

A Significant Modern Scientific Hazard in Contemporary World: Earphones, Bluetooth Devices, and Headphones in Causing Hearing Loss

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Introduction:

In keeping with the ever increasing use of digital devices, the widespread use of personal listening devices (PLDs), including earphones, Bluetooth headsets, and headphones, has significantly increased over the past two decades. These devices deliver sound directly into the ear canal, often at high intensity levels, making them an important risk factor for noise-induced hearing loss (NIHL) and related auditory disorders. NIHL is one of the most common preventable causes of hearing impairment worldwide.

Recent studies indicate that prolonged exposure to loud sound through headphones is associated with symptoms such as tinnitus, reduced hearing sensitivity, and auditory fatigue, particularly among young adults and adolescents.

Mechanisms of Hearing Damage

1. Noise-Induced Hearing Loss (NIHL)

The primary mechanism of hearing damage from earphones and headphones is noise-induced injury to cochlear hair cells.

Pathophysiology

Excessive sound exposure leads to:

Mechanical damage to outer hair cells

Metabolic exhaustion of cochlear cells

Free radical formation

Synaptic injury between hair cells and auditory nerve

Repeated exposure causes irreversible sensorineural hearing loss because cochlear hair cells do not regenerate. Prolonged listening at loud volumes has been shown to produce both temporary and permanent hearing loss due to cumulative cochlear damage.

2. Temporary Threshold Shift (TTS)

Short-term exposure to loud sound may produce:

Temporary hearing loss

A feeling of ear fullness

Difficulty hearing speech

Repeated episodes of TTS may eventually lead to permanent threshold shift (PTS).

3. Tinnitus

Tinnitus (ringing in the ears) is a common symptom among frequent headphone users.

Studies show a significant proportion of users report tinnitus after regular headphone use, often associated with unsafe listening levels.

Hazards Associated with Earphones and Headphones

1. High Sound Pressure Levels

Earphones deliver sound directly into the external auditory canal, increasing the effective sound pressure level.

Risk factors include:

Listening above safe volume levels

Listening for prolonged duration

Use in noisy environments (volume increases automatically)

Long-term exposure to loud noise is a major contributor to permanent hearing loss.

2. Prolonged Duration of Use

Duration of exposure is as important as volume.

Common harmful practices:

Listening >2–3 hours continuously

Sleeping with earphones

Daily prolonged use

Studies demonstrate that frequency and duration of headphone use are significantly associated with hearing problems.

3. Use in Noisy Environments

When used in noisy surroundings:

Users increase volume to overcome background noise

This leads to unsafe sound levels

This behavior significantly increases the risk of NIHL.

4. Risk of Ear Canal Infections

Earphones may promote:

Moisture retention

Wax accumulation

Bacterial and fungal growth

This can lead to:

Otitis externa

Otitis media

Conductive hearing problems

Microbial growth in the ear canal has been reported with prolonged earphone use due to retained moisture and debris.

5. Ear Wax Impaction

Frequent earphone use may:

Push wax deeper

Cause cerumen impaction

Result in temporary conductive hearing loss

6. Skin and Dermatological Problems

Possible complications include:

Ear canal dermatitis

Allergic reactions to materials
Pressure-related irritation

Hazards Specific to Bluetooth Devices

Bluetooth earphones have similar acoustic risks to wired devices because hearing damage depends mainly on sound intensity, not transmission mode.

1. Acoustic Risk (Primary)

Bluetooth devices can produce:

High decibel levels

Continuous exposure to sound

Thus, the hearing risk remains similar to other headphones.

2. Electromagnetic Radiation (Secondary Concern)

Bluetooth devices emit low-level radiofrequency radiation, but current evidence indicates:

Exposure is typically far below harmful thresholds

No strong evidence links Bluetooth radiation directly to hearing loss

However, research continues in this area.

Hazards Specific to Noise-Cancelling Headphones

Noise-cancelling technology reduces environmental noise, but excessive use may:

Reduce natural auditory stimulation

Affect sound-processing ability

Some experts suggest prolonged exclusive use may contribute to auditory processing difficulties, although long-term evidence is still limited.

Other Health Hazards beyond Hearing Loss

1. Reduced Environmental Awareness

Users may not hear:

Traffic

Warning signals

Emergency alerts

This increases the risk of accidents.

2. Psychological and Behavioral Effects

Possible associations:

Listening dependency

Social isolation

Reduced attention to surroundings

Risk Factors for Hearing Damage

Major contributing factors include:

High volume levels

Long listening duration

Daily usage

Use during sleep

Use in noisy surroundings

Pre-existing ear disease

Occupational noise exposure

Age, smoking, and environmental noise exposure also contribute to hearing problems among headphone users.

Vulnerable Populations

Higher-risk groups include:

Children

Adolescents

Students

Music professionals

Call-center workers

Gamers

Young individuals are particularly vulnerable due to frequent and prolonged device use.

Public Health Significance

Noise-induced hearing loss from personal listening devices is now considered a global public health concern. Large-scale reviews estimate that a substantial proportion of young people worldwide are exposed to unsafe listening levels, putting them at risk of permanent hearing damage.

Preventive Measures

Evidence-based recommendations include:

Safe Listening Guidelines

Keep volume $\leq 60\%$ of maximum

Limit listening time to ≤ 60 minutes continuously

Follow the 60/60 rule

Device-Related Measures

Use noise-isolating headphones

Avoid sleeping with earphones

Use volume-limiting features

Behavioral Measures

Take regular listening breaks

Avoid use in noisy environments

Seek medical advice for:

* Tinnitus

* Ear fullness

* Hearing difficulty

Conclusion:

Earphones, Bluetooth devices, and headphones pose significant risks to hearing when used improperly. The primary mechanism of injury is noise-induced damage to cochlear hair cells, resulting in irreversible sensorineural hearing loss. Risk increases with higher sound intensity, prolonged listening duration, and unsafe listening habits. In addition to hearing loss, complications such as tinnitus, infections, cerumen impaction, and auditory processing disturbances may occur. Given the rising global use of personal listening devices, promoting safe listening habits and public awareness is essential to prevent avoidable hearing impairment.

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