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The Effect of Headset/Earphone Use on Hearing Decrease

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Abstract

Chronic noise exposure due to the use of a *headset* for listening to music can reduce hearing function. This thesis aims to determine the effect of the use of a headset to function hearing in terms of duration of use, frequency of use, and the volume when listening to music. Some people listen to music using the headset is not only for relaxation but also to increase their concentration on work. Using a headset can avoid interference, thereby increasing the concentration of the individual. It is essential to realize the influence of music and the use of a headset on the performance and safety of workers while doing their job.

Keywords: Headset, the effect of the use of headsets

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INTRODUCTION

The number of hearing loss in Indonesia is quite surprising, including the highest in Southeast Asia, which is 16.8% for hearing loss. According to the Decree of the Minister of Health No. 768/Menkes/SK/VII/2007, there are five causes of hearing loss (deafness) that can be prevented and treated, namely chronic suppurative otitis media, deafness from birth, deafness in parents, deafness due to noise and cerumen [1]. Today, teenagers are increasingly fond of listening to music through a headset connected to music players. These habits can trigger hearing loss. It was recorded that 15% of adolescents had problems with hearing. This number jumped to 19.5% in 2000 [2].

According to the EU's Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), 5 to 10% of music player users are at risk of permanent hearing loss if they listen to music for more than 1 hour a day at high volume levels for at least five years. Hearing loss is caused by continuous exposure to noise, and the disturbance can be prevented [3].

Rabinowitz found the case of a teenage girl who experienced an increase in the permanent hearing threshold of 30 dB at a frequency of 4,000 Hz. Teenager is known to have a habit of listening to music for hours through headphones. In 2010 stereo headphones had the same noise level as a train locomotive which was 100dB [4; 5]. Based on the description of the background above, one can be identified, namely: "Can the use of a headset affect a person's hearing?" with the aim of the research, namely to determine the effect of using a headset on hearing, by looking at the behaviour of using a headset, namely duration of use, frequency, volume.

LITERATURE REVIEW

The labyrinth (inner ear) contains the organs of hearing and balance, located in the petrous part of the temporal bone [6; 7]. The labyrinth consists of a) The bony labyrinth, consisting of semicircular canals, vestibule and cochlea; and b) The membranous labyrinth, which is located within the bony labyrinth, consists of the semicircular canals, utricle, saccule, sac and endolymphatic duct and cochlea. Between the bony labyrinth and the membrane, there is a space filled with perilymph fluid from the cerebrospinal fluid and filtration from the blood. Within the membranous labyrinth, endolymph fluid is produced by the stria vascularis and reabsorbed in the endolymphatic sac [8; 9; 10].

The vestibule is a small oval space, measuring ± 5x3 mm and separating the cochlea from the semicircular canals [11]. On the lateral wall is the foramen ovale (fenestra vestibuli), to which the footplate of the stapes is attached. The foramen rotundum is located on the lower lateral side. There is a spherical indentation on the anterior medial wall containing the macula sacculi and a small opening containing the inferior vestibular nerve fibres. The utricle macula is located on the upper back of this area. On the posterior wall is the opening of the semicircular canals and the anterior part is related to the cochlear scala vestibule [12].

There are three semicircular canals: superior, posterior and lateral which form 90° angles to each other. Each canal forms two-thirds of a circle is between 0.8 – 1.0 mm in diameter and is almost doubled in ampulla size. There are five openings of the semicircular canals in the vestibule where the superior and posterior canals unite to form a crus before entering the vestibule [13].

Located in front of the vestibule resembling a cochlea length of ± 30-35 mm. The cochlea forms two and a half times to two three quarters of rotation with its axis called the modiolus, which contains the nerve bundles and blood supply from the vertebral arteries [14; 15]. Then these nerve fibres travel to the lamina spiralis ossea to reach the sensory cells of the organ of Corti. The bony part of the cochlea is divided in two by a septum. The inside of this septum is the lamina spiralis ossea, and the outside is the lamina spiralis membrane so that the space containing perilymph is divided into 2, namely the scala vestibule and the scala tympani. These two scales meet at the end of the cochlea, called the helicotrema. The scala vestibuli begins at the foramen ovale and the scala tympani ends at the foramen rotundum. The meeting between the lamina spiralis ossea and the membrane towards the periphery forms a thin membrane called Reissner's membrane, which separates the scala vestibule from the scala media (cochlear duct).

The cochlear duct is triangular, connected to the bony labyrinth by periosteal connective tissue and contains the end organs of the cochlear nerve and the organ of Corti. The cochlear duct communicates with the saccule through the duct of Reunions. The organ of Corti is located above the basilar membrane, which contains organelles important for the peripheral hearing mechanism. The organ of Corti consists of one row of inner hair cells containing about 3000 cells and three rows of outer hair cells containing about 12,000 cells. These cells hang through the holes in the horizontal arms of a seesaw formed by the supporting cells. The afferent and efferent nerve endings attach to the lower ends of the hair cells. On the hair cell surface, there are stereocilia attached to a flattened sheath known as the tectorial membrane. The tectorial membrane is secreted and supported by the limbus [16].

A headset or headphone is a pair of small loudspeakers used close to the user's ear and connected to a signal source such as a radio, CD player, portable media player, etc. [17]. The following are the types of headsets that are commonly used with music player media [18]: a) A Circumaural is a headset that surrounds the ear. Circumaural means around the ear. It allows the wearer's ears to be completely covered and is designed to rest against the head, thus providing plenty of isolation from the outside, which aims to drown out unwanted environmental noise (noise-cancelling headsets). It allows users to listen to music at a minimum volume even in a noisy environment; b) Supra-aural, also known as earpad headphones, are headphones that attach to the surface of the earlobe but do not completely cover the ear like circumaural. Supra-aural headphones are not as bulky as circumaural headphones. Because the shape is not as big as circumaural headphones, supra-aural types are easier to carry because of their smaller size and weight than the circumaural. However, because this type of headphone is only partially attached to the earlobe, it doesn't completely cover it, so environmental sounds can't be completely muffled like in circumaural headphones; c) Earbuds or earphones are a form of inter-aural headphones where the size is much smaller than the previous two types of headphones. Its use is directly placed outside the ear canal. Its small size makes these headphones the best for easy portability. They can fit in even the smallest compartments in travel, such as the user's shirt or trouser pocket. While the best headphones for portability purposes, headphone earbuds have a few drawbacks. Some users felt uncomfortable with the rigid shape made of plastic, and usually, these types of headphones are made with the standard and fixed sizes and are not adjusted to the size of the user. A third drawback of earbud headphones is that they don't fit snugly in the ear and don't muffle outside noise well. So this type of headphone is not as good as the previous two types of headphones in reducing environmental noise. It allows users to increase the volume level when listening to music in noisy environments such as roads, cafeterias, etc; and d) Canalphone, also known as In-Ear-Monitor (IEM), is another type of inter-aural headphone. As the name implies, In-Ear-monitor, this headset is used by inserting the ear tip of the headset into the front of the ear hole, which aims to "seale" the ear. Seals generally serve two functions: 1) to block out noise and 2) to shape the acoustic space in order to achieve a clearer sound. Canal phones are much better at attenuating environmental noise (29-377dB) than circumaural and supraaural headphones (8-11dB).

Stereo headphones have the same noise level as a train locomotive, 100dB [24]. In 2010, the case of a female adolescent who experienced an increase in the permanent hearing threshold was raised. Teenager is known to have a habit of listening to music for hours through headphones. The results of the audiometric tests performed showed an increase of 30 dB at a frequency of 4,000 Hz [19].

Noise is a sound or sound that is annoying or unwanted. This definition shows that noise is very responsive, depending on each individual, the time and place of the noise. For example, people who used to visit a discotheque did not feel the music as noise, but people who had never been to a discotheque would feel the music as a disturbing noise [20]. While audiologically, noise is a mixture of pure tones with various frequencies. 4 Noise whose intensity is 85 dB or more can cause damage to the Corti auditory receptors in the inner ear. The most frequently damaged is the Corti device for sound receptors with a frequency of 3000 Hz - 6000 Hz, and the heaviest damage is the Corti device for sound receptors with a frequency of 4000 Hz.

Based on the time of occurrence and frequency, noise is divided into three types, namely: a) Continuous noise with a broad spectrum, for example, noise due to engines fans; b) Continuous noise with a narrow spectrum, for example, the sound of saws, gas shutoffs; and c) intermittent noise, for example, traffic, the sound of aeroplanes flying in the air, researchers assume that the music produced by the headset is continuous noise with a broad spectrum [21].

Noise Exposure Limit Table

Large Exposure	*Exposure Time*
80 dB	24 hours
82 dB	16 hours
85 dB	8 hours
88 dB	4 hours
91 dB	2 hours
94 dB	1 minute
100 dB	15 minutes
112 dB	1 minute

The ear consists of the outer, middle, and inner ear. The outer and middle ear receives and transmits sound waves from the air to the inner ear. The presence of fluid in the inner ear so that the outer ear and inner ear are useful for amplifying the received vibrations, and there are two sensory systems in the inner ear, namely the cochlea and the vestibular apparatus [22]. The outer ear consists of the pinna (the auricle), the external auditory meatus (the ear canal), and the tympanic membrane (the eardrum). The pinna, a cartilage plate covered with skin, receives sound waves and transmits them to the external ear canal. Because of their shape, the auricle partially blocks sound waves that approach the ear from behind. It serves to help a person distinguish whether the sound is coming from the front or the back [23].

Fine hairs guard the entrance to the ear canal (ear canal). The ear canal's skin contains modified sweat glands that produce cerumen (earwax). The fine hairs and cerumen help prevent particles and air from entering the inner ear canal. The tympanic membrane, which stretches to cover the entrance to the middle ear, vibrates when exposed to sound waves. Alternating areas of high- and low-pressure sound waves cause the very sensitive eardrum to bend in and out in rhythm with the frequency of the sound waves. The middle ear consists of three movable bones or ossicles: the malleus, incus, and stapes. These three bones function to transmit the vibrating motion of the tympanic membrane to the fluid in the inner ear. The first bone, the malleus, is attached to the tympanic membrane, and the last bone, the stapes, is attached to the oval window, the entrance to the fluid-filled cochlea. The bone also moves with the same frequency when the tympanic membrane vibrates in response to sound waves [24].

Several smooth muscles in the middle ear contract reflexively in response to loud sounds (more than 70 dB), causing the tympanic membrane to tighten and the movement of the bones in the middle ear to be restricted. This reduced movement of the middle ear structures eliminates the transmission of loud sound waves to the inner ear to protect the highly sensitive sensory apparatus from damage. However, this reflex response is relatively slow, occurring at least 40 ms after hearing a loud sound. Thus, this reflex only protects against prolonged loud noises, not against sudden loud noises, such as explosions [25; 26].

Hair cells in the organ of Corti convert fluid movement into nerve signals. The cochlear part of the inner ear is shaped like a snail is a system of coiled tubules located in the temporal bone. The cochlea is divided into three longitudinal fluid-filled compartments: the upper, middle, and lower. The middle compartment is also known as the cochlear duct. This duct runs along the centre of the cochlea, almost reaching its end. The upper compartment, also known as the vestibular duct, follows the inner contour of the spiral. The lower compartment, also known as the tympanic duct, follows the outer contour of the spiral. The fluid in the cochlear duct is called endolymph. At the same time, the fluid in the vestibular duct and tympanic duct is called perilymph [27]. The organ of Corti, which lies above the basilar membrane, contains hair cells that are receptors for sound throughout its length. Hair cells produce nerve signals when the hair on their surface is mechanically deformed by fluid movement in the inner ear.

Noise-induced deafness affects the organ of Corti in the cochlea, especially the hair cells. The first area to be affected is the outer hair cells which show a degeneration that increases with the intensity and duration of exposure. The stereocilia of the outer hair cells become less rigid, thereby reducing the response to stimulation. With increasing intensity and duration of exposure, more damage will be found, such as loss of stereocilia. The first affected area is the basal area. With the loss of the stereocilia, the hair cells die and are replaced by scar tissue. The higher the intensity of sound exposure, the inner hair cells and supporting cells are also damaged. With the extent of damage to the hair cells, the degeneration can occur in the nerves that can also be found in the brain stem auditory nucleus. Damage to the middle ear (cochlea) is caused by prolonged exposure to loud sounds because it can cause damage to hair cells in the cochlea, which results in sound signals not reaching the auditory nerve, and this is called sensorineural deafness.

RESEARCH METHOD

In this thesis research, the author uses a type of library research, which is a series of activities related to library data collection methods. Library research uses methods to obtain information data by placing existing facilities in the library, such as books, magazines, documents, historical stories or pure library research related to the object of research. The research approach used is qualitative, namely a systematic research method used to examine or examine an object in a natural setting. Qualitative research is descriptive research and tends to use inductive binding analysis. This approach was chosen because the researcher wanted to examine the effect of using a headset on hearing decrease through sources related to the topic, either in research results such as journals, monographs, references or non-research books.

DISCUSSION

The ear consists of the outer, middle, and inner ear. The outer and middle ear receives and transmits sound waves from the air to the inner ear. The presence of fluid in the inner ear so that the outer ear and inner ear are useful for amplifying the received vibrations, and the tympanic membrane, stretched to cover the entrance to the middle ear, vibrates when exposed to sound waves. Alternating regions of high- and low-pressure sound waves cause the very sensitive eardrum to bend in and out in rhythm with the frequency of the sound waves. The middle ear consists of three movable bones or ossicles: the malleus, incus, and stapes. These three bones function to transmit the vibrating motion of the tympanic membrane to the fluid in the inner ear. The first bone, the malleus, is attached to the tympanic membrane, and the last bone, the stapes, is attached to the oval window, the entrance to the fluid-filled cochlea. The bone also moves with the same frequency when the tympanic membrane vibrates in response to sound waves.

Several smooth muscles in the middle ear contract reflexively in response to loud sounds (more than 70 dB), causing the tympanic membrane to tighten and the movement of the bones in the middle ear to be restricted. This reduced movement of the middle ear structures eliminates the transmission of loud sound waves to the inner ear to protect the highly sensitive sensory apparatus from damage. However, this reflex response is relatively slow, occurring at least 40 ms after hearing a loud sound. Thus, this reflex only protects against prolonged loud noises, not against sudden loud noises, such as explosions.

Hair cells in the organ of Corti convert fluid movement into nerve signals. The cochlear portion of the slug-like inner ear is a system of coiled tubules located within the temporal bone. The cochlea is divided into three longitudinal fluid-filled compartments: the upper, middle, and lower. The middle compartment is also known as the cochlear duct. This duct runs along the centre of the cochlea, almost reaching its end. The upper compartment, also known as the vestibular duct, follows the inner contour of the spiral. The lower compartment, also known as the tympanic duct, follows the outer contour of the spiral. The fluid in the cochlear duct is called endolymph. The fluid in the vestibular duct and tympanic duct is called perilymph.

Exposure to music with a headset can affect the human hearing threshold, especially when performed at high volumes and for long periods. Gradually this effect will lead to permanent hearing loss. Music heard through an in-ear headset has a greater noise intensity than the noise intensity of music heard without using a headset with the same volume because the sound source is close. In addition, in-ear headsets cannot completely prevent the entry of noise from the surrounding environment, so users tend to listen to music at a high enough volume. It causes a greater traumatic effect on the sound receptors in the organ of Corti.

The organ of Corti, which lies above the basilar membrane, contains hair cells that are receptors for sound throughout its length. Hair cells produce nerve signals when the hair on their surface is mechanically deformed by fluid movement in the inner ear. The results of several studies show that the use of headsets can reduce hearing function, characterized by an increase in the hearing threshold at low frequencies, which is temporary and improves after the use of the headset is reduced or discontinued. Hearing loss is characterized by an increase in the hearing threshold above 20 dB or a marked increase in the hearing threshold even though it is less than 20 dB.

Deafness due to noise can affect discrimination in speech (speech discrimination) and social functions. Disturbance at high frequencies can cause difficulty in receiving and distinguishing consonants. Tinnitus is a symptom that is often complained of and can eventually interfere with the acuity of hearing and concentration.

Clinically, exposure to noise in the auditory organ can cause an adaptation reaction, an increase in the temporary threshold of hearing (temporary threshold shift) and an increase in the permanent threshold of hearing (permanent threshold shift). The adaptation reaction is a response to fatigue due to stimulation by sound. This situation is a physiological phenomenon in the ear nerves exposed to noise. Temporary increase in hearing threshold is a condition where there is an increase in hearing threshold due to exposure to noise with a high enough intensity. Recovery can occur within minutes or hours. It is rare to recover in one day. Persistent increase in hearing threshold is a condition in which a persistent increase in hearing threshold occurs due to exposure to very high intensity (explosive) or prolonged noise, causing damage to various cochlear structures, including the organ of Corti, hair cells, stria vascularis, and others.

CONCLUSION

Using a headset that is too frequent and for a long time and high volume affects hearing because the cochlea is exhausted caused by the above factors. In order to avoid hearing loss, the use of a good and correct music player is as follows: a) The volume should not exceed 80 dB or the volume button should be set at 50-60% of the total volume; b) Not too long to listen to music through earphones, let alone continuously. Give ear rest every 30-60 minutes. Because the organs in the cochlea feel tired, hearing can be permanently damaged; c) Use a music player that has volume control; and d) Do not use music players in aeroplanes or crowded environments, because in such situations, people tend to increase the volume which will damage hearing.

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