Curbside Consultation

Making Recommendations to Reduce Noise Exposure

Commentary by Daniel Fink, MD, Board Chair, the Quiet Coalition, Lincoln, Massachusetts, and Jan L. Mayes, MSc, Vancouver, British Columbia

Case Scenario

A 23-year-old patient, M.P., presents to your office with upper respiratory symptoms. When you enter the room, M.P. is using earbuds to listen to music on a personal listening device. The volume is loud enough for you to hear the music but not distinguish details. After addressing the patient's symptoms, you ask about M.P.'s listening habits.

M.P. reports using earbuds to listen to music for two to three hours a day while commuting to work, exercising, or just passing time. M.P. sets the volume loud enough to hear the music over ambient noise. Is M.P. at risk of developing hearing problems, and if so, how should the patient be counseled?

Commentary

Noise-induced hearing loss has long been recognized as a preventable occupational disease, but the extent of nonoccupational noise-induced hearing loss has only recently been acknowledged as a public health problem. Audiometry data collected by the National Health and Nutrition Examination Survey identified noise-induced hearing loss in 24.4% of Americans 20 to 69 years of age.[1] More than half (53%) of those reported no significant occupational noise exposure.[1] An estimated 19% of American teenagers also have noise-induced hearing loss.[2]

Noise levels in everyday life can cause hearing loss.[3-5] Traffic noise is 80 to 85 decibels (dB), motorcycle noise is 95 dB, a subway train is 100 dB, and a siren is 110 to 129 dB. Personal listening devices at maximum volume can reach approximately 100 to 110 dB.[6] The only evidence-based safe noise dose to prevent hearing loss is a daily average of 70 dB.[7-9] Noise risk is based on the combination of sound level and duration of exposure. A short, high-volume sound can have the same risk for hearing loss as a longer, lower-level sound if the total sound energy is equivalent. The dB scale is logarithmic. For each 3-dB increase in sound level, the exposure time must be cut in half to maintain the same energy exposure. Therefore, an average 24-hour noise dose of 70 dB is equivalent to eight hours at 75 dB or one hour at 85 dB.

The World Health Organization (WHO) recommends limiting noise exposure to one hour daily at 85 A-weighted dB to prevent hearing loss in adults.[10] (A-weighting adjusts noise measurements to mimic the effects of human hearing, which is especially sensitive to frequencies heard in human speech.) Auditory damage can occur after single or very brief exposures to loud noise. *Table 1* lists equivalent safe listening times based on the 3-dB exchange rate.[5]

Anecdotally, the average American listens to a personal listening device (e.g., a smart phone) for more than four hours daily, often at high volume.[11] High-volume personal listening and unprotected exposure to loud audio material (e.g., music, podcasts) increase the risk of developing permanent noise-induced hearing loss within five to 10 years.

Case scenarios are written to express typical situations that family physicians may encounter; authors remain anonymous. Send scenarios to afpjournal@aafp.org. Materials are edited to retain confidentiality.

This series is coordinated by Caroline Wellbery, MD, associate deputy editor.

A collection of Curbside Consultation published in *AFP* is available at https://www.aafp.org/afp/curbside.

Author disclosure: Dr. Fink serves as an expert consultant to the World Health Organization on its Make Listening Safe program and as a subject matter expert on noise and the public to the National Center for Environmental Health at the Centers for Disease Control and Prevention. Dr. Fink served on the board of the American Tinnitus Association from 2015 to 2018. Jan Mayes served on the board of the Right to Quiet Society in 2019 and discloses receiving royalties for hearing health–related audiology books.

The risk of auditory damage from personal listening devices is likely higher than from ambient noise exposure because earbuds and headphones transmit acoustic energy directly into the external auditory canals. Users of personal listening devices often turn the volume higher than the 50% setting (75 to 80 A-weighted dB or louder) to compensate for ambient noise, especially when using ill-fitting earbuds. Most personal listening devices can produce maximum approximate volumes of 100 to 110 dB, depending on which models are tested.[6]

Single or repeated noise exposures may cause tinnitus and hyperacusis. These symptoms were believed to be largely reversible, but research now indicates that tinnitus or any muffling of sound denotes permanent auditory damage. Any noise-induced temporary hearing changes increase the risk of developing noise-induced hearing loss.[12]

Approach to the Patient

After obtaining a medical and family history from the patient, a basic inspection and hearing screening should be conducted in a quiet room. Screening includes finger rub, watch tick, and tuning fork testing; additional testing may be indicated.[13] You may also suggest that the patient download the WHO's hearWHO digits-in-noise hearing test app to screen for hearing loss; the app allows users to track their hearing over time.[14]

Giving advice about noise reduction can be challenging. For younger patients, the immediate pleasurable rewards of listening to audio material at high sound levels often outweigh considerations of potential long-term adverse effects. Additionally, many regard hearing loss as an inevitable part of normal aging. Patients erroneously believe that when they get older, they will probably need hearing aids; however, hearing loss as people age is not inevitable. Usually, the loss represents noise-induced hearing loss. Most hearing loss and related conditions such as tinnitus and hyperacusis can be prevented by avoiding loud noise exposure, starting at a young age.[15]

The patient should be educated about auditory health. Loud noise exposure is never benign, no matter how brief or occasional. M.P. should be counseled that temporary symptoms of muffled hearing, tinnitus, or hyperacusis indicate increased risk of permanent inner ear and auditory nerve damage. If tinnitus has been experienced, even temporarily—for example after attending a concert—the patient should complete the Tinnitus and Hearing Survey.[16] This survey screens for any significant auditory distress in everyday life.

If appropriate, the patient should be told that hearing loss in older adults is strongly correlated with a variety of adverse consequences, including social isolation, depression, falls, accidents, and dementia.[13]

M.P. should be advised to never use a personal listening device higher than the 50% volume output. Volume-limiting headphones are available, most using the 85-dB volume limit. These are safer than headphones without a volume limit but still do not prevent hearing damage. To enhance satisfactory listening at lower volumes, M.P. should use noise-isolating canal earbuds, noise-canceling headphones, or circumaural headphones to prevent introduction of ambient noise.

Hearing protection should always be used when listening to loud music or when attending activities at venues such as clubs, bars, concerts, or performances. Inexpensive silicone, wax, foam, no-roll foam, or premolded music earplugs are available online or in most stores. Custom-molded high-fidelity earplugs can be obtained from a hearing health care professional.

TABLE 1

Average Noise Exposure Levels Needed to Reach Daily Noise Sufficient to Cause Hearing Loss

Average noise exposure level (A-weighted decibels)	Time to reach 100% adult noise dose
70	24 hours
75 to 76	8 hours
79	4 hours
82	2 hours
85	1 hour
88	30 minutes
91	15 minutes
94	7.5 minutes
97	< 4 minutes
100	< 2 minutes

Information from reference 5.

No cures are available for noise-induced auditory damage, and no medications are approved by the U.S. Food and Drug Administration for tinnitus and hyperacusis; patients with hearing loss can benefit from hearing aids. A variety of evidence-based audiology and psychology treatments for patients with significant distress from tinnitus or hyperacusis are available but do not help all patients and are rarely covered by insurance.[17] Patients with significant distress from tinnitus or hyperacusis should be referred to a specialist.

The authors thank David Sykes for his editorial review and helpful comments.

Address correspondence to Daniel Fink, MD, at djfink01@aol.com. Reprints are not available from the authors.

References

1. Carroll YI, Eichwald J, Scinicariello F, et al. Vital signs: noise-induced hearing loss among adults—United States 2011–2012. *MMWR Morb Mortal Wkly Rep*. 2017;66(5):139-144.
2. Shargorodsky J, Curhan SG, Curhan GC, et al. Change in prevalence of hearing loss in US adolescents. *JAMA*. 2010;304(7):772-778.
3. Flamme GA, Stephenson MR, Deiters K, et al. Typical noise exposure in everyday life. *Int J Audiol*. 2012;51(suppl 1):S3-S11.
4. Neitzel RL, Gershon RRM, McAlexander TP, et al. Exposures to transit and other sources of noise among New York City residents. *Environ Sci Technol*. 2012;46(1):500-508.
5. Mayes JL. Urban noise levels are high enough to damage auditory sensorineural health. *Sound and the Healthy City,* special issue of *Cities & Health*. 2019. Accessed November 2, 2020. https://www.tandfonline.com/doi/full/10.1080/23748834.2019.1577204
6. National Institute on Deafness and Other Communication Disorders. Noise-induced hearing loss. Accessed November 2, 2020. https://www.nidcd.nih.gov/health/noise-induced-hearing-loss
7. Fink DJ. What is a safe noise level for the public? *Am J Public Health*. 2017;107(1):44-45.
8. World Health Organization. Environmental noise guidelines for the European region. Updated May 31, 2019. Accessed November 2, 2020. https://www.euro.who.int/__data/assets/pdf_file/0008/383921/noise-guidelines-eng.pdf?ua=1
9. Kardous C, Themann CL, Morata TC, et al.; Centers for Disease Control and Prevention. Understanding noise exposure limits: occupational vs. general environmental noise [science blog]; February 8, 2016. Accessed November 2, 2020. https://blogs.cdc.gov/niosh-science-blog/2016/02/08/noise/
10. Śliwińska-Kowalska M, Zaborowski K. WHO environmental noise guidelines for the European region: a systematic review on environmental noise and permanent hearing loss and tinnitus. *Int J Environ Res Public Health*. 2017;14(10):1139.
11. McIntyre H. Americans are spending more time listening to music than ever before. November 9, 2017. Accessed November 2, 2020. https://www.forbes.com/sites/hughmcintyre/2017/11/09/americans-are-spending-more-time-listening-to-music-than-ever-before/#759b8c8b2f7f
12. Ramakers GGJ, Kraaijenga VJC, Cattani G, et al. Effectiveness of earplugs in preventing recreational noise-induced hearing loss: a randomized clinical trial. *JAMA Otolaryngol Head Neck Surg*. 2016;142(6):551-558.
13. Michels TC, Duffy MT, Rogers DJ. Hearing loss in adults: differential diagnosis and treatment. *Am Fam Physician*. 2019;100(2):98-108. Accessed November 2, 2020. https://www.aafp.org/afp/2019/0715/p98.html
14. World Health Organization. Check your hearing; 2020. Accessed November 2, 2020. https://www.who.int/health-topics/hearing-loss/hearwho
15. Wu P-z, O'Malley JT, de Gruttola V, et al. Age-related hearing loss is dominated by damage to inner ear sensory cells, not the cellular battery that powers them. *J Neurosci*. 2020;40(3):6357-6366.
16. Henry JA, Griest S, Zaugg TL, et al. Tinnitus and hearing survey: a screening tool to differentiate bothersome tinnitus from hearing difficulties. *Am J Audiol*. 2015;24(1):66-77.
17. Han BI, Lee HW, Kim TY, et al. Tinnitus: characteristics, causes, mechanisms, and treatments. *J Clin Neurol*. 2009;5(1):11-19. ■