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Earphone Use Patterns and Hearing Loss Risk Affecting Quality of Life

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ABSTRACT

In today's modern life, most people are constantly exposed to noise every day, potentially disrupting their hearing function. One such factor is the use of hearing devices, namely earphones. Approximately 1.1 billion young adults and adolescents are at risk of experiencing hearing loss in their lifetime. If someone is at risk of hearing loss, it can undoubtedly impact their quality of life. Participants in this study were students at the Christian University of Indonesia in 2019, 2020, and 2021. The purpose of this study was to determine whether risky earphone use patterns are associated with quality of life. Data for this study were collected using a cross-sectional observational analytical methodology with a consecutive sampling technique. The study sample was assessed with a questionnaire created using Google Forms. The questionnaire, which is divided into two parts: the Earphone Use Pattern Questionnaire (PPE) and the Hearing Handicap Inventory for Adults (HHIA), to determine the patient's quality of life, was then analyzed using the Chi-Square and Spearman tests. Of the 225 respondents, there were 62.2% risky earphone usage patterns and 37.8% non-risky earphone users. According to the HHIA score findings, 74.2% of people had no disabilities, 9.8% had mild to moderate disabilities, and 16.0% had severe disabilities, with $p = 0.015$ ($p < 0.05$) obtained through the use of the Chi-Square statistical test. There is a relationship between earphone usage patterns and the risk of hearing loss, which affects the quality of life of students of the Faculty of Medicine, Universitas Kristen Indonesia, Class of 2019, 2020, and 2021.

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Keywords
Earphone Use Patterns
Hearing Loss
Hearing Handicap Inventory
Quality of Life

Introduction

The ability to hear is at the heart of all human communication, both with each other and with the world around us [1]. Hearing loss is one of the most common disabilities worldwide, affecting more than 1.5 billion people, according to the World Health Organization (WHO) [2]. While common, hearing loss often goes unrecognized by patients and doctors, leading to inadequate treatment. The prevalence of clinically significant hearing loss has been found to double every decade [3]. In Southeast Asia, the prevalence of hearing loss is estimated at 27%, which equates to approximately 156 million people in the total population. In contrast, the prevalence of hearing loss in Indonesia nationally is 2.6% of the total population, and this figure is expected to increase over time [4].

In today's modern life, most people are constantly exposed to noise that can potentially disrupt hearing function [5]. The use of personal audio devices, specifically earphones, is a significant and growing risk factor for hearing loss in the context of this study. WHO estimates that 1.1 billion adolescents and young adults are at risk of hearing loss as a direct result of exposure to loud noises from electronic devices. This risk is primarily associated with the increased volume of sound produced by these devices [6]. The use of earphones is a significant indicator of increased risk, especially for noise-induced hearing loss (NIHL), as earphones can bring the noise source closer to the ear, resulting in the listener receiving significantly greater exposure [7]. A study by Rumampuk in Indonesia found that 26.7% of students who use earphones experience some level of hearing loss, with 6.7% experiencing moderate hearing loss [8]. According to data from the WHO, approximately 430 million people, or more than 5% of the global population, experience hearing loss that affects their quality of life. The habit of listening to music at high volumes via earphones and other noisy environments for long periods of time is a primary cause [9]. In addition, university students are considered a vulnerable group because academic activities and lifestyle habits often encourage prolonged earphone use for entertainment, online learning, and communication purposes. Based on the above background, the researcher wants to know the relationship between earphone usage patterns (including volume and duration) and the risk of hearing loss, which affects the quality of life of students of the Faculty of Medicine, Indonesian Christian University, Class of 2019-2021.

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Literature Review

A. Ear Anatomy

Human ear development begins with the appearance of the otic placode and vestibulocochlear ganglia at three weeks of gestation. This is followed by the appearance of the external canal, which begins to develop from the first branchial cleft in the fourth week, then forms a hole through ectodermal proliferation. By the 28th week, the epithelial core has canalized from medial to lateral, resulting in a fully patent external canal [10].

The ear can be divided into three parts: the outer ear, the middle ear, and the inner ear [11]. The outer ear consists of the auricle (also known as the pinna) and the external auditory canal, as well as the lateral surface of the tympanic membrane, which is part of the outer ear [12]. The middle ear consists of the tympanic membrane and three auditory ossicles: the malleus, incus, and stapes. These three ossicles allow sound waves to travel from the outer ear to the inner ear by connecting the tympanic membrane to the inner ear [13]. The inner ear is a system of canals and a cavity within the petrous part of the temporal bone. The inner ear is formed by the bony labyrinth (osseous labyrinth), which contains the membranous labyrinth. The bony labyrinth consists of three components: the semicircular canals, the vestibule, and the bony cochlea. The membranous labyrinth is located within the bony labyrinth and is a system of interconnected channels lined with epithelium and containing endolymph. The membranous labyrinth consists of the membranous semicircular canals, the utricle, the saccule, the endolymphatic duct, the endolymphatic sac, and the reuniens duct. The cochlear duct contains the organ of Corti, which is the organ of hearing. There are sensory nerve endings in the ampullae of the semicircular canals (crista ampullaris) and in the utricle and saccule (macula sacculi and utriculi), which function as static and kinetic senses.

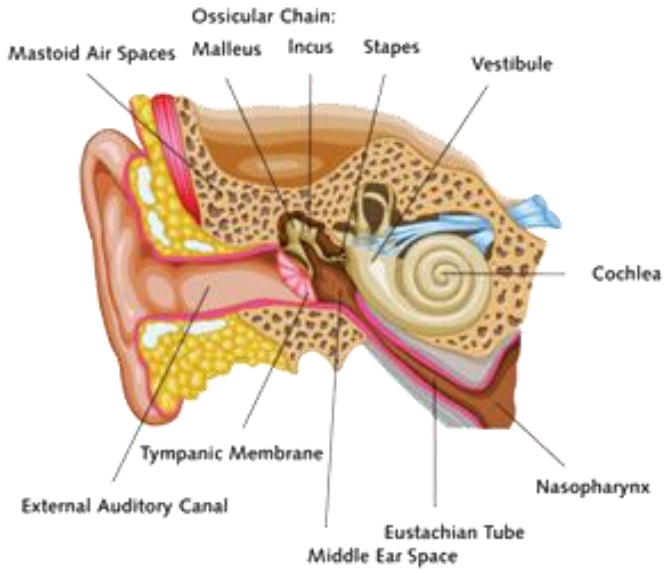

Fig. 1. Ear Anatomy [3]

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B. Physiology of Hearing

Hearing and balance are functions performed by the human ear. The transduction mechanism in the ear is responsible for detecting and analyzing sound. This mechanism is responsible for converting sound waves into electrochemical impulses. If the anatomy is abnormal, hearing will not function properly even if the nerves are intact. Hearing is the process by which sound vibrations from the surrounding environment are converted into action potentials in the cochlea and auditory nerve. Sound is produced when an object is made to vibrate, such as when a guitar string is plucked. The resulting vibrational pressure is called a sound wave. Therefore, the ear is designed to detect and categorize various sonic qualities, including pitch (the frequency of the sound wave) and loudness (the perceived intensity of the sound). Hertz is the standard system of frequency measurement (Hz, cycles per second). The human ear can generally detect sounds between 1,000 and 4,000 hertz, but younger ears can detect sounds between 20,000 and 200,000 hertz. The decibel (dB) is the unit used to measure the loudness of sound, and the audible range that humans can tolerate on the decibel scale is from 0 to 130 dB (where the sound can become painful). To enter the central nervous system, each of these physical properties must first undergo some kind of transformation. Air vibrations are first converted into vibrations of the tympanic membrane, which is the first step in the process. Once they reach these structures, the vibrations are captured by the middle ear and ossicles. Then, in the inner ear and cochlea, these vibrations are converted into vibrations of fluid, and these fluid vibrations stimulate areas known as the basilar membrane and the organ of Corti. Ultimately, these vibrations are converted into nerve impulses, which are then transmitted to the nervous system [14].

The primary function of the organ of Corti is auditory signal transduction. Sound waves enter the ear through the auditory canal and cause vibrations in the tympanic membrane. Movement of the tympanic membrane causes subsequent vibrations in the auditory ossicles, the three middle ear bones, which transfer energy to the cochlea through the oval window. As the oval window moves, the waves travel through the perilymph fluid in the scala tympani and then the scala vestibuli of the cochlea. As fluid moves through these structures, the basilar membrane, located between the scala media and scala tympani, shifts against the tectorial membrane, respectively [15].

C. Hearing Loss

Hearing loss is a condition that occurs when the transmission of sound from the outer ear to the brain is disrupted. The disruption can occur at any stage, before, after, or after and before the cochlea. Hearing loss can be conductive, sensorineural, or mixed [16]. Conductive hearing loss is caused by impaired transmission of sound waves to the cochlea, which ultimately causes problems primarily in the outer ear and auditory canal. The problem may originate in the

external canal due to obstruction from debris, wax, or foreign objects, or may result from a congenital abnormality such as aural atresia, which causes incomplete development of the outer ear. Perforation of the tympanic membrane can also cause conductive hearing loss. Perforation can be associated with trauma from using cotton swabs to clean the ears, barotrauma from diving, or as a sequela of otitis media [17]. Sensorineural hearing loss (SNHL) is the most common type and accounts for the majority of all hearing loss. Hearing loss resulting from neurological, otologic, or vascular disorders is referred to as SNHL. Sensorineural hearing loss can be caused by damage to the auditory nerve, the vestibulocochlear nerve, or the central auditory processing area of the brain [18].

Noise can damage the sensory hair cells of the inner ear through direct mechanical pressure and intense sound pressure, as well as by activation of stress-induced molecular pathways, including the formation of reactive oxygen species and excess calcium. Assessed by the decibel level and duration of exposure, this can cause noise-induced hearing loss, which can also be known as noise-induced hearing loss (NIHL) [19]. NIHL is hearing loss caused by exposure to sounds that are too strong so that they can damage hearing cells. This kind of hearing loss is often described as “noise-induced”. NIHL can be classified into three, namely, Temporary Threshold Shift (TTS), Permanent Threshold Shift (PTS), and Acoustic Trauma. Four factors contribute to the effects of noise, namely, sound level (volume), audio spectrum, distribution of exposure time, and cumulative noise exposure over days, weeks, or years [20]. The term "transient threshold shift" is used to describe objective changes in hearing acuity that can be measured on audiometry immediately after an episode of loud noise exposure and which return to pre-exposure levels after a few days to two weeks. A temporary threshold shift is subjectively characterized by decreased hearing sensitivity, a feeling of fullness in the ear, tinnitus (ringing), and the perception of hearing loss. Prolonged or repeated exposure to noise can lead to the death of sensory hair cells and result in permanent hearing loss, referred to as a “permanent threshold shift.” Hair cell death may be followed by a gradual loss of spiral ganglion neurons over months or years [21].

D. Earphones

To listen to audio, people usually need a device called earphones, which convert electrical energy into sound waves. Earphones are most often used for media consumption and digital communication via gadgets such as smartphones and computers [22]. Consumers are increasingly turning to earphones due to advances in audiovisual and communication technology. Earphones are now commonly used to listen to music on mobile phones and other audio devices, thanks to these innovations. People, especially teenagers, have made listening to music through headphones or earphones a regular part of their lives. Most teenagers wear earphones or headphones, typically to listen to music for extended periods of time. They do so

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even while engaging in other activities, such as traveling, exercising, or even sleeping. Prolonged use can cause continuous noise, which can damage hearing [6].

Recent advances in audiovisual technology have had a significant impact on the creation of modern music players and the hearing aids used to listen to music on these devices. Earphones, headsets, headphones, and other types of hearing aids are just a few of the many types that have been produced, with varying capacities and sound output functions [23]. According to one study, 88.2% of 1,407 children used personal music players, also known as MP3 players, and 27.4% of these children listened to music at the highest possible volume for extended periods without interruption. Another study found that 94.3% of those participating used personal music players daily for between one and three hours over three years. Conversely, earphones are the most common form of amplification for the hearing impaired. This demonstrates the widespread use of earphones among today's youth [23].

E. The Impact of Earphone Use Patterns on Hearing Loss

While earphone use is currently more effective than loudspeakers, it's important to note that earphone use can impact hearing response and chronic noise. Even at the same volume, listening to music through earphones produces a higher overall noise intensity than listening to the same music without earphones. When someone listens to music with earphones, the sound source is physically closer to them than when listening without earphones. Earphones also don't fully distribute sound and don't completely block out external noise, which can contribute to hearing loss. Earphone use patterns can be divided into four components: frequency, duration, noise volume, and length of earphone use. These four components are the primary assessments for determining earphone use patterns, which are then classified into two categories: risky and non-risky earphone use patterns [24].

Hearing loss is one of the effects caused by earphone use, resulting from improper use. Continuous exposure is a risk factor for hearing loss. Approximately 5 to 10% of earphone users are at risk of hearing loss and even permanent hearing loss if they listen to music for more than one hour a day at high volume [23]. Due to the length of earphone use of more than three years and daily use, earphones require attention, as literature indicates that prolonged exposure to loud noise can cause noise-induced hearing loss (NIHL) [25].

Research by Setianiet [26] found that 77.8% of those with a history of noise exposure from earphones experienced NIHL, and 22.2% experienced NIHL with more than five years of use. Therefore, using earphones for five years or more can increase the risk of NIHL. Noise-induced hearing loss (NIHL) is a form of sensory deficit that can lead to sensorineural hearing loss due to continuous exposure to loud noise over a prolonged period [27].

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F. The Impact of Hearing Loss on Quality of Life

According to the World Health Organization (WHOQOL), quality of life is defined as an individual's perception of their life in society within the context of their culture and existing value systems, related to goals, expectations, standards, and concerns. Based on this definition, quality of life can be defined as life satisfaction or the fulfillment of life's needs based on a person's perceived physical, psychological, and social conditions [28], [29]. Factors that can influence a person's quality of life include psychological conditions. For example, psychological conditions can arise from the impact of an individual's physical limitations, which can lead to anxiety disorders, which can reduce the sufferer's ability to work and socialize with others. This can indirectly impact a person's quality of life. Beyond psychological factors, there are social relationship factors such as social support, which is the presence of others who can be relied upon to provide assistance, encouragement, acceptance, and attention, thereby improving and influencing the well-being or quality of life for the individual concerned [30].

Hearing loss can lead to a potential handicap or disability, limiting the individual's ability to perform various tasks in life. This can have psychological impacts, such as communication barriers, leading to anxiety, depression, and even impaired social interaction. Psychological and social relationships are factors that can impact a person's quality of life [31].

Material and Methods

This study employed a cross-sectional observational analytical design to assess the association between earphone usage patterns and the risk of hearing loss and its impact on quality of life among medical students at the Faculty of Medicine, Universitas Kristen Indonesia (UKI), from the 2019–2021 cohorts. The study was conducted between December 2022 and January 2023 at the Faculty of Medicine, Universitas Kristen Indonesia, located at Jl. Mayjen Sutoyo No. 2, Cawang, Kramat Jati District, East Jakarta. The target population consisted of all undergraduate medical students enrolled in the 2019–2021 intake years at the Faculty of Medicine, UKI. Based on academic registry data, the total number of eligible students during the study period was [N =225], which constituted the sampling frame for this study. A non-probability sampling method using consecutive sampling was applied.

All students within the sampling frame who met the inclusion and exclusion criteria (Table 1) were invited to participate. Recruitment was conducted online by distributing an invitation link to a Google Forms questionnaire through official student communication channels, including class-based WhatsApp groups and institutional mailing lists. Participation was voluntary, and electronic informed consent was obtained before questionnaire completion. The sample consisted of all students who met the inclusion and exclusion criteria as in Table 1, and had given their consent.

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Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Students from the 2019–2021 intake of UKI from any faculty.	Students who have previously been diagnosed with a hearing disorder (e.g., presbycusis, otosclerosis, chronic otitis media).
Willing to participate and sign the informed consent form.	Students who are currently taking medication known to be ototoxic (e.g., certain antibiotics or chemotherapy agents).
Own and regularly use earphones/headphones for leisure or study purposes.	Students who did not complete the entire questionnaire.

The sampling technique used in this study was non-probability sampling, namely, consecutive sampling, which was used to determine the research sample based on predetermined criteria and objectives. The research instrument consisted of two questionnaires: the Earphone Usage Pattern Questionnaire (EUPQ), which was used to examine respondents' habits of using earphones, and the Hearing Handicap Inventory for Adults (HHIA) questionnaire, which was used to determine the quality of life of earphone user respondents.

Data collected through the questionnaire were processed using IBM SPSS (Statistics for Social Science) and Microsoft Office Excel. Categorical data were displayed as percentages, while numerical data were displayed as means and standard deviations. All data were presented in tabular form. An inferential analysis was then performed to analyze the relationship between EUPQ and HHIA using the Chi-square test. The Pearson correlation test was used to analyze the relationship between EUPQ scores and HHIA, provided the data were normally distributed; otherwise, the Spearman test was employed.

Results

This study used an online questionnaire created using Google Forms and administered to students of the Faculty of Medicine, Universitas Kristen Indonesia, between December 2022 and January 2023. This study aimed to determine the relationship between earphone use patterns and self-perceived hearing difficulties that may affect quality of life, as measured by the Hearing Handicap Inventory for Adults (HHIA). The HHIA questionnaire was translated and culturally adapted into Indonesian following a forward–backward translation process conducted by bilingual experts to ensure semantic and conceptual equivalence with the original version. The Indonesian version of the HHIA has been previously validated and shown to have good psychometric properties in adult populations. In the present study, the internal consistency reliability of the Indonesian HHIA was evaluated using Cronbach's alpha, which demonstrated high reliability (Cronbach's $\alpha = 0.91$). This indicates that the adapted instrument was suitable for assessing self-reported hearing handicap in the study population.

The study population comprised 225 students from the 2019, 2020, and 2021 intakes at the Faculty of Medicine, Universitas Kristen Indonesia. The study lasted three months and was divided into two parts. In the first phase, participants were asked to complete a questionnaire about their regular earphone use patterns, and then they were asked to complete the HHIA questionnaire. The data was then analyzed, and a thesis was prepared. See Table 2 and Fig. 2.

Table 2. EUPQ Distribution Overview

Assessment Criteria		*f*	%
Length of Use of Earphones	0-3 years	52	23.1
	>3 years	173	76.9
Duration of Earphone Use	<1 hour	97	43.1
	1-2 hours	66	29.3
	>2-4 hours	36	16.0
	>4-6 hours	14	6.2
	>6-8 hours	5	2.2
	>8 hours	7	3.1
Frequency of Earphone Use	1-2 days	115	51.1
	3-4 days	62	27.6
	5-6 days	17	7.6
	Every Days	31	13.8
Earphone Usage Volume	<60%	140	62.2
	60-80%	69	30.7
	>80%	16	7.1
Earphone Usage Patterns	No Risk	85	37.8
	Risk	140	62.2
Total		225	100.0

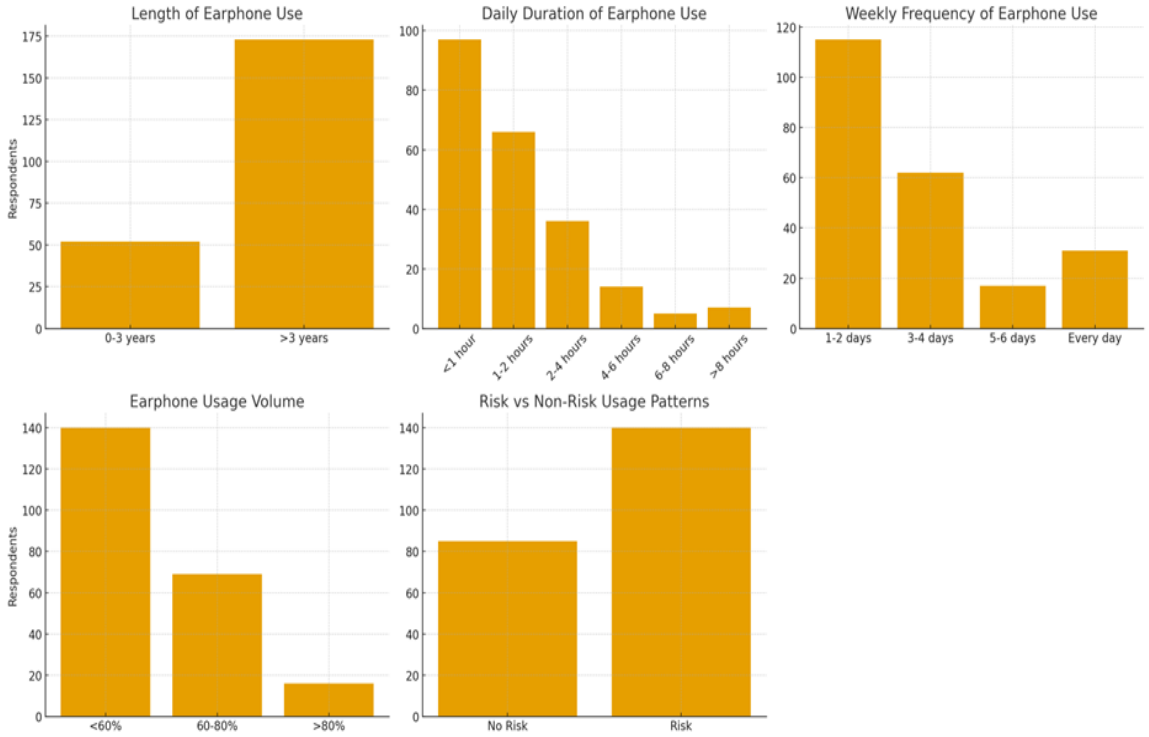

Fig. 2. The Chart of EUPQ Distribution Overview

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Based on Table 2, 52 respondents used earphones for 0-3 years, representing 23.1% of the total, while 173 respondents used earphones for more than 3 years, representing 76.9% of the total. Based on these findings, the majority of students using earphones at the Faculty of Medicine, Universitas Kristen Indonesia (UKI) have used them since their teenage years, with some even using them since junior high school. A total of 97 respondents (43.1%) used earphones for more than 1 hour, 66 respondents (29.3%) used earphones for 1-2 hours, 36 respondents (16.0%) used earphones for more than 2-4 hours, 14 respondents (6.2%) for more than 4-6 hours, 5 respondents (2.2%) for more than 6-8 hours, and 7 respondents (3.1%) for more than 8 hours. From this table, it can be seen that students of the Faculty of Medicine, Christian University of Indonesia, Class of 2019, 2020, and 2021 mostly use earphones for more than one hour per day.

In total, 115 respondents (51.1%) reported using earphones 1-2 days a week, while 62 (27.6%) used them 3-4 days a week, 17 (7.6%) used them 5-6 days a week, and 31 (13.8%) used them daily. Here, we see that first-, second-, and third-year medical students at the Christian University of Indonesia used earphones between two and three days a week. 140 (62.2%) respondents used earphones with a volume of <60% (≤9 clicks of 0 volume), 69 (30.7%) used earphones with a volume of 60-80% (10-12 clicks of 0 volume), and 16 (7.1%) used earphones with a volume of >80% (>12 clicks of 0 volume). In this case, students at the Faculty of Medicine, Indonesian Christian University, Class of 2019, 2020, and 2021 mostly used earphones with a volume of <60% (≤9 clicks from 0% volume). 85 respondents (37.8%) had earphone usage patterns that did not pose a risk, while 140 (62.2%) had earphone usage patterns that did. From what we can tell from this study, the majority of medical students at the Christian University of Indonesia (UI) in the 2019, 2020, and 2021 intakes are at risk of hearing loss. Heavy, long-term earphone use (>3 years), daily use (>1 hour), weekly use (>4 days), and high-volume use (>60%) all contribute to risky earphone use.

Table 3. HHIA Score Results Overview

Indicator		*f*	%
Hearing Handicap Inventory Adults Score Results	No Handicap	167	74.2
	Mild Moderate Handicap	22	9.8
	Severe Handicap	36	16.0
	Total	225	100.0

Table 3 shows the scores from the Hearing Handicap Inventory for Adults (HHIA) questionnaire distributed to groups at risk for hearing loss. Of the respondents who completed the questionnaire, 167 (74.2%) had no handicap, 22 (9.8%) had a mild-moderate handicap, and 36 (16%) had a severe handicap.

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Table 4. The Relationship Between EUPQ and HHIA

Earphone Usage Patterns	Hearing Handicap Inventory Adults (HHIA)						p-value
	No Handicap		Mild Moderate Handicap		Severe Handicap		
	f	%	*f*	%	*f*	%	
No Risk	71	83.5	8	9.4	6	7.1	0.015
Risk	96	68.6	14	10.0	30	21.4	
Total	167	74.2	22	9.8	36	16	

Table 4 shows that 96 respondents (68.6%) had earphone use patterns that put them at risk for hearing loss, 14 (10.0%) had mild-moderate handicaps, and 30 (21.4%) had severe handicaps. Meanwhile, 71 respondents (83.5%) were not at risk for hearing loss, 8 (9.4%) had mild-moderate handicaps, and 6 (7.1%) had severe handicaps. Statistical tests revealed a statistically significant relationship between risky and non-risky earphone use and handicaps that can affect respondents' quality of life, with a p-value of 0.015 ($p<0.05$). Therefore, it can be concluded that there is a significant relationship between earphone use patterns and the risk of hearing loss. This relationship affects a person's quality of life. To determine the significance of the correlation and the degree of correlation between the independent and dependent variables, an analysis was conducted based on numerical data from the earphone usage pattern questionnaire and HHIA scores using the Pearson correlation test if the data were normally distributed and alternatively using the Spearmann correlation test if the data were not normally distributed. A normality test was conducted to determine the normality of the data distribution, using the Kolmogorov-Smirnov test because the sample size was >50.

Table 5. Normality Test Results

Variable	Median (IQR)	Mean ± SD	Min	Max	*p-value*
Earphone Usage Patterns	9.0 (7.0–12.0)	9.48 ± 3.24	4.0	18.0	<0.001[a]
HHIA	6.0 (2.0–26.0)	16.14 ± 21.42	2.0	96.0	<0.001*

Description:
[a]Kolmogorov-Smirnov
Table 5 shows the results of the Kolmogorov-Smirnov test on earphone usage patterns, with a p-value of <0.05 and HHIA of <0.05.

Table 6. Spearman Test Results

Variable	r	P-value
EUPQ HHIA	0.202	0.002[b]

Description:
[b]Spearman's Test
A Spearman's correlation test followed this. Table 5.6 shows a weak, significant relationship between earphone use patterns and the risk of hearing loss, which impacts students' quality of life.

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Discussion

A. Distribution of Respondents' Earphone Usage Patterns

From the results of the research conducted by researchers, a questionnaire was completed to assess earphone usage patterns, which included information on duration, frequency, duration, and volume. It was found that the majority of respondents (173 respondents) had used earphones for more than three years, totaling 76.9%. This indicates that students from the Faculty of Medicine, Christian University of Indonesia (2019-2021) have been listening to music through earphones since they were in school. This aligns with research conducted by Fatimah Hamzah and Nurul, whose respondents were students from the Faculty of Medicine, Muhammadiyah University of Makassar, with an average duration of earphone use of more than three years (95.7%) [32]. According to the ENT-KL textbook, hearing loss due to prolonged exposure to excessively loud noise can lead to sensorineural hearing loss [33]. According to the World Health Organization (WHO), the largest number of earphone users worldwide are adolescents aged 12 to 24, who constitute part of the urban population [34].

The use of earphones has become commonplace in modern culture, especially among young people, who are more likely to use them as part of their daily routine than older generations. Earphones can be used as a means of listening to music and communicating because they can produce clearer sound than listening through the earphone speakers themselves. Furthermore, earphones are easy to carry anywhere, the volume can be adjusted, and they can provide privacy for the user. Regarding the duration of earphone use, the respondents in this study mostly used earphones for less than 1 hour, amounting to 97 people (47.1%). This result is in line with research by Martanegara and Ilman, who found that most respondents in the study used earphones for <1 hour, accounting for 61.34%. Noise-induced hearing loss can occur in the general public, especially teenagers, if they are often exposed to the use of earphones at high volume and continue to use them for an average of one to three hours per day [26]. More frequent use of earphones can be caused by the attachment to using earphones at high intensity because the use of earphones can be used in all things, such as when driving, sitting relaxing, or doing activities. These earphones are very helpful so that even while doing activities, the person can still communicate or listen to music [22].

This study also found that 51.5% of the sample, or 115 students, from the Faculty of Medicine, Universitas Kristen Indonesia, Class of 2019, 2020, and 2021, mostly used earphones once or twice a week. A low frequency of earphone use can be determined when respondents wear their earphones for 1-2 days per week. This finding is consistent with that obtained from a study conducted in the past by Fatimah Hamzah and Nurul on students of the Faculty of Medicine, Universitas Muhammadiyah Makassar. The researchers found that almost half of the students (47.8%) used earphones for 1-2 days per week.

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Based on the results of this study, as many as 140 respondents (62.2% of the total) often use earphone volume with > 60% on earphones. This is different when compared to research by Velaro, Adrian on Medical Faculty Students, University of North Sumatra, most of the respondents in their study used earphones with a volume of 60-80%. 26 respondents who use earphones with high volume usually do so because users are not satisfied listening to them at low volume, so they choose to increase the volume of the sound produced by the earphones, even though they are aware of the dangers of using earphones with high volume. This occurs even though respondents are aware of the dangers of using earphones at high volume [35]. If the use of earphones with high volume has become a habit for its users, there will be a trauma effect on the sound receptors due to the use of earphones with high volume intensity, and cause a decrease in hearing function.

B. HHIA Score Overview

Information about hearing loss, expectations, and motivation can be collected using the Hearing Handicap Inventory for Adults (HHIA). The World Health Organization (WHO) defines disability or handicap as "a disadvantage to a person due to an impairment or impairment that limits or prevents the fulfillment of a normal role," taking into account the person's age, gender, and social and cultural context. The HHIA is a questionnaire used to assess the extent of handicap in adults with hearing loss. The HHIA is just one of many self-report instruments available to measure the functional impact of hearing loss on a person's daily life. In addition, the HHIA evaluates both emotional and social/situational consequences experienced by individuals with hearing impairment, making it useful for identifying the broader psychosocial effects of hearing loss. The questionnaire is also widely used in clinical and research settings because it provides a simple yet reliable method for assessing perceived hearing-related difficulties among adults. HHIA results can be used to address some of the psychological impacts of hearing loss. The higher the HHIA score, the greater the recognition that hearing loss is a significant disability for the respondent due to the greater limitations or obstacles experienced by the sufferer in fulfilling their daily roles, resulting in a diminished quality of life.

This tool can assist audiologists by providing additional information regarding: (1) helping to substantiate complaints of hearing loss that are not apparent on conventional audiometric testing results; (2) facilitating candidate decisions regarding the use of amplification (hearing aids); (3) assisting in the counseling process; (4) serving as a guide for determining client-centered rehabilitation programs; and (5) serving as a measurement criterion in rehabilitation evaluations, including the benefits of post-surgical hearing aids. 46 hearing loss can impact quality of life and limit activities or participation in daily life. The impact of this hearing loss can be assessed using the HHIA questionnaire [36]. In this study, the researchers used the

HHIA questionnaire, which had been adapted into Indonesian and had been tested for validity and reliability.

The HHIA questionnaire in this study was administered to groups of people at and not at risk of developing hearing loss due to earphone use. 225 people (100%) completed the HHIA questionnaire. The results showed that 74.2% had no handicap, 9.8% had mild-moderate handicap, and 16% had severe handicap. In a previous study by Marcus and Dayse, the majority of respondents (70.8%) had a severe handicap, 22.9% had a mild-moderate handicap, and 6.3% had no handicap [37]. The HHIA questionnaire varies widely and depends on life experiences, health expectations, and even the individual's ability to adapt. People with hearing loss will experience communication difficulties and experience social and emotional difficulties in their daily lives. This will lead to different perceptions of their quality of life [36].

C. Relationship between Earphone Use Patterns and HHIA Scores

This study found a statistically significant relationship between earphone use patterns and the risk of hearing loss, which impacts the quality of life of students at the Faculty of Medicine, Christian University of Indonesia, in the 2019, 2020, and 2021 intakes ($p = 0.015$) of the 2019, 2020, and 2021 intakes ($p<0.05$). Furthermore, the Spearman correlation test revealed a weakly significant relationship between earphone use patterns and the risk of hearing loss, which impacted students' quality of life ($p = 0.002b$). Similarly, research by Marcus and Dayse confirmed that hearing loss can significantly impact quality of life [37].

The correlation between the two variables supports this finding. Incorrect use of earphones can lead to a risk of hearing loss and negatively impact quality of life, as measured by the HHIA questionnaire. Earphone use patterns can increase the risk of hearing loss, which can lead to physical, social, and emotional changes in individuals. These changes can persist and disrupt daily activities, significantly impacting quality of life, especially for those at risk for hearing loss.

The results demonstrating a higher HHIA score in respondents with risky earphone use patterns can be explained through well-established biological mechanisms. Exposure to sounds above 85 dB for long durations causes damage to outer hair cells (OHCs) in the cochlea. These OHCs function as mechanical amplifiers, improving frequency selectivity and sound sensitivity. High sound pressure levels lead to excessive mechanical vibration, which triggers oxidative stress and mitochondrial dysfunction in cochlear cells. Over time, this results in apoptosis and irreversible loss of sensory cells, leading to permanent threshold shifts and progressive hearing impairment.

Furthermore, loud music, especially when transmitted directly into the ear canal via in-ear earphones, causes temporary threshold shifts that, with repeated exposure, accumulate into permanent hearing loss. Research indicates that high-volume listening can induce excessive

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glutamate release, resulting in excitotoxicity at the ribbon synapses between inner hair cells and auditory nerve fibers. This "hidden hearing loss" may develop even before pure-tone audiometry detects deficits, and can manifest as difficulties in speech.

Limitations

This study has an important limitation related to the assessment of hearing outcomes. Hearing difficulties were evaluated using the Hearing Handicap Inventory for Adults (HHIA), which is a self-reported questionnaire measuring perceived hearing problems and their impact on daily life. No objective hearing examinations were performed. Therefore, the results do not represent confirmed hearing loss or sensorineural hearing impairment. Self-reported hearing difficulties may be influenced by individual perception and may not always reflect actual audiometric abnormalities. The absence of objective assessments such as pure-tone audiometry or otoacoustic emission (OAE) testing limits the ability to directly identify cochlear damage or early noise-induced hearing loss. Future studies should combine self-reported questionnaires with objective hearing tests to strengthen the evidence and better distinguish between perceived hearing difficulties and clinically confirmed hearing loss.

Conclusion

This study shows that students with risky earphone use patterns—such as long listening duration, high volume, and frequent weekly use—are more likely to experience hearing difficulties, as indicated by their HHIA scores. Although most students reported no handicap, a meaningful number already showed mild to severe hearing problems, indicating early signs of noise-induced hearing loss. Unsafe listening habits can gradually damage the cochlea and affect communication, concentration, and overall quality of life. Because many students have used earphones since adolescence, early prevention is important. To reduce the risk of hearing loss, educational institutions and related agencies should take more active steps, such as: 1) Providing education about safe listening habits (e.g., 60–60 rule); 2) Offering regular hearing screenings for students; 3) Creating campus policies that encourage healthy gadget use; 4) Running digital campaigns to raise awareness of safe earphone practices; 5) Partnering with health professionals to offer counseling for at-risk students. In summary, unsafe earphone use is a growing concern among young adults, and schools and health agencies should work together to promote safer listening habits and protect students' long-term hearing health.

Conflict of Interest

The authors declare that there is no conflict of interest.

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