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**THE NON-AUDITORY EFFECTS OF NOISE**

*Community Noise*

Noise is an unwanted sound that irritates the receiver, is discordant with their expectations, and interferes with wanted sounds. The World Health Organisation (WHO) classifies community noise as a common pollutant, and provides a definition of community noise that includes road, rail and air traffic, industry, construction and public works, and neighbourhood noise.

Evidence is accumulating in the health literature in relation to the adverse impacts of community noise, including effects on hearing, quality of life, sleep, psychological wellbeing, and physiological function. Noise can also impede rest, relaxation, and recreation activities. The WHO (1999) report: "People may feel a variety of negative emotions when exposed to community noise, and may report anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation or exhaustion".

Community noise can impact health in two ways. First, by directly damaging the hearing organ, noise can cause temporary or irreversible impairment to a person's ability to process auditory information. Hearing loss resulting from noise exposure is sufficiently predicted by the physical characteristics (e.g., level, frequency) of the noise; specifically noise exceeding terminal threshold (i.e., greater than 120 dB SPL). Second, the non-auditory effects of community noise are defined as the effects on health and wellbeing that are caused by exposure to noise, with the exclusion of effects on the hearing organ.

Non-auditory effects include sleep disturbance and stress-related disease, and prevail in small but significant numbers of individuals. Because of the individual differences in the response to noise, the non-auditory effects of community noise are not predictable by the physical properties of the noise alone, and can potentially occur for any audible sound.

*Community Noise as a Health Issue*

Health refers not only to a lack of disease and infirmity, but also wellbeing, quality of life, and amenity. International groups of experts have concluded that sufficient evidence now exists for the effects of noise on health regarding annoyance, school performance, ischaemic heart disease, hypertension, and various aspects of sleep disturbance. The WHO note "The risk of adverse health effects must be considered in the light that noise as a stressor may operate through physiological responses modified in complex ways by individual psychological processes".

Noise-induced stress has been shown to directly influence the activity of the human endocrine system, the process that regulates the hormone levels in the body. Noise exposure influences the endocrine system by evoking a maladaptive emotional response or by disturbing sleep. The response of the endocrine system to noise can result in disease, including cardiovascular, respiratory, and musculoskeletal pathology (WHO, 2004).

Acting as a stressor, community noise can induce sleep disturbances by waking a sleeper, altering sleep patterns, reducing dream (or REM) sleep, increasing body movement, and changing cardiovascular responses. Sleep disturbance in turn can result in a reduction in waking vigilance, memory, learning, and concentration, and mood. Sleep may be disturbed due to noise level or due to psychological responses to the noise.

In 2004 the WHO released the first, and to date only, comprehensive report on the non-auditory effects of noise. This study determined that chronic noise annoyance, and not noise level, was a strong predictor of increased health risks. The report stated that, of 8325 participants, approximately 25% reported noise-induced sleep disturbances, and additionally, that those reporting sleep disturbances were at greater risk of suffering depression, hypertension, and migraines.

Moderate annoyance to traffic noise increases the risk of asthma, diabetes, and migraine slightly, and the risk of cardiovascular symptoms significantly. They also report that people reacting negatively to community noise also have a greater chance of developing the symptoms of major depression. For those exhibiting strong annoyance with respect to traffic noise, their annoyance is a risk factor for respiratory symptoms, cardiovascular symptoms, bronchitis and arthritis.

### *Community Noise and Policy*

Community noise is recognised by the World Health Organisation as a significant health issue, and many health institutions now view the growth of community noise as unsustainable. A significant challenge is that individuals report a wide range of different responses to noise ranging from highly tolerant to highly sensitive, and different specific health impacts including increased irritability, headaches, and poor sleep.

Current noise standards assume that noise level is the primary variable predicting adverse health effects. Such a stimulus-orientated approach negates the reality and experiences of the listener. Increasingly, research is demonstrating that it is not noise level *per se* but rather noise annoyance that best predicts the potential adverse effects of noise. As such, while overall noise level is an important variable, it is only one of many important variables.

Furthermore, adverse health effects are more likely to be mediated through stress-related processes than through gross insult to the hearing organ. The non-auditory effects of community noise are defined as the effects on health and wellbeing that are caused by exposure to noise, with the exclusion of effects on the hearing organ. International research in the last five years has demonstrated that noise annoyance is the best predictor of non-auditory health effects of community noise.

However, little research has been undertaken into the variables that determine noise annoyance, and a number of studies have been undertaken demonstrating that while noise characteristics are important variables in predicting adverse health outcomes they are merely a subset of important variables that need to be considered. Other variables that are increasingly being identified as predictors of adverse health outcomes in relation to noise include annoyance, personality type, attitude to noise, psychological wellbeing, and noise sensitivity.

Currently the psychological and social determinants of annoyance do not significantly contribute to national standards and other criteria informing health guidelines on acceptable noise exposure. Instead, noise level is adopted as the sole criterion on whether or not a noise may be damaging to health. Health organisations should therefore put the listener to the forefront of noise policy by building on recent international studies that clearly demonstrate that even though community noise may not be of sufficient magnitude to induce hearing loss it can still be a potent risk to health.

Specifically, it is the response of the listener to noise, and not noise level *per se*, that best predicts health effects. For example, the meaning assigned to the noise by the listener (e.g., intrusive, unnecessary) is likely to determine annoyance, and not noise level. This explains why the same noise can annoy some listeners and not others.

Noise level, when used in isolation, is an invalid predictor of health effects. The WHO (1999) states that it is evident that noise emission standards have proven insufficient and that noise, irrespective of its source – road, rail, air traffic, or neighbourhood activities – remains a key issue in most European countries.

A recent investigation by The Department of Health and Aging in Australia called for an immediate review of all noise guidelines, standards and policies in light of the adverse health outcomes being associated with community noise. A difficulty arises however in that there is little research currently available that explores the relationship between psychological variables and annoyance, and the relationship between physical noise characteristics and annoyance.

The WHO states that “In contrast to many other community problems, noise pollution continues to grow and it is accompanied by an increasing number of complaints from people exposed to noise”. The growth in noise pollution is unsustainable because it involves direct, as well as cumulative, adverse health effects. It also adversely affects future generations, and has socio-cultural, aesthetic and economic effects.

### *Community Noise and New Zealand*

In the New Zealand context the effects of community noise have been debated recently with some intensity in the public domain. Issues with community noise have emerged in a number of high-profile public reactions to resource consent applications to build airports (e.g., Whenuapai (Auckland); Paraparaumu (Wellington)) and wind turbine complexes (e.g., Motorimu (Manawatu); Mill Creek (Wellington)), and the continued operation of racing tracks (e.g., Western Springs Speedway (Auckland); Ruapuna Raceway (Christchurch)).

Additionally, most city councils are experiencing an increase in complaints relating to stereo, bass and party noise. The continued use of standards based solely on noise level in New Zealand (e.g., NZS6808 in relation to wind turbine noise) constitutes a risk to public health as these standards are based upon the invalid notion that noise level alone determines health risk.

The demands on the natural resources of New Zealand presents significant land-use planning challenges, not least of which is protecting public health in a political environment where perception of costs and benefits are paramount.

There is virtually no reputable information currently available regarding the exposure of New Zealand's communities to community noise and the impact of this exposure on public health and wellbeing. Given that New Zealand is facing rapid growth, it is likely that more people will be chronically exposed to community noise.

Baseline information about how current exposure impacts on communities and public health is required by regional health boards, local authorities and other stakeholders in order to provide informed decision-making.

**National Foundation for the Deaf  
5 May 2009**