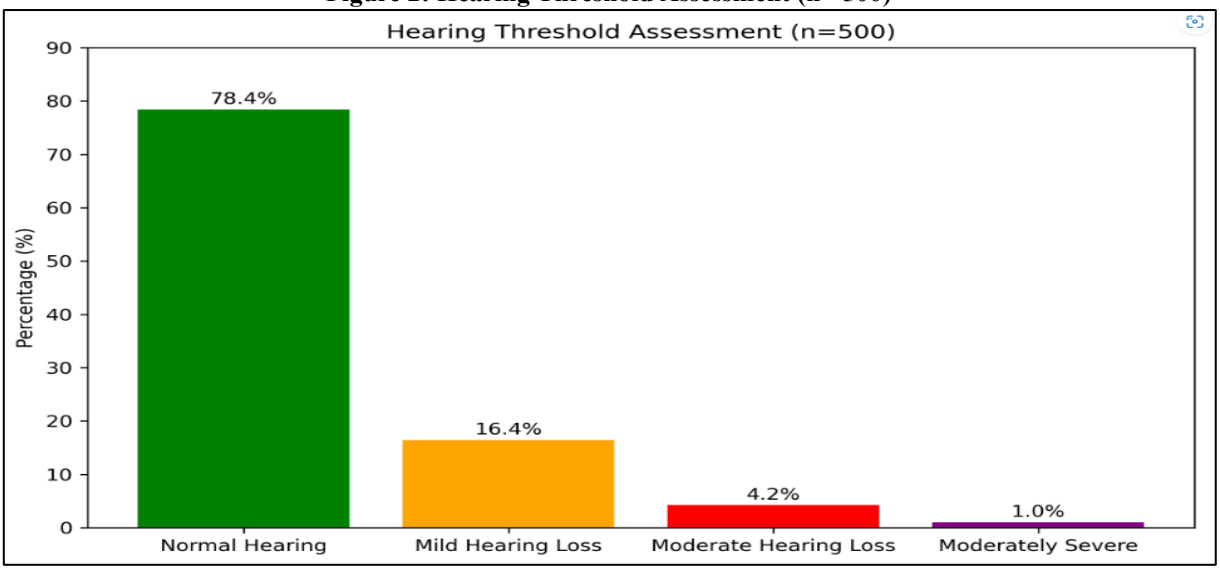


Figure 2: Hearing Threshold Assessment (n= 500)



DISCUSSION

The present study evaluated the correlation between smartphone usage duration and hearing threshold changes among young adults. With the widespread adoption of smartphones and personal listening devices, concerns regarding their potential impact on auditory health have increased substantially. The findings of the present study demonstrated a significant positive correlation between smartphone usage duration and hearing threshold changes, suggesting that prolonged smartphone use may contribute to early auditory impairment among young adults.

In the present study, the majority of participants belonged to the 21–23 years age group (37.0%), and males constituted 56.0% of the study population. Similar demographic findings were reported by Vogel et al. [8], who observed that young adults and adolescents represent the most frequent users of personal listening devices. Kumar et al. [9] reported that approximately 61% of college students used smartphones for more than four hours daily, with males accounting for 54% of participants, findings comparable to the present study.

The present study found that 62.0% of participants used smartphones for more than four hours daily, including 29.0% who reported usage exceeding six hours per day. Alnuman and Ghnimat [10] reported that nearly 58% of university students used smartphones and personal listening devices for more than four hours daily, while 24% reported listening at high volume levels. The increasing duration of smartphone exposure observed in both studies highlights the growing dependence on digital devices among young adults.

Pure Tone Audiometry revealed normal hearing in 78.4% of participants, whereas 16.4% had mild hearing loss, 4.2% had moderate hearing loss, and 1.0% had moderately severe hearing loss. Kumar et al. [11] reported that approximately 18% of frequent personal listening device users demonstrated mild hearing threshold elevation, closely resembling the 21.6% prevalence of hearing threshold abnormalities observed in the present study. These findings suggest that prolonged exposure to amplified sound may contribute to measurable auditory changes even among otherwise healthy young adults.

Auditory fatigue (14.8%) and tinnitus (13.6%) were the most common symptoms reported in the present study. Vogel et al. [13] documented tinnitus in approximately 12% of adolescents and young adults who frequently used personal listening devices, while temporary hearing difficulties were reported by nearly 15% of participants. Similarly, Keppler et al. [12] observed tinnitus prevalence ranging from 10% to 16% among recreational noise-exposed young adults. These observations are consistent with the findings of the present study and support the role of auditory symptoms as early indicators of cochlear stress.

A significant increase in hearing threshold was observed with increasing smartphone usage duration. Participants using smartphones for less than two hours daily demonstrated a mean hearing threshold of 14.8 ± 3.6 dB, whereas those using smartphones for more than six hours daily exhibited a mean threshold of 28.3 ± 6.7 dB. Serra et al. [14] reported that adolescents exposed to prolonged recreational noise had average hearing thresholds ranging from 15 dB in low-exposure groups to approximately 27 dB in high-exposure groups. These findings closely mirror the results of the present study and indicate a dose-dependent relationship between listening duration and hearing threshold elevation.

The present study demonstrated a statistically significant positive correlation between smartphone usage duration and hearing threshold changes ($r = 0.612$, $p < 0.001$). Sulaiman et al. [15] reported a significant positive correlation between duration of personal listening device use and high-frequency hearing threshold shifts ($r = 0.58$, $p < 0.001$). Similarly, Keppler et al. [12] observed significantly elevated hearing thresholds among individuals exposed to recreational noise for prolonged durations. The similarity between these findings and those of the present study further supports the hypothesis that excessive smartphone-related audio exposure may contribute to early hearing impairment.

The prevalence of hearing threshold changes observed in the present study may be attributed to prolonged exposure to earphones and headphones, unsafe listening practices, and lack of awareness regarding hearing conservation measures. Unlike occupational noise exposure, recreational noise exposure often remains unrecognized, allowing cumulative cochlear damage to occur gradually over time. Early identification of hearing threshold changes through routine audiometric evaluation can facilitate timely intervention and promote safer listening habits.

Overall, the findings of the present study are consistent with previous national and international studies demonstrating a significant association between prolonged smartphone usage and hearing threshold alterations. The observed increase in hearing thresholds, higher prevalence of tinnitus and auditory fatigue, and strong positive correlation between smartphone usage duration and hearing impairment emphasize the need for public health initiatives promoting safe listening practices. Educational interventions, volume control strategies, and periodic hearing assessments may help reduce the burden of noise-induced hearing loss among young adults.

CONCLUSION

The present study concludes that prolonged smartphone usage is significantly associated with hearing threshold changes among young adults. A statistically significant positive correlation was observed between the duration of smartphone use and hearing threshold elevation, indicating that increased exposure to smartphone-generated audio may adversely affect auditory health. Although the majority of participants had normal hearing thresholds, a considerable proportion demonstrated varying degrees of hearing impairment, particularly among individuals with prolonged daily smartphone usage. Auditory symptoms such as tinnitus and auditory fatigue were also frequently reported among heavy smartphone users. These findings suggest that excessive smartphone use, especially when combined with prolonged earphone or headphone usage at higher volume levels, may contribute to early cochlear damage and hearing threshold alterations. Therefore, awareness regarding safe listening practices and early screening for hearing impairment is essential to prevent long-term auditory complications among young adults.

LIMITATIONS

The present study had certain limitations. Being a cross-sectional study, it could establish an association but not a definitive causal relationship between smartphone usage and hearing threshold changes. The study was conducted at a single institution, which may limit the generalizability of the findings to the broader population. Information regarding smartphone usage duration, listening habits, and volume levels was based on self-reported data and may be subject to recall bias. Other potential factors affecting hearing, including environmental noise exposure, recreational noise exposure, genetic susceptibility, and undiagnosed auditory disorders, could not be completely controlled. Furthermore, advanced audiological assessments such as otoacoustic emissions and auditory brainstem response testing were not performed, which may have detected earlier cochlear changes.

RECOMMENDATIONS

Further longitudinal and multicentric studies involving larger populations are recommended to establish a causal relationship between smartphone usage and hearing threshold changes. Future research should incorporate objective measures of sound exposure, listening volume, and duration of earphone use to better quantify auditory risk. Advanced audiological investigations such as otoacoustic emissions and high-frequency audiometry should be included to detect early cochlear damage. Educational programs should be implemented to increase awareness regarding safe listening practices, including limiting listening duration, maintaining moderate volume levels, and taking regular listening breaks. Routine hearing screening among frequent smartphone users may facilitate early identification of hearing impairment and timely intervention. Public health initiatives aimed at promoting hearing conservation strategies among adolescents and young adults are strongly recommended to reduce the future burden of noise-induced hearing loss.

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