e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15 (3); 1568-1576

Original Research Article

A Comparative Study on Auditory Reaction Time among Prolonged Headphone Users and Non-Users

Priyanka Verma[1], Ajay Bhatt[2]*, Sunita Solanki[3]

[1]Assistant Professor, Department of Physiology, L.N.C.T. Medical College Indore, India

[2]Associate Professor, Department of Physiology, M.G.M. Medical College Indore, India

[3]Associate Professor, Department of Physiology, M.G.M. Medical College Indore, India

Received: 02-01-2023 / Revised: 29-01-2023 / Accepted: 12-02-2023

Corresponding author: Dr. Ajay Bhatt

Conflict of interest: Nil

Abstract

Introduction: There is an increasing public health concern about the effects of recreational noise, especially among young people who listen to music at high volumes at concerts and other events. The prevalence of noise-induced hearing loss among adolescents is rising, affecting 1.7% of the world's population. Hearing loss can occur from Exposure to loud noises if it lasts too long.

Aims and Objectives: This research aims to determine if regular headphones users have slower auditory reaction times than non-headphone users.

Methods: Between May 2020 and April 2023, 80 patients who were seen in our hospital's Physiology Department were surveyed for this study. Participants' auditory reaction times were measured with the 0.001-second resolution, +1-digit accuracy Reaction Time Machine 653. To establish their baseline auditory reaction time, each participant undertook three trials. The average reaction time (ART) was then calculated and ART of both headphone users and non-users was compared.

Results: There was no statistically significant variation in response time to any of the three auditory stimuli tested between the sexes in this study. However, using earphones significantly slowed auditory reaction time to the first stimulus but did not affect the second or third stimuli. Male participants' reaction times increased significantly with earphone use for both stimuli, while female participants' reaction times increased significantly with earphone use for both stimuli.

Conclusion: The study has concluded a significant difference in auditory reaction time between headphones and non-users.

Keywords: Auditory Reaction, Headphone Users, Reaction Time, Hearing.

Introduction

The reaction time (RT) unit is a way to measure how quickly an organism reacts to a stimulus. It is calculated how long (RT) it takes between the introduction and the manifestation of the subject's proper voluntary response to a stimulus reaction [1]. Luce and Welford described three different types of RT. In this straightforward RT, there is just one trigger and one response. [2] Identification Reaction Time: In this situation, some stimuli should prompt a response while others should not. [3] Option RT: Different inputs and different reactions are present in this scenario. In human RT, the input is perceived by the nervous system. The message is then sent to the brain by the neurons. The subject's hands and fingers receive the signal after it leaves the brain & travels through the spinal cord [2]. The fingertips and hands are then instructed to respond by the motor neurons. Average simple RTs for college-aged individuals have been calculated to be about 160 milliseconds over sound stimuli and around 190 ms for light stimuli [3]. RT is a response to an incident that can significantly impact our lives because of its real-world implications. While slow RTs can have detrimental effects (like trouble driving or handling road safety issues), fast RTs can yield rewards (such as in sports). Being born with the Left or right, practice, tiredness, vision in the centre versus peripheral vision, a fast respiration period, types of personalities, Exercise, subject intelligence, and other factors can all affect the usual human RT [4].

Recreational noise exposure is a growing public health issue that can cause hearing damage. Young people frequently listen to loud music at unsafe volumes on their headphones or are subjected to loud songs or noise at sporting events, concerts, bars, and clubs. 85 dB is the highest exposure level safe for up to eight hours [5]. As sound levels rise, the amount of time that can be spent listening safely decreases. Other adverse effects of using these hearing aids include multiple sclerosis, ear infections, earaches, numbness, negative impacts on the nervous system, congested airways, external dangers, and hyperacusis. Overusing headphones can also raise psychological anguish, impacting people's potential by making them less alert, unsociable, uninformed, and active. Overuse of hearing aids could result in external dangers like accidents and even fatalities [6].

According to reports, noise-induced hearing loss affects 1.7% of the global population, and adolescent cases are rising. Thirty million people throughout the United States were only among those subjected to ambient noise; 10 million had hearing loss from noise. Auditory cells are irreparably harmed due to prolonged loud noise exposure, which is hearing loss caused by noise [7]. The second most prevalent form of Age-related hearing loss (presbycusis) comes first, then noise-induced hearing loss. In the United States, noise constitutes one of the most frequent factors in hearing impairment and hearing loss, while hearing impairment due to noise is among the most prevalent occupational disorders [8]. However, because it has an impact on life satisfaction, hearing loss brought on by noise is a significant problem in the field of health science. Noise levels at industrial sites and daily life can rise as science and technology improve. As a result, it is anticipated that in the future, there will be a steady rise in the there are many patients who have hearing loss due to noise [9]. Loud music is the leading cause of noise-induced hearing loss in young individuals. According to numerous studies, Exposure to loud music for extended periods is one of the most common causes of hearing loss in teenagers-the usage of mobile audio equipment like iPods or MP3 players when attending concerts or clubs. Due to the widespread usage of cellphones, there has been a rise in recent years in noise exposure, particularly from portable music devices [10].

More than 2 million (perhaps 10 million) teenagers in Europe are thought to use loud volumes over an hour on MP3 players, which can harm their hearing [11]. According to one study conducted in the US, 15% of college students reported experiencing hearing loss, while 12.5% of adolescents aged 6 to 19 experienced signs of noise-induced hearing damage [12]. The same research discovered that incorrect usage of portable audio devices was the primary contributor to this hearing loss. Mainly, using Causes for sound-induced hearing loss include using mobile audio devices frequently when travelling to school or enjoying music in public spaces with noise levels above 80 dBA, such as buses and subways [13].

Materials and Methods

Study design

A study was conducted on patients who came to the outpatient department of our hospital during the year May 2020 to April 2023. The study was conducted on 80 patients in the Department of Physiology. The objective of this study was to compare the auditory reaction time (ART) of individuals who use headphones or earbuds frequently for mobile calls or music listening with those who do not use headphones or use them minimally. To collect data, a pre-validated self-administered questionnaire was given to each participant to obtain information about their personal, present, past, family, socioeconomic, and medical history. Information regarding headphone/earbud use for mobile calls and music listening, frequency of use, and duration of use was also collected. The study used an RTM608 electronic reaction time meter supplied by the Medicaid system in Chandigarh. The instrument had two modes of providing stimulus, auditory and visual. For the auditory reaction time test, the apparatus had three sets of continuous sounds of different pitch on the speaker, high, medium, and low.

Figure 1: RTM608 electronic reaction time meter

To conduct the test, each participant was familiarized with the apparatus, and the procedure was explained to them. The study used a choice reaction time test, and participants rehearsed for several times before the test. The apparatus had three auditory stimuli, low, moderate, and high pitch sound, and independent operation was provided. The subject had to react to the sound stimuli by pressing the respective key for the sound as soon as the respective frequency sound was produced. During the auditory reaction time test, the subjects sat on one side, and the examiner sat on the other side of the instrument. When the subject pressed the key as a response to auditory stimuli, the instrument stopped counting the time, which was directly taken as the auditory reaction time.

Inclusion and exclusion criteria

Systemically healthy individuals who are ready to consent, non-smokers, and patients who use earphones are included in the study.

Patients, who are not ready to give informed consent, injury to the upper limb, patients with a habit of consuming alcohol, hearing disease, sleep disorder, and cardiovascular or respiratory disease are excluded from the study.

Statistical Analysis

The study used SPSS 25 statistical software for effective analysis. The continuous data were expressed as mean ± standard deviation, while the discrete data were expressed as frequency and its respective percentage. The study employed one-way ANOVA as a statistical tool for analyzing the measurements between the two groups. The level of significance considered was P<0.05.

Ethical Approval

The author obtained consent from all the patients during their respective treatment schedules. The study used the patients' data, maintaining the privacy of the patient's details. The study was done according to the Declaration of Helsinki (World Medical Association).

Results

Gender does not affect auditory reaction time without using earphones for any of all three auditory stimuli, according to Table 1 below, which suggests that there is no statistically significant distinction between male and female volunteers for any of the three audio stimuli.

Table 1: Distribution of auditory reaction time based on gender without the use of earphones

Gender	Stimuli 1		Stimuli 2		Stimuli 3	
	Male	Female	Male	Female	Male	Female
Mean ± SD	0.52 ± 0.5	0.59 ± 0.6	0.44 ± 0.5	0.59 ± 1.1	0.37 ± 0.4	0.37 ± 0.4
	Second	Second	Second	Second	Second	Second
Unpaired t-test	0.85		1.28		0.37	
P-Value	0.42		0.22		0.73	
Overall	Gender	Mean± SD	Paired t-test	P-value		
	Male	0.44 ± 0.3	0.88	0.42		
	Female	0.49± 0.6				

Since every participant has been habitually using earphones for the past three years, there may be no statistically significant distinction in Auditory Reaction Time between male and female volunteers for any of the three auditory stimuli. This could be because of habituation. Gender does not impact the duration of any of the three auditory stimuli when using earphones (Table 2).

Table 2: Distribution of mean auditory reaction time based on gender without the use of earphones

Gender	Stimuli 1		Stimuli 2		Stimuli 3	
	Male	Female	Male	Female	Male	Female
Mean ±SD	0.72 ± 0.7	0.63 ± 0.6	0.49 ± 0.7	0.44 ± 0.5	0.43 ± 0.4	0.38 ± 0.5
	Second	Second	Second	Second	Second	Second
Unpaired t-test	0.08		0.7		0.99	
P-Value	0.95		0.62		0.33	
Overall	Gender	Mean±SD	Paired t-test	P-value		
	Male	0.51 ± 0.7	0.43	0.69		
	Female	0.47± 0.4				

Table 3 shows a statistically significant rise in auditory reaction time for stimulus 1 when earphones are used compared to when they are not. Still, there is no statistically significant distinction between stimuli 2 and 3 when earphones are used versus when not. There is no statistically significant distinction in auditory reaction time with or without headphone usage for both the second and third auditory stimuli. This may be because habituation sets in after the first auditory stimulus. Overall, using earphones increases auditory reaction time significantly compared to not using them. Overall, using earphones increases auditory reaction time significantly compared to not using them.

Table 3: Comparison between the auditory reaction time with or without using earphones

Gender	Stimuli 1		Stimuli 2		Stimuli 3	
	Without	With	Without	With	Without	With
Mean ± SD	0.52 ± 0.6	0.63 ± 0.6	0.47 ± 0.7	0.47 ± 0.6	0.37 ± 0.4	0.39 ± 0.4
	Second	Second	Second	Second	Second	Second
Unpaired t-test	2.96		0.025		1.24	
P-Value	0.005		0.99		0.23	
Overall	Earphone Use	Mean± SD	Paired t-test	P-value		
	Without earphone	0.45 ± 0.32	1.559	0.124		
	With earphone	0.49 ± 0.31				

In table 4 below, it is shown that for male participants, there can be a statistically significant rise in auditory reaction time with earphone use compared to no earphone use for the first auditory stimulus. Still, there is no statistically significant distinction between the second and third auditory stimuli. There is no statistically significant distinction in auditory reaction time with or without earphone use for the second and third auditory stimuli. This may be because habituation sets in after the first auditory stimulus.

Table 4: Stimuli of auditory reaction time in males with or without using earphones

Gender	Stimuli 1		Stimuli 2		Stimuli 3	
	Without	With	Without	With	Without	With
Mean ± SD	0.50 ± 0.5	0.71 ± 0.7	0.43 ± 0.5	0.49 ± 0.7	0.39 ± 0.4	0.44 ± 0.4
	Second	Second	Second	Second	Second	Second
Unpaired t-test	0.82		1.25		0.35	
P-Value	0.41		0.21		0.72	
Overall	Earphone Use	Mean± SD	Paired t-test	P-value		
	Without earphone	0.44 ± 0.3	2.39	0.03		

	With earphone	0.50 ± 0.5		

According to Table 5 below, female respondents' auditory response times for the first stimulus were statistically longer when using earphones than when they were not. Still, the differences for the second and third auditory stimuli were not statistically different. There is no statistically significant distinction in auditory reaction time with or without earphone use for the second and third auditory stimuli. This may be because adaptation sets in after the first auditory stimulus.

Table 5: Stimuli of auditory reaction time in females with or without using earphones

Gender	**Stimuli 1**		**Stimuli 2**		**Stimuli 3**	
	Without	**With**	**Without**	**With**	**Without**	**With**
Mean ± SD	0.58 ± 0.6	0.62 ± 0.6	0.56 ± 0.9	0.43 ± 0.5	0.37 ± 0.4	0.38 ± 0.3
	Second	Second	Second	Second	Second	Second
Unpaired t-test	2.1		0.21		0.56	
P-Value	0.06		0.87		0.73	
Overall	Earphone Use	Mean± SD	Paired t-test	P-value		
	Without earphone	0.49 ± 0.6	0.79	0.31		
	With earphone	0.47± 0.4				

Discussion

The way a person reacts to a stimulus is determined by reaction time (RT). Due to the possible severity of its application, RT has a tremendous impact on our daily lives. Gender, age, seeing left or right shared, practice, tiredness, central vision against peripheral vision, a fast respiration period, types of personalities, Exercise, subject intelligence, and other factors can all affect the usual human RT [14]. The objective was to evaluate medical first-year students' visual reaction times (VRTs) & auditory reaction times (ARTs) of their ages and levels of physical activity. In the current cross-sectional study, 120 healthy medical learners between 18 and 20 participated. Using the laptop, the RT for the target stimulus in Inquisit 4.0 (Computer Software) was a beep tone to measure ART and a red circle for evaluating VRT [15] calculated. Right away, as the stimulus was provided, the assignment was to press the spacebar. Each stimulus received five readings, and the corresponding for each stimulation, the fastest RT was noted. There was a statistical analysis. ART takes less time than VRT for medical students. Additionally, the RTs of Male medical students respond to visual and aural stimuli more quickly than female medical students do. Medical trainees who routinely exercise had faster RTs than those who lead sedentary lifestyles [16].

Young adults use headphones and personal listening devices (PLDs) more frequently, and they do so most often in noisy surroundings. The type of headphones you use can matter since some Background noise can be reduced more effectively with headphones than with stock earphones. High-volume PLD usage has also been linked to binge drinking, marijuana use, and hard drug use [17]. The present investigation sought to determine whether listening loudness, preferred headphone style, and other health-risk behaviours were related. A survey on PLD use and risky behaviour was administered to 230 undergraduate students. Self-reported use of marijuana and alcohol was included in the survey results [18]. Tympanometry, testing the pure-tone threshold (0.25-8 kHz), and bilateral otoscope was all finished. Participants used the favourite headphone type to listen to an hour of music while the ear canal was probed using a microphone. To determine the comparable consistent volume (LAeq). While headphone type was unrelated to any of these factors, young adults with normal hearing and stronger musical preferences also admitted to abusing alcohol and marijuana more frequently [19].

Individuals are exposed to mobile phones early, and they have become crucial for daily tasks. However, there are worries about the electromagnetic radiation that mobile phones emit having a negative impact [20]. The study's goals were to determine how long-term use of a mobile phone affects a person's mean pure tone audiometry (PTA) thresholds and how that affects changes in purity tone threshold in children at high frequencies such as 2 kHz, 4 kHz, and 8 kHz. based on the study, the exposed ear's hearing threshold has changed when compared to the non-exposed ear. Although many questions remain unanswered, this presents an intriguing area for future study. Limiting the time mobile phones are used is the only practical strategy to reduce Exposure until definite evidence is available [21].

Young adults use headphones and personal listening devices (PLDs) more frequently, and they do so most often in noisy surroundings. The type of headphones you use can matter since some background noise reduction is better achieved with headphones than with stock earphones. High-volume PLD usage has also been linked to binge drinking, marijuana use, and hard drug use. The present investigation sought to determine whether listening loudness, preferred headphone style, and other health-risk behaviours were related. Although headphone kind was unrelated to any of these factors, young adults with hearing loss who had greater musical preference levels also mentioned using more marijuana and alcohol [22].

Using headphones raises the risk of hearing loss and ear canal infection. In this study, we examined 136 Celcom (Malaysia) Sdn. Bhd. Customer care representatives who wore headphones all day. The research objective was to ascertain the frequency of infections of the ears along with other ear, nose, & throat problems [23]. The hearing limits were also based on Amplaid 309 Medical Audiometer results. The absence of evidence for an external eardrum infection among the individuals. There were 4 cases of affected wax and 4 cases of a middle ear infection still present. There were 25 participants (21.2%) who had hearing loss. However, there was no connection between hearing loss and Exposure to sound headphones because higher frequencies were not the primary victims. Additionally, no link was found between assistance duration and hearing loss [24].

Recreational noise exposure is a growing public health issue that can cause hearing damage. From their audio systems, young people frequently listen to music at dangerous volume levels during their free time. The research aimed to look into hearing loss in young people brought on by contact with various audio devices. Two hundred forty-one healthcare professionals and patients between 20 and 40 participated in this cross-sectional survey [25]. A questionnaire about headphones' usage history and trends was the data collection tool. The World Health Organization (hear WHO) certified Smartphone hearing screening device, an application-based hearing test, was used to assess hearing. The present research discovered that many headphone users had subclinical hearing loss. This study provided participants with important information and emphasized their need to care for their hearing. This study describes how new technology might be utilized in an Indian context where the provision of hearing healthcare is problematic [26,27].

Conclusion

The study concluded a significant difference in auditory reaction time between headphones and non-users. Despite the general trend toward faster reaction times among males, no statistically significant differences exist between the sexes. This suggests that using headphones may have a varied effect on cognitive processes in males and females. After using earphones, females showed a faster reaction time compared to males. They were educating people about the dangers of using headphones while driving is crucial to reduce the prevalence of this dangerous behaviour. The research concludes that automakers should spend money on campaigns emphasising the safe usage of headphones and other mobile devices and using headphones while behind the wheel is risky for the user, their passengers, and anybody else in the area. Pedestrians who use hands-free devices may also be more distracted, which can increase the likelihood of accidents.

The findings of this study further stress the need to educate young people about the risks associated with using portable music players and to place restrictions on their use. Although laws prohibiting the use of headphones while driving have garnered a lot of attention, educating the public on the dangers of doing so is still important. Therefore, the study suggests that the government and other interested parties fund a broad public awareness campaign to educate people on the dangers of using headphones and other hands-free devices behind the wheel.

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