City of Toronto
Community and Neighbourhood Services
Toronto Public Health
Health Promotion and Environment Protection Office

HEALTH EFFECTS OF NOISE

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INTRODUCTION

Noise, which is often referred to as unwanted sound, is typically characterized by the intensity, frequency, periodicity (continuous or intermittent) and duration of sound. Sound is the result of pressure changes in the air caused by vibration (Thompson, 1994). Unwanted sound to some may be considered wanted sound by others, as in the case of loud music (Talbott, 1995).

More people are affected by noise exposure than any other environmental stressor. However, because its associated health effects are not as life-threatening as those for air, water and hazardous waste, noise has been on the bottom of most environmental priority lists (Cowan, 1994).

Traditionally, much of the scientific evidence has been based on studies of occupational exposures. These noise exposures tend to be of greater intensity over longer periods of time as compared with exposures to community noise. In earlier research, investigators also tended to assume that noise produced direct health effects, such as hearing loss with noise exposures above 90 decibels, and paid little attention to individual differences in response to noise, and noise as a stressor (Thompson, 1996).

More recently, research has focused on noise as an auditory stressor that can produce both direct and indirect health effects. The direct health effect known to be attributable to noise is hearing loss (resulting from damage to the inner hair cells of the organ of corti) with noise exposure higher than 90 decibels. There are several non-auditory physiological effects of noise exposure including a possible increase in cardiovascular disease from elevated blood pressure and physiological reactions involving the cardiovascular endocrine system (Talbott, 1995). In addition, community noise has been shown to adversely affect sleep, communication, performance and behaviour, reading and memory acquisition, and mental health (Talbott, 1995).

Noise affects millions of people worldwide on a daily basis. Highway noise alone affects more than 18 million people in the United States and 100 million people worldwide (Cowan, 1994). It is estimated that community noise levels in the United States have increased over eleven percent during the last decade, with aviation noise projected to rise at an even more rapid rate (Staples, 1997). Most urban noise stems from automobile traffic. Motor vehicle use worldwide continues to climb despite campaigns to encourage reliance on public transportation. Increasing population densities, especially in urban areas, have also resulted in escalating noise levels. This has serious impending health implications for all cities worldwide. Internationally, the issue of noise is gaining more attention as countries set their own national standards regarding noise control (Berglund & Lindvall, 1995).

In the Greater Toronto Area, it has been estimated that the population will increase by forty percent in the next twenty years and that automobile ownership is estimated to increase by sixty percent (from 1996) (Environmental Task Force Sustainable Transportation Work Group, Final Report, 1999). The expansion of the Pearson Airport is currently being projected to increase air

traffic from approximately twenty seven million passengers to fifty million passengers over the next decade. Further, the former City of Toronto area is becoming known as a center for music festivals on city streets, parks and public areas. This increase in public leisure activities will likely add to noise levels in the city.

It is evident that reducing noise levels in homes and the community at large requires a multiplicity of actions by all levels of government, the private sector and the general public. Within the City of Toronto, the Public Health Division has a unique role to play in reviewing the latest research on noise. This information may assist city officials and the public in preventing or reducing excess noise levels where reasonable and possible.

GOVERNMENT ROLES AND RESPONSIBILITIES REGARDING NOISE-RELATED ISSUES

In Canada, the federal, provincial and municipal levels of government have different roles and responsibilities with respect to noise-related issues.

Federal Role

The federal government is responsible for establishing and ensuring compliance with standards for noise emission labelling and maximum noise emission for consumer products, equipment, and vehicles. These regulations do not extend to "after sale" situations where products deteriorate and exceed sound levels required at the time of manufacture. The federal government also establishes guidelines for noise control over interprovincial transportation systems including aircraft, trains and navigable waterways. Health Canada is legally required to provide expert advice on the health effects of environmental noise to environmental assessments involving other federal departments (Health Canada, 1998).

Provincial Role

Provincial governments establish guidelines for noise control in land use planning. They authorize and assist municipalities in creating and implementing municipal plans and noise control by-laws to abate individual sources of noise. Provincial governments are also responsible through various statutes for controlling the operational noise levels of many consumer products, equipment and vehicles (Health Canada, 1998).

Municipal Roles

Most environmental noise control legislation has been enacted at the municipal level. Municipalities exercise environmental noise control through municipal noise control by-laws, municipal land use plans and zoning, traffic management and road noise barrier retrofit programs (Health Canada, 1998).

Within the City of Toronto, Urban Development Services, Works & Emergency Services, Corporate Services, and the Public Health Division have distinct yet complementary roles and responsibilities regarding environmental noise.

i) Urban Development Services

In December 1973, Toronto City Council adopted a Noise Control Programme based on two key principles: 1) noise must be eliminated at the source and 2) general ambient noise standards should not be adopted or used for the purpose of policing the City's sound environment. The general approach to eliminating unnecessary noise is based on co-operation through education, consultation, and mediation complemented by prosecution if required (City of Toronto Public Works and the Environment, 1994). The Noise Section currently administers the Noise Control Programme. Within the former municipalities, only the City of Toronto had a Noise Section.

The types of complaints that have been forwarded to the Noise Control Programme in the past include complaints about noise from music, fans, air conditioners, and construction. During 1995, 1996 and 1997 in the former municipalities, there were approximately 2900 complaints concerning noise per year. Music was the most common complaint in some of the former municipalities, whereas complaints about construction or mechanical noise were more common in others.

The handling of complaints regarding noise and the harmonization of the Noise By-law are presently under review by an internal by-law review working group. In the interim, the Noise Section and Toronto Police Services are responsible for enforcing the Noise By-law. The By-law regulates or prohibits certain noises within the City of Toronto which disturb, or may disturb, the quiet, peace, rest, enjoyment, comfort or convenience of Toronto residents.

The Noise By-law currently applies only to the former City of Toronto. The noise by-laws in the former municipalities are still in place and enforced by municipal standards officers. All of these noise by-laws attempt to address the localized nature of particular problems in the community. For example, in the former Toronto, there are more stringent rules in place to govern HVAC systems and other equipment noises due to the close proximity of residences with each other and with other conflicting landuses.

ii) Works & Emergency Services

Discussions between Works & Emergency Services and Urban Development Services are taking place to identify noise policy and technical functions currently with the Noise Section which could be transferred to Works & Emergency Services (e.g., Noise Impact Statement reviews as part of development review, noise barrier installations, special studies etc.). A decision to transfer the agreed upon functions is expected soon.

iii) Corporate Services

Occupational health and safety consultants within the Human Resources Division are responsible for assisting the City, as an employer, in identifying and controlling workplace noise hazards so as to protect employees from noise-induced hearing loss.

Program activities include:

- Conducting noise surveys and dosimetry to determine employee exposure and assist in ensuring compliance with legislative requirements and accepted industry standards;
- Providing technical services and advice regarding control measures to minimize employee noise exposure;
- Assisting in the development of specifications for equipment and vehicles to ensure employee noise exposures are progressively decreased;
- Assisting in the selection of hearing protection appropriate to work being performed, where needed;
- Providing noise training and education; and
- Providing employee noise exposure data, upon request, to the Workplace Safety and Insurance Board in response to hearing loss claims of City employees.

iv) Public Health Division

The Ontario Mandatory Health Programs and Services Guidelines (MHPSG, 1997) require public health units to identify health hazards and take appropriate action, and to provide educational materials to raise public awareness of health hazards. With respect to noise-related services, the MHPSG require public health units to provide a child health program that addresses topics such as hearing.

Toronto Public Health currently provides Speech & Language Services for children up to five years of age in the Toronto area. A child who is experiencing difficulty with speech and language issues can be referred for an assessment to a speech pathologist. A referral is made to an audiologist to test for hearing difficulties as part of the initial assessment. A speech and language treatment plan can be developed following the assessment. Toronto Public Health has the lead role for this provincially funded program, and contracts out to community-based agencies so as to provide more accessibility for services. Animal Services is responsible for responding to calls from the public regarding noise from animals (e.g., barking dogs). Animal Services enforces the Noise By-law in only three of the former municipalities: North York; East York; and Toronto. This service is addressed by other by-laws in the other former municipalities.

NOISE AS A HEALTH THREAT

The World Health Organization (WHO) defines "health as …a state of complete physical, mental and social well-being. Governments have responsibility for the health of their people which can be fulfilled only by the provision of adequate health and social measures" (Environmental Protection Agency, 1978).

A document prepared by Berglund and Lindvall (1995) for the World Health Organization critically reviews the negative health effects of community noise and provides guidelines regarding acceptable noise levels. This document is a revision of the earlier WHO document, "Noise" (1980). The document states that there needs to be inclusion of noise fluctuations, number of noise events, and assessment of low frequency components, along with noise measures to correctly predict noise impacts on health. Countries are expected to develop their own national and local noise standards in accordance with the noise hazards they are prepared to accept.

In Canada, the Working Group on Environmental Noise of the Federal/Provincial Advisory Committee on Environmental and Occupational Health acknowledged that:

> Noise is more than just a nuisance since it constitutes a real and present danger to people's health. Day and night, at work and at play, noise can produce serious physical and psychological stress. No one is immune to this stress. People appear to adjust to noise by ignoring it but the ear, in fact, never closes. The body at times still responds with extreme tension, such as to a strange sound in the night (Health and Welfare Canada, 1989).

Data on the health costs associated with exposure to excessive noise is limited. Research in Germany has estimated that the annual cost of noise on public health is approximately $500 to $1900 million ECU (726.4 million dollars to 2.76 billion US dollars) per year for road noise, and $100 million ECU (1.45 million US dollars) per year for rail noise (European Commission, 1996).

Measurement of Noise

Sound is typically described in terms of sound pressure which rate the pressure fluctuations that stimulate the sense of hearing. Sound pressure fluctuations are described in terms of decibels which are based on a logarithmic scale, similar to that of a Richter scale. The ear also responds to changes in pitch (or frequency). This variation in response has been utilized to program the filtering systems found in most sound measuring equipment. Decibels that have been filtered in this way account for human sensitivity to frequency sounds. This measurement is known as A-weighted decibels and are denoted dB(A). Typical dB(A) levels that are encountered range from 0 dB(A), at which sound can barely be heard, to 120 dB(A), at which sound can cause pain from excessive exposure (Cowan, 1994). Table 1 (on page 13) compares some common sounds and ranks them according to potential harm to hearing. In many industries, workers are exposed to dangerous noise levels. This is particularly true in the construction, lumber, mining, steel and textile industries.

Since the sensitivity of the ear to sound is not the same for all frequencies, weighting or attenuating filters are included in the sound level meter's circuits to simulate the ears' response. A sound level meter gives an instantaneous measurement of the noise present, but does not measure the duration of the exposure. To measure the amount of noise a person is exposed to over a period of time, a "dosimeter" or an integrated sound level meter must be used (Talbott, 1995).

The most common ratings of sound levels over extended periods of time are Leq and Ldn. Leq is the equivalent sound level, which is an energy average of sound over a specified period of time. Since sound levels can be continuously fluctuating, the Leq provides a single number rating. For example, a 1-hour Leq can be used to evaluate the impact of a new or expanded highway. The Ldn is the day-night exposure level, which is a 24-hour Leq value with the stipulation that all levels occurring between 10:00 pm and 7:00 am have a dB(A) added to them to compensate for the extra sensitivity of sounds during normal sleeping hours (Cowan, 1994).

Since sound levels are logarithmic, a small increase in decibels represents a large increase in sound energy (Talbott, 1995). For example, an addition of 10 dB(A) would sound as if the sound source had doubled in loudness. Therefore, a 70 dB(A) would sound twice as loud as a 60 dB(A) sound source (Cowan, 1994).

A type of noise worthy of further consideration is low frequency noise. Low frequency noise is common as background noise in urban environments and as emission from many artificial sources: vehicles; aircraft; industrial machinery; artillery and mining explosions; and air movement machinery including wind turbines; compressors; and indoor ventilation and air conditioning units. Low frequency noise is of particular concern because of its pervasiveness due to numerous sources and the reduced efficacy of many structures including dwellings (Berglund & Lindvall, 1995).

Impact of Noise on the Community

It is suggested that the measures of equivalent continuous sound pressure levels currently used in occupational settings are not adequate to reflect community noise-induced adverse effects. This is due to the fact that the community is exposed to a variety of exposures simultaneously: number of noise events over time; time of day; equivalent level and maximum level of the noise event (Berglund & Lindvall, 1995).

One way of measuring excessive noise is the point at which 10 percent of the population is seriously affected or highly annoyed by the noise (Job, 1996). This reliance on dose-response data that relates physical exposure to reported annoyance does not accurately reflect the issue of excessive noise (Staples, 1997). Firstly, it relies on annoyance as the index of public response without an understanding of the social and psychological variables that determine when a given noise generates annoyance in a particular person or community. Secondly, this one dimensional

approach limits consideration of other key health outcomes that also appear to be moderated by psychosocial variables (e.g., increase in blood pressure) (Staples, 1997). Thirdly, complaints may not be reflective of the problem as subjects who deny adverse effects (e.g., use an avoidance coping style) were seen to have more negative health effects (Pulles, 1990).

According to Staples (1997), the dose-response relationship has not been accurate in predicting community annoyance because communities, as do individuals, differ in the criteria they set for acceptable noise levels. For example, there may be an expectation of a certain amount of quiet in a given area; there may have been public discourse on the issue of economic versus environmental considerations in expanding a local airport. Therefore, it is not appropriate to attempt to predict a given community's response to new noise in an area based on reactions of people who have lived in high noise exposure areas (Staples, 1997).

Individual Responses to Noise

The evidence that people show negative subjective responses to noise (e.g., annoyance, dissatisfaction, and disturbance) is strong (Job, 1996). However, there is no clear noise level threshold for measuring community reaction. This is likely due to the considerable variation in people's tolerance to noise levels and the different types of noise, making it difficult to quantify direct health effects (European Commission, 1996).

The potential adverse health effects are usually classified according to the type of noise. Sudden (or impulsive) noise appears to create substantially more reaction than non-impulsive noise (Job, 1996), and intermittent noise has greater effect than louder, more continuous noise (Westman & Walters, 1981). Predictability and controllability are clearly influencing factors in individual reactions to noise (Job, 1996).

Individual physiological and psychological responses to noise are also influenced by susceptibility. For example, noise sensitive people attend more to noises, discriminate between noises, find more noises threatening and out of their control, and react to, and adapt to noises more slowly than less noise sensitive people (Stansfield, 1992). There may be a small risk amongst some people that exposure to the stress of high noise levels increases susceptibility to disease and infection and can be a complicating factor in heart problems and other diseases (Health and Welfare Canada, 1989).

While there are reasonable indicators of a casual connection between noise exposure and health effects, the exact nature of this causal relationship is not known (Job, 1996). Table 2 (on page 14) outlines the possible causal connections. Many of these connections are already reasonably established and some suggested by the model are less clearly established. There is a relationship between sleep loss and stress with possible causal connections in both directions. It is less understood how reaction modifiers, including attitude to the noise source, noise sensitivity, and

perceived control over the noise consciously or unconsciously influence an individual's reaction to noise (Job, 1996).

The Health Council of the Netherlands (1996) has summarized the weight of scientific evidence for the possible long-term effects of exposure to noise (Table 3 on page 15).

DEMONSTRATED HEALTH EFFECTS RELATED TO NOISE

Hearing Loss

The evidence for a cause-effect relationship between noise and hearing loss is considered sufficient in the scientific community. There is consensus that sound levels less than 75 dBA are unlikely to cause permanent hearing loss and that sound levels about 85 dBA with exposures of 8 hours per day will produce permanent hearing loss after many years (United States Institute of Health Consensus Statement on Noise and Hearing Loss, 1990). According to data from the Workers' Compensation Board (1998) in British Columbia, almost thirty percent of young adults entering the workforce have already suffered some hearing damage due to noise.

Stress-Induced Health Outcomes

The most common outward symptom of stress building up in humans, when faced with noise, is annoyance (Health and Welfare Canada, 1989). Exposure to excessive noise can also induce or aggravate stress-related health outcomes, including those on the cardiovascular system, immune system, sleep, task performance, behaviour, and mental health.

(i) Annoyance

Annoyance can be defined as "the expression of negative feelings resulting from interference with activities, as well as disruption of one's peace of mind and the enjoyment of one's environment" (Suter, 1991). Evidence has shown that unexpected or impulse noise is more annoying than continuous noise of equivalent energy.

Annoyance in the workplace has been studied and may yield useful insights into annoyance caused by ambient urban noise. The Health Council of the Netherlands (1996) found no association between noise level in the workplace and annoyance. The Council, however, identified five non-acoustic variables that have a greater effect on annoyance than noise level: meaningfulness and information content of the noise; predictability, avoidability, and controllability of the noise; attitude of workers to the noise; task demand; and susceptibility.

(ii) Cardiovascular Disease

Noise-induced cardiovascular effects have been extensively studied in occupational settings. The Health Council of the Netherlands (1996) concluded that prolonged exposure to occupational noise may contribute to increased blood pressure and hypertension. These effects were shown to occur at sound levels of 85 dB(A). Other noise-induced cardiovascular effects include: abnormalities in the electrocardiogram; more heart beat irregularities; faster pulse rate; and slower recovery of vascular constriction.

It has been more difficult to determine the effects of noise in the urban environment. Most studies have focused on the effects of air and road traffic noise on people in their own homes. A complicating factor has been to distinguish exposure to traffic noise versus other, often even louder noises, from other sources. Housing features, as well as personal habits and proximity of sleep areas to the noise source (e.g., road) affect the actual noise exposure. There is some evidence that suggests an increased risk of hypertension and ischaemic heart disease for people living in areas with road or air traffic noise at outdoor equivalent sound levels above 70 dB(A) based on exposure between 6:00 a.m. and 10:00 p.m.

According to Thompson (1996), some studies have found that kindergarten children had significantly higher systolic and diastolic blood pressures when exposed to noisy or very noisy environments (kindergarten and home) as compared to quiet environments. However, these effects appear to be of temporary nature (Health Council of the Netherlands, 1996).

(iii) Sleep Disturbance

Noise has been reported to lessen the quality and the duration of sleep. Epidemiological studies have focused on the impact of noise on individuals such as patients in hospital and the impact of particular sources of noise (e.g., aircraft) on sleep. The Health Council of the Netherlands (1996) has considered the evidence to be sufficient for a causal relationship between the long-term effects of noise-related sleep disturbances, with changes in sleep patterns, awakening, sleep stages, and subjective sleep quality. Susceptible persons may be affected by noise occurring during sleep, as well as the waking state, with day and night noise being a significant problem for night workers, mothers with babies, elderly persons (Horne et al., 1994), persons who are especially vulnerable to physical or mental disorders, and other individuals who experience sleeping difficulty (Berglund & Lindvall, 1995).

(iv) Immune Effects

There appears to be an association between sleep and the immune response (Thompson, 1996). Thus, it would follow that further study is required on the immune responses of people exposed to noise during sleep, especially those exposed to intermittent transportation noise. For example, nocturnal noise has been indicated as a health risk (Altena & Beersman, 1993) because of the disturbance to the distribution of sleep stages resulting in direct immunosuppressive effects (specifically inhibition of eosinophils and basophils which usually proliferate during sleep) (Thompson, 1996).

The Caerphilly and Speedwell Study (1990) found an increased concentration of leucocytes in the blood of persons exposed to high levels of traffic noise (Health Council of the Netherlands, 1996). Although no studies have reported a causal relationship between noise and compromised immunity, increased concentration of leucocytes in blood might lead to increased prevalence of diseases such as influenza.

(v) Biochemical Effects

Noise-induced biochemical changes (specific hormones and metal ions such as magnesium) have been found in persons exposed to very high environmental or occupational noise, suggesting noise acts as a stressor. Several studies also show biochemical changes indicating an increased risk of ischaemic disease. However, limited data on the causal relationship is currently available (Health Council of the Netherlands, 1996).

(vi) Reproductive Effects

There is limited evidence to suggest a relationship between air traffic noise exposure of pregnant women in the living environment and low birthweight. There is virtually no data to suggest an increased risk of congenital anomolies (Health Council of the Netherlands, 1996).

(vii) Performance Effects

Very little research has focused on the effect of noise on human productivity in community situations. Most studies have occurred in the laboratory and work settings. Noise has been shown in test subjects to increase alertness, affect task strategy, and decrease attention to the task. Performance on simple tasks, however, especially those that are monotonous, may actually be improved by noise, presumably by elevating the subject's alertness (Suter, 1991). There are consistent aftereffects of noise on tasks requiring higher cognitive performance (e.g., proofreading, completing a puzzle). Some accidents may also be a result of the effects of noise on performance (Berglund & Lindvall, 1995).

Susceptible Groups

There may be some populations at greater risk for the harmful effects of noise. These groups include: the elderly, those with a mental health disorder (Thompson, 1996), the blind, possibly fetuses, and young children (Berglund & Lindvall, 1995). For example, children appear to be particularly susceptible to noise-induced health effects including: interference with speech acquisition and language development (which can create frustration and impair social interaction), inattention and impaired task performance, lower reading scores, and delayed motor reflex reactions (Westman & Walters, 1981). According to Berglund and Lindvall (1995), classrooms and day care facilities often surpass the recommended sound pressure level (e.g., 35 dB(A) during teaching sessions), compromising the optimum learning environment for children. For hearing impaired children, it is suggested that the sound level needs to be even lower.

Youth and young adults appear to be at greater risk for noise-induced hearing loss due to their exposure to very high levels of noise during leisure activities including concerts and bars, use of personal cassette players, car stereos, firearms (including pellet guns and toy cap guns), fireworks, arcade games and motor sports such as racing cars (Axelsson, 1991).

The Health Council of the Netherlands (1996) suggests that susceptible populations to the adverse health effects of noise can also include: people that are highly annoyed by low levels of road traffic noise (for hypertension); men exposed to high levels of road traffic noise at home as well as occupational noise (for ischaemic heart disease); and pregnant women who are exposed to occupational noise (for hypertension). Further, people with sleep disturbances have an increased risk of hypertension and ischaemic heart disease compared to people who live in the same environment that do not experience sleep disturbance. Finally, exposure of hospitalized patients to relatively high levels of noise from sources inside or outside the hospital delays recovery and wound healing (Health Council of the Netherlands, 1996).

RESEARCH IMPLICATIONS

More research is necessary to fully identify the impacts of noise on human health. The following are recommendations (Foo et al., 1994; Lercher et al., 1998; Van Raaji & Oortgiesen, 1996) for future research endeavors:

(a) Consider total noise exposure (including rest periods), fully describe sound (i.e., loudness, roughness, sharpness), and distinguish sound sufficiently among sound environments (i.e., low frequencies);

(b) Consider selection bias of study participants to ensure validity of results (self-selected, place of residence dictated involvement in the study);

(c) Focus on susceptible groups such as those with noise sensitivity or a family history of hypertension;

(d) Consider coping styles and coping resources (perception of control) and ability to escape from the noise;

(e) Examine how lifestyle behaviours (alcohol, tobacco, other drugs) may act as mediators between noise and health outcomes;

(f) Consider potential biochemical mediating factors (e.g., magnesium deficiency, fibrinogen and serum lipids) when looking at cardiovascular outcomes;

(g) Examine more closely the most obvious mediator (namely annoyance) when focusing on emotional responses to noise;

(h) Track into adulthood, children who show blood pressure changes in very noisy environments, particularly children with a potential predisposition to hypertension based on family history of hypertension or low birthweight. This may identify possible physiological long term effects of noise exposure on children; and

(i) Examine more closely the synergistic and additive effects of noise exposure and chemicals such as solvents and ozone.

Toronto Public Health will continue to monitor the scientific research on the impacts of excessive noise on human health and advise the Board of Health of any significant concerns that emerge in the future.

PUBLIC HEALTH INITIATIVES TO PROMOTE NOISE AWARENESS

Toronto Public Health is currently planning a variety of health promotion activities to promote noise awareness, in consultation with Urban Development Services, Corporate Services and NoiseWatch. Activities are underway to:

(a) Provide noise awareness materials to schools through curriculum development (including the "The Book of Noise" by R. Murray Schafer);

(b) Develop a brochure on the health effects of noise and disseminate to the public through public health nurses, day care personnel and family physicians;

(c) Write articles for various newsletters including those to work sites, physicians and city employees (e.g., Inside TO);

(d) Include information on the health effects of noise on the City's website; and

(e) Provide in-reach education to public health staff including public health inspectors, public health nurses, and prenatal educators.

CONCLUSIONS

Noise is an important health issue that affects more than hearing. The scientific research demonstrates that health effects occur at noise levels below those that impair hearing. Some of these health effects include increased risk for cardiovascular disease, negative effects on sleep, communication, performance and behaviour, reading and memory acquisition, and mental health.

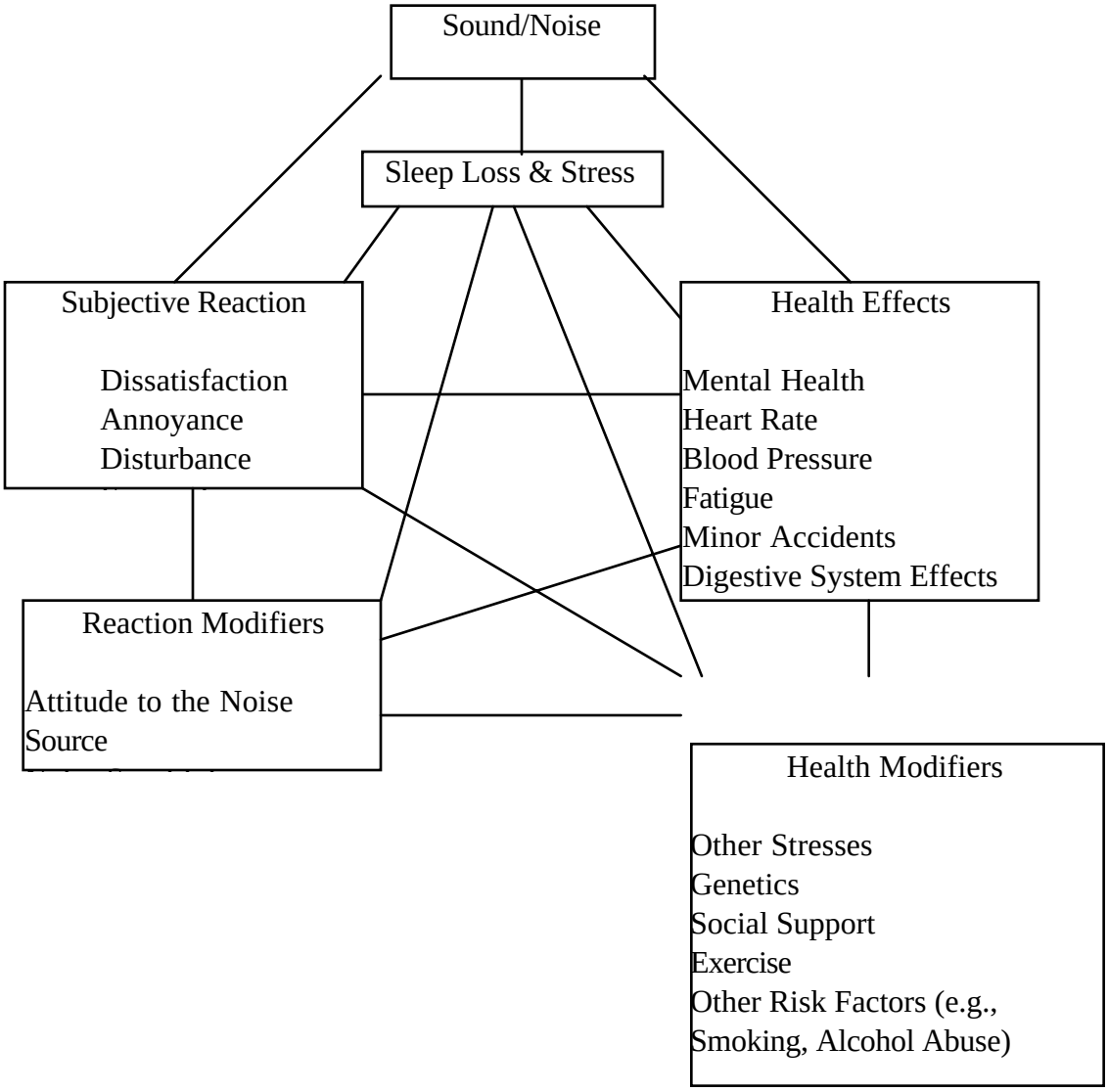
Controlling noise in Toronto is a very difficult and complex undertaking that involves all levels of government as well as the private sector and the general public. Toronto Public Health is committed to increasing public awareness of the health effects of noise and encouraging concerted action to reduce noise. This report has been prepared in consultation with staff in Urban Development Services, Works & Emergency Services and Corporate Services. Public Health staff will continue to collaborate with others in the corporation and community during implementation of outreach activities.

Table 1: Sound Levels and Human Response

COMMON SOUNDS	NOISE LEVEL (dB)	EFFECT
Boom Cars	145	Beyond threshold of pain (125 dB)
Jet Engines (Near)	140	
Shotgun Firing	130	
Jet Takeoff (100-200 ft)	130	
Rock Concerts (Varies)	110-140	
Oxygen Torch	121	
Symphony Orchestra	110	
Discotheque/Boom Box	120	Threshold of sensation (120 dB)
Thunderclap (Near)	120	
Stereos (Over 100 watts)	110-125	
Power Saw (Chain Saw)	110	Regular exposure of more than 1 min. risks permanent hearing loss (over 100 dB)
Pneumatic Drill/Jackhammer	110	
Snowmobile	105	
Jet Flyover (1000 Feet)	103	
Electric Furnace Area	100	
Garbage Truck/Cement Mixer	100	No more than 15 min. unprotected exposure recommended (90-100 dB)
Farm Tractor	98	
Newspaper Press	97	
Subway, Motorcycle (25 ft)	90	Very annoying
Lawnmower, Food Blender	85-90	85 – level at which hearing damage (8 hrs.) begins
Recreational Vehicles, TV	70-90	
Diesel Truck (40 mph, 30 ft)	84	
Washing Machine	78	
Dishwasher	75	
Average City Traffic Noise	80	
Garbage Disposal	80	Annoying, interferes with conversation, constant exposure may cause damage
Vacuum Cleaner, Hair Dryer	70	
Inside a Car (Loud Engine)		Intrusive, interferes with telephone use
Garbage Disposals	50-60	
Normal Conversation	50-65	
Quiet Office	50-60	
		Comfortable (under 60 dB)
Refrigerator Humming	40	
Living Room, Bedroom		
Whisper	30	
Broadcasting Studio		Very Quiet
Rustling Leaves	20	
Normal Breathing	10	Just Audible
	0	Threshold of normal hearing (1000-1000 Hz)

Source: Adapted from "Health Effects from Environmental Noise Exposure" by Evelyn Talbott and Shirley Jean Thompson. Lewis Publishers, New York, 1995.

Table 2: A Model of the Causal Connections between Noise, Community Reaction, Modifiers and Health Effects



Source: Adapted from "The influence of subjective reactions to noise on health effects of the noise" by R.F.S. Job, Environment International, 1996.

Table 3: Possible Long-term Effects of Noise Exposure

EFFECT	CLASSIFICATION OF EVIDENCE	SITUATION	EXPOSURE		
			VALUE IN dB(A)	DURATION	LOCATION
Hearing loss	Sufficient	Occ Env recr Occ unb	75 70 <85	Occupational exposure dB(A) Leq 24 hours Occupational exposure	Inside Inside Inside
Annoyance	Sufficient	Occ off Occ ind Env	<55 <85 42	Occupational exposure Occupational exposure Ldn	Inside Inside Outside
Hypertension	Sufficient	Occ ind Env road Env air	<85 70 70	Occupational exposure dB(A) Leq 06-22 hours dB(A) Leq 06-22hours	Inside Outside Outside
Ischaemic heart disease	Sufficient	Env road Env air	70 70	dB(A)Leq 06-22 hours	Outside Outside
Sleep disturbance, changes in:					
- Sleep pattern	Sufficient	Sleep			
- Awakening	Sufficient	Sleep	60	SEL	Inside
- Sleep stages	Sufficient	Sleep	35	SEL	Inside
- Subjective sleep quality	Sufficient	Sleep	40	Leq 11pm-7am	Outside
- Heart rate	Sufficient	Sleep	40	SEL	Inside
- Mood next day	Sufficient	Sleep	<60		Outside
Performance	Sufficient Limited	School Occ Env	70	Leq dB(A) school hours	Outside
Sleep disturbance, changes in hormones	Limited	Sleep			
Sleep disturbance, changes in performance next day	Limited	Sleep			
Immune effects	Limited	Occ Env			
Biochemical effects	Limited	Occ Env			
Birthweight	Limited	Occ Env air			
Psychiatric disorders	Limited	Env air			
Absentee rate	Limited	Occ ind Occ off			
Psycho-social well-being	Limited	Env			
Sleep disturbance, changes in immune system	Inadequate	Sleep			
Congenital effects	Lack	Occ Env			

Abbreviations:
occ = occupational situation,
ind = industrial,
off = office,
env = living environment,
recr = recreational environment,
road = road traffic,
air = air traffic,
sleep = sleeping time,
unb = unborn: exposure of pregnant mother,
school = exposure of children at school.

Source: Adapted from "Effects of Noise on Health" Health Council of the Netherlands, Noise/News International, September 1996.

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