Review Article

Noise Pollution: A Modern Plague

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Abstract: Noise is defined as unwanted sound. Environmental noise consists of all the unwanted sounds in our communities except that which originates in the workplace. Environmental noise pollution, a form of air pollution, is a threat to health and well-being. It is more severe and widespread than ever before, and it will continue to increase in magnitude and severity because of population growth, urbanization, and the associated growth in the use of increasingly powerful, varied, and highly mobile sources of noise. It will also continue to grow because of sustained growth in highway, rail, and air traffic, which remain major sources of environmental noise. The potential health effects of noise pollution are numerous, pervasive, persistent, and medically and socially *significant*. Noise produces direct and cumulative adverse effects that impair health and that degrade residential, social, working, and learning environments with corresponding real (economic) and intangible (well-being) losses. It interferes with sleep, concentration, communication, and recreation. The aim of enlightened governmental controls should be to protect citizens from the adverse effects of airborne pollution, including those produced by noise. People have the right to choose the nature of their acoustical environment; it should not be imposed by others.

Key Words: noise pollution, adverse effects, governmental intervention, history

Throughout recorded history, mankind has been plagued by a variety of both natural and man-made ills. In the 21st Century, we are experiencing the manmade plague of environmental noise from which there is virtually no escape, no matter where we are – in our homes and yards, on our streets, in our cars, at theaters, restaurants, parks, arenas, and in other public places. Despite attempts to regulate it, noise pollution has become an unfortunate fact of life worldwide. In a way that is analogous to second-hand smoke, second-hand noise is an unwanted airborne pollutant produced by others; it is imposed on us without our consent, often against *our wills*, and at times, places, and volumes over which we have no control.

There is growing evidence that noise pollution is not merely an annoyance; like other forms of pollution, it has wide-ranging adverse health, social, and economic effects.[1–11] A recent search (September 2006) of the National Library of Medicine database for adverse health effects of noise revealed over 5000 citations, many of recent vintage. As the population grows and as sources of noise become more numerous and more powerful, there is increasing exposure to noise pollution, which has profound public health implications. Noise, even at levels that are not harmful to hearing, is perceived subconsciously as a danger signal, even during sleep.[2] The body reacts to noise with a "fight or flight" response, with resultant nervous, hormonal, and vascular changes that have far reaching consequences.[1–11] Despite the fact that much has been written about the health effects of noise, it seems that much of the following information is not appreciated by the medical community and even less so by the general public.[7] In 1990, a National Institute of Health (NIH) panel concluded that "high visibility media campaigns are needed to develop public awareness of the effects of noise on hearing and the means of self protection. In addition to informing the public, these programs should target primary healthcare physicians and educators who deal with young people."[7] To these recommendations, we would add the need to inform about all the other adverse effects of noise.

Thus, the purpose of this review is to summarize what is known of these adverse health effects and to encourage physicians, nurses, and other health professionals to join with groups around the country that are trying to restore the Constitutionally guaranteed right of domestic tranquility. Noise Free America and the Noise Pollution Clearinghouse are two such organizations. There are numerous Internet sites that contain relevant information about noise and the ongoing efforts to restore quiet in communities across the United States. The interested reader should consult Noise Off (www.

Key Points

- Noise pollution is a growing problem that remains unaddressed.
- Society now ignores noise the way it ignored the use of tobacco products in the 1950s.
- Until people at all levels recognize the inherent dangers of noise pollution, nothing will change. In our view, health professionals will have to lead the way in this effort.

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NoiseOFF.org), The Noise Pollution Clearinghouse (www.nonoise.org), Noise Free America (www.noisefree.org), or the League for the Hard of Hearing (www.lhh.org/noise) for additional information about this subject.

Background

Because their wheels clattered on paving stones, chariots in ancient Rome were banned from the streets at night to prevent the noise that disrupted sleep and caused annoyance to the citizens. Centuries later, some cities in Medieval Europe either banned horse drawn carriages and horses from the streets at night or covered the stone streets with straw to reduce noise and to ensure peaceful sleep for the residents.[1] In more recent times in Philadelphia, the framers of our Constitution covered nearby cobblestone streets with earth to prevent noise-induced interruptions in their important work. These examples pinpoint two major effects of noise from which men of all ages have sought relief: interruption of sleep and interference with work that requires concentration. It is interesting that noises emanating from the various types of roadways of today are still among the most important sources of environmental noise, even though the types of noise are not those that existed in Rome, Medieval Europe, or 18th century Philadelphia. Our modern roadways (including road, rail, and air) and the products of modern technology produce increasing levels of unwanted noise of varying types and intensities throughout the day and night that disturb sleep, concentration, and other functions.[4,6,12,13] This noise affects us without our being consciously aware of it. Unlike our eyes, which we can shut to exclude unwanted visual input, we cannot voluntarily shut our ears to exclude unwanted auditory input. Our hearing mechanisms are always "on" even when we are asleep.[2]

"Favor me with silence."
—Horace (65 BCE–8 BCE).

The noise problems of the past pale in significance when compared with those experienced by modern city dwellers; noise pollution continues to grow in extent, frequency, and severity as a result of population growth, urbanization, and technological developments.[1,4] For example, within the European Common Market, 65% of the population is exposed to unhealthy levels of transportation noise.[13] In New York City, maximum noise levels measured 106 dB on subway platforms and 112 dB inside subway cars. These levels have the potential of exceeding recommended exposure limits given sufficient duration of exposure.[14] In 1991, it was estimated that environmental noise increased by 10% in the decade of the 1980s.[3] The 2000 United States Census found that 30% of Americans complained of noise, and 11% found it to be bothersome. Among those who complained, noise was sufficiently bothersome to make nearly 40% want to change their place of residence.[15] That noise pollution continues to grow in scope, variety, and magnitude is unquestioned; it is only the extent of the growth that remains unknown.[1]

In comparison to other pollutants, the control of environmental noise has been hampered by insufficient knowledge about its effects on humans and about dose-response relationships, but this seems to be changing as more research is carried out. However, it is clear that noise pollution is widespread and imposes long-term consequences on health.[1–11] In 1971, a World Health Organization (WHO) working group concluded that noise is a major threat to human well-being.[3] That assessment has not changed in the intervening 30-plus years; if anything, the threat has intensified.

The various sounds in our environment (excluding all those sounds that arise in the workplace) to which we are exposed can be viewed as being either necessary (desirable) or unnecessary (undesirable). One might consider the sounds produced in and around our homes by garbage disposals, dishwashers, clothes washers and dryers, refrigerators, furnaces, air-conditioners, yard maintenance equipment, and the many other mechanized time—and labor—saving devices, which we all use and enjoy, as being necessary. We are exposed to the noise of radio, television, and related technologies; children are exposed to a wide variety of noisy toys.[5,16] The noise of internal combustion engines (modulated by legally required mufflers), jet engines (modulated by improved design and by altered flight paths), and train horns at grade crossings (modulated by new Federal Quiet Zone rules), might all be considered necessary. There are numerous other such examples of machines or activities that produce sounds that are tolerated because they accompany a desired activity or they serve an important societal purpose, such as the sirens of emergency vehicles.

But what about sounds that accompany an undesired activity, that have no societal importance, or that we consider unnecessary? What about the sounds produced by the so-called boom-cars that are roving, pulsating noise factories? What about the uncomfortable sound levels at concerts, in theaters, and public sporting events? What about the noise of slow-moving train horns in urbanized areas or the early morning sounds accompanying garbage collection? What about all the noise on our streets to which buses, trolley cars, car horns, car alarms, motorcycles, and unmuffled exhaust systems contribute? What about the risks to children from noisy toys and from personal sound systems? What about the noise of barking dogs, leaf blowers, and recreational vehicles? What about the noise of low flying aircraft? In general, sounds that we deem unwanted or unnecessary are considered to be noise. Our society is beset by noise, which is intrusive, pervasive, and ubiquitous; most important of all, it is unhealthy. Most reasonable people would agree that much of the environmental noise to which we are subjected serves no useful purpose and is therefore undesirable. The variety of noise polluting devices and activities is large and seems to be growing on a

daily basis, although there is no consensus about what items are useful and desirable or noise polluting and unnecessary.

Domestic tranquility is one of the six guarantees in the United States Constitution, a guarantee that is echoed in some form or other in every state Constitution. In 1972, the Noise Control Act was passed by Congress, declaring, ". . . it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes health and welfare." In 1974, the Environmental Protection Agency (EPA) estimated that nearly 100 million Americans lived in areas where the daily average noise levels exceeded those identified as being safe.[17] However, in 1982, the government abruptly terminated federal funding for the Office of Noise Abatement and Control, the vehicle by which the public was to be protected from the adverse effects of noise. The lack of funds threw total responsibility for noise control to the states, which have had a spotty and generally poor record with respect to noise abatement.[7,18] Since the Act itself was not repealed, local and state governments may have been deterred from trying to regulate noise. Furthermore, failure to repeal the Act sent the message that noise was not an important environmental concern.[7] As a result, in the United States, most police departments seem to be unwilling or unable to respond to noise-related problems in a way that provides any measure of genuine or timely control. Yet, in most cities, as noise pollution continues to grow—some say as much as sixfold in the past 15 years—so do complaints about noise. Complaints to police and other officials about noise are among the most frequent complaints by residents in urban environments; in 1998, noise was the number one complaint to the Quality of Life Hotline in New York City. In 1996, the Federal Environmental Agency in Germany reported two out of three of its citizens had complained about excessive noise.[18] The number of people exposed to unhealthy levels of noise in the United States is unquestionably greater than it was in 1974; the degree of oversight and control is unquestionably less.

Adverse Health Effects of Noise

The WHO has documented seven categories of adverse health effects of noise pollution on humans. Much of the following comes from the WHO Guideline on Community Noise and follows its format.[1] The guideline provides an excellent, reasonably up-to-date, and comprehensive overview of noise-related issues, as do the other recent reviews on this subject.

1. Hearing Impairment

Hearing is essential for well-being and safety. Hearing impairment is typically defined as an increase in the threshold of hearing as clinically assessed by audiometry. Impaired hearing may come from the workplace, from the community, and from a variety of other causes (eg, trauma, ototoxic drugs, infection, and heredity). There is general agreement that exposure to sound levels less than 70 dB does not produce hearing damage, regardless of the duration of exposure.[1,17] There is also general agreement that exposure for more than 8 hours to sound levels in excess of 85 dB is potentially hazardous; to place this in context, 85 dB is roughly equivalent to the noise of heavy truck traffic on a busy road.[1] With sound levels above 85 dB, damage is related to sound pressure (measured in dB) and to time of exposure. The major cause of hearing loss is occupational exposure, although other sources of noise, particularly recreational noise, may produce significant deficits. Studies suggest that children seem to be more vulnerable than adults to noise induced hearing impairment.[1]

Noise induced hearing impairment may be accompanied by abnormal loudness perception (loudness recruitment), distortion (paracusis), and tinnitus. Tinnitus may be temporary or may become permanent after prolonged exposure.[1] The eventual results of hearing losses are loneliness, depression, impaired speech discrimination, impaired school and job performance, limited job opportunities, and a sense of isolation.[3,19,20]

In 2001, it was estimated that 12.5% of American children between the ages of 6 to 19 years had impaired hearing in one or both ears.[21] As many as 80% of elementary school children use personal music players, many for extended periods of time and at potentially dangerous volume settings.[19] There is little doubt that the use of consumer products, which produce increasingly high levels of noise and which are used with headsets or earphones, is growing and may well be responsible for the impaired hearing that is being seen with growing frequency in younger people.[19,22–24] This form of noise is largely unregulated, despite warnings by the manufacturers.

In the young, hearing loss affects communication, cognition, behavior, social-emotional development, academic outcomes, and later vocational opportunities.[25] These effects have been well documented in a number of large scale investigations in children.[23]

Leisure-time exposure, which is generally unregulated, is increasing in other ways as well with resultant adverse effects. In a recent survey, a majority of young adults reported having experienced tinnitus or impaired hearing after exposure to loud music at concerts or in clubs. Very few (8%) considered loss of hearing a significant problem. Many of the respondents said they would be motivated to use ear protection if they were aware of the potential of permanent hearing loss (66%) or if such protection were advised by a medical professional (59%).[22]

Those working in clubs, bars, and other places of entertainment are also at risk. It is well known that rock musicians frequently have noise-induced hearing loss. Apart from the musicians themselves, employees of music clubs, where noise frequently exceeds safe levels, are at risk.[26] Thus, nearly a third of students who worked part time (bar staff or security

staff) in a university entertainment venue were found to have permanent hearing loss of more than 30 dB.[27]

The WHO recommends that unprotected exposure to sound levels greater than 100 dB (for example, the sound of a jackhammer or a snowmobile) should be limited in duration (4 h) and frequency (four times/yr).[1] The threshold for pain is usually given as 140 dB, a level readily achieved in today's boom-cars. Impulse noise exposure (gunfire and similar sources of intense noise of brief duration) should never exceed 140 dB in adults and 120 dB in children. Firecrackers, cap pistols, and other toys can generate sufficient sound levels to cause sudden and permanent hearing loss.[19] Levels greater than 165 dB, even for a few milliseconds, are likely to cause acute cochlear damage.[1] It is important to remember to counsel patients that ears do not "get used" to loud noise. As the League for the Hard of Hearing notes—they "get deaf."

2. Interference with Spoken Communication

In 1974, in an attempt to protect public health and welfare against the adverse effects of noise, the EPA published so-called safe levels of environmental noise that would permit normal communication both in and out of doors.[17] Noise pollution interferes with the ability to comprehend normal speech and may lead to a number of personal disabilities, handicaps, and behavioral changes. These include problems with concentration, fatigue, uncertainty, lack of self confidence, irritation, misunderstandings, decreased working capacity, disturbed interpersonal relationships, and stress reactions. Some of these effects may lead to increased accidents, disruption of communication in the classroom, and impaired academic performance.[1,5,10,11] Particularly vulnerable groups include children, the elderly, and those not familiar with the spoken language.[1]

3. Sleep Disturbances

Uninterrupted sleep is known to be a prerequisite for good physiologic and mental functioning in healthy individuals.[28] Environmental noise is one of the major causes of disturbed sleep.[1,10] When sleep disruption becomes chronic, the results are mood changes, decrements in performance, and other long-term effects on health and well-being.[3] Much recent research has focused on noise from aircraft, roadways, and trains. It is known, for example, that continuous noise in excess of 30 dB disturbs sleep. For intermittent noise, the probability of being awakened increases with the number of noise events per night.[1]

The primary sleep disturbances are difficulty falling asleep, frequent awakenings, waking too early, and alterations in sleep stages and depth, especially a reduction in REM sleep. Apart from various effects on sleep itself, noise during sleep causes increased blood pressure, increased heart rate, increased pulse amplitude, vasoconstriction, changes in respiration, cardiac arrhythmias, and increased body movement.[28] For each of these, the threshold and response relationships may be different. Some of these effects (waking, for example) diminish with repeated exposure; others, particularly cardiovascular responses, do not.[29] Secondary effects (so-called after effects) measured the following day include fatigue, depressed mood and well-being, and decreased performance.[30] Decreased alertness leading to accidents, injuries, and death has also been attributed to lack of sleep and disrupted circadian rhythms.[31]

Long-term psychosocial effects have been related to nocturnal noise. Noise annoyance during the night increases total noise annoyance for the following 24 hours. Particularly sensitive groups include the elderly, shift workers, persons vulnerable to physical or mental disorders, and those with sleep disorders.[1]

Other factors that influence the problem of night-time noise include its occurrence in residential areas with low background noise levels and combinations of noise and vibration such as produced by trains or heavy trucks. Low frequency sound is more disturbing, even at very low sound pressure levels; these low frequency components appear to have a significant detrimental effect on health.[32]

4. Cardiovascular Disturbances

A growing body of evidence confirms that noise pollution has both temporary and permanent effects on humans (and other mammals) by way of the endocrine and autonomic nervous systems. It has been postulated that noise acts as a nonspecific biologic stressor eliciting reactions that prepare the body for a "fight or flight" response.[1,2,6] For this reason, noise can trigger both endocrine and autonomic nervous system responses that affect the cardiovascular system and thus may be a risk factor for cardiovascular disease.[1,2,6,11,33–36] These effects begin to be seen with long-term daily exposure to noise levels above 65 dB or with acute exposure to noise levels above 80 to 85 dB.[1,3] Acute exposure to noise activates nervous and hormonal responses, leading to temporary increases in blood pressure, heart rate, and vasoconstriction. Studies of individuals exposed to occupational or environmental noise show that exposure of sufficient intensity and duration increases heart rate and peripheral resistance, increases blood pressure, increases blood viscosity and levels of blood lipids, causes shifts in electrolytes, and increases levels of epinephrine, norepinephrine, and cortisol.[3] Sudden unexpected noise evokes reflex responses as well. Cardiovascular disturbances are independent of sleep disturbances; noise that does not interfere with the sleep of subjects may still provoke autonomic responses and secretion of epinephrine, norepinephrine, and cortisol.[29] These responses suggest that one can never completely "get used to" night-time noise.

Temporary noise exposure produces readily reversible physiologic changes. However, noise exposure of sufficient intensity, duration, and unpredictability provokes changes that

may not be so readily reversible. The studies that have been done on the effects of environmental noise have shown an association between noise exposure and subsequent cardiovascular disease.[1,2,6,33–36] Even though the increased risk for noise-induced cardiovascular disease may be small, it assumes public health importance because both the number of people at risk and the noise to which they are exposed continue to increase.[1,2]

Children are at risk as well. Children who live in noisy environments have been shown to have elevated blood pressures and elevated levels of stress-induced hormones.[2,11,18]

5. Disturbances in Mental Health

Noise pollution is not believed to be a cause of mental illness, but it is assumed to accelerate and intensify the development of latent mental disorders. Noise pollution may cause or contribute to the following adverse effects: anxiety, stress, nervousness, nausea, headache, emotional instability, argumentativeness, sexual impotence, changes in mood, increase in social conflicts, neurosis, hysteria, and psychosis. Population studies have suggested associations between noise and mental-health indicators, such as rating of well-being, symptom profiles, the use of psychoactive drugs and sleeping pills, and mental-hospital admission rates. Children, the elderly, and those with underlying depression may be particularly vulnerable to these effects because they may lack adequate coping mechanisms.[1] Children in noisy environments find the noise annoying and report a diminished quality of life.[10,37]

Noise levels above 80 dB are associated with both an increase in aggressive behavior and a decrease in behavior helpful to others.[38–40] The news media regularly report violent behavior arising out of disputes over noise; in many cases these disputes ended in injury or death. The aforementioned effects of noise may help explain some of the dehumanization seen in the modern, congested, and noisy urban environment.[2]

6. Impaired Task Performance

The effects of noise pollution on cognitive task performance have been well-studied. Noise pollution impairs task performance at school and at work, increases errors, and decreases motivation.[11,41] Reading attention, problem solving, and memory are most strongly affected by noise. Two types of memory deficits have been identified under experimental conditions: recall of subject content and recall of incidental details. Both are adversely influenced by noise. Deficits in performance can lead to errors and accidents, both of which have health and economic consequences.[1]

Cognitive and language development and reading achievement are diminished in noisy homes, even though the children's schools may be no noisier than average.[18] Cognitive development is impaired when homes or schools are near sources of noise such as highways and airports.[4,11] Noise affects learning, reading, problem solving, motivation, school performance, and social and emotional development.[3,5,10,18,42] These findings suggest that more attention needs to be paid to the effects of noise on the ability of children to learn and on the nature of the learning environment, both in school and at home. Moreover, there is concern that high and continuous environmental noise may contribute to feelings of helplessness in children.[11,18]

Noise produces negative after-effects on performance, particularly in children. It appears that the longer the exposure, the greater the effect. Children from noisy areas have been found to have heightened sympathetic arousal indicated by increased levels of stress-related hormones and elevated resting blood pressure.[18] These changes were larger in children with lower academic achievement. As a whole, these findings suggest that schools and daycare centers should be located in areas that are as noise-free as possible.[1]

7. Negative Social Behavior and Annoyance Reactions

Annoyance is defined as a feeling of displeasure associated with any agent or condition believed by an individual to adversely affect him or her. Perhaps a better description of this response would be aversion or distress. Noise has been used as a noxious stimulus in a variety of studies because it produces the same kinds of effects as other stressors.[2] Annoyance increases significantly when noise is accompanied by vibration or by low frequency components.[32] The term annoyance does not begin to cover the wide range of negative reactions associated with noise pollution; these include anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, or exhaustion. Lack of perceived control over the noise intensifies these effects.[1,10]

Social and behavioral effects of noise exposure are complex, subtle, and indirect. These effects include changes in everyday behavior (eg, closing windows and doors to eliminate outside noises; avoiding the use of balconies, patios and yards; and turning up the volume of radios and television sets); changes in social behavior (eg, aggressiveness, unfriendliness, nonparticipation, or disengagement); and changes in social indicators (eg, residential mobility, hospital admissions, drug consumption, and accident rates); and changes in mood (increased reports of depression).[1]

Noise exposure per se is not believed to produce aggressive behavior. However, in combination with provocation, preexisting anger or hostility, alcohol or other psychoactive agents, noise may trigger aggressive behavior.[38] Our news is filled with examples of this kind of behavior.

The degree of annoyance produced by noise may vary with the time of day, the unpleasant characteristics of the noise, the duration and intensity of the noise, the meaning associated with it, and the nature of the activity that the noise interrupted.[1] Annoyance may be influenced by a variety of

nonacoustical factors including individual sensitivity to noise.[43] These include fear of the noise source, conviction that noise could be reduced by third parties, individual sensitivity, the degree to which an individual feels able to control the noise, and whether or not the noise originated from an important economic activity.[1,10] Other less direct effects of annoyance are disruption of one's peace of mind, the enjoyment of one's property, and the enjoyment of solitude.

Greater annoyance has been observed when noise is of low frequency, is accompanied by vibrations that contain low-frequency components, or when it contains impulses such as the noise of gunshots.[1,32] Annoyance is greater when noise progressively increases rather than remaining constant. Average outdoor residential day-night sound levels below 55 dB were defined as acceptable by the EPA; acceptable average indoor levels were less than 45 dB.[17] To put these levels into perspective, sound levels produced by the average refrigerator or the sounds in the typical quiet neighborhood measure about 45 dB.[17] Sound levels above this produce annoyance in significant numbers of people.

The results of annoyance are privately felt dissatisfaction, publicly expressed complaints to authorities (although underreporting is probably significant), and the adverse health effects already noted. Given that annoyance can connote more than slight irritation, it describes a significant degradation in the quality of life, which corresponds to degradation in health and well-being. In this regard, it is important to note that annoyance does not abate over time despite continuing exposure to noise.[12]

Former U.S. Surgeon General William H. Stewart said in 1978, "Calling noise a nuisance is like calling smog an inconvenience. Noise must be considered a hazard to the health of people everywhere."

Effects of Multiple Sources of Noise Pollution

Most environments contain a combination of sounds from more than one source (eg, aircraft, motor vehicles, and trains). In urban environments, boom—cars, car horns, car alarms, and public transit systems may be the offenders. In suburban areas, leaf blowers, other power equipment, and barking dogs may be the source. There is, as yet, no consensus on a model for measuring total annoyance from multiple noise sources. Adverse health effects appear to be related to total noise exposure from all sources rather than the noise from any single source.

The evidence related to low-frequency noise is sufficiently strong to warrant immediate concern. It is a special concern because of its pervasive nature, because it arises from multiple sources, and because of its efficient propagation, which is essentially unimpeded by conventional methods of either building or ear protection. Adverse health effects from low-frequency noise are thought to be more severe than from other forms of community noise. This form of noise is underestimated with the usual types of sound measuring equipment.[32,44]

In residential populations, combined sources of noise pollution will lead to a combination of adverse effects such as impaired hearing; sleep disturbances; cardiovascular disturbances; interference at work, school, and home; and annoyance, among others. These effects are the result of stress from noise, stress that has been increasingly linked to illness.[2]

Groups Vulnerable to the Effects of Noise Pollution

Vulnerable groups, generally underrepresented in study populations, include patients with various diseases, patients in hospitals or those who are rehabilitating from injury or disease, the blind, the hearing impaired, fetuses, infants and young children, and the elderly. Although anyone might be adversely affected by noise pollution, groups that are particularly vulnerable include neonates, infants, children, those with mental or physical illnesses, and the elderly. Because children are particularly vulnerable to noise induced abnormalities, they need special protection.[5,19] This vulnerability to noise may be an age-related sensitivity but may be also be due to increased risk based on behavior (personal music systems, loud concerts) or to an inability of the very young to remove themselves from a noxious source.[5] The evidence is strong enough to warrant monitoring programs in schools and elsewhere to protect children from noise exposure.[1,5,19]

The effects of noise on the fetus and newborn are unclear. Exposure to noise during pregnancy may increase the risk of high-frequency hearing loss in the newborn, shortened gestation, prematurity, and intrauterine growth retardation.[5,19,20,45,46] Noise in the NICU may cause cochlear damage and may impair the growth and development of the premature infant.[24] Even though studies have been inconsistent with respect to noise and congenital malformations, the data were sufficiently compelling for the National Research Council to recommend that pregnant women avoid noisy work settings.[18]

WHO Guidelines

Because health effects are relevant to specific environments, guidelines have been proposed for the following: dwellings, including bedrooms; schools and preschools; hospitals, industrial, commercial, shopping, and traffic areas; ceremonies, festivals, and entertainment events; use of headphones for music and other sounds; impulse sounds from toys, fireworks, and firearms; and outdoors in parklands and

other such areas.[1] Similar guidelines were being developed by the EPA, but ended with termination of federal funding in 1982.

Conclusions and Recommendations

As a society, our history is filled with failures to recognize the agents that cause disease; once the causes have been recognized, we have responded reluctantly, slowly, and often inadequately. The case with tobacco is an instructive one. It took many years of lobbying by dedicated individuals before legislators and the general public recognized the links between the hazards of tobacco smoke and disease; as a result, laws were finally enacted and behaviors changed accordingly.

Despite the evidence about the many medical, social, and economic effects of noise, as a society, we continue to suffer from the same inertia, the same reluctance to change, and the same denial of the obvious that the anti-tobacco lobby faced a couple of decades ago. This inertia and denial are similar to those that delayed appropriate action on lead, mercury, and asbestos. Now we seem unable to make the connection between noise and disease, despite the evidence, and despite the fact, which we all recognize, that our cities are becoming increasingly more polluted with noise.

Noise makers and the businesses that support them are as reluctant as smokers to give up their bad habits. Legislators at all levels should protect us from noise pollution the same way they protected us from tobacco smoke and other forms of pollution. It is clear that laws can change behaviors in ways that benefit society as a whole.

Noise represents an important public health problem that can lead to hearing loss, sleep disruption, cardiovascular disease, social handicaps, reduced productivity, impaired teaching and learning, absenteeism, increased drug use, and accidents. It can impair the ability to enjoy one's property and leisure time and increases the frequency of antisocial behavior. Noise adversely affects general health and well-being in the same way as does chronic stress. It adversely affects future generations by degrading residential, social, and learning environments with corresponding economic losses. Local control of noise has not been successful in most places. This points out the need for improved methods of local control that should include public education, enlightened legislation, and active enforcement of noise ordinances by local law enforcement officials. Part of the solution may require federal or state legislation aimed at supporting local efforts or the restoration of federal funding for the Office of Noise Abatement and Control.

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Please see Lawrence M. Schell's editorial on page 241 of this issue.

Answers to CME Questions

1. B, **2.** C, **3.** E, **4.** A, **5.** C & D