

ASSOCIATION BETWEEN TRUE WIRELESS STEREO (TWS) USAGE HABITS AND EAR HEALTH PROBLEMS AMONG MEDICAL STUDENTS AT BAITURRAHMAH UNIVERSITY

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Abstract

Introduction: The increasing use of True Wireless Stereo (TWS) earphones has raised concerns regarding their potential impact on auditory health, particularly among young adults. Prolonged exposure to high-volume audio through personal listening devices may not produce immediate symptoms; however, continuous and long-term use has been associated with progressive hearing impairment and other ear-related disorders. This study aimed to investigate the association between TWS usage habits and ear health problems among medical students at the Faculty of Medicine, Baiturrahmah University.

Methods: A quantitative cross-sectional study was conducted among active undergraduate medical students enrolled between 2022 and 2024. Forty-six participants who met the inclusion criteria were recruited. Data were collected using a structured questionnaire assessing TWS usage habits, including duration of ownership, frequency of use, daily listening duration, and listening volume, as well as self-reported ear health problems. Bivariate analysis was performed using the Chi-square test, with statistical analyses conducted using IBM SPSS Statistics version 26.0. Statistical significance was established at $p < 0.05$. **Results:** Most participants were female and primarily used TWS earphones. Ear itching was the most frequently reported symptom. Significant associations were observed between ear health problems and the duration of TWS ownership ($p = 0.009$), frequency of TWS use ($p = 0.008$), daily listening duration ($p = 0.023$), and listening volume ($p = 0.032$). Although most respondents reported experiencing ear health problems only occasionally or rarely, prolonged and frequent TWS use at higher listening volumes was associated with an increased prevalence of ear-related complaints. **Conclusion:** TWS usage habits, including prolonged duration of use, frequent use, extended daily listening time, and higher listening volume, were significantly associated with self-reported ear health problems among medical students at Baiturrahmah University.

Keywords: True Wireless Stereo; Personal Listening Devices; Ear Health; Hearing Problems; Medical Students; Safe Listening; Noise-Induced Hearing Loss

INTRODUCTION

Hearing is one of the five primary human senses and plays a fundamental role in communication, learning, and social interaction. Sound waves entering the external ear are transmitted through the auditory pathway and converted into electrical impulses by the cochlea before being conveyed to the brain via the auditory nerve. In addition to its auditory function, the inner ear contains the vestibular system, which is responsible for maintaining balance and spatial orientation. Consequently, disorders affecting the ear may impair both hearing and

balance, ultimately reducing an individual's quality of life and daily functioning. Therefore, preserving auditory health is an important public health concern (World Health Organization, 2021; Sheikh *et al.*, 2022).

The widespread adoption of Personal Listening Devices (PLDs) has substantially changed listening habits, particularly among adolescents and young adults. One of the most popular PLDs is the True Wireless Stereo (TWS) earphone, which offers convenience, portability, and wireless connectivity. Although these devices provide significant benefits for communication, entertainment, and online learning, excessive or inappropriate use may expose users to hazardous sound levels that increase the risk of auditory damage (WHO world health organization, 2019; Edi Termiko, Indra Zachreini and Cut Khairunnissa, 2023).

The World Health Organization (WHO) has estimated that approximately 1.1 billion adolescents and young adults worldwide are at risk of hearing impairment due to unsafe listening practices associated with recreational noise exposure. In 2019, the WHO reported that nearly 50% of individuals aged 12–35 years regularly listen to audio at unsafe volume levels through personal listening devices. Continuous exposure to excessive sound intensity may gradually damage the auditory system, even in the absence of immediate clinical symptoms (WHO world health organization, 2019; World Health Organization, 2021).

Indonesia has experienced a similar trend, with increasing TWS use among adolescents and university students. Previous studies have shown that more than half of young users demonstrate listening behaviors that may increase the risk of auditory disorders, including tinnitus and early hearing impairment. A study conducted among medical students at the University of North Sumatra reported that many respondents had used earphones for more than three years, reflecting the early adoption of personal listening devices beginning in junior high school. These findings suggest that prolonged exposure to recreational noise has become increasingly common among young adults (Dewi *et al.*, 2022; Erlanda Putra Negara *et al.*, 2022).

Noise-Induced Hearing Loss (NIHL) remains one of the most preventable forms of sensorineural hearing loss. Repeated exposure to high-intensity sound may damage the outer hair cells of the organ of Corti, resulting in progressive deterioration of auditory function. The risk of NIHL is influenced by several behavioral factors, including cumulative years of device use, frequency of listening, daily listening duration, and listening volume. Exposure to sound levels exceeding 85 dB, particularly over prolonged periods, has been associated with irreversible cochlear injury and permanent hearing loss (Pawlaczyk-Łuszczynska *et al.*, 2022; Setiawati and Djunaidi, 2023).

Daily listening duration is considered a critical determinant of hearing safety. Listening for more than 60 minutes per day, especially at high volume levels, substantially increases cumulative acoustic exposure and places greater metabolic stress on cochlear hair cells. Likewise, frequent use throughout the week and consistently high listening volumes further elevate the likelihood of developing auditory symptoms such as tinnitus, ear discomfort, and progressive hearing impairment. International safe-listening recommendations therefore encourage limiting listening duration while maintaining moderate volume levels to minimize the risk of noise-induced hearing damage.

Medical students represent a population with extensive reliance on digital technology for academic activities, online lectures, and entertainment. Consequently, they are likely to use TWS devices more frequently than the general population, making them particularly vulnerable to unsafe listening behaviors. Despite the increasing popularity of TWS devices, evidence regarding their association with ear health problems among Indonesian medical students remains limited (Poluan, 2022; Triansyah *et al.*, 2024).

Therefore, this study aimed to investigate the association between TWS usage habits—including duration of ownership, frequency of use, daily listening duration, and listening volume—and self-reported ear health problems among medical students at the Faculty of Medicine, Baiturrahmah University. The findings are expected to contribute to the growing body of evidence regarding safe listening practices and support the development of preventive strategies to promote hearing health among young adults.

METHODS

This study employed an analytical quantitative design with a cross-sectional approach to investigate the association between True Wireless Stereo (TWS) usage habits and ear health problems among medical students. The study was conducted at the Faculty of Medicine, Baiturrahmah University, Padang, Indonesia. The target population consisted of active undergraduate medical students from the 2022, 2023, and 2024 cohorts. Participants were recruited using a simple random sampling technique, and a total of 46 students who fulfilled the eligibility criteria were included in the study.

Eligible participants were active medical students who regularly used TWS devices and voluntarily agreed to participate by providing informed consent. Students with a history of ear infection, previous ear surgery, or head and ear trauma were excluded to minimize potential confounding factors that could influence ear health outcomes. Data were collected using a structured self-administered questionnaire designed to obtain information on participants' demographic characteristics, TWS usage habits, and self-reported ear health problems.

The questionnaire evaluated four dimensions of TWS usage habits, including the duration of TWS ownership, frequency of use, daily listening duration, and preferred listening volume. Ear health problems were assessed based on self-reported symptoms, including otalgia, tinnitus, ear itching, otorrhea, and the absence of ear-related complaints. The independent variables comprised the four TWS usage characteristics, whereas the dependent variable was the presence of self-reported ear health problems.

All data were entered and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize participants' characteristics, TWS usage patterns, and ear health complaints, with categorical variables presented as frequencies and percentages. The association between TWS usage habits and ear health problems was analyzed using the Chi-square test. A two-tailed *p*-value of < 0.05 was considered statistically significant.

RESULT

A total of 46 medical students participated in this study. Most respondents were female and predominantly used True Wireless Stereo (TWS) earphones. The most frequently reported ear-related symptom was ear itching, experienced by 23 participants (50.0%), followed by the absence of symptoms (30.4%), otalgia (8.7%), otorrhea (6.5%), and tinnitus (4.3%).

Association between Duration of TWS Ownership and Ear Health Problems

As presented in Table 1, students who had used TWS devices for 0–3 years were more likely to report no ear health problems (59.1%) than those who had used TWS for more than three years. Conversely, respondents with more than three years of TWS use reported a higher proportion of frequent ear health complaints (8.3%). The Chi-square test demonstrated a statistically significant association between the duration of TWS ownership and ear health problems ($p = 0.009$).

Table 1. Association Between Duration of TWS Use and Ear Health Problems Among Medical Students at Baiturrahmah University

Duration of TWS Use	No Ear Health Problems (%)	Rarely (%)	Occasionally (%)	Frequently (%)	Total (%)	p-value
0–3 years	59.1	18.2	18.2	4.5	100	
>3 years	12.5	54.2	25.0	8.3	100	0.009
Total	34.8	37.0	21.7	6.5	100	

Association between Frequency of TWS Use and Ear Health Problems

Table 1 shows that respondents who used TWS 1–2 days per week most frequently reported no ear health problems (60.0%). In contrast, students who used TWS every day exhibited the highest proportion of frequent ear-related complaints (33.3%). Statistical analysis indicated a significant association between the frequency of TWS use and ear health problems ($p = 0.008$).

Table 2. Association Between Frequency of TWS Use and Ear Health Problems Among Medical Students at Baiturrahmah University

Frequency of TWS Use	No Ear Health Problems (%)	Rarely (%)	Occasionally (%)	Frequently (%)	Total (%)	p-value
1–2 days/week	60	20.0	15	5	100	
3–4 days/week	5.9	58.8	35.3	0	100	
5–6 days/week	16.7	50	16.7	16.7	100	
Every day	66.7	0	0	33.3	100	0.008
Total	34.8	37	21.7	6.5	100	

Association between Daily Listening Duration and Ear Health Problems

As shown in Table 3, participants who used TWS for less than one hour or 1–2 hours per day generally reported fewer ear health complaints than those with longer daily listening durations. Frequent ear-related problems were observed more often among participants who used TWS for 2–4 hours per day (18.8%). The association between daily listening duration and ear health problems was statistically significant ($p = 0.023$).

Table 3. Association Between Daily Duration of TWS Use and Ear Health Problems Among Medical Students at Baiturrahmah University

Daily Duration of TWS Use	No Ear Health Problems (%)	Rarely (%)	Occasionally (%)	Frequently (%)	Total (%)	p-value
< 1 hour	50	31.3	18.8	0	100	
1–2 hours	54.5	45.5	0	0	100	
2–4 hours	6.3	43.8	31.3	18.8	100	
4–6 hours	33.3	0	66.7	0	100	0.023
Total	34.8	37	21.7	6.5	100	

Association between Listening Volume and Ear Health Problems

The distribution of ear health problems according to listening volume is presented in Table 4. Participants who listened at less than 60% of maximum volume most commonly reported no ear health complaints (61.1%). Conversely, respondents who listened at more than 80% volume more frequently experienced ear-related symptoms, particularly occasional complaints (50.0%). The Chi-square analysis revealed a statistically significant association between listening volume and ear health problems ($p = 0.032$).

Table 4. Association Between Listening Volume and Ear Health Problems Among Medical Students at Baiturrahmah University

Listening Volume	No Ear Health Problems (%)	Rarely (%)	Occasionally (%)	Frequently (%)	Total (%)	p-value
< 60%	61.1	27.8	5.6	5.6	100	
60–80%	18.2	50	27.3	4.5	100	
> 80%	16.7	16.7	50	16.7	100	0.032
Total	34.8	37	21.7	6.5	100	

Overall, the findings indicate that all investigated TWS usage characteristics—including duration of ownership, frequency of use, daily listening duration, and listening volume—were significantly associated with self-reported ear health problems among medical students.

DISCUSSION

The present study demonstrated significant associations between several TWS usage behaviors and self-reported ear health problems among medical students. Specifically, the duration of TWS ownership, frequency of use, daily listening duration, and listening volume were all significantly associated with ear-related complaints. These findings suggest that cumulative exposure to recreational

noise through personal listening devices may adversely affect auditory health, particularly among young adults who rely extensively on TWS devices for educational and recreational purposes.

The significant association between the duration of TWS ownership and ear health problems indicates that prolonged use over several years may increase the cumulative acoustic burden on the auditory system. Participants who had used TWS devices for more than three years reported ear-related complaints more frequently than those with shorter durations of use. This finding is consistent with previous studies reporting that long-term exposure to recreational noise contributes to progressive cochlear damage, particularly affecting the outer hair cells within the organ of Corti. Repeated acoustic stimulation may induce oxidative stress, mitochondrial dysfunction, and irreversible degeneration of cochlear sensory cells, thereby increasing the risk of noise-induced hearing loss (Pawlaczyk-Luszczynska *et al.*, 2018; Listiana, Hasan and Rosmayati, 2021; Wang *et al.*, 2021).

Frequency of TWS use was also significantly associated with ear health problems. Students who reported daily TWS use experienced ear-related complaints more frequently than those who used the devices only a few days per week. This observation agrees with previous studies indicating that repeated exposure to recreational noise limits the recovery time of cochlear hair cells between listening sessions, thereby increasing susceptibility to auditory fatigue and tinnitus. Frequent exposure may also accelerate cumulative cochlear injury even when individual listening sessions are relatively short (Kurabi *et al.*, 2017; Jarvey and Gouyaso, 2021).

Daily listening duration likewise demonstrated a significant association with ear health problems. Participants who listened for more than two hours per day reported a greater frequency of auditory complaints than those with shorter listening durations. This finding supports international evidence indicating that prolonged daily exposure to personal listening devices increases cumulative acoustic energy reaching the cochlea and elevates the risk of temporary threshold shift, which may eventually progress to permanent threshold shift following repeated exposure. The World Health Organization recommends limiting both listening duration and sound intensity to reduce the risk of hearing damage among users of personal listening devices.

Listening volume represented another important determinant of ear health. Respondents who typically listened at volumes exceeding 80% of the device's maximum output experienced ear-related symptoms more frequently than those who maintained lower volume levels. High listening volumes substantially increase sound pressure levels reaching the cochlea, leading to excessive metabolic activity within outer hair cells and increased production of reactive oxygen species. Persistent oxidative stress contributes to stereocilia damage, mitochondrial dysfunction, and progressive sensorineural hearing impairment. Recent studies have consistently identified high listening volume as one of the strongest behavioral predictors of recreational noise-induced hearing loss (Erlanda Putra Negara *et al.*, 2022; Poluan, 2022).

Among all reported symptoms, ear itching was the most common complaint, affecting half of the study participants. Although ear itching is not a direct indicator of sensorineural hearing loss, it may reflect irritation of the external auditory canal

resulting from prolonged earphone use, increased humidity within the ear canal, accumulation of cerumen, or inadequate hygiene of the listening device. Similar observations have been reported in previous otolaryngology studies, suggesting that extended use of in-ear devices may alter the microenvironment of the external auditory canal and predispose users to irritation or mild inflammatory conditions (Pawlaczyk-Łuszczyńska *et al.*, 2019; Sarlus *et al.*, 2019; Edi Termiko, Indra Zachreini and Cut Khairunnissa, 2023).

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference between TWS usage habits and ear health problems. Second, ear health outcomes were assessed using self-reported symptoms rather than objective audiological examinations, which may introduce reporting bias. Third, the relatively small sample size from a single institution may limit the generalizability of the findings to broader student populations. Nevertheless, this study provides valuable evidence regarding potentially modifiable listening behaviors associated with ear health among Indonesian medical students and highlights the importance of promoting safe listening practices in young adults.

CONCLUSION

The present study demonstrated a significant association between TWS usage habits and self-reported ear health problems among medical students at Baiturrahmah University. Longer duration of use, more frequent use, extended daily listening time, and higher listening volume were all associated with an increased prevalence of ear-related complaints.

These findings highlight the importance of promoting safe listening behaviors among young adults to minimize the risk of preventable auditory disorders associated with personal listening devices. Educational interventions emphasizing appropriate listening duration and moderate listening volume may contribute to improved hearing health in this population. Future longitudinal studies incorporating objective audiological examinations are warranted to confirm these findings and further clarify the long-term impact of TWS use on auditory function.

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