

REPORT OF THE COUNCIL ON SCIENCE AND PUBLIC HEALTH

CSAPH Report 6-A-08

Subject: Portable Listening Devices and Noise-Induced Hearing Loss  
(Resolution 425, A-07)

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Referred to: Reference Committee D  
(Robert T. M. Phillips, MD, PhD, Chair)

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1 Introduction

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3 Resolution 425, introduced by the Michigan Delegation at the 2007 Annual Meeting and referred  
4 to the Board of Trustees, asks:

5  
6 That our American Medical Association (AMA) support limiting the maximum output of  
7 portable musical devices to acceptable Occupational Safety & Health Administration  
8 (OSHA) guidelines; and

9  
10 That our AMA lobby the federal government and/or appropriate federal agencies for the  
11 establishment of regulations or rules that would limit the output of portable musical  
12 devices sold in the United States to limits within OSHA guidelines.

13  
14 Our AMA has long recognized the problem of noise-induced hearing loss. In 1990, a Board of  
15 Trustees report reviewed scientific data and concluded "...the misuse of personal headphones can  
16 pose a threat to the listener's hearing. Such potential for harm depends upon a number of  
17 variables, including the station signal strength, battery strength, accuracy of volume settings, etc." This  
18 report encouraged physicians to counsel patients about the potential loss of hearing  
19 associated with the misuse of personal listening devices; urged that research be directed at more  
20 specific definition of the relationship between acute and chronic use of personal listening devices  
21 and the occurrence of short-term and long-term noise-induced hearing loss; and directed the  
22 AMA to work with key stakeholders to enhance awareness, knowledge, and remediation of  
23 causes of noise-induced hearing loss (Policy H-440.957, AMA Policy Database).

24  
25 Responding to continued concern about noise-induced hearing loss, the House of Delegates  
26 adopted Resolution 407 (I-00), which called on our AMA to encourage public education about  
27 the dangers of noise-induced hearing loss especially from toys and electronic devices, and  
28 encourage the Consumer Product Safety Commission and other federal agencies to study the  
29 impact of toys and electronic devices on noise-induced hearing loss among children and  
30 adolescents (Policy H-440.897).

31  
32 Portable music players have continued to increase in popularity, and these listening devices have  
33 become smaller and more sophisticated. This report reviews the use of personal listening devices;  
34 the epidemiology of recreational, noise-induced hearing loss; current national guidelines for the  
35 maximum output of portable musical devices; and data on the decibel levels of in-ear  
36 headphones.

1 Methodology

2  
 3 Published studies from 1985 through February 2008 were identified by a MEDLINE search of  
 4 English-language articles, using the search terms “noise induced hearing loss,” “acquired hearing  
 5 loss,” “headphones,” “in-ear headphones,” and “portable listening devices.” A total of 14 articles  
 6 were identified; additional articles were identified by review of references cited in these  
 7 publications. In addition, web sites of OSHA, the National Institute of Occupational Safety and  
 8 Health (NIOSH), and the National Institute on Deafness and Other Communication Disorders  
 9 were searched for information relevant to noise-induced hearing loss. Reports from the National  
 10 Institutes of Health Consensus Development Conference on Noise and Hearing Loss and from the  
 11 American Speech-Language-Hearing Association also were consulted. Consultation with  
 12 national experts and key stakeholder organizations provided additional perspective.

13  
 14 Use of Personal Listening Devices

15  
 16 Rapid technological advances have revolutionized personal listening devices, leading to an  
 17 electronics market dominated by Walkman, iPod, and other brands of MP3 players. A 2006  
 18 national study of 1000 individuals aged 18 to 70 years conducted on behalf of the American  
 19 Speech-Language-Hearing Association provides information on the contemporary listening habits  
 20 of youth and adults.<sup>1</sup> This study found that approximately 36% of adults and 62% of students  
 21 used Walkman personal electronic listening devices, 11% and 36% respectively used iPod  
 22 devices, and 11% and 25% respectively used other brands of MP3 players (Table). Hispanic and  
 23 African Americans were more likely than Caucasians to report using each of the listening  
 24 devices. Use rose with family income, and declined with age. Regardless of the type of portable  
 25 musical device, the typical listening session lasted from 1 to 4 hours for approximately 40% of  
 26 adults and 25% to 30% of youth. In addition, approximately 35% of adults and 40% to 59% of  
 27 teens reported listening at loud volumes.

Table: Listening Practices with Portable Musical Devices<sup>1</sup>

	Usage of Devices		Length of Typical Session: 1-4 hrs		Usual Volume: Loud	
	Adult	Student	Adult	Student	Adult	Student
Walkman*	36%	62%	37%	--	34%	--
Apple iPod	11%	36%	38%	30%	38%	41%
Other MP3 player	11%	25%	43%	24%	34%	59%

\*portable CD player

28 The Relationship between Personal Listening Devices and Hearing Loss

29  
 30 The intensity, frequency, and duration of noise exposure affect hearing loss.<sup>2</sup> OSHA regulations,  
 31 promulgated in 1983, set the industrial standard for permissible noise exposure levels at 4 hours  
 32 for 95 decibels, 2 hours for 100 decibels, and 1 hour for 105 decibels.<sup>3</sup> When employees are  
 33 subjected to sound exceeding these levels, feasible administrative or engineering controls should  
 34 be utilized. If such controls fail to reduce sound levels within OSHA limits, personal protective  
 35 equipment must be provided and used to reduce sound levels within the noise exposure standards.  
 36 When information indicates that any employee's exposure may equal or exceed an 8-hour time-  
 37 weighted average of 85 decibels, employers should develop and implement a monitoring program

1 as part of a “hearing conservation program,” and make audiometric testing available to all  
2 employees whose exposures equal or exceed such limits.

3  
4 In 1998, NIOSH updated its previous 1972 recommendations on permissible sound level in order  
5 to focus on preventing hearing loss, not merely conserving hearing. Similar to OSHA, NIOSH  
6 recommends a “hearing loss prevention program” for workers whose noise exposures equal or  
7 exceed 85 decibels for 8 hours, that includes exposure assessment, engineering and administrative  
8 controls, proper use of hearing protectors, audiometric evaluation, education and motivation,  
9 recordkeeping, and program audits and evaluations. Additionally, NIOSH recommends that  
10 occupational noise exposure be controlled at certain levels based on the combination of exposure  
11 level (*L*) and duration (*T*), according a formula that is more stringent based on the requirement  
12 that noise exposure time be halved for each 3-decibel increase in noise level. Consequently, the  
13 most recent NIOSH recommendations are more stringent than OSHA’s as the noise level  
14 increases.<sup>4</sup> It should be noted, however, that occupational noise levels average the intensity and  
15 reflect a steady-state of continuous high level noise; when daily noise exposure consists of  
16 periods of different noise levels, these can also be converted to a time-weighted average. In  
17 contrast to industrial noise, music has wide ranges of frequency as well as intensity and does not  
18 reflect a continuous state.

19  
20 Although individual preferences for music loudness are subjective, portable music devices are  
21 capable of producing decibel levels that exceed occupational safety limits. According to the  
22 American Speech-Language-Hearing Association, at maximum volume, Apple iPods produce  
23 sound at 120 to 125 decibels, the Sony Walkman MP3 player at 108 to 115 decibels, and the  
24 Bratz-Liptunes MP3 player at 115 to 120 decibels.<sup>5</sup> Portnuff and Fligor studied the loudness  
25 produced at different volume settings.<sup>6</sup> Averaging the results from different types of earphones, a  
26 volume control of 50% produced sound at approximately 70 decibels, of 70% at approximately  
27 80 decibels, and of 100% at approximately 100 decibels. On average, the output level of in-ear  
28 headphones was 5.5 decibels higher than over-the-ear headphones.

29  
30 Although portable music devices and attendant headphones have the potential to cause hearing  
31 damage, actual effects are probably short-lived. After exposure to a loud noise of either long  
32 duration and low intensity or high intensity and short duration, a person may have a temporary  
33 threshold shift in hearing, which is an immediate hearing loss sometimes accompanied by ringing  
34 in the ears (tinnitus). Usually, the cochlea will recover over a period of a few days. If the duration  
35 and intensity are too great, however, permanent hearing loss might occur. The results of a number  
36 of studies suggest that 5% to 20% of people who use portable music devices with over-the-ear  
37 headphones experience either tinnitus or dull hearing.<sup>7-12</sup> It is difficult, however, to extrapolate  
38 these results to current patterns of use, because these studies were conducted before the most  
39 recent advances in earphone technology. The results of epidemiological studies from both the  
40 United States and Argentina suggest, in fact, that no correlation exists between the use of portable  
41 music devices and hearing deficits.<sup>9,13</sup> Furthermore, there are no studies on the long-term effects  
42 of portable music devices, regardless of the type of earphones used.

43  
44 At least six factors complicate the design and interpretation of studies on portable music devices  
45 and noise-induced hearing loss: (1) OSHA standards are based on using occupational noise in  
46 calculating hearing loss; however, compared with occupational noise, music varies in acoustic  
47 spectrum and intensity; (2) musical sounds reaching the inner ear are discontinuous, thus  
48 providing the hair cells an opportunity for some recovery; (3) listening devices vary in their  
49 output capacity; (4) headphones vary in terms of the distance at which they deliver sound to the  
50 ear canal; (5) users vary the actual listening volume according to environmental noise and the  
51 noise reduction capability of the headphone; and (6) individuals vary in their sensitivity to

1 damage and recovery from noise.<sup>9,12,14,15</sup> More research is needed to increase basic understanding  
2 of the physiology of hearing loss from in-ear headphones, the relationship of noise-induced  
3 hearing loss to age, and recovery expectations.

4  
5 Technological advances in headphones have created smaller and more efficient devices for  
6 delivering music. More efficient blocking of ambient noise translates to a lower volume used  
7 when listening to music.<sup>14</sup> Whereas 20 years ago headphones were relatively bulky, most MP3  
8 players today are sold with in-ear headphones.<sup>14</sup> These devices do not block as much ambient  
9 noise as over-the-ear devices, and they also deliver sound more directly to the ear canal. Thus,  
10 independent of the type of portable music device, in-ear headphones produce noise levels in the  
11 ear canal that are substantially greater than noise levels of over-the-ear headphones at the same  
12 volume control setting.<sup>15</sup> For example, in a laboratory study on 100 young adults, Fligor and Ives  
13 demonstrated that the preferred listening level of most subjects using different in-ear headphones  
14 was around 65 decibels in low background noise (range 63 to 67), and 83 decibels with high  
15 background noise (range 77 to 89).<sup>16</sup> Two earphones used in this study had built-in ambient noise  
16 isolation. When using earphones with this technology, the preferred listening decibel level was  
17 lower than with the use of non-dampened earphones (77 and 84 decibels vs. 89 decibels).

## 18 19 Summary and Discussion

20  
21 Theoretically, current portable music devices produce maximum sound levels that can damage  
22 hearing and lead to hearing loss. In addition, in-ear headphones produce sound at substantially  
23 greater levels than do over-the-ear models. It is not clear, however, if the combination of high-  
24 output portable music devices and in-ear headphones causes long-term hearing loss. Although  
25 some laboratory and epidemiological data suggest a link between temporary noise-induced  
26 hearing loss and listening devices, this relationship is not as well established for in-ear  
27 headphones. The rising popularity of portable music devices and in-ear headphones, however,  
28 raises the question of how to address the potential public health risk of noise-induced hearing  
29 loss. Three potential approaches are:

- 30  
31 1. Promote a health education message to alert users that listening to music at high volume  
32 and for long durations may damage hearing. Various public and private organizations  
33 could work to educate the public on the potential hazard of listening to loud music.  
34 Although national guidelines do not exist, a set of recommendations based on scientific  
35 information for maximum listening times per day for in-ear headphones to prevent noise-  
36 induced hearing loss risk criteria has been proposed.<sup>6</sup> Thus, when the volume control on  
37 the music device is  $\leq 60\%$ , there is no limitation for the length of an individual listening  
38 session. However, with the volume at 70%, a person should not listen for more than 6  
39 hours, at 80% not more than 1.5 hours, at 90% not more than 22 minutes, and at 100%  
40 not more than 5 minutes.
- 41  
42 2. Advocate for expansion and use of technology to reduce earphone-delivered sound. At  
43 least four technologies reduce the potential damage. Noise isolation devices work like  
44 earplugs to block background noise, thus enabling a person to listen comfortably at lower  
45 volumes even in loud environments. Noise cancellation headphones, by comparison, are  
46 bulkier and employ an active technology that is run by batteries. The sound isolation  
47 devices are relatively expensive (\$40 to \$100). Finally, automatic volume limiter systems  
48 are built into some portable listening devices and permit the user to set a maximum  
49 volume control. Two companies currently produce products with this technology.

- 1           3. Advocate for health protection legislation. This option raises the issue of whether or not  
2 the government should mandate that manufacturers of portable music devices should  
3 limit the maximum sound their devices can emit. When deciding if government  
4 intervention to reduce public health risks is warranted, it is important to consider the  
5 scientific evidence on the nature of the problem, as well as the feasibility and cost of  
6 potential solutions.<sup>17</sup> Although there is no doubt that portable music devices produce  
7 sound that can damage hearing, epidemiological data on the extent of noise-induced  
8 hearing loss caused by in-ear headphones are lacking. Furthermore, as discussed above,  
9 companies are already producing earphones and music devices that permit a person to  
10 voluntarily limit the sound output.

11  
12 Given all of these considerations, invoking a mandate to limit sound emission from portable  
13 music devices appears unwarranted and unnecessary at this time, and the most expedient  
14 approach is to promote a health education message. Therefore, the Council believes that existing  
15 AMA policy is adequate.

16  
17 RECOMMENDATION

18  
19 The Council on Science and Public Health recommends that the following statement be adopted  
20 in lieu of Resolution 425 (A-07) and the remainder of the report be filed:

21                   That our American Medical Association reaffirm Policies H-440.897 and H-440.957.  
22                   (Reaffirm HOD Policy)  
23

Fiscal Note: None

## References

1. Zogby International: Survey of Teens and Adult about the Use of Personal Electronic Devices and Head Phones. March, 2006. Available at: [http://www.asha.org/NR/rdonlyres/10B67FA1-002C-4c7b-ba0B-1C0A3AF98A63/0/zogby\\_survey2006.pdf](http://www.asha.org/NR/rdonlyres/10B67FA1-002C-4c7b-ba0B-1C0A3AF98A63/0/zogby_survey2006.pdf). Accessed November 9, 2007.
2. Noise and Hearing Loss. National Institutes of Health Consensus Statement. January 22-24, 1990;8:1-24. Available at: <http://consensus.nih.gov/1990/1990NoiseHearingLoss076html.htm>. Accessed October, 17, 2007.
3. Occupational Noise Exposure. Regulations Standards 29 CFR, 1910 Subpart G. U.S. Department of Labor, Occupational Safety & Health Administration. Available at: [www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=9735](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9735). Accessed October 2007.
4. Criteria for a recommended standard: occupational noise exposure, 1998. Public Health Service, Centers for Disease and Prevention, National Institute for Occupational Safety and Health. Available at: [www.nonoise.org/hearing/criteria/criteria.htm](http://www.nonoise.org/hearing/criteria/criteria.htm). Accessed October 2007.
5. American-Speech-Language-Hearing Association. Popular technology unpopular with ear's hair cells; 2006. Available at: [www.asha.org/about/news/2006/techdamage.htm](http://www.asha.org/about/news/2006/techdamage.htm)? Accessed November 19, 2007.
6. Portnuff CDF, Fligor BJ. Sound output levels of the iPod and other MP3 players: is there potential risk to hearing? Paper presented at the NIHL in Children Meeting, Cincinnati, Ohio, October 19, 2006. Available at: [www.hearingconservation.org/docs/virtualPressRoom/portnuff.htm](http://www.hearingconservation.org/docs/virtualPressRoom/portnuff.htm). Accessed October 17, 2007.
7. Smith PA, Davis A, Ferguson M, Lutman ME. The prevalence and type of social noise exposure in young adults in England. *Noise Health*. 2000;2:41-56. Available at [noiseandhealth.org/article.asp?2000/2/6/41/32650](http://noiseandhealth.org/article.asp?2000/2/6/41/32650). Accessed November 19, 2007.
8. Rice CG, Bresin M, Roper RG. Sound levels from personal cassette players. *Br J Audio*. 1987;21:273-278.
9. Biassoni EC, Serra MR, Richter U, Joekes S, et al. Recreational noise exposure and its effects on the hearing of adolescents. Part II: development of hearing disorders. *Int J Audiology*. 2005;44:74-85.
10. Bradley R, Fortnum H, Coles R. Research note: patterns of exposure of school children to amplified music. *Br J Audio*. 1987;21:119-125.
11. Lee PC, Senders CW, Gantz BJ, Otto SR. Transient sensorineural hearing loss after overuse of portable headphone cassette radios. *Otolaryngol Head Neck Surg*. 1985;93:622-625.

12. Mostafapour SP, Lahargoue K, Gates GA. Noise-induced hearing loss in young adults: the role of personal listening devices and other sources of leisure noise. *Laryngoscope*. 1998;108:1832-1839.
13. Niskar AS, Kieszak SM, Holmes A, Esteban E, et al. Prevalence of hearing loss among children 6 to 19 years of age: the Third National Health and Nutrition Examination Survey. *JAMA*. 1998;279:1071-1075.
14. Hodgetts WE, Rieger JM, Szarko RA. The effects of listening environmental and earphone style on preferred listening levels of normal hearing adults using an MP3 player. *Ear & Hearing*. 2007;28:290-297.
15. Fligor BJ, Cox LC. Output levels of commercially available portable compact disc players and the potential risk to hearing. *Ear & Hearing*. 2004;25:513-527.
16. Fligor BJ, Ives TE. Does earphone type affect risk for recreational noise-induced hearing loss? Available at: [www.hearingconservation.org/docs/virtualPressRoom/FligorIves.pdf](http://www.hearingconservation.org/docs/virtualPressRoom/FligorIves.pdf). Accessed October 20, 2007.
17. Gostin LO. Public health law in a new century, Part III: public health regulation: a systematic evaluation. *JAMA*. 2000;283:3118-3122.