Dix, A. (2011). Noise and public health. Perspectives on Public Health Issues Related to Hearing and Balance (American Speech Language Hearing Association) Vol. 1 No. 1 19-23.

The impact of noise on human health is emerging as an important public health issue. Audiologists and speech language pathologists have educational background and training in the areas of sound and human hearing, and as professionals our advice is sought for questions related to hearing, language and speech. We are in contact with the general public through our roles in schools, universities, clinics and hospitals. As such, it is our responsibility to be well informed and to disseminate realistic, up-to-date, and practical public health information related to noise. This article provides an overview of current issues and resources for speech and hearing professionals and our clients.

Damage to hearing from exposure to noise was first noted almost three hundred years ago, when Italian physician Bernardino Ramazzini described health problems related to various occupations in his treatise De Morbus Artificum (Ramazzini, 1713/1964). He observed that the ears of coppersmiths were "injured by that perpetual din…so that workers of this class become hard of hearing and if they grow old at this work, completely deaf" (Ramazzini, 1964, p. 437). The problem is still with us; as of 2011 hearing loss is listed by the Centers for Disease Control as the number one work related injury in the U.S. (CDC, 2011). Industrialization and mechanization have resulted in increased noise in urban environments and recreational life as well as in the workplace. There is currently a subtle but important shift in terminology that all speech, language and hearing professionals are advised to adopt: the older phrase "hearing conservation" is being updated to "hearing loss prevention" (Pallarito, 2008). The implications of this shift are clear; prevention of hearing loss should be our goal. An ongoing, diligent effort to educate the public is one important aspect of prevention.

Hearing loss prevention education requires understanding the basics of noise measurement and the risk to hearing from noise. Early researchers grappling with the best way to measure sound settled on the A weighted sound pressure level, expressed as dBA SPL. Attempts to predict the amount of exposure that will cause a deterioration of hearing began when Eldred, Gannon, and von Gierke (1955) considered noise from jet aircraft at Wright Patterson Air Force Base, and Burns and Robinson (1970) measured sound levels and workers' hearing at factories in Great Britain. Their findings supported the equal energy principle: that for an eight-hour work day, a doubling of sound energy meeting the ear should be met with a halving of time in order to protect workers' hearing. This is also known as 3 dB trading, as an increase of 3 dB SPL represents a doubling of energy.

While most agencies in the U.S. and abroad base their safe exposure guidelines on 3 dB trading (NAE, 2011), the Occupational Safety and Health Administration (OSHA) uses 5dB trading. It is important to recognize that OSHA's 5 dB trading is only part of its comprehensive hearing conservation programs required in noisy workplaces. These programs include ongoing monitoring and adherence to strict guidelines, and must be supervised by an audiologist, otolaryngologist or other physician. But noise induced hearing loss (NIHL) is not just a work-related issue; the National Institute on Deafness and Other Communication Disorders estimates that 26 million Americans have a noise induced hearing loss that may result from leisure and home activities such as recreational firearms, snowmobiles, lawnmowers, leaf blowers, power

tools, playing in a band or attending rock concerts (NIDCD, 2011). Speech and hearing professionals who counsel individuals or groups about environmental and/or recreational noise exposure should not use OSHA guidelines but instead should refer to the National Institute of Occupational Safety and Health Administration (NIOSH) website. NIOSH guidelines use 3 dB trading, with 85 dBA SPL as the recommended exposure limit for an eight-hour time weighted average: "Exposures at and above this level are considered hazardous" (NIOSH, 1998, p. 1). Relatively inexpensive sound level meters and personal dosimeters are now available, making it possible for professionals and interested consumers to calculate noise dose for environmental sound.

Mobile listening devices such as mp3 players might be added to the NIDCD list of leisure noise risks. As audiologists who fit hearing aids are well aware, coupling of a sound source directly to the ear affects the sound pressure level at the eardrum. The time/intensity trading guidelines described above are based on free-field measurements, and a number of studies have tackled the problem of estimating risk from listening to mobile devices through earphones (e.g., Fligor and Cox, 2004). While there is disagreement among researchers as to the extent of the epidemiological risk to hearing from mobile listening devices, there is no doubt that some listeners are at risk for NIHL due to their tendency to listen at high volumes and for extended periods of time (Dix, 2006). The popularity and formats of mobile listening devices continue to grow and evolve, and marketing campaigns target the youth market, including very young children. Thus it is especially important that educational messages about prevention of noise induced hearing loss continue to reach this impressionable audience.

Many resources that promote behaviors for hearing loss prevention offer fun learning activities such as games and songs appropriate for children, adolescents and families, for example: Listen to Your Buds (ASHA), Dangerous Decibels (Oregon Health and Science University), and Wise Ears (NIDCD). These resources suggest strategies to recognize when sound is too loud as a way to explain the concept of time/intensity trading. They advise listeners to turn down the volume, walk away, or use hearing protection devices (HPD). For certain applications such as recreational firearms, the use of appropriate HPDs is the only practical recommendation. For a list of different types of HPD for shooters, the National Hearing Conservation Association provides a brochure that is available online and for purchase (NHCA, 2011).

In addition to behavioral strategies for hearing loss prevention, treatments for prevention as well as rescue are under investigation. The National Institute on Deafness and Other Communication Disorders (NIDCD) is funding research for treatments including gene therapy for regrowth of hair cells and the use of otoprotective agents. When taken as a prophylaxis, certain antioxidants have been found to protect against cell damage in the human cochlea by detoxifying free radicals, which are produced in excess with noise exposure. In addition, data from recent studies with guinea pigs suggest the possibility of a post-exposure time window during which a chemical regimen may help to rescue hearing from damage (NIDCD, 2011). However, until clear guidelines become available in terms of appropriate doses, regimens, and specific types of antioxidants, speech and hearing professionals should avoid recommending their use (Campbell, 2007).

Tinnitus is an auditory problem that is strongly correlated with hearing loss, and especially with NIHL (Axelsson and Barrenas, 1992). Chronic tinnitus is a serious problem that has stress-inducing effects similar to those of other chronic health problems. Tinnitus can trigger an autonomic nervous system response and feelings of fear, and can lead to depression and suicide. Prevention of tinnitus related distress (TRD) can be brought about by curing or preventing tinnitus (Malouf, Schutte, and Zucker, 2011). Current treatments for tinnitus include biofeedback and cognitive, sound, and drug therapies, however according to the American Tinnitus Association (2011), no single type of therapy has been found that can "cure" everyone's tinnitus. Given the relationship between NIHL and tinnitus, it follows that hearing loss prevention measures are also tools for prevention of tinnitus and TRD.

Two other clinical issues bear mention in a discussion related to noise, hearing, and public health. The first is the synergistic interaction between exposure to certain chemicals, including some chemotherapy agents, and exposure to noise, that can result in a risk of hearing loss that is greater than with either type of exposure alone (Steyger, 2009). The second is the recent increase in blast exposure in combat situations, resulting in a rise in incidences of traumatic brain injury, auditory processing disorders, and peripheral hearing damage in military personnel. Differential diagnosis and treatment involve audiologists and speech language pathologists who work with adults, especially service personnel returning from combat in Iraq and Afghanistan (Dennis, 2009).

The health effects of noise exposure go beyond the auditory system, and can occur with sound pressure levels well below NIOSH's recommended exposure limit of 85 dBA. According to Moudon (2009), the level of sound that can cause physiological and psychosocial problems may be as low as 60 dBA SPL. Disruption of sleep, increase in heart rate, blood pressure and adrenalin secretion, and dilation of the pupil of the eye have been identified as specific health risks. Psychosocial effects such as annoyance, reduced performance quality, and increased aggressive behavior may be disruptive to individuals and to relations among people. When the noise occurs at night, interference with sleep is of concern, along with issues related to sleep deprivation such as an increased risk of injury and accident. In addition, noise can interfere with reading, and classrooms with poor signal to noise ratio have been found to have detrimental effects on children's ability to learn and to focus (Anderson, 2004). The recommendation for maximum background noise in unoccupied classrooms is 35 dBA SPL (ANSI/ASA 2010).

The World Health Organization considers noise pollution to be an important public health problem. Using an annoyance factor metric based largely on reports from people, they estimated that one million "healthy life years" are lost each year in Western Europe from traffic-related environmental noise (WHO, 2011). The time of day or night, the type of setting (e.g., rural vs. urban), the type of noise, and other factors contribute to people's annoyance or acceptance of environmental noise. A recent comprehensive report organized by the National Academy of Engineering (2011) suggested a number of ways to improve public policy in the U.S. regarding noise, including more involvement by the Environmental Protection Agency, better educational programs in noise control engineering, and support for "buy quiet" programs. This report also recognized the importance of providing information on noise exposure "in a form understandable to the public" (NAE, 2011 p. 19), acknowledging the fact that the damage/risk criteria for

hearing protection are difficult to understand and to explain. ASHA is among the agencies that have been involved with efforts to educate the public about environmental noise (ASHA, 1991).

Another issue that confounds efforts to educate and protect the public from the health risks associated with noise is the complexity of the human response to sound. One person's annoying noise may be another person's enjoyable music. Even for the same individual, a sound that is pleasant in one setting or at one time of day may be highly annoying at a different time or place. One of the reasons for the popularity of mobile listening devices seems to be the isolation they provide the listener from unwanted environmental sounds, possibly providing a sense of control over the personal acoustic space. However drowning out the acoustic environment with a mobile device increases health risks even though it may be pleasurable to the listener; there is an increased risk of listening at elevated levels because of the need to turn up the volume as well as an increased risk to life and limb, because warning sounds may not be heard, including oncoming traffic and sirens (Blesser and Salter, 2008).

One suggestion that is easy to explain and relatively easy to follow is this: seek frequent quiet breaks. Taking quiet breaks is a protective measure against NIHL and may reduce stress as well, providing time for personal respite and reflection. In the ongoing "favorite sounds" project, while only three percent of respondents have listed "silence" as their favorite sound, 70% have listed natural sounds as opposed to mechanical sounds (Meinke, Lankford and Wells, 2002), suggesting that the majority of people would choose a natural soundscape if offered the choice. Author George Prochnik (2010) compared healthy listening to healthy eating, suggesting that just as people need nutritional food choices in order to stop overeating junk food, we need quiet listening opportunities as well as noisy ones. It is possible that some people will have to develop the ability to appreciate a quiet setting, and public health campaigns that encourage such behaviors may be effective in reducing health problems associated with noise exposure. Certainly the observation that many people enjoy loud sounds suggests that scolding and admonition will not result in the best outcomes. As speech and hearing professionals, we will have better success if we acknowledge that loud sound is sometimes enjoyable, while providing clear and practical information about healthy listening, including the need for quiet breaks.

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Other online resources:
Dangerous Decibels (Oregon Health and Science University) *http://www.dangerousdecibels.org/*
Listen to Your Buds (ASHA) *http://www.listentoyourbuds.org/*
Wise Ears (NIDCD) *http://www.nidcd.nih.gov/health/wise/*