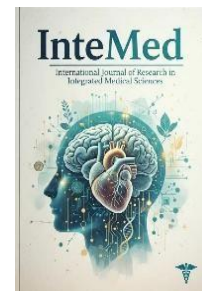




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Review Article

## *Unsafe Listening and Asatmyendriyārtha Samyoga: Preventing Hearing Loss from Headphones and Entertainment*

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**Abstract:** Headphones, gaming headsets and amplified entertainment make it easy to accumulate a high sound dose without noticing it. Hearing risk depends on sound level, duration and repeated exposure, together with individual susceptibility. This narrative review brings together evidence on recreational listening, contemporary prevention guidance and the Ayurvedic concept of *Asatmyendriyārtha Samyoga*, or unsuitable interaction between the senses and their objects. Selected epidemiological and auditory studies, World Health Organization standards and a relevant passage from the *Charaka Samhita* were examined through targeted literature searches. Unsafe listening is common among young people, but estimates of populations at risk should not be read as counts of established hearing loss. Excessive sound can injure cochlear sensory and neural structures. Animal evidence of persistent synaptic damage after temporary threshold recovery is strong; its routine diagnosis in humans remains uncertain. Prevention should focus on measured sound dose, lower listening levels, shorter exposure, suitable hearing protection and safer devices and venues. The classical category of *Atiyoga* offers a possible way to explain excessive auditory exposure in culturally familiar language.

It does not supply modern decibel limits or establish a biological explanation of cochlear injury. The proposed integration is therefore educational and requires evaluation.

Future studies should test whether adding this framing to standard counselling improves objectively recorded listening behaviour, while preserving timely audiological assessment and established hearing-conservation advice.

**Keywords:** hearing loss, noise-induced; noise exposure; headphones; health education; Ayurveda; *Asatmyendriyārtha Samyoga*.

### Introduction

A student may listen to lectures during the day, use headphones on the journey home and spend the evening gaming. None of these activities alone describes the hearing risk. The relevant question is how much sound reaches the ears across the day and week. The World Health Organization (WHO) identifies sound level, listening time and repeated exposure as the main features of safer listening.<sup>[1]</sup>

Dillard and colleagues estimated that unsafe recreational listening could place 0.67–1.35 billion people aged 12–34 years at risk worldwide.<sup>[2]</sup> This estimate concerns potentially hazardous exposure. It does not mean that this many people already have hearing loss or will inevitably develop it. The distinction matters when communicating prevention without exaggerating the evidence.

Ayurveda considers unsuitable contact between a sense and its object under *Asatmyendriyartha Samyoga*. The *Charaka Samhita* distinguishes excessive, absent and inappropriate sensory use, including examples involving loud sound.<sup>[3]</sup> This review examines whether that principle can help explain modern listening risks. Its aim is to connect a culturally familiar preventive idea with evidence-based hearing conservation while keeping historical interpretation, biological mechanisms and clinical recommendations distinct.

Scope and approach

This focused narrative review for unsafe listening, personal listening devices, recreational noise, cochlear synaptopathy, hearing education and *Asatmyendriyartha Samyoga*. Priority was given to studies directly relevant to young listeners, established hearing-science literature, and WHO, International Telecommunication Union (ITU), National Institute for Occupational Safety and Health (NIOSH) and National Institute for Health and Care Excellence (NICE) guidance.

Table 1. Interpreting evidence on recreational listening

| Evidence type                | What it can establish                              | Main limitation                                      |
|------------------------------|----------------------------------------------------|------------------------------------------------------|
| Exposure surveys and reviews | How often selected listening criteria are exceeded | Exposure definitions and recall differ               |
| Audiological studies         | Hearing thresholds and other measured functions    | An association may not identify its cause            |
| Laboratory injury studies    | Biological responses under controlled conditions   | Animal findings require careful human translation    |
| Prevention standards         | Practical approaches to reducing exposure          | A reference limit cannot guarantee individual safety |

Synthesis of the exposure literature and guidance cited above.<sup>[1,2,4]</sup>

Auditory injury and the limits of “hidden hearing loss”

Loud sound can cause mechanical stress within the cochlea and increase the metabolic demands of sensory cells. Oxidative stress and related injury pathways can damage hair cells and supporting structures. Severe injury may produce permanent sensorineural hearing loss. A temporary threshold shift means that sounds must briefly be louder to be detected; recovery of that threshold does not establish that every cochlear structure is unaffected.<sup>[5]</sup>

In a mouse study, Kujawa and Liberman found persistent loss of auditory nerve connections after exposure that produced a reversible threshold shift.<sup>[6]</sup> The result helped explain why conventional thresholds may miss some neural injury. It is strong experimental evidence, but it is not a diagnostic rule for a person who reports tinnitus after using headphones.

The classical comparison uses the accessible *Charaka Samhita* text and translation at *Sutra Sthana* 11.37–38 and 11.43. It is an interpretive comparison rather than a philological analysis.

Evidences

The Dillard review included 33 studies, with 35 records representing 19,046 participants. The pooled prevalence of unsafe exposure from personal listening devices was 23.81% (95% confidence interval, 18.99–29.42%). Because entertainment-venue estimates varied substantially, the authors also modelled exposure against sound level and duration, obtaining an estimate of 48.20%.<sup>[2]</sup> The studies used differing definitions and measurement methods; the two percentages should not be treated as directly interchangeable population rates.

An earlier systematic review by Jiang and colleagues also found substantial variation in daily music dose and reported hearing problems among adolescents and young adults.<sup>[4]</sup> This variation is understandable: device output, headphone fit, background noise and listening habits all affect exposure. Self-reported hours or volume settings provide incomplete information about the sound delivered to the ear. Table 1 distinguishes the questions addressed by the main types of evidence.

Human studies of cochlear synaptopathy remain difficult to interpret because direct measurement is limited and proposed physiological markers are influenced by several factors. The review by Liu and colleagues describes the continuing uncertainty around mechanisms and assessment of hidden hearing loss.<sup>[7]</sup> A normal audiogram does not make a listening complaint unimportant, but neither does difficulty hearing in noise prove synaptic loss. Persistent symptoms warrant clinical assessment and consideration of alternative explanations.

Sound dose: level and time belong together

A volume slider shows a device setting, not a calibrated sound level at the ear. The same percentage can produce different outputs with another headset, recording or device. A rule such as keeping volume below 60% may serve as a simple reminder, but it cannot certify a safe dose. Where compatible equipment provides a validated listening-exposure estimate, level and duration are more informative than the slider alone.<sup>[8]</sup>

Decibels are logarithmic. Under an equal-energy approach, a rise of approximately 3 dB doubles sound energy and halves the time available for the same dose. A-weighted decibels, written dBA, incorporate a frequency weighting used in exposure assessment. WHO’s public guidance illustrates the rapid fall in weekly listening time as sound level rises; selected examples appear in Table 2.<sup>[1]</sup>

Table 2. Selected WHO examples of weekly listening duration

| Average sound level | Approximate time per week | Interpretation                                    |
|---------------------|---------------------------|---------------------------------------------------|
| 80 dB               | 40 hours                  | Reference example for general listening advice    |
| 90 dB               | 4 hours                   | Higher level substantially reduces listening time |
| 100 dB              | 20 minutes                | Very little exposure time remains at this level   |

Selected values reproduced from WHO public guidance.<sup>[1]</sup>

Exposure frameworks serve different purposes. The WHO–ITU personal-device standard offers adult and sensitive-user modes, while NIOSH recommendations address occupational exposure.<sup>[8,9]</sup> A venue ceiling addresses how an event is operated. None should be substituted casually for another. Table 3 sets out the main distinctions;

Table 3. Exposure references that should not be conflated

| Framework                         | Reference value                                   | Intended use                                     |
|-----------------------------------|---------------------------------------------------|--------------------------------------------------|
| WHO–ITU adult device mode         | 80 dBA for 40 hours per week                      | Personal audio dose tracking                     |
| WHO–ITU sensitive-user mode       | 75 dBA for 40 hours per week                      | Lower reference exposure, including for children |
| NIOSH recommendation occupational | 85 dBA over an 8-hour workday; 3-dB exchange rate | Workplace hearing-loss prevention                |
| WHO venue and event standard      | Maximum 100 dB LAeq,15min                         | Average venue sound level over 15 minutes        |

Sources: WHO–ITU, NIOSH and WHO venue guidance.<sup>[8,9,10]</sup> LAeq,15min is the equivalent continuous A-weighted level over 15 minutes.

Personal devices, commuting and gaming

Counselling should begin with a person’s actual routine. Ask where listening occurs, whether volume rises in background noise and whether the device records exposure. The WHO–ITU implementation toolkit supports dose feedback, volume-limiting functions and clear user information.<sup>[11]</sup> A brief review of these settings during a consultation can make advice easier to apply than an instruction simply to “listen less”.

Well-fitting or noise-cancelling headphones may reduce the need to overcome background noise with louder playback. They still require sensible volume control. Consumer active noise cancellation should not be assumed to provide certified hearing protection; NIOSH makes this distinction explicit.<sup>[12]</sup> Where awareness of traffic or warnings is necessary, the listening arrangement must also preserve situational awareness.

At loud events, properly fitted earplugs offer a more appropriate protective option. In a randomized festival trial, Ramakers and colleagues found less temporary hearing loss among participants assigned to earplugs.<sup>[13]</sup> The trial supports short-term protection under the studied conditions. It does not establish that any earplug, however fitted, makes every exposure safe.

Gaming deserves attention because sessions can be long and audio contains both continuous background sound and sudden effects. The 2025 WHO–ITU standard addresses this setting through features such as risk information, volume controls for different sound categories and headphone listening modes.<sup>[14]</sup> These features should make quieter listening practical without requiring players to lose access to dialogue or useful game cues. Protection still depends on implementation and actual use.

Quiet breaks reduce the time spent in noise. They do not erase exposure already received or provide a fresh allowance for another loud session. For young listeners, a useful plan is to review the whole routine with a parent or caregiver, enable a suitable lower-dose mode and agree on manageable listening habits. Prevention should support access to learning and communication, including prescribed hearing care, rather than treat all headphone use as harmful.

#### Safer entertainment requires action by venues

An attendee cannot control the public-address system or redesign room acoustics. The WHO venue standard therefore combines six measures: control of average sound level, monitoring and recording, acoustic design, access to hearing protection, quiet areas, and staff training with audience information.<sup>[10]</sup> These measures distribute responsibility among organizers, sound engineers and listeners.

**Table 4. A cautious educational use of the classical categories**

| Concept                          | Possible counselling application             | Boundary of interpretation                                          |
|----------------------------------|----------------------------------------------|---------------------------------------------------------------------|
| <i>Asatmyendriyarthā Samyoga</i> | Discuss suitability of sensory exposure      | A broad Ayurvedic concept, not an audiological diagnosis            |
| <i>Atiyoga</i>                   | Explain repeated excessive auditory exposure | Does not define a decibel or time limit                             |
| <i>Mithyayoga</i>                | Discuss context and suitability of listening | Should not be equated with a particular cochlear lesion             |
| <i>Ayoga</i>                     | Explain the classical category of non-use    | Does not justify stopping hearing aids or prescribed rehabilitation |

Classical basis: *Charaka Samhita, Sutra Sthana* 11.37–38 and 11.43.<sup>[3]</sup>

This comparison has a clear limit. The classical passage does not describe headphones, oxidative stress or auditory-nerve synapses. Equating *Atiyoga* with a specific lesion would give the text a precision it does not claim. Likewise, a listener's symptoms should not be attributed to inadequate sensory discipline. Effective counselling should remain practical and respectful, especially when work, travel or social circumstances make noise difficult to avoid.

#### Symptoms that need assessment

The 100 dB LAeq,15min ceiling is one part of that package. It should not become a target level or a claim that an entire event is safe without protection. Practical implementation also requires choosing suitable monitoring positions, maintaining equipment and ensuring that quiet areas and earplugs are easy to find. For local programmes, event organizers and educational institutions are useful partners because they can change the listening environment as well as the message.

#### The Ayurvedic comparison

In *Charaka Samhita, Sutra Sthana* 11.37 describes *Atiyoga* through excessive sensory use, including loud auditory examples such as thunder, drums and cries. *Ayoga* concerns non-use, while *Mithyayoga* includes inappropriate sensory experiences. Verses 38 and 43 place these categories within the broader account of unsuitable sensory interaction.<sup>[3]</sup> The Sanskrit term is rendered here consistently as *Asatmyendriyarthā Samyoga*.

The proposed connection is strongest at the level of prevention. *Shrotrendriya* denotes the auditory sense and *Shabda* its object; repeated excessive sound can be discussed as an example of overuse. This gives educators a familiar language for asking whether an everyday habit has become excessive. Modern exposure measurement remains necessary to determine how loud, how long and how often that habit occurs. Table 4 outlines the interpretation and its boundaries.

Prevention messages should include a route to care. Persistent tinnitus, difficulty following speech or a change in hearing should prompt assessment rather than repeated self-testing through headphones. Sudden hearing loss is particularly time-sensitive. NICE recommends assessment within 24 hours for adult hearing loss developing over three days or less within the previous 30 days, when it is not explained by an external- or middle-ear cause.<sup>[15]</sup>

Persistent unilateral or pulsatile tinnitus also merits further assessment, as do tinnitus accompanied by asymmetrical hearing loss or substantial distress.<sup>[16]</sup> A noise history should inform the assessment without becoming the assumed explanation for every symptom. Table 5 summarizes the relevant referral messages. Local pathways and age-appropriate services should guide implementation.

**Table 5. Clinical messages to include in listening education**

| Reported feature                                           | Suggested response                                                                  | Reason                                                    |
|------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Recent sudden loss of hearing                              | Seek urgent medical assessment; relevant adult cases require review within 24 hours | Delay may affect management of a time-sensitive condition |
| Persistent ringing or difficulty understanding speech      | Arrange hearing-health assessment                                                   | Symptoms need evaluation even after apparent recovery     |
| Persistent unilateral or pulsatile tinnitus                | Seek medical evaluation and referral as appropriate                                 | Noise exposure may not explain the symptom                |
| Hearing or tinnitus symptoms with acute neurological signs | Seek immediate emergency assessment                                                 | Possible acute neurological illness                       |

Adapted from NICE hearing-loss and tinnitus recommendations.<sup>[15,16]</sup>

#### From awareness to sustained behaviour

Knowing that loud sound can damage hearing is only one part of changing a habit. A listener may understand the risk but still turn the volume up on a crowded bus or avoid earplugs because friends do not wear them. Hearing education therefore needs practical demonstrations, opportunities to ask questions and follow-up that checks what people actually do. Keppler and colleagues reported changes after an education programme, but their study lacked a non-educational control group, limiting causal interpretation.<sup>[17]</sup>

For an Indian educational setting, the proposed Ayurvedic framing could be offered alongside plain-language explanations and demonstrations of device settings. Its usefulness is an open question. Cultural familiarity may improve understanding, but unfamiliar terminology may also add complexity. Content should be piloted with the intended audience, including people who do not study Ayurveda, and revised according to their feedback.

A useful future trial would compare standard safe-listening education with the same programme plus a concise explanation of appropriate sensory use. Both groups should receive equal contact time, the same practical prevention advice and equivalent access to protective tools. The additional component would then be the conceptual framing itself. Table 6 proposes outcomes that could distinguish better knowledge from a measurable reduction in exposure.

**Table 6. Proposed evaluation of the integrated educational approach**

| Domain                          | Candidate measure                                 | Design consideration                                 |
|---------------------------------|---------------------------------------------------|------------------------------------------------------|
| Primary behaviour outcome       | Change in weekly personal-audio dose              | Use compatible, validated exposure measurement       |
| Other recreational exposure     | Event attendance and structured noise history     | Device logs miss some environmental exposure         |
| Understanding and acceptability | Knowledge, comprehension and participant feedback | Test plain-language meaning of Ayurvedic terms       |
| Protective habits               | Use of dose limits, breaks and fitted earplugs    | Record adherence rather than intention alone         |
| Exploratory hearing outcomes    | Symptoms and standardized audiological assessment | Short follow-up cannot establish lifetime prevention |

Device logs should be supplemented by a record of exposure outside headphones. The Noise Exposure Structured Interview provides a published approach to estimating lifetime noise exposure, although recall-based estimates cannot replace prospective measurement.<sup>[18]</sup> Any adapted version would need justification for the local language, age group and intended outcome.

A trial would require an appropriate sample-size calculation, registration, ethics approval and consent, with assent and parental permission where relevant. No group should be assigned hazardous listening. Missing device data, changes in headphone model and adherence should be handled in a prespecified analysis plan. Standardized hearing assessments may be useful secondary outcomes, but a small, short educational study would not establish prevention of permanent hearing loss.

## Discussion

The main contribution of this review is to define a limited, testable role for Ayurvedic sensory concepts within modern prevention. Sound-dose measurement supplies the quantitative basis. Hearing science explains established injury mechanisms and remaining uncertainties. The classical concept may help some audiences reflect on habits that expose the auditory sense to excess. These contributions can be used together without making them equivalent.

Several public-health messages require careful wording. A population at risk is not a population with confirmed disease. Recovery after a loud event does not prove absence of injury, but symptoms with a normal audiogram do not establish synaptopathy. A personal-device exposure reference is different from a workplace recommendation or an entertainment-venue ceiling. Preserving these distinctions makes counselling more credible and reduces the chance that a simple rule is misused.

Individual advice also has practical limits. A person may have little control over transport noise, compulsory headset work or an event's sound level. Programmes should therefore combine manageable personal actions with institutional changes. Safer default settings, accessible earplugs, clearer exposure information and better event management can support decisions that education alone cannot sustain.

This review is limited by its non-systematic search and selective treatment of the literature. The classical interpretation is based on one directly relevant textual section, and the integrated educational framework has not been tested. The evidence reviewed does not support an Ayurvedic treatment claim for established noise-induced hearing loss. Future work should examine comprehension, acceptability and objectively measured exposure before making claims about improved clinical outcomes.

## Conclusions

Prevention of recreational hearing loss begins with attention to sound level, duration and repeated exposure. Useful actions include monitoring listening dose, lowering playback levels, shortening noisy sessions, using suitable hearing protection and improving device and venue practices. *Asatmyendriyārtha Samyoga* can provide a culturally relevant way to discuss excessive sensory exposure, provided that modern limits and clinical decisions remain grounded in hearing science. Its additional value should be tested through well-designed educational studies. Persistent or sudden hearing symptoms require appropriate assessment, regardless of the explanation used in counselling.

## Declarations

Ethics approval and consent to participate: Not applicable. This narrative review reports no new human or animal research.

Consent for publication: Not applicable. No identifiable participant information is included.

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