The Effect of Community Noise on Health and Well-being

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ABSTRACT

There has been considerable recent research in relation to the effects of environmental noise on one's health and wellbeing. However, there is limited research within a New Zealand context and with recent concerns about aviation and wind turbine noise making this especially important. The current research is a pilot study that attempted to investigate the relationship between aviation noise and noise sensitivity on annoyance and self reported quality of life. The findings from this study indicate that noise sensitivity significantly predicted for the quality of life domains of physical health, psychological well-being, environment and social relationships. In relation to the link between noise sensitivity and annoyance, the findings indicate that noise sensitivity significantly predicts for annoyance with habitation negatively predicting for general annoyance. In relation to aviation annoyance, length of stay was found to be the only predictor with longer length of stay found to negatively predict for annoyance towards aviation noise.

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And Finally, I would like to acknowledge the participants who took part in this study. Without your help, this study would not have been possible.

I'm a quiet living man,
Who prefers to spend the evening in the silence of his room,
Who likes an atmosphere as restful as an undiscovered tomb,
A pensive man am I, of philosophic joys,
Who likes to meditate, contemplate,
Free from humanities' mad inhuman noise,
Just A quiet living man....

My Fair Lady
Alan Jay Lerner and Frederick Loewe

There are a number of environmental pollutants that have an adverse impact on our health, including air pollution, water pollution and noise pollution. Noise pollution has been largely ignored in terms of its impact on health and wellbeing. However, this is undergoing a change with a number of health institutions now considering the growth of community noise as unsustainable. It is now recognized that the effect of noise exposure is not simply limited to a direct and cumulative impairment to health, but to future generations who will be affected through the degradation of residential, social, and learning environments (Berglund, Lindvall & Nordin, 1990). Noise not only leads to direct auditory insult contributing to hearing loss, it can also to lead to a number of non auditory impacts on health such as chronic annoyance, sleep disturbances, cardiovascular problems and compromised mental health. Most city councils in New Zealand are experiencing an increase in complaints relating to stereo, bass and party noise. Additionally, public opposition to noise has emerged in a number of high-profile resource consent applications to build airports and wind turbine complexes, and the continued operation of racing tracks and public bars. This highlights the importance of investigating the relationship between noise and health, which could potentially impact future decisions by policymakers with regard to noise standards.

NOISE AND THE NEW ZEALAND CONTEXT

There has recently been some research internationally (Pedersen & Persson Waye, 2008; Pedersen & Persson Waye, 2007; Neimann et al., 2006) focusing on the harmful effect of noise on health and wellbeing. However, there is little New Zealand research that has investigated these harmful effects of noise on ones' health.

In New Zealand, the effects of noise are particularly important especially for residents of Makara Valley in Wellington. Residents living in the vicinity of the wind farms have been suffering from the effects of noise induced sleep disturbances which has resulted in chronic fatigue and annoyance from wind turbine noise. This is supported by research on wind turbine noise, with residents reporting significant distress from noise as well as damage to the aesthetic quality of the environment. The noise has had a significant impact on this small rural community with some residents choosing to leave the town to escape the harmful effects of noise pollution.

A recent study of Pacific Island families found noise pollution to be a significant problem reported by the residents, with 44.4% finding transportation noise and noise from other homes to be some problem, and 15.2% reporting it to be a serious problem (Carter, Williams, Paterson & Lusitini, 2009). This is consistent with findings from Europe with Lambert and Vallet (1994 as cited in Miedema, 2007) who estimate about 49% of Europeans live in areas that do not assure acoustic comfort, of which, depending on the country, between 20-25% of individuals reported noise annoyance.

The effect of airport noise on health has also been of concern in New Zealand, an example of this is the proposed upgrade of Paraparaumu airport in Kapiti coast north of Wellington. The Kapiti coast has been known for its outdoor lifestyle and for this reason preservation of this lifestyle is important to the community. The Paraparaumu airport during the 1950's was temporarily the main airport for Wellington, since then it has remained a general aviation airport with intermittently and few scheduled services. The recent concern in relation to the Paraparaumu Airport is that there has been a planned increase in aircrafts using the airport. It is this impact on the long term health and wellbeing of the residents, which is of concern for residents whose experience of it so far has been both intrusive and distressing. This is particularly significant for residents of this area since Paraparaumu airport, unlike other major New Zealand airports, is situated in a densely populated residential area. In recent years the air traffic has been extremely variable, varying between being extremely intense with training activities and dropping to its usual quiet levels. It is this variable air traffic and concerns about Air Zealand starting services to Paraparaumu that has been of concern to the residents of the Kapiti Coast who fear the increase in air traffic can have a significant impact on their health and quality of life. The current research focuses on the Auckland International Airport and residents residing in the immediate vicinity.

A FORMAL DEFINITION OF NOISE

Noise is defined as any sound which is considered unpleasant and which can result in interference with the reception of wanted sound (EnHealth Council, 2004). Noise is generally the unwanted part of sound and is specific to a particular person, time or place (Thorne, 2008; Westman & Walters, 1981). According to WHO (1999) community noise is defined as noise produced from all sources except industrial noise and includes noise from road, rail, air traffic, construction and neighborhood noise. Environmental noise or community noise interferes with normal behavioural activities or relaxation and is considered to be a potent stressor (Miedema, 2007). The unwanted health effects of community noise can be temporary or long-term, and include impairment of physical, psychological, or social functioning (WHO, 1999). The ability to cope with environmental stressors is considered to be necessary for an individual's health and wellbeing (Miedema, 2007). Noise then is an intrusive sound that can be thought of as an environmental stressor and community burden (Stansfeld & Matheson, 2003) and is known to cause irritation, anxiety and anger for the respondent (Thorne, 2008). Noise not only has a physical impact on an individual but also results in strong emotional reactions, which if the individual has insufficient ability to cope with, can subsequently result in stress reactions and regulatory diseases (Niemann et al., 2006). The meaning one gives to sound, whether one perceives it as threatening or if it is significant to the particular individual, is an important factor that determines an individual's response to it (Westman & Walters, 1981). Research suggests that the health effects associated with chronic noise exposure can only be evident ten to fifteen years later in different biological systems (Graff et al 1968 as cited in Niemann et al., 2006).

NEW ZEALAND NOISE STANDARDS

The New Zealand Noise standards 7.8.(1991) were developed for the purpose of defining and limiting airport noise as well as to control noise sensitive developments close to an airport. The New Zealand Noise standards acknowledge that excessive or high levels of noise can have a detrimental effect on the quality of the environment. Excessive noise has also been recognized as having a major impact on public health and has also been seen to affect amenity values of a neighbourhood (Noise Standards, 1991). According to the noise standards 7.8.1, in relation to residential areas, noise levels should not exceed over 55 dBA L10 between 11pm and 8am, Monday to Friday. The decibel (dB) is a logarithmic unit used to measure sound and sound pressure, while ‘A’ is the sound level filter. Sound pressure levels are measured on a dBA scale which is considered easy to use and widely applicable (Martin, 1929). These noise levels are not applicable to road traffic noise, which is exempt from these standards. For industrial, port and cement zones, the maximum noise levels should not exceed more than 60 dBA L10 between 11pm and 8am. The New Zealand Noise standards however seem to be overly simplistic and do not reflect the effect that noise has on an individual’s health and quality of life.

A FORMAL DEFINITION OF HEALTH

Health refers not only to physical consequences, but also well-being, quality of life, and amenity. The World Health Organization (WHO) defines health as *“A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”* (Pg no). From this definition of health, it is clear that noise can impact adversely on the quality of life and health of those who are exposed to it by not only contributing to physical problems like cardiovascular problems and sleep difficulties, but also impacting on the psychological wellbeing of individuals. These impacts occur for traffic noise, rail noise, aircraft noise, and wind turbine noise, and policymakers and the public remain largely unaware of the major impacts of noise in the residential environment, which should not to be underestimated (Niemann et al., 2006). In modern society where people are constantly being exposed to increasing noise load, it is suggested that even moderate and low level noise could be perceived as annoying and thereby reduce restoration time needed to recover from daily life stresses (Pedersen & Persson Waye, 2008).

CAN NOISE DEGRADE HEALTH?

Noise can have a major impact on an individual’s health and wellbeing, not just in relation to its auditory effects but contributing to non-auditory effects such as annoyance, sleep disturbance, cardiovascular difficulties and psychological wellbeing. The effects of noise are moderated by the physical characteristics of noise as well as psychological and attitudinal factors as well.

Noise Characteristics

The physical characteristics of noise include noise level, frequency and the associated vibration from the noise. It has been theorized that human senses act as change detectors, responding to changes in sound rather than to the absolute level of the sound itself. Furthermore, humans are more sensitive to change in continuous noise (such as impulsive turbine noise or intermittent aircraft flights) than to discrete auditory events (e.g., the loudness of a dripping tap at night) (Harry, 2007). In relation to frequency of sound, it appears that noise containing lower frequency components generally elicits stronger negative evaluations than noise that does not. The WHO (1999) state that “a large proportion of low-frequency components in noise may increase the adverse effects on health” and low frequency sound even at low sound pressure levels can disturb rest. All these characteristics contribute to how an individual responds to noise and it is important to consider these characteristics when looking at the effects of noise.

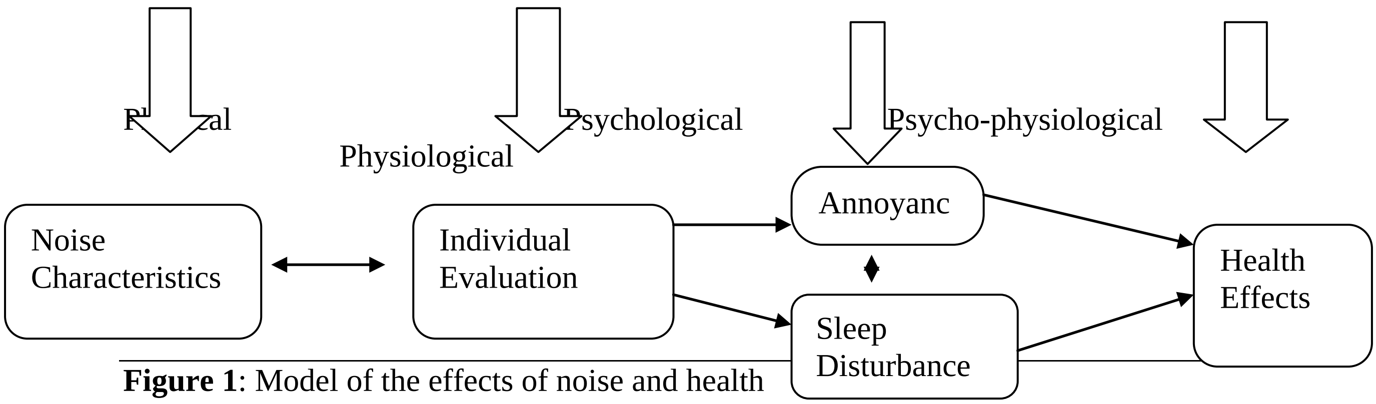


Figure 1: Model of the effects of noise and health

Noise Induced Hearing Loss

It is well known that some noises degrade our hearing; it’s why we wear earmuffs when mowing the lawn and why we don’t enjoy smoke detectors or house alarms being activated when we’re in their immediate vicinity. Direct impairment to the hearing sense is termed as the auditory effects of noise. The human auditory system is extremely sensitive to sound and damage to hearing is caused by intense noise that has an effect on the inner ear and is related to characteristics of the sound such as the intensity, frequency profile and duration and phase of the signal (Thorne, 2008; Gloag, 1980). However, this is not the same for everyone with individuals depicting varying susceptibility to damage and the effects of age and other pathological conditions can add to the effects of noise (Gloag, 1980). For instance, the threshold of audibility varies for different individuals due to age and their exposure to sound that causes hearing damage (Thorne, 2008).

In the last decade evidence has emerged for what we call the non-auditory health effects of noise. These non-auditory effects include irritability, stress, and poor sleep, all of which can compromise health and wellbeing.

Non-Auditory Health Effects

In addition to hearing impairments, noise can have an effect on perceptual, motor and cognitive behaviour as well as cause sleep disturbance and can lead to cardiovascular disease, cause learning deficits in school children, annoyance in adults and is also linked to impaired mental health.

<u>Annoyance</u>

Annoyance is characterized as a “feeling of displeasure associated with any agent or condition believed by an individual to adversely affect him or her” (Goines & Hagler, 2007, p 291). Noise annoyance is considered to be a sensitive indicator of adverse effects of noise (Miedema, 2007) which greatly interferes with an individual’s quality of life. Annoyance caused by noise often results in feelings of displeasure, nuisance, disturbance, aggravation, concern, bother and irritation and is considered a major effect of environmental noise (Goines & Hagler, 2007; Guski, Felscher-Suhr & Schuemer, 1999; Kamp, 2001; Ouis, 2001). In addition, noise pollution can cause a number of negative reactions which include “anger, dissatisfaction, disappointment, withdrawal, helplessness, depression, anxiety, distraction, agitation or exhaustion” (Goines & Hagler, 2007, p. 291). It has been established that a lack of perceived control of the noise can intensify its effects on an individual.

The extent of annoyance caused by noise is dependant on a number of characteristics such as the duration, intensity and meaning of the noise and can also vary depending on the time of day and the activity disturbed by the noise. Annoyance is also dependant on non-acoustical factors such as an individual’s personal sensitivity to noise (Goines & Hagler, 2007; WHO, 1999). Research conducted in Australia identified 12 percent of residents were seriously annoyed by aircraft noise and 38 percent were moderately annoyed (Morrell, Taylor & Lyle, 1997). This has been supported by Bjorkman et al 1995 (as cited in Morrell et al, 1997) who found a significant relationship between aircraft noise exposure and annoyance. However annoyance reactions are also dependant on personal and situational factors with greater annoyance reactions found in those individuals who have a fear of air crashes, those concerned with the health effects of noise, and those that reported interference in everyday activities like watching television, talking and sleeping (Morrell et al., 1997). Those individuals who are sensitive to noise are even more susceptible to noise annoyance (ENHealth Council, 2004; Ouis, 2001; WHO, 1999).

The findings from the WHO LARES study (2004) conclusively demonstrated a link between chronic annoyance and stress reactions with findings from the study showing evidence that strong chronic annoyance generates psychological stress in individuals in the form of negative emotionality which in turn is expressed in annoyance, fear, hopelessness, aversion, rage or despair (Niemann et al, 2006). Consequently, these emotions can be converted into physiological reactions which are manifested in the neural, hormonal and immune systems (Niemann et al, 2006). Research conducted by Bierbaumer et al, (1996) and Shavity et al (1987) (as cited in Niemann et al, 2006) concluded that emotional stress can cause an increase in the production of endogenous opiates which can result in the inhibition of the immune system processes.

<u>Sleep Disturbances</u>

Sleep is an essential requirement for good physiological and mental health, and chronic sleep disorders can have a detrimental effect on health and well-being (Westman & Walters, 1981). There is a lot of research that has focused on the effect of noise on sleep (ENHealth Council, 2004; Goines & Hagler, 2007; Griefahn, 1991; Morrell, Taylor & Lyle, 1997; Stansfeld & Matheson, 2003). Noise can interfere with sleep by repeatedly awakening a person, altering sleep patterns, reducing REM sleep, increasing body movements and changing cardiovascular responses, such as increased blood pressure, increased heart rate, changes in respiration and cardiac arrhythmias (EnHealth Council, 2004; Goines & Hagler, 2007).

Data from social surveys consider sleep disturbance to be a major consequence of environmental noise (Lambert & Vallet as cited in WHO, 1999), with noise having both primary and secondary effects on an individual. Exposure to noise can induce primary effects such as difficulty falling asleep, alteration of sleep patterns (Griefahn, 1991; WHO, 1999) as well as increased blood pressure, heart rate and finger pulse amplitude. While exposure to night time noise can produce after effects or secondary effects which consist of reduced perceived sleep quality, increased fatigue, decreased mood or wellbeing and decreased performance in tasks (WHO, 1999; Stansfeld & Matheson, 2003; Goines & Hagler, 2007).

There is also research suggesting that noise disturbances during sleep can result in acute and chronic stress hormone increases even at relatively low sound levels (Ising & Kruppa, 2004). Research also suggests that nocturnal noise exposure can permanently increase cortisol concentrations above the normal range in those individuals likely to be stressed by noise (Ising & Kruppa, 2004). This is considered to be a serious effect of noise since an increase in cortisol results in activation of the hypothalamus, pituitary, and adrenal cortex (HPA) system, a key component in the body's fight or flight system. Consequences of long term HPA activation can lead to insulin resistance, stress-ulcers and cardiovascular diseases (Ising & Kruppa, 2004). Additionally, sleep loss can result in reduction of cognitive function such as memory, learning and speech as well as affect physiology, behaviour and subjective outcomes (ENHealth Council, 2004).

According to Lercher (1995 as cited in Miedema & Vos, 2003) the effects of noise can also be affected by an individual's personal noise sensitivity for high level noise, with a higher percentage of noise sensitive individuals reporting sleep disturbance than non-noise sensitive individuals. It has also been reported that noise exposure during sleep can lighten the level of sleep in those individuals who have anxiety-introversion personality type (Westman & Walters, 1981). A number of sleep studies undertaken by Morell, Taylor and Lyle (1997) on the effect of aircraft noise on sleep found that sleep disturbance was a common effect of aircraft noise, with one study (Horne, Pankhurst, Reyner, Hume & Diamond, 1994 as cited in Morell at al, 1997) finding that males were more likely to respond negatively to aircraft noise events than females. According to Morell at al (1997) sleep deprivation has been shown to compromise an individual's immune system, and Ohstrom (1982, 1989 as cited in WHO, 1999) found that decrease in perceived sleep quality resulted in low mood and increased tiredness which subsequently results in low performance in tasks. Vallet (1979 as cited in WHO, 1999) also found that sleep related conditions are often adversely affected by exposure to community noise with some findings even indicating a permanent deterioration of sleep patterns. Thereby evidence from the research on the effect of noise on sleep indicates that it contributes significantly to an individual's psychosocial health and wellbeing (Ohstrom, 1991 as cited in WHO, 1999).

Stress

Noise being either a stimulant or a stressor is dependant on the source, the onset, duration, frequency and characteristics of the noise and whether it is wanted or unwanted (ENHealth, 2004). Noise, even at levels below the threshold of waking, can affect stress hormone levels. It has been demonstrated that when noise intrudes on an individual's personal space, it can affect their well-being, causing irritation, anxiety and anger (Thorne, 2008). Human beings are by nature designed to respond to noise, whether it is to analyze different characteristics of sound or to differentiate between the levels of sound and pitch (ENHealth Council, 2004). Consequently, sound, whether wanted or unwanted can induce emotions and actions from the respondent by acting as either a stressor or a stimulant. Thereby physiologically, our body instinctively either moves towards or away from a sound and may react defensively depending on the nature of the sound and "our ability to interpret and attribute meaning to the sound"(EnHealth Council, 2004, p. 7).

Sound can evoke emotions and actions in an individual through the inner ear's connection with the autonomic nervous system, which when activated can result in the fight or flight mechanism. Due to this defensive ability and the inability of hearing to be switched off, sound registers in the brain even during sleep (Westman & Walters, 1981). Thereby, a sound of sufficient intensity, significance or duration which is perceived as threatening by the respondent can mobilize the fight or flight reaction (Westman & Walters, 1981). This response triggers the activation of the cerebral cortex and emotional arousal and prepares the body for action. This is evident when smoke alarms and house alarms are activated in the middle of the night, it results in emotional arousal and subsequently the fight or flight action.

Sound arouses people by activating areas in the brain (e.g., the reticulating activating formation, thalamus) that regulate our mental states (e.g., alert, relaxed, sleepy etc). As a stressor, community noise can impact the cardiovascular system through the release of hormones (e.g., cortisol and adrenalin) that directly or indirectly regulate blood pressure, heart rate, and other internal processes (e.g., digestion) via the HPA axis (ENHealth Council, 2004). The response triggers the fight or flight state, and though it is a vital process in the survival of an organism, it can, if sustained unnecessarily for long periods of time, result in a breakdown of physical and mental health (Selye, 1976).

It has also been concluded that noise can have a physiological impact on an individual through interference with functioning of the Central Nervous System (CNS). The CNS is responsible for a number of activities that initiate physiological, emotional and behavioural responses, a number of which are beyond the control of the individual (Rylander, 2004). According to Rylander (2004) the auditory pathways of the central nervous system consist of direct pathways from the inner ear to the auditory cortex as well as indirect pathways to the reticular activating system, which is connected to the limbic system and other parts of the brain, to the autonomic nervous system via the neuro-endocrine system. Sound levels in the range of 70 to 120 dB can elicit a defensive response which appears first in the form of muscular tension followed by a decrease in skin electrogalvanic resistance after which there is rapid pulse rate followed by decrease in pulse pressure. This defensive response also has an effect on the reduction of salivary and gastric secretions, slowing down the digestive processes (Westman & Walters, 1981). In some cases, the defensive response can lead to stress which consequently results in the General Adaptation Syndrome (GAS).

According to Selye (1950) anything that endangers an individual's life, causes stress which may lead to an adaptive response, the GAS. The GAS develops in three stages: the alarm reaction, the stage of resistance and finally the stage of exhaustion. In the first stage, the body secretes adrenaline to fight the stress which results in the fight or flight reaction, once the stressor is removed the body will revert back to normal (Selye, 1950). If however, the stressor is not removed the GAS is in the second stage known as resistance or adaptation, which is considered the human body's long term reaction to stress. This involves the secretion of more hormones to increase blood sugar levels and sustain energy. This subsequently results in long term effects such as fatigue, irritability and lapses in concentration (Selye, 1950). Finally, the exhaustion stage is the stage wherein the body has run out resources and its reserve of body energy which subsequently results in mental and physical breakdown (Selye, 1950).

Noise and Cardiovascular disturbances

Noise can cause a number of physiological responses which are mediated by the autonomic nervous system, these include increasing heart rate and blood pressure, peripheral vasoconstriction and increased peripheral vascular resistance (Stansfeld &

Matheson, 2003). It has been theorized that long term exposure to environmental noise often results in increased blood pressure leading to an increased risk of cardiovascular disease (Rylander, 2004). However, with regard to blood pressure, there are a number of confounding factors, which include age, smoking and alcohol consumption, which have not been controlled for in some studies (Rylander, 2004). There has been much research on the effects of noise on cardiovascular health, in particular with regard to hypertension and ischaemic heart disease (ENHealth Council, 2004).

According to Goines and Hagler (2007) there is a body of literature that indicates evidence of both temporary and permanent effects of noise pollution on an individual's endocrine and autonomic nervous systems. It has been theorized that noise acts as a stressor that elicits reactions in the body, preparing it for a flight or fight response (Goines & Hagler, 2007; WHO, 1999). Thereby in doing so, the neuro-endocrine and autonomic nervous system are triggered, subsequently effecting the cardiovascular system and thus increasing the probability of it being a risk factor for cardiovascular disease (WHO, 1999). There is evidence that indicates acute exposure to noise can lead to activation of nervous and hormonal responses, thereby leading to temporary increases in blood pressure, heart rate and vasoconstriction (Goines & Hagler, 2007). However, effects of noise on cardiovascular disturbances can be influenced by an individual's sensitivity to noise. Stansfeld (1992) found that higher noise levels stimulated acceleration of cardiovascular problems in those with high noise sensitivity. It has been reported that the effects of temporary noise can be reversible; however, this is not true of noise exposure of certain intensity, duration and unpredictability which can incite changes in an individual that is irreversible (Goines & Hagler, 2007).

DETERMINANTS OF ANNOYANCE AND SLEEP DISTURBANCES

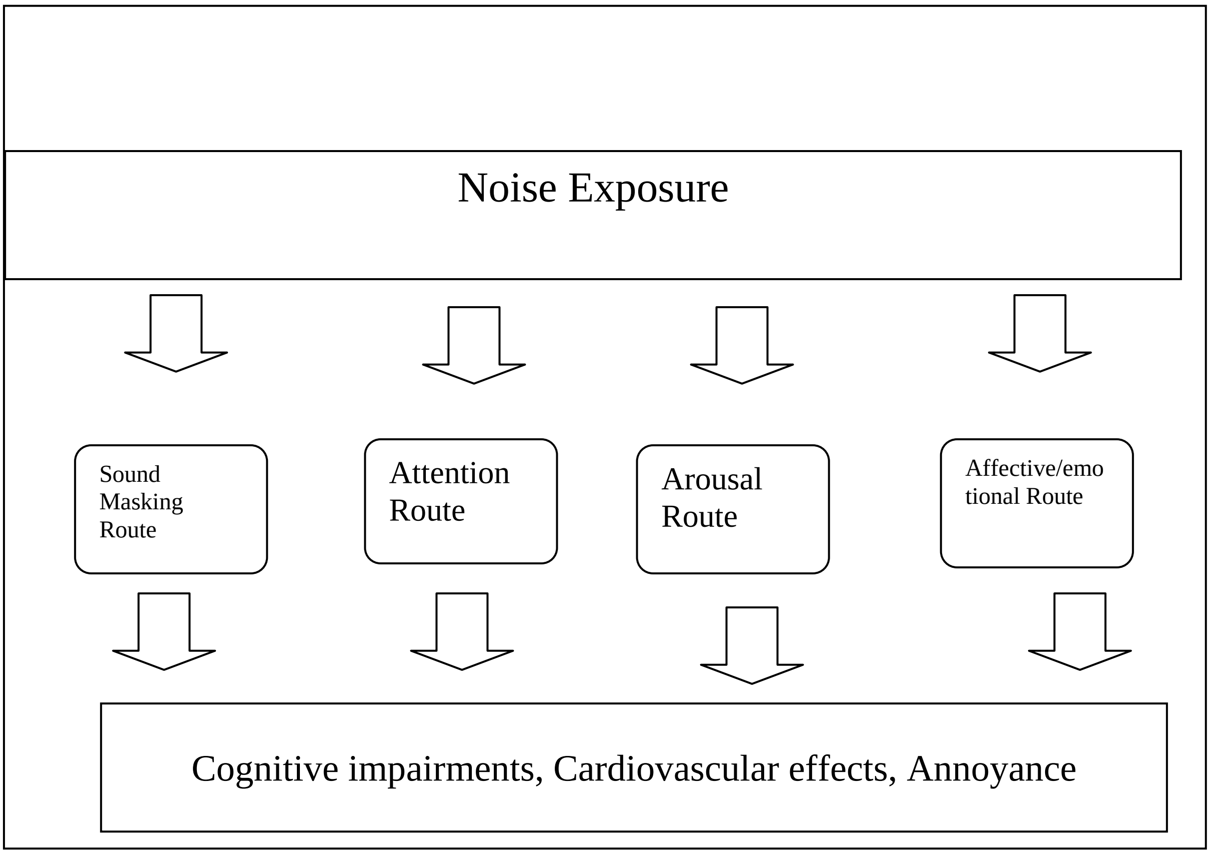
PSYCHOLOGICAL DETERMINANTS

Meidema's Model

There are a number of perspectives on the way environmental noise effects individuals. A common perspective has been the stress hypothesis which has been discussed previously, in terms of the general adaptation syndrome. This perspective centers around an individual's lack of ability to cope with the stress of environmental noise in addition to the presence of other stressors (Miedema, 2007). However, this perspective is considered too narrow to completely explain the impact of environmental noise since noise can also interfere in everyday activities, with interference in spoken communication being one of the main difficulties for individuals. This interference can lead to difficulty comprehending normal speech, which in turn can effect concentration, lack of self confidence, irritation and induce misunderstandings.

Miedema (2007) proposed a framework that states four primary interferences caused by environmental noise; these primary interferences may or may not be accompanied by acute and chronic stress responses. It is proposed that this is likely to lead to long term consequences which include chronic stress and cardiovascular problems. According to Miedema (2007) the four main interferences caused by noise are:

1) Sound masking route
2) Attention route
3) Arousal route
4) Affective/emotional route



The first interference, according to this model, is the sound masking route or communication disturbance, which basically involves the masking of signals or natural sounds which can result in the speaker having to increase the effort required when making conversation, thereby increasing the distance between the speaker and the listener (Miedema, 2007). This masking of speech not only has an effect on the individual level but also at a societal level, wherein individuals may cease conversations in noisy environments since it is too uncomfortable or impossible (Miedema, 2007).

The second interference involves disturbance to concentration or disturbance to the attention route. Noise negatively affects attention by attracting the limited attention resources, thereby affecting other processes requiring attention (Miedema, 2007). This distraction caused by noise is most disruptive when the task requires that information is retained in working memory (Miedema, 2007). This effect of noise on attention is largely experienced when individuals resort to less cognitively demanding tasks in noisy environments (Miedema, 2007) thereby, substituting the complex cognitive tasks with other tasks that require less concentration and attention.

The third interference caused by environmental noise is that of sleep disturbance, which is caused by disturbance to the arousal route (Miedema, 2007). Thereby the higher the arousal the lower the chance of the individual falling asleep or continuing sleep (Miedema, 2007). This ability of sound to cause arousal can prevent an individual from falling asleep and subsequently result in poor sleep quality (Miedema, 2007). Research has established that a single noise event can cause a number of effects including change in sleep states, EEG arousals, momentary change in heart parameters and conscious awakening (as cited in Miedema, 2007).

And finally according to this model, noise exposure can disrupt the affective-emotional route by frustrating communication and leading to a number of negative reactions such as anger and irritation (Miedema, 2007). It has been theorized that individual factors such as personal noise sensitivity and coping style mediates the effect of noise exposure, with those individuals more susceptible to anger reactions more likely to express more intense reactions to noise and those individuals who are more sensitive to noise more likely to depict stronger fear reactions (Miedema & Vos, 2003).

The effects noise has on an individual can depend on acoustical and non acoustical factors (Ouis, 2001). The effects of environmental noise is dependant on acoustical characteristics of noise, namely the noise level and pattern of occurrence, aspects of noise situation and the lack of control associated with it (Miedema, 2007).

Attitudes towards noise

Attitudinal factors vary from person to person and within an individual but show considerable stability over time (Guski, 1999). Factors such as fear of the source of the noise feeling that noise annoyance is preventable (Miedema & Vos, 1999), the belief that the authorities can control the noise, the awareness of non-noise impacts of the source and the belief that the noise source is not important all have an impact on an individual's reaction to annoyance (Fields, 1993).

<u>Fear</u>

Those individuals, who express fear of the source of the noise, will experience more annoyance at the same exposure level. Fear has a large impact on annoyance, with those individuals who experience an intense fear related to the transportation that causes the noise reporting more annoyance than those who do not experience this similar fear (Miedema & Vos, 1999; Guski, 1999). It is, however, unclear whether this relationship is dependant on the actual experience of fear or due to the predisposition of noise annoyance and fear (Miedema & Vos, 1999). Schuemer (1974 as cited in Guski, 1999) considers fear to be the most important non-acoustic variable in airport noise studies followed by noise sensitivity.

<u>Evaluation of the noise source</u>

The individuals affected by this attitudinal factor are dependant on how convinced they are of the importance and the necessity of the source of the noise. Those who consider the source of noise important have been shown to depict less noise annoyance when compared to those not convinced of their importance (Guski, 1999). People evaluate the different sources of noise and this evaluation varies from person to person and differs between the different types of transportation (Guski, 1999). For instance, recent research has found that most people find aircraft noise annoyance to be greater than road traffic annoyance, while railroad traffic noise produces less noise annoyance when compared to road traffic noise at the same energy levels (Guski, 1999). This could be linked to fear of the source of transportation noise; with aircraft noise being considered the most dangerous followed by road traffic and then railroad noise. A study on the evaluation of seven different sources of noise (Finke et al., 1980 as cited in Guski, 1999) found that the non acoustic characteristics such as perception of the noise source as being unhealthy has been a significant contributor towards annoyance reactions. Another important finding was that those who considered the importance of the noise source (e.g., airport) and hoped to benefit from it in the long run showed less annoyance in comparison to those who did not believe their would benefit from living in the vicinity of the airport (Finke et al., 1980 as cited in Guski, 1999).

Capacity to cope with noise

Psychological stress is the consequence of an individual's inability to cope with demands from their environment. An important aspect of this is the assumption that the individual has the ability to cope with these demands (Guski, 1999). This can be done either directly (by turning off the noise source or negotiating with the people involved with this stress) or indirectly (by cognitive control). In most situations, circumstances prevent the individual from directly dealing with the source of the stress thereby indirect ways of coping with the stress are most often to best way of reducing noise annoyance (Guski, 1999).

Demographic factors on the other hand have been shown to not have an effect on noise annoyance with the exception of age and gender which has a small effect on noise annoyance (Miedema & Vos, 1999; Guski, 1999).

Mental Illness

A mental disorder is defined as the existence of a "clinically recognisable set of symptoms or behaviour associated in most cases with distress and with interference with personal functions" (WHO, 1992 as cited in ENHealth, 2004). An individual with good mental health is someone who can function effectively in society and cope with everyday pressures whereas those who are considered mentally ill are individuals who struggle with day-to-day tasks, dealing with mood swings, sleep disturbances and in some situations needing help to get through daily activities.

The findings on the association between noise and mental health have produced mixed results. There appears to be a relationship between noise sensitivity and annoyance with depression, however, the nature of this relationship is still unclear. Noise is not believed to cause mental illness but it appears that it might merely exacerbate the development of underlying mental disorders (Goines & Hagler, 2007). Noise is also believed to cause or contribute to anxiety, stress, nervousness, nausea, headaches, emotional instability, argumentativeness, sexual impotence, changes in mood, neurosis, hysteria and psychosis (Stansfeld & Matheson, 2003). This is supported by Morrell et al (1997) who reported a community study consisting of 6000 people living near Heathrow airport, the results of which indicated a significantly higher incidence of night waking, depression and irritability in individuals from high noise areas. It is theorised that those most vulnerable to these effects include children and the elderly since they may lack adequate defence mechanisms needed to combat the effects of noise (Goines & Hagler, 2007). While no association has been conclusively established between noise and psychiatric disorders, it appears there is a close relationship between noise exposure and the propensity to develop or suffer from psychiatric symptoms like anxiety after controlling for social class and marital status (Stansfeld et al., 1996).

With regard to psychiatric hospital admissions, the studies have not shown consistent results. Morrell et al (1997) in their review of the effects of aircraft noise reported on an ecological study undertaken around Heathrow airport. The results over a two year period indicated that those individuals exposed to high aircraft noise had significantly higher rates of psychiatric hospital admissions compared to those exposed to lower aircraft noise (Morrell et al., 1997). These findings were however not replicated after adjustments were made for age, sex and marital status (Morrell et al., 1997). Jenkins et al (as cited in Morrell et al., 1997) subsequently conducted a study of a psychiatric hospital and found a negative relationship between aircraft noise and admission rates.

Mild Traumatic brain injury has been considered the ‘silent epidemic’ since the problems associated with a brain injury are often not visible but may have consequences such as long term physical, mental, social or occupational sequelae (Dischinger et al., 2009). The consequences of traumatic brain injury (TBI) include cognitive, physical, emotional or behavioural symptoms. Cognitive consequences include short term memory loss, problems processing information, physical consequences include headaches, seizures, dizziness and noise sensitivity and emotional and behavioural consequences could include apathy, anxiety, irritability and depression (Dischinger et al., 2009; Ingebrigtsen et al., 1998). Dischinger et al (2009) found that anxiety, noise sensitivity and problem thinking were the strongest individual predictors of long-term post concussive syndrome (PCS). Noise sensitivity was also found to be significantly associated with prolonged PCS with patients who reported this symptom post injury were three times more likely to experience four or more persistent symptoms at three months (Dischinger et al., 2009; Smith-Seemiller et al., 2003). This was also supported by findings from Dikmen et al (1986 as cited in

Dischinger et al., 2009) who found that those patients with a head injury reported being more sensitive to noise after injury more frequently than a non injury group. Thereby incidents of brain injury and evidence of noise sensitivity point to the fact that noise sensitivity may have an organic cause.

Noise Sensitivity

An individual's personal characteristics such as sensitivity to noise can have a major impact on the effect of environmental noise (Miedema, 2007). Noise Sensitivity is defined as the "internal states (be they physiological, psychological or related to life style or activities conducted) of any individual which increase their degree of reactivity to noise in general" (Job, 1999, p. 59). Those individuals sensitive to noise possess a general negative attitude towards noise and report strong reactions in noisy environments (Miedema & Vos, 2003). Those sensitive to noise may pay more attention to noise, discriminate more between noises, find noise more threatening, out of their control and react or adapt to noise more slowly than those less sensitive to noise (EnHealth, 2004). Noise sensitivity can be thought of as a personality trait that is stable over time and maybe be related to neuroticism (Miedema & Vos, 2003; Schutte, Marks, Wenning & Griefahn, 2007). Neuroticism can be defined as an enduring tendency to experience negative emotional states and feelings like anxiety and depression. These individuals are also more likely to be affected by environmental stress and interpret ordinary situations as threatening and tend to be hostile, self-conscious, insecure and vulnerable (Matthews, Deary & Whiteman, 2003; Weiten, 2004). Noise sensitivity has been shown to exhibit relationships with heath related variables, with Nivison & Endresen (1993 as cited in Job, 1999) finding evidence of a relationship between noise sensitivity and sleep-loss in women. This finding was also evident in Stansfeld's (1992) study, who found a complex inter-relationship between noise sensitivity, noise exposure, reaction and depression, wherein those individuals who were found to be sensitive to noise also exhibited more depression in response to noise.

A REVIEW OF KEY STUDIES

Airport Noise

Tarnopolsky, Barker, Wiggins & McLean (1978) conducted one of the earliest studies on the effects of noise to identify the relationship between aircraft noise exposure and mental health in a community sample. The study aimed to investigate whether there was a relationship between noise exposure and psychiatric morbidity, whether there was a relationship between noise sensitivity and psychiatric morbidity and finally, whether there was a relationship between noise annoyance and psychiatric morbidity. The sample was obtained from two areas, high and low noise areas and included 208 interviews. The participants were asked to complete a questionnaire which included subsections investigating health, subjective noise sensitivity, annoyance and the General Health Questionnaire (GHQ). This GHQ is a screening instrument for psychiatric disorders, particularly for anxiety and depression. In relation to annoyance, the results suggested that those people in the high noise area were found to be more annoyed when compared to those in the low noise area. These individuals reported more annoyance for all sources than those in low noise areas. The findings suggested that there was an association between noise sensitivity and annoyance with only 59 % of those who reported being very annoyed was sensitive to noise. In relation to psychiatric morbidity, there was no association between noise exposure and psychiatric morbidity; however there was an association between high noise sensitivity and GHQ scores, with a strong likelihood of those who are highly sensitive to noise having possible psychiatric morbidity. Thereby being noise sensitive might predispose individuals to psychiatric morbidity.

Hygge, Evans & Bullinger (1996) conducted a study to investigate the longitudinal effects of chronic aircraft noise on the psychophysical, cognitive, motivational and quality of life of children. The sample consisted of a total of 327 children, aged 9-12 years, living around the old Munich airport which was shut down in May 1992 and children around the new airport site (Hygge et al., 1996). The children in the study were assessed on psychophysiological, perceptual, cognitive and motivational measures (Hygge et al., 1996). The results indicated that children chronically exposed to noise suffered cognitive deficits, with cognitive tasks that required the use of central processing such as reading and memory being affected by the noise. There was also evidence of the effect of chronic noise ceasing after a few years post exposure to the noise. It also appears that when children were exposed to noise, the impairments are only evident a few years after the exposure (Hygge et al., 1996).

Haines et al, (2001) conducted a study to investigate whether aircraft noise exposure has an effect on cognitive impairments, annoyance and stress responses in school children. The study also examined whether those children exposed to high levels of social disadvantage are at greater risk of the effects of noise (Haines et al., 2001). The participant sample consisted of children attending ten schools in a high aircraft noise urban area compared to children from ten matched low aircraft noise urban areas (Haines et al., 2001). The results from this study established that there was an association between noise exposure and some cognitive impairments and annoyance in children, but did not find an association with reading impairments, memory, attention and self reported stress (Haines et al., 2001). There was a weak association between airport noise exposure and hyperactivity and psychiatric morbidity (Haines et al., 2001).The results indicated that aircraft noise exposure was associated with annoyance after adjustment for age and social deprivation. The study also found that annoyance had an effect on health but there was no evidence of its long term effect on general health (Haines et al., 2001).

Stansfeld et al., (2005) conducted research to assess the effect of exposure to aircraft and road traffic noise on the general health and cognitive performance in children. The researchers assessed 2844 children, aged 9-10 years from schools in the Netherlands, Spain and the UK, located around three major airports. Exposure to noise was measured by external noise measurements, while cognitive outcomes was measured by the Suffolk reading scale, episodic memory was measured by a task from the child memory scale, sustained attention was measured by the Toulouse Pieron test and health outcomes was assessed by a questionnaire that included items on perceived health, perceptions of noise and annoyance (Stansfeld et al., 2005). In relation to the effect of chronic aircraft noise exposure on cognitive performance, data from the Netherlands, Spain and UK suggested that it was associated with significant impairment in reading comprehension (Stansfeld et al., 2005). Episodic memory was measured by recognition and cued recall, it was found that exposure to aircraft noise was associated with significant impairment in recognition but not on information recall or conceptual recall (Stansfeld et al., 2005). Aircraft noise was not related to impairment in the working memory, prospective memory or sustained attention whereas road traffic noise was associated with a significant increase in scores for information recall and conceptual recall (Stansfeld et al., 2005). Aircraft noise exposure was found to be related to impairments in children's cognition, namely with regard to reading comprehension, long term memory and motivation with tasks that involve central processing and language comprehension mostly affected by exposure to noise (Stansfeld et al., 2005). Road traffic noise did not affect reading comprehension, recognition, working memory, prospective memory and sustained attention in their sample (Stansfeld et al., 2005). With regard to heath effects, it was found that increased exposure to both aircraft and road traffic noise was linked to increased annoyance responses in children, there was, however no association between chronic aircraft noise and road traffic noise and self-reported health or mental health, after controlling for socioeconomic status (Stansfeld et al., 2005). It was theorised that due to the intensity, unpredictability and variability of aircraft noise it is likely to have a greater effect when compared to the constant intensity of road traffic noise (Stansfeld et al., 2005).

Haines, Stansfeld, Job, Berglund & Head (2001) conducted a study to identify the effects of aircraft noise exposure on children around the Heathrow airport in London, England with regard to mental health, stress responses and cognitive performance. The results found evidence that chronic aircraft noise exposure was associated with high annoyance reactions and poorer reading comprehension whereas there was no reported association with mental health in children, possibly due to their resilience (Haines, Stansfeld, Job, Berglund & Head, 2001). A follow up study was conducted comparing the children living around the airport with those children exposed to lower levels of aircraft noise (Haines, Stansfeld, Job, Berglund & Head, 2001). The results at follow up found chronic aircraft noise exposure was associated with higher levels of annoyance, perceived stress and poorer reading comprehension (Haines et al., 2001). These results support the Caerphilly study (Stansfeld, Gallacher, Babisch & Shipley, 1996) which found no evidence of a link between baseline noise level and mental health disorders. This was explained by the likelihood that residents had become habituated to aircraft noise exposure (Stansfeld et al., 1996). Habituation refers to the tendency of the residents to adjust to the noise and not find it disturbing. There was however a link between environmental noise, depression and anxiety, which contradicts the theory of habituation (Stansfeld et al., 1996).

Road and Rail Noise

One of the early studies on the effects of road traffic noise was conducted by Stansfeld, Sharp, Gallacher & Babisch (1993) who looked at the relationship between road traffic noise, noise sensitivity and psychiatric disorders. The participant population for this study consisted of a random sample of 2398 men aged between 50-68 years from Caerphilly, South Wales, UK (Stansfeld et al., 1996). Participants were asked to complete a questionnaire which included Weinstein’s ten-item self-report noise sensitivity, while self-reported annoyance was measured by a single question

“Does traffic noise at home annoy you?” (Stansfeld et al., 1996). Psychological disorder was measured by the GHQ, which is primarily a screening test for depression and anxiety (Stansfeld et al., 1996). Trait anxiety was measured by the Trait scale of the State-Trait Anxiety Inventory. The results of the study indicated that there was a strong association (r =) between traffic noise levels and annoyance. The findings also suggested that high noise sensitivity was linked to noise annoyance, with individuals with greater noise sensitivity having higher incidence of noise annoyance. Noise level was not found to be directly associated with depression and anxiety, however, noise sensitivity was strongly related to trait anxiety in this sample (Stansfeld et al., 1996).

Belojevic, Jakoviljevic & Aleksic (1997) conducted a study to identify the relationship between personality factors and subjective reactions to noise in a sample of 413 residents in Belgrade. The questionnaire consisted of four parts which included 14 questions on quality of sleep, psychological symptoms was measured by a questionnaire which included items on frequency of headaches, consumption of sedatives, and feelings of depression and nervousness (Belojevic, Jakoviljevic & Aleksic, 1997). Subjective noise sensitivity was measured by Weinstein’s Noise Sensitivity scale, which consisted of 21 items, noise annoyance was assessed subjectively by a ten graded numeric scale and personality traits of extro-introversion and neuroticism was assessed by the Eysenck Personality Inventory. The findings of this study indicated that the population in the noisy area had significantly more difficulties falling asleep, more night time awakenings, worse subjective sleep quality and more tiredness when compared to the control group. With regard to psychological disturbances, the population from the noisy area reported more fatigue, depression, nervousness and headaches than the control area (Belojevic et al., 1997). A high level of noise annoyance was also reported by those living in the noisy area, which might underlie the psychological and behavioural effects of noise. There were also some reported behavioural effects as a result of noise with worsening of interpersonal relationships between those dwelling in the flat and longer periods of windows being closed. Further results also indicated that there was a strong link between neuroticism, subjective noise sensitivity and sleep disorders and psychological disturbances (Belojevic et al., 1997). It was concluded that those individuals with high levels of neuroticism are likely to be prone to long-term negative psychological effects of environmental noise (Belojevic et al., 1997).

Paunovic, Jakovljevic & Belojevic (2009) conducted a study to identify the main factors that influence noise annoyance in individuals living in noisy and quiet urban areas. The study consisted of a randomised sample of 1954 participants obtained through questionnaires being dropped in every tenth household. Questionnaires consisted of sections that included annoyance related questions, noise sensitivity as measured by Weinstein's Noise Sensitivity Scale and stress level measured by Paykel's Interview for Recent Life Events which covers 61 stressful life events in the previous 12 months (Paunovic et al., 2009). The results showed that noise was ranked as the second most important factor that influenced annoyance to noise for most participants in the sample, with the highest source of environmental noise being considered to be road traffic noise (Paunovic et al., 2009). The findings suggest that for residents in quiet streets, the most important factors for high noise annoyance were subjective noise sensitivity and amount of time spent at home. In contrast, residents in noisy streets identified subjective noise sensitivity, orientation of windows towards the street and noise annoyance at the workplace as the most significant factors for high noise annoyance (Paunovic et al., 2009). Subjective noise sensitivity was considered to be the most common indicator of annoyance in this study (Paunovic et al., 2009) and was defined as a stable personality trait that has a big impact on attitudes towards environmental noise (Miedema & Vos, 2003; Schutte, Marks, Wenning & Griefahn, 2007). The other significant finding in this study was that noise-related characteristics were less significant predictors of noise annoyance when compared to personal, social and housing characteristics, with noise levels, only being an indicator of annoyance in noisy streets (Paunovic et al., 2009).

Jakovljevic, Paunovic & Belojevic (2009) conducted a study to identify primary factors for the onset of annoyance in an urban population. The sample consisted of 3097 residents, mostly middle-aged intellectuals with children. The questionnaire included a Noise Annoyance scale and Noise Sensitivity was measured by Weinstein's Noise Sensitivity scale, which deals with attitudes towards noise as well as emotional reactions towards a number of different sounds (Jakovljevic et al., 2009). Analysis on the data found there was weak correlation between noise annoyance and noise exposure (Jakovljevic et al., 2009). As with previous studies, noise annoyance was found to significantly and positively correlate with noise sensitivity, orientation of windows to the street, average stress scores, age of residents and other age related factors such as length of residence and duration of stay in the apartment during the day (Jakovljevic et al., 2009). Night time noise was found to be to be the strongest independent predictor for high level of annoyance. Another factor shown to have an impact on annoyance in this study was found to be noise events, with the number of noise events correlating with annoyance (Jakovljevic et al., 2009).

Wind Turbine Noise

Wind power is a relatively new form of generation of electricity which is purposed to have a comparatively lower impact on the environment. It is established that noise emitted from wind turbines is of lower magnititude when compared to other sources of community noise. However, the character of the sound and its localization increase the risk of negative perception of wind turbine noise. The reported effects of wind turbine noise on individuals include symptoms of headaches, sleep disturbance, anxiety, depression, stress, vertigo and tinnitus (Harry, 2007). This frequency of wind turbine noise has previously not been considered important since the blade frequency is 1 Hz, where human’s hearing is relatively insensitive to the frequency. However, multiple turbines can interact with each other to increase the effect (Harry, 2007). Another factor that interacts with the wind turbine noise is that wind is variable and is not consistent, thereby the noise produced is also impulsive and unpredictable. Low frequency noise has been extensively researched and has been found to cause vibroacoustic disease in which low frequency noise compromises the mechanotransduction signalling of cells which can lead to structural changes in tissues and cells (Harry, 2007). The effects of wind turbine noise is greatest in those individuals sensitive to noise, particularly low frequency noise sensitive individuals, who, when exposed have elevated salivary cortisol levels (Harry, 2007).

Pedersen and Persson Waye (2007) conducted a cross sectional study to assess annoyance due to wind turbine noise among those people living in the vicinity of wind turbines. The study areas consisted of seven wind turbine areas around Sweden, which represented both terrain and urbanisation landscapes (Pedersen & Persson Waye, 2007). The survey included questions on respondent’s living conditions, their reactions to possible sources of annoyance in the living environment, their sensitivity to environmental factors and their general health and wellbeing (Pedersen & Persson Waye, 2007). Perception of and annoyance with wind turbine noise was also measured as well as specific questions related to development of wind turbines in their community (Pedersen & Persson Waye, 2007). The questionnaires were mailed to potential participants and the resulting sample consisted of 754 respondents, the majority of respondents being female (55 %). The results indicated that the number of respondents who noticed the sound increased with the increasing sound pressure level and indicated that there was an association between perception of noise and sound pressure level (Pedersen & Persson Waye, 2007). Analysis also indicated that those individuals living in rural areas were more likely to become aware of the sound compared to those living in the suburban areas (Pedersen & Persson Waye, 2007). The results of their study indicated that residing in a rural area, an area with low background noise, noise sensitivity and a negative attitude towards wind turbines was associated with annoyance. Noise annoyance was related to poor sleep quality and negative emotions (Pedersen & Persson Waye, 2007). Respondents felt that the noise disturbed their sleep, they felt more tired and tense during the day, resigned and violated and strained (Pedersen & Persson Waye, 2007).

Pedersen & Persson Waye (2008) conducted two additional cross-sectional studies to explore the effect of wind turbine noise on individuals. One study took place in a flat landscape which was mainly rural, while the other was conducted in a landscape with different terrains which consisted of both rural and suburban areas. The sample consisted of 1095 respondents who were living within 30dB immision level from wind turbines (Pedersen & Waye, 2008). The findings from this study indicated that respondents described the wind turbines as environmentally friendly but also found them visually ugly (Pedersen & Waye, 2008). The results also found that annoyance was related to a negative attitude towards wind turbines and their visual impact. The respondents who were annoyed by wind turbine noise were also those who appeared to be under more strain and reported more stress symptoms than those who were not annoyed by wind turbine noise (Pedersen & Waye, 2008). The results from this study found that noise annoyance was more prevalent in rural areas as opposed to urban areas and those living in rural areas could also see the wind turbines from their dwelling. This study also found that those respondents who moved from the city to the rural area were more sensitive to noise, possibly due to their extra effort to seek a natural lifestyle.

Neighborhood Noise

The findings of the WHO LARES study (2004) is important to the study on the effects of noise annoyance on people, especially those living next to transportation noise and those sensitive to neighbourhood noise. The LARES study was co-ordinated by the WHO European centre for environment and health and included eight European cities, and took place between 2002 and 2003 (Niemann et al, 2006). The LARES study included three instruments, the inhabitant questionnaire, which consisted of information on the perception of the dwelling as well as the perception of the immediate environment, an inspection sheet which consisted of technical and objective data about the dwelling and a health questionnaire probing health status (Niemann et al, 2006). The households selected for the study were randomly chosen from each of the eight European cities and resulted in the final sample of 1079 participants (Niemann et al, 2006). With regard to annoyance, the results showed that 39% of those surveyed were annoyed by traffic noise, which closely followed by neighbourhood noise with about 36%, aircraft noise ranked fourth with about 13 % followed by railway noise in fifth with 6.8%.

With regard to adults, in this study the results were significant and confirmed that chronic annoyance from traffic noise has been associated with increased cardiovascular risk, with evidence of significantly higher risk of cardiovascular symptoms as well as high blood pressure in those severely annoyed by traffic noise. There was also increased risk in relation to respiratory symptoms and bronchitis in those with chronic and severe traffic annoyance. Increased risks for arthritis and arthritic symptoms were reported for those adults with severe and chronic annoyance. There was also an increased risk of allergies in those reporting chronic and severe traffic annoyances. The findings also suggested that there appeared to be a link between chronic annoyance and migraines and depression, as well as medically diagnosed depression. The reported findings in relation neighbourhood noise for adults found similar findings to that reported by traffic noise annoyance. The findings from this study for the elderly indicate that there was no association between chronic noise annoyance from traffic noise and increased risk of cardiovascular problems (Niemann et al, 2006).

The effect of chronic annoyance on the elderly was evident in the locomotor system with an increased risk of arthritis and arthritic symptoms. These findings were also similar for neighbourhood noise with increased risk for arthritics and arthritic symptoms.

Children appear to be the highest risk group since many of their functional systems, such as the nervous system and cognitive systems are in the development phase and are not designed to compensate for high environmental noise, thereby resulting in the possibility of lasting dysfunctions. Due to the effect of early exposure to environmental influences, children have more time to develop chronic illness and are thereby considered to be an independent risk group. In relation to the respiratory system, the findings suggest a close link between severe and chronic annoyance and respiratory system disorders as well as for bronchitis (Niemann et al, 2006). It was also reported that there appeared to be a higher risk for children who indicated traffic noise induced annoyance. Chronic annoyance from neighbourhood noise appears to have a strong effect on children, with evidence of an increased risk for bronchitis as well as in the respiratory system, markedly higher than for adults.

SPECIFIC HYPOTHESIS FOR THIS STUDY

The current study aims to investigate the relationship between quality of life, psychological factors (e.g., noise sensitivity and psychological wellbeing) and annoyance in those individuals living in the vicinity of the Auckland International Airport. Quality of life is defined as an *"individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns"* (WHO, 1996, p.5).The survey will assess the perceived intrusiveness of noise, annoyance towards the noise, sleep interference due to the noise exposure, and general health as measured by the WHOQoL. Most of the current research has failed to measure the impact of noise on quality of life and this study aims to identify the impact of noise on the physical, social and psychological wellbeing of individuals while controlling for age and mental disorders.

The current study hypothesizes that:

1) There will be a link between noise annoyance and quality of life. It is assumed that the negative consequences of annoyance towards the noise source might have an impact on the individuals' quality of life.

2) It is assumed that noise sensitivity is linked to noise annoyance which has been found in numerous studies (Pedersen & Persson Waye, 2008; Jakovljevic et al., 2009; Paunovic et al., 2009) with evidence that individuals with high noise sensitivity resulted in high noise annoyance.

3) In relation to noise levels, it is hypothesized that noise level will not have an impact on noise annoyance.

4) In relation to mental illness, it is hypothesized that there will not be a link between noise annoyance and mental illness. It appears that noise does not cause mental illness but can possibly exacerbate their development.

5) In relation to demographic details, it is hypothesized that there will be a link between length of residence and noise annoyance, with longer length of stay enabling the residents to become habituated to the noise and hence showing less noise annoyance when compared to those residents who have lived in the area for a shorter period of time.

METHOD

This epidemiological study investigates the effects of airport noise on residents living around the Auckland International Airport. An Epidemiological study is specifically focused on the health of the human population, while incorporating principles of scientific research (Wang, 2002). Since this type of research has not been conducted in New Zealand prior to this study, this study will be largely exploratory in nature.

Participants

The participants in this study were 104 residents from the South Auckland area situated in the vicinity of the Auckland International Airport (Appendix). The participants were selected from the suburbs of Manakau and West Papatoetoe of South Auckland. According to New Zealand deprivation scores (2006) Mangaore-Manakau area is ranked four while West Papatoetoe is ranked nine on the ordinal scale from 1 to 10, where 1 represents the areas with the least deprived population and 10 represents the areas with the most deprived populations. The New Zealand Deprivation scores (2006) takes into consideration ownership of the household, the employment status, qualifications received and access to communication and transport. The New Zealand deprivation scores are not individual but represent the entire area. The area around the airport was selected on the basis of an Aircraft Noise Contour (2009) of the Auckland International Airport (Appendix) which was divided into three areas, a High aircraft noise area, a Moderate aircraft noise area and a noise notification area. The Aircraft Noise Contours (2009) are produced annually and is a prediction of noise from aircraft operations for the following 12 months (Manakau Operative District Plan, 2002). According to the Aircraft Noise contours (2009) the three areas differentiate on the basis of the average overhead noise from the aircrafts over a period of a year. The moderate noise area is exposed to noise levels averaging about 60 dBA, while the high noise area is averaging 65 dBA. The Aircraft Noise Notification Area(ANNA) is the area outside the moderate and the high noise areas that will have future noise levels between Ldn 55dBA and Ldn 60dBA (Manakau Operative District Plan, 2002). Participants were selected from all three areas on the basis that comparisons could be made between the three groups, differing on the level of noise. The sample consisted of 25 males and 72 females, a total of 7 participants failed to complete demographic details. The participant sample consisted of individuals from different ethnic groups, with the ethnic profile of the sample displayed in Table 2.

Table 1: Ethnic profile of the sample

Ethnic Categories	*N*
NZ European	48
Pacific Islander	12
Maori	20
European	3
Indian	6
Other	10
Did not specify	6

Procedure

A small pilot study of ten people was conducted prior to data collection to indicate how long it would take to complete the questionnaire as well as to give an indication if the questionnaire was easily understood.

The participants for the current study were randomly selected from the three areas around the Auckland international airport. The three areas were selected on the basis of the Auckland airport noise contours (Appendix A) and the questionnaires were distributed to 700 randomly selected houses in the residential areas. Each selected household received two copies of the questionnaire accompanied by information sheets and two reply paid envelopes for the participants to return the questionnaires. The participants were informed in great detail in the Participant Information sheet about the study and were informed that their participation was completely voluntary and that they were under no obligation to return the questionnaires. The questionnaires were hand delivered to potential respondent's mailbox between mid April and early May, corresponding with the Easter break to enable the respondents to make use of the break to complete the questionnaire. The streets were also randomly selected from the three areas to enable a proper sample distribution.

Instrument

The self report questionnaire for this study consisted of five sections including four established inventories, with a total of 123 items (Appendix). The inventories used in this survey include the WHOQoL-BREF, five items measuring aviation noise annoyance (Kroesen, Molin, van Wee, 2008), Noise Sensitivity Scale (NOISEQ) (Shutte et al., 2007), the Depression, Anxiety and Stress Scale (DASS-42) (Lovibond & Lovibond, 1995) and a Demographics section.

WHOQoL-BREF

The WHOQoL-BREF is a brief 26 item version of the World Health Organization Quality of Life (QoL) -100 (WHOQoL-100) Scale. The WHOQoL-BREF consists of 26 items divided into four domains: physical health (7 items), psychological wellbeing (6 items), social relationships (3 items), and environmental factors (8 items). There are two additional items probing overall quality of life and general health. All 26 items in the WHOQoL-BREF are rated on a five point Likert scale. The respondents are asked to respond to these items, keeping the last two weeks in mind. A low score on this scale would be associated with negative feelings and perceptions of life while a high score would mean positive perception of life. The WHOQoL-BREF has been tested to assess its validity and reliability and has been shown to have excellent reliability and validity (Skevington, Lofty & O'Connell, 2004; WHO, 1996). Furthermore, the WHOQoL-BREF has also been tested for its validity for different cultural groups and the results demonstrate that the WHOQoL-BREF is a valid instrument to use across different cultural groups (Skevington et al., 2004).

Annoyance

The five annoyance statements assessing Aviation i.e. aircraft noise annoyance were adapted from Kroesen, Molin, van Wee (2008). The five items measured perceived disturbances caused by aviation noise and was scored on a five point likert scale ranging from 1 = Not annoyed at all to 5 = Extremely annoyed . These items depicted high internal consistency with the Cronbach's alpha for the Annoyance scale being 0.88 (Kroesen et al., 2008).

Noise Sensitivity Questionnaire (NOISEQ)

Noise sensitivity is considered to be a stable personality trait which has a major effect on an individual's reaction towards sources of noise (Schutte et al., 2007). The NOISEQ scale was developed to measure global Noise Sensitivity as well as the sensitivity for different domains of everyday life including:

- Leisure
- Work
- Sleep
- Communication
- Habitation

Noise sensitivity, according to the NOISEQ scale is considered to be a multi-dimensional construct (Schutte et al., 2007). The items for the NOISEQ scale were adapted from two noise sensitivity scales, The Weinstein Scale (WSS) and the Fragebogen zur Erfassung der indiviuellen Larmempfindlichkeit (LEF) (The Individual Questionnaire of Noise Sensitivity), and reformulated to increase face validity (Schutte et al., 2007, p.15). The final version of the NOISEQ scale is a self report scale consisting of 35 items, with each of the sub-scales where respondents are asked to indicate the extent to which the items apply to their attitudes around noise using a five point likert scale ranging from 1 = strongly agree and 5 = strongly disagree. The final version measures global noise sensitivity by averaging the Leisure, Work, Habitation, Communication and Sleep subscales (Schutte et al., 2007). The findings testing the reliability and validity of the NOISEQ scale indicate that the subscales work, sleep and communication are sufficiently reliable. The leisure and habitation subscales required extra questions in order to improve reliability of these subscales. (Schutte et al., 2007; Schutte, Sandrock & Griefahn, 2007).

Depression Anxiety Stress Scale (DASS-42)

The DASS-42 (Lovibond & Lovibond, 1995) is a 42 item self report inventory. The 42 items each represent a symptom of mental illness and are divided into three subscales: Depression, Anxiety and Stress, each of which consists of 14 items. Tests on the scale conclude that it is an accurate measurement scale for the assessment of depression, anxiety and stress in the general population (Lovibond & Lovibond, 1995). The DASS-42 has been found to have excellent reliability (Lovibond & Lovibond, 1995; Crawford & Henry, 2003) with high internal consistency and adequate concurrent (Antony, Bieling, Cox, Enns & Swinson, 1998), convergent, and determinant validity (Crawford & Henry, 2003). The DASS-42 Anxiety subscale corresponds closely with the criteria for all the anxiety disorders and the Depression scale is closely related to the criteria for mood disorders in the Diagnostic and Statistical Manual of Mental Disorders (American Psychological Association, 2000). Table 3 below lists the scores for depression, anxiety and stress according to its severity level, ranging from normal to extremely severe (Table 2). The DASS-42 is scored on a four point likert scale, where respondents are asked how applicable the items are to themselves using four responses: 0 = “Did not apply to me at all”, 1 = “Applied to me to some degree, or some of the time”, 2 = “Applied to me a considerable degree, or a good part of the time” and 3 = “Applied to me very much or most of the time”. The respondents are asked to answer the items based on the past week and are asked not to spend too much time deliberating over the items.

Table 2: Scores for the Depression, Anxiety and Stress Scales

Severity	Depression	Anxiety	Stress
Normal	0 – 9	0 – 7	0 – 14
Mild	10 – 13	8 – 9	15 – 18
Moderate	14 – 20	10 – 14	19 – 25
Severe	21 – 27	15 – 19	26 – 33
Extremely Severe	28+	20+	34+

Demographics

The demographic section consisted of questions wherein the respondents were asked to indicate their age by selecting which age bracket was most applicable to them. They were also asked to indicate their gender, the ethnic group they most identified with, their marital status, level of education and their current employment status. The final page of the questionnaire also included a section where the respondents were invited to comment on the research topic or the research *per se*.

Analysis

The data was first entered into Excel and then imported into the Statistical Package for Social Sciences (SPSS), where all analyses were undertaken. Any reverse coded items were re-coded. Missing value analysis was carried out, followed by the calculation of the means, standard deviations, Cronbach's alpha and item-total correlations for each individual item. Composite variables were then constructed for all subscales excluding items with low item-total correlations. This was done by taking the average of all the items forming the scales. The internal consistency of the scales was then assessed by calculating the Cronbach's alpha for all the sub-scales.

The analysis to test hypotheses was carried out thus:

- Hypothesis one: There will be a link between noise annoyance and quality of life: A Hierarchical multiple regression analysis (MLR) will be undertaken to identify which of the four quality of life variables predict for quality of life, while controlling for age, income and length of stay. Multiple regression analysis is employed to understand how much variance in a dependant variable is accounted for by the group of independent variables (Punch, 2006). A multiple regression analysis also indicates which independent variable is the strongest predictor of the dependent variable and thereby bringing about the most change in the dependent variable (Punch, 2006).
- Hypothesis two: Noise sensitivity is linked to noise annoyance. This relationship will be tested using a hierarchical MLR, which will introduce the noise sensitivity variables and identify the best model that will predict for annoyance.
- Hypothesis three: In relation to noise levels, it is hypothesized that noise level will not have an impact on noise annoyance. A one-way ANOVA will be carried out to identify if there is a relationship between the three different noise levels and annoyance towards noise.
- Hypothesis four: In relation to demographic details, it is hypothesized that there will be a link between length of residence and aircraft annoyance. A hierarchical MLR will be undertaken to identify whether the demographic variable of length of stay significantly predicts for aircraft annoyance. The

hierarchical MLR will include other demographic variables and will attempt to identify the variable that has the most predictive power for annoyance.

Results

Missing Data Analysis

Missing data analysis was undertaken separately for each scale, that is, for the WHOQoL-BREF, the Annoyance scale, the General Annoyance Scale and both the NOISEQ and DASS sub-scales. The missing data analysis indicated that for all sub-scales with the exception of Item 21 in the WHOQoL-BREF scale the percentage of missing data was between 1 % and 3%. Item 21 in the WHOQoL-BREF had 9.5% of its data missing; this is consistent with other studies which have found a low response rate to this particular item (Naumann & Byrne, 2004). Some studies have even excluded this item, which probes sexual satisfaction, from their studies due to the belief that this question is unacceptable in certain cultures (Kim et al., 2005).

Item Analysis

The means and standard deviations were calculated for each scale item to attain the measures of central tendency and dispersion and to identify possible floor and ceiling effects. These statistics and reliability analysis (i.e. Cronbach's alpha, item-total correlations) of the scales used in this study are reported below.

<u>WHOQOL-BREF</u>

Inspection of the means and standard deviations for the items in the physical, psychological, social and environment subscales identified no floor and ceiling effects (Appendix). The item-total correlations were all found to be above .3, which indicates that the scale is unidimentional in nature and demonstrates that the items are all tapping into the same concept (de Vaus, 2002). This supported the construction of summated subscales for the four domains that included all the items. The Cronbach's alpha of all the WHOQOL-BREF subscales were found to be above .7. Thus the healthy Cronbach's alpha and the high item-total correlations indicate that the subscales are reliable and may have sufficient variance to produce significant difference between groups (Punch, 2005).

Table 3: Means, standard deviations and the Cronbach's alpha of the summated scales for the WHOQOL-BREF

	N	No of items	*M*	*SD*	α_c
Physical	103	7	13.63	2.75	.800
Psychological	104	6	13.87	2.52	.785
Social	102	3	14.55	3.59	.848

Environment	104	8	14.65	2.56	.793

Aviation Annoyance

The Aviation Annoyance items were scrutinized for floor and ceiling effects and were found to have adequate means and standard deviations. The item-total correlations for the Aviation Annoyance were all above .3 supporting the construction of the summated Aviation Annoyance subscale which included all five items. The Aviation Annoyance sub-scale depicted a high Cronbach's alpha co-efficient of .94 and the Cronbach's alpha if deleted indicated there would not be a significant improvement to the overall Cronbach's alpha if any of the items were to be deleted. The high item total correlations and the high Cronbach's alpha support the conclusion that the Aviation Annoyance scale is adequately reliable.

NOISEQ Scale

The means and standard deviations of the leisure, work, habitation, communication and sleep subscales were scrutinized and most of the items depicted satisfactory scores with the exception of items 11 and 19 (leisure) and item 8 (communication) which had means just under .2, possibly manifesting a floor effect. The item-total correlations for the items indicated that item 34 had to be excluded from the leisure summated subscale due to low item-total correlations which was under .3 (r = .247) and indicated that the item was not correlating with the other items. Inspection of the item-total correlations for the work subscale found that item 6 had a low item-total correlation (r = .140) and had to be excluded from the work summated scale. The item-total correlations of the habitation subscale identified item 11 had a low correlation just under .2 (r = .199) and was subsequently excluded from the construction of the summated scale. The item-total correlations of the communication subscale indicated that item 8 was the only item that had a significantly low item correlation (r = .107) and had to be left out from the summated subscale. The item-total correlations for the sleep scale indicated that all the items had item-total correlations above .3 which enabled the inclusion of all seven items to form the sleep summated scale. Inspection of the overall Cronbach's alpha for the summated scales indicate that they are all above .8 with no meaningful change expected to the cronbach's alpha if an item was to be deleted. The high cronbach's alpha and good item-total correlations infer that the NOISEQ subscales are sufficiently reliable.

Table 4: Means, standard deviations and the Cronbach's alpha of the summated scales for the NOISEQ

	n	No of items	*M*	*SD*	α_c
Leisure	102	6	15.980	5.240	.816
Work	102	6	14.980	4.102	.843
Habitation	103	6	16.203	5.170	.836
Communication	102	6	17.068	5.267	.827
Sleep	103	7	16.194	5.352	.864

DASS-42

The means and standard deviations of the depression, anxiety and stress scales exhibited evidence of floor effects, with the means for all the subscales being under

.1. These findings were expected since the current sample was a non-clinical sample. The item-total correlations of all the items indicated that they were all above .3 which enabled the construction of the three summated scales, with all 14 items. The Cronbach's alpha for the depression, anxiety and stress summated scales were all above .9 and no major change to the Cronbach's alpha was expected if any item were to be deleted. This signified that the DASS subscales are sufficiently reliable, demonstrating high internal consistency.

Table 5: Means, standard deviations and the Cronbach's alpha of the summated scales for the DASS-42

	n	*M*	*SD*	α_c
Depression	99	7.080	8.987	.953
Anxiety	99	6.440	8.573	.936
Stress	103	11.193	9.376	.942

Multiple Regression Analysis of WHOQOL-BREF

Table 6: Hierarchical multiple linear regression statistics for the predictors of psychological welling and noise sensitivity variables on social relationships.

	B	*SE*	*B*	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.289*	.083	.056	3.027	.033	3.459
Age	.439	.260	.212						
Income	.304	.122	.242*						
Length of stay	-.011	.033	-.041						
Model 2	-	-	-	.652**	.425	.389	11.936	>.001	2.782
Age	.400	.210	.193						
Income	.183	.101	.146						
Length of Stay	-.015	.027	-.059						
Depression	-.352	.069	-.871*						
Stress	.094	.057	.248*						
Anxiety	.046	.071	.110						
Model 3	-	-	-	.684**	.468	.404	7.346	.000	2.748
Age	.423	.227	.204						
Income	.152	.110	.121						
Length of stay	-.029	.028	-.111						
Depression	-.339	.070	-.838*						
Stress	.092	.058	.241						
Anxiety	.055	.071	.129						
Leisure	-.023	.096	-.033						
Work	.124	.102	.142						
Habitation	.035	.084	.049						
Communication	-.126	.092	-.185						
Sleep	.107	.070	.160						

**p*<.05, ***p*<.001

Dependant variable = social relationships

Hierarchical multiple linear regression analysis were conducted after screening for normality. Four hierarchical MLRs were conducted to test the association between the four WHOQOL-BREF domains and three sets of predictor variables: demographic variables (length of stay, age and income: **Model 1**); Psychological wellbeing (depression, anxiety and stress: **Model 2**) and noise sensitivity (leisure, work, habitation, communication and sleep: **Model 3**).

For social relationships (Table 6) the fits of all three models were adequate, with *F*-tests indicating that all *R* values were significantly different from 0. The R^2 and *adj.*-R^2 values show that the predictor variables adequately account for variability in social QOL, with Model 3 accounting for the most variance (*adj.*-R^2= .404). However, while the R^2 change between Model 1 and Model 2 (R^2_{change} = .341) was significant ($F(3,97)=19.193$, $p<.001$), the change between Model 2 and Model 3 (R^2_{change} = .043) was not ($F(3,92)=1.482$, $p=.203$). Depression and stress were identified as predictive factors in Model 2 and Model 3 and income significantly predicted social relationships in Model 1.

Table 7: Hierarchical multiple regression statistics for the predictors wellbeing and noise sensitivity variables on Psychological wellbeing

	B	*SE*	*Β*	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.162	.026	-.003	.903	.443	2.528
Age	.107	.942	.072						
Income	.102	.190	.115						
Length of stay	.011	.090	.058						
Model 2	-	-	-	.680**	.462	.429	13.872	.000	1.908
Age	.055	.144	.037						
Income	-.019	.069	-.021						
Length of Stay	.001	.018	.008						
Depression	-.182	.047	-.636*						
Stress	-.002	.039	-.009						
Anxiety	-.012	.049	-.039						
Model 3	-	-	-	.749**	.561	.509	10.704	.000	1.769
Age	.122	.146	.083						
Income	-.049	.071	-.054						
Length of stay	.000	.018	.000						
Depression	-.181	.045	-.631*						
Stress	.022	.038	.082						
Anxiety	-.019	.046	-.062						
Leisure	.000	.062	-.001						
Work	.097	.066	.156						
Habitation	-.011	.054	-.023						
Communication	.019	.059	.039						
Sleep	.100	.045	.211*						

*$p<.05$, **$p<.001$
Dependant variable = Psychological wellbeing

In relation to psychological wellbeing (Table 7) two of the three models in the hierarchical multiple regression analysis were found to be satisfactory, with *F*-tests indicating that *R* values were significant and found to have a strong relationship (Model 2, *R*= .680; Model 3, *R*= .749) (Cohen, 1988). The R^2 and *adj.*-R^2 values confirm that predictor variables effectively explains the variability in psychological QOL, with the most explained variance found in Model 3 (*adj.*-R^2= .509). The adjusted R^2 of model one was negative (*adj.*-R^2= -.003) which indicated that the R^2 is less than what would be expected to be achieved by chance. R^2 between Model 1 and Model 2 suggested it was significant with R^2_{change} = .435 (F (3,97)= 26.161, p<.001), while the change between Model 2 and Model 3 (R^2_{change} = .100) was also significant (F(3,92)= 4.176, p>.001). Depression was found to be the only predictive factor predicting for psychological wellbeing in Model 2, while in Model 3 Depression and Sleep significantly predicted for psychological wellbeing.

Table 8: Hierarchical multiple regression statistics for the predictors of wellbeing and noise sensitivity variables on the Environment aspect of QOL

	B	*SE*	*B*	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.286*	.082	.055	2.980	.035	2.497
Age	.316	.188	.211						
Income	.206	.088	.227*						
Length of stay	-.004	.024	-.018						
Model 2	-	-	-	.630**	.396	.359	10.616	.000	2.056
Age	.257	.155	.172						
Income	.097	.075	.107						
Length of Stay	-.011	.020	-.057						
Depression	-.105	.051	-.360*						
Stress	.015	.042	.056						
Anxiety	-.087	.052	-.286*						
Model 3	-	-	-	.690**	.476	.413	7.595	.000	1.967
Age	.314	.163	.163						
Income	.064	.079	.079						
Length of stay	-.007	.020	.020						
Depression	-.113	.050	.050*						
Stress	.045	.042	.042						
Anxiety	-.094	.051	.051						
Leisure	.024	.069	.069						
Work	.091	.073	.073						
Habitation	-.044	.060	.060						
Communication	.047	.066	.066						
Sleep	.065	.050	.050						

*p<.05, **p<.001
Dependant variable = Environment quality of life

With regard to Environment QOL (Table 8) all of the three models in the hierarchical multiple regression analysis was found to be adequate, with F-tests indicating that all R values were significant. The hierarchical multiple regression found that Model 1 indicated a small relationship (R= .286) between the demographic variables and Environment QoL, while Model 2 and 3 depicted stronger relationships (Table 8). The R^2 and *adj.*-R^2 values demonstrated that the predictor variables effectively account for the variability in environment QOL, with Model 3 having the most predictive power (*adj.*-R^2= .476). The R^2 change (R^2_{change} = .314) between Model 1 and Model 2 signified that it was not significant (F(3,97)=16.836, p = .), while the change between Model 2 and Model 3 (R^2_{change} = .080) was significant (F(3,92)= 2.793, p<.001). In Model 1 Income was found to be the only predictive variable while in Model 2 and Model 3 depression and anxiety significantly predicted for Environmental QOL.

Table 9: Hierarchical Multiple regression statistics for the predictors of psychological wellbeing and noise sensitivity variables on Physical health

	B	SE	B	R	R^2	Adj. R^2	F	P	SE_{EST}
Model 1	-	-	-	.358*	.129	.102	4.915	.003	2.598
Age	-.206	.195	-.129						
Income	.318	.092	.328*						
Length of stay	.011	.025	.056						
Model 2	-	-	-	.666**	.444	.410	12.908	.000	2.107
Age	-.267	.159	-.167						
Income	.197	.077	.204*						
Length of Stay	.001	.020	.007						
Depression	-.101	.052	-.323*						
Stress	-.021	.043	-.071						
Anxiety	-.069	.054	-.213*						
Model 3	-	-	-	.691**	.478	.415	7.646	.000	2.097
Age	-.313	.174	-.196						
Income	.146	.084	.151						
Length of stay	.002	.021	.012						
Depression	-.106	.054	-.342*						
Stress	-.008	.045	-.026						
Anxiety	-.068	.054	-.210						
Leisure	-.046	.073	-.087						
Work	.135	.078	.200						
Habitation	-.026	.064	-.049						
Communication	-.012	.071	-.023						
Sleep	.052	.053	.100						

*p<.05, **p<.001

Dependant variable = Physical health

For Physical health (Table 9) all of the three models in the hierarchical multiple regression analysis was found to be suitable, with *F*-tests indicating that all *R* values were statistically significant from zero. Models 2 and 3 demonstrated a strong relationship (Table 9) between the predictor variables and Physical health and Model 1 depicted a small relationship (*R*= .358). The R^2 and *adj.*-R^2 values demonstrate that the predictor variables sufficiently account for the variability in physical health, with Model 3 accounting for the most variance (*adj.*-R^2= .415). The R^2 change between Model 1 and Model 2 (R^2_{change} = .315) suggested that it was significant (F(3,97)=18.343, p<.001), while the change between Model 2 and Model 3 (R^2_{change} = .034) was not significant (F(3,92)= 1.184, p= .323). In Model 1 and Model 2 Income, depression and anxiety were found to be the predictive variables while in Model 3 Depression and Income significantly predicted for physical health.

Table 10: Hierarchical multiple regression statistics for the predictors of psychological wellbeing and noise sensitivity variables on Overall QoL

	B	SE	B	R	R^2	Adj. R^2	F	P	SE_{EST}
Model 1	-	-	-	.071	.346	.043	2.552	.060	.720
Age	.044	.054	.102						
Income	.063	.025	.241*						
Length of stay	.002	.007	.037						
Model 2	-	-	-	.588**	.346	.306	8.557	.000	.614
Age	.029	.046	.068						
Income	.036	.022	.137						
Length of Stay	.001	.006	.014						
Depression	-.038	.015	-.455*						

Stress	.015	.013	.194						
Anxiety	-.023	.016	-.260*						
Model 3	-	-	-	.673**	.452	.387	6.910	.000	.577
Age	.089	.048	.207						
Income	.034	.023	.133						
Length of stay	.000	.006	-.012						
Depression	-.041	.015	-.488*						
Stress	.022	.012	.280						
Anxiety	-.021	.015	-.244*						
Leisure	.058	.020	.406*						
Work	.004	.021	.020						
Habitation	-.019	.018	-.134						
Communication	-.017	.019	-.122						
Sleep	.023	.015	.167						

**p*<.05, ***p*<.001
Dependant variable = overall quality of life

In relation to overall QOL (Table 10) models 2 and 3 in the hierarchical multiple regression analysis were found to have a good fit, with *F*-tests indicating that all *R* values were statistically significant from zero, though model one was close ($p = .060$). Inspection of Models 2 and 3 found that there was a strong relationship (Table 10) between the predictor variables and overall QoL. The R^2 and *adj.*-R^2 values reveal that the predictor variables adequately account for the variance in the overall QOL, with Model 3 accounting for the most variance (*adj.*-$R^2 = .452$). The R^2 change between Model 1 and Model 2 ($R^2_{change} = .275$) implied that it was significant ($F(3,97)=13.597$, $p<.001$), and the change between Model 2 and Model 3 ($R^2_{change} = .106$) was also found to be significant ($F(3,92)= 3.572$, $p=.005$). In Model 1 income was found to be the only predictive variable, depression and anxiety negatively predicted for overall QOL in Model 2 and depression, anxiety and leisure significantly predicted for overall QOL in Model 3.

Table 11: Hierarchical multiple regression statistics for the predictors psychological wellbeing and noise sensitivity variables on general health

	B	*SE*	*Β*	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.238	.057	.029	2.010	.117	.956
Age	.022	.072	.038						
Income	.079	.034	.230*						
Length of stay	.003	.009	.036						
Model 2	-	-	-	.448**	.201	.152	4.066	.001	.894
Age	.009	.378	.015						
Income	.051	.067	.149						
Length of Stay	.000	.032	.006						
Depression	-.034	.009	-.307*						
Stress	-.002	.022	-.018						
Anxiety	-.009	.018	-.077						
Model 3	-	-	-	.493*	.243	.152	2.683	.005	.893
Age	.005	.074	.009						
Income	.052	.036	.152						
Length of stay	-.002	.009	-.033						
Depression	-.026	.023	-.236*						
Stress	-.004	.019	-.034						
Anxiety	-.011	.023	-.096						
Leisure	-.035	.031	-.189						

Work	.028	.033	.118
Habitation	.033	.027	.175
Communication	-.008	.030	-.043
Sleep	.016	.023	.086

*p<.05, **p<.001
Dependant variable = General health

For general health (Table 11) the hierarchical multiple regression analysis identified models 2 and 3 as acceptable, with *F*-tests indicating that all *R* values were statistically significant from zero, model one however was not found to predict for general health. Models 2 and 3 were examined and were shown to have a moderate relationship (Table 11) between the predictor variables and general health, signifying the predictive power of the two models. The R^2 and *adj.*-R^2 values reveal that the predictor variables adequately account for the variance in the overall QOL, with Model 3 explaining the most variance (*adj.*-R^2= .152). The R^2 change between Model 1 and Model 2 (R^2_{change} = .144) was identified as significant ($F(3,97)$=5.831, p =.001), however the change between Model 2 and Model 3 (R^2_{change} = .106) was not significant ($F(3,92)$= 1.019, p=.411) which implied that the models were not significantly different from each other. Income was identified as the single most predictive variable that predicted for general health in Model 1, and depression was identified as the negative predictors for Models 2 and 3.

Multiple Regression Analysis of Annoyance

Table 12: Hierarchical multiple regression statistics for the predictors psychological wellbeing and noise sensitivity variables on general annoyance

	B	*SE*	B	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.069	.004	-.025	.150	.930	4.687
Age	.233	.353	.087						
Income	.016	.166	.009						
Length of stay	-.023	.045	-.066						
Model 2	-	-	-	.226	.051	-.008	.866	.523	4.647
Age	.262	.351	.097						
Income	.078	.169	.048						
Length of Stay	-.009	.045	-.027						
Depression	-.073	.115	-.139						
Stress	.174	.096	.352						
Anxiety	-.021	.118	-.039						
Model 3	-	-	-	.539**	.291	.206	3.426	.001	4.125
Age	-.157	.341	-.058						
Income	-.065	.165	-.040						
Length of stay	.018	.042	.053						
Depression	-.151	.106	-.287						
Stress	.166	.088	.337						
Anxiety	.012	.106	.023						
Leisure	-.042	.144	-.047						
Work	-.196	.153	-.172						
Habitation	-.378	.126	-.421*						
Communication	.078	.139	.088						
Sleep	-.021	.105	-.024						

*p<.05, **p<.001

Dependant variable = General annoyance

A hierarchical MLR was carried out to test the association between the annoyance variables of General annoyance and Aviation annoyance as well as perceived noisiness of neighbourhood noise and the three sets of predictor variables: demographic variables (length of stay, age and income: **Model 1**); Psychological wellbeing (depression, anxiety and stress: **Model 2**) and noise sensitivity (leisure, work, habitation, communication and sleep: **Model 3**).

With regard to General annoyance (Table 12) the fits of all three models indicated that only Model 3 was statistically significant, illustrating a strong relationship between annoyance and noise sensitivity (*R* =.539). The R^2 and *adj.*-R^2 values show that the predictor variables effectively explain the variability in general annoyance, with Model 3 accounting for the most variance (*adj.*-R^2= .206). The adjusted R^2 of model 1 indicated that the R^2 was less than what would be expected using the same variables. However, while the R^2 change between Model 1 and Model 2 (R^2_{change} = .046) was not significant ($F(3,97)=1.580$, $p=.199$), the change between Model 2 and Model 3 (R^2_{change} = .240) was statistically significant with ($F(3,92)=6.218$, $p<.001$). Habitation was the single most predictive variable in Model 3 predicting for general annoyance.

Table 13: Hierarchical multiple regression statistics for the predictors' psychological wellbeing and noise sensitivity variables on perceived noisiness of neighbourhood

	B	*SE*	*Β*	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.177	.031	.002	1.078	.362	.991
Age	-.048	.075	-.083						
Income	.040	.035	.114						
Length of stay	-.005	.009	-.063						
Model 2	-	-	-	.234	.055	-.004	.939	.471	.994
Age	-.042	.075	-.073						
Income	.052	.036	.147						
Length of Stay	-.003	.010	-.037						
Depression	-.006	.025	-.055						
Stress	.020	.020	.187						
Anxiety	.002	.025	.021						
Model 3	-	-	-	.564**	.318	.236	3.893	.000	.867
Age	-.137	.072	-.237						
Income	.027	.035	.076						
Length of stay	.002	.009	.032						
Depression	-.018	.022	-.164						
Stress	.016	.018	.154						
Anxiety	.007	.022	.062						
Leisure	-.033	.030	-.173						
Work	-.068	.032	-.280*						
Habitation	-.069	.026	-.356*						
Communication	.033	,029	.175						
Sleep	.007	.022	.039						

**p*<.05, ***p*<.001
Dependant variable = perceived noisiness of neighbourhood

With regard to perceived noisiness of neighbourhood noise (Table 13) the hierarchical MLR indicated that only Model 3 was statistically significant and depicted a strong relationship (*R*= .564) between the predictor variables and perceived noisiness, the dependent variable. The R^2 and *adj.*-R^2 values show that the predictor variables satisfactorily accounts for the variability in perceived noisiness, with Model 3 explaining the most variance (*adj.*-R^2= .236). However, while the R^2 change between Model 1 and Model 2 (R^2_{change} = .046) was not significant ($F(3,97)$=.807, p=.493), the change between Model 2 and Model 3 (R^2_{change} = .263) was statistically significant with ($F(3,92)$=7.084, p<.001). Habitation and Work were the most predictive variables in Model 3, negatively predicting for perceived noisiness.

Table 14: Hierarchical Multiple regression statistics for the predictors psychological welling and noise sensitivity variables on aviation annoyance

	B	*SE*	*Β*	*R*	R^2	Adj. R^2	*F*	*p*	SE_{EST}
Model 1	-	-	-	.219	.048	.019	1.674	.177	6.346
Age	.646	.477	.173						
Income	-.047	.225	-.021						
Length of stay	-.132	.061	-.277*						
Model 2	-	-	-	.240	.058	.000	.989	.437	6.410
Age	.661	.484	.177						
Income	-.002	.233	.000						
Length of Stay	-.127	.062	-.266						
Depression	.069	.159	.095						
Stress	.027	.132	.040						
Anxiety	-.025	.163	-.033						
Model 3	-	-	-	.406	.165	.065	1.655	.096	6.195
Age	.406	.513	.109						
Income	-.054	.247	-.024						
Length of stay	-.109	.063	-.228						
Depression	.008	.159	.012						
Stress	-.002	.132	-.003						
Anxiety	.013	.160	.017						
Leisure	.113	.216	.092						
Work	-.131	.230	-.083						
Habitation	-.234	.189	-.188						
Communication	-.072	.208	-.059						
Sleep	-.194	.158	-.161						

**p*<.05, ***p*<.001
Dependant variable = aviation annoyance

For Aviation annoyance (Table 14) the hierarchical MLR indicated that none of the three models were statistically significant, which indicated that none of the predictor variables were predicting for aviation annoyance, though Model 3 was close (p = .096). The R^2 and *adj.*-R^2 values show that the predictor variables effectively explain the variation in aviation annoyance, with Model 3 accounting for the most variance (*adj.*-R^2= .065). However the models were not found to be significantly different from each other with the R^2 change between Model 1 and Model 2 being (R^2_{change} = .010) which was not significant ($F(3,97)$= .336, p=.199), while the change between Model 2 and Model 3 (R^2_{change} = .108) was also not significant ($F(3,92)$=2.372, p =.045). The single most predictive variable was found to be length of stay (p = .032) in Model one which negatively predicted for aviation annoyance.

Between Groups Results

A oneway ANOVA was undertaken to identify if there were any significant differences between the three different areas of noise levels. The findings produced no significant differences between the groups which enabled us to conclude that noise level did not contribute to annoyance.

Table 15: Anova of the between groups analysis of the three different areas of the WHOQOL-BREF variables, the NOISEQ variables and the DASS variables

Scales	Sub-scales	Within *df*	Between *df*	*F*	*p*
WHOQOL-BREF	Physical	99	2	1.413	.248
	Psychological	100	2	.313	.732
	Social	98	2	.032	.969
	Environment	100	2	.169	.845
NOISEQ	Leisure	98	2	.204	.816
	Work	98	2	.005	.995
	Habitation	99	2	.089	.915
	Communication	98	2	.013	.987
	Sleep	99	2	.189	.828
DASS	Depression	96	2	.064	.938
	Stress	100	2	.169	.845
	Anxiety	96	2	.100	.905

DISCUSSION

The current study is a pilot study, conducted primarily to look at the effects of noise on one's quality of life as well as looking at the effects of annoyance and noise sensitivity on quality of life and psychological wellbeing. The current sample consisted of respondents who were dealing with not only the effects of aviation noise, but also some areas were exposed to road and rail traffic noise, neighbourhood noise and noise from boy racers in the area (Appendix), making this sample particularly vulnerable. With respect to the study, there appears to be a number of concerns, which must be taken into account, when interpreting the findings.

Predictors of Quality of life

The current study aimed to identify the predictors of overall quality of life. The findings from this study indicate that noise sensitivity significantly predicted for individual perception of their QOL. Individuals who are sensitive to noise have a general negative attitude towards noise or report a strong reaction to specific noise related situations (Miedema & Vos, 2003). It has been theorised that noise sensitivity might be an aspect of negative affectivity; with findings indicating that noise sensitive individuals are less likely to look at aspects in their life favourably when compared to less sensitive individuals (Miedema & Vos, 2003). Noise sensitivity has also been shown to impact on how one evaluates one's environment (Miedema & Vos, 2003). Thereby consistent with the findings in the current research, how sensitive one is to noise can impact on how one perceives their environment and subsequently the overall quality of their life. Being depressed was identified as a negative predictor of overall quality of life. Depression has been considered to be one of the negative outcomes of stress and has a negative impact on quality of life (Abbey & Andrews, 1985). This stress could be related to the impact of noise, which as mentioned previously, has been known to contribute to stress and stress related illnesses. It has been established that the negative impact of depression might be influenced by perception of control and the amount of social support available to the individual (Abbey & Andrews, 1985). In relation to overall quality of life, the findings suggested that income and leisure predicted for overall quality of life. It is evident that being satisfied with one's leisure activities predicts for overall quality of life in the current sample. This is consistent with Lloyd & Auld (2002) who identified leisure as being an important predictor of an individual's quality of life. With social interaction being the main component of most leisure activities, it appears that the most positive experiences reported by people are those with friends which enable them to put the chaos of their life in perspective, and contribute to life satisfaction (Csikszentmihalyi,1997;Cummins 1996 as cited in Lloyd & Auld, 2002). It appears that having a stable income is an important aspect of one's quality of life. This is consistent with research that suggests that low and unstable income can adversely affect health and quality of life (Guyatt, Feeny & Patrick, 1993).

Predictors of General health

The findings from the current study suggest that the psychological wellbeing model was the best predictor of general health, indicating that good psychological wellbeing is an important prerequisite for good general health. Noise sensitivity was also found to predict for perception of general health. Lercher & Kofler (1996) found that those sensitive to noise were less likely to employ coping strategies and more likely to exhibit difficulties with sleeping, experience poor life satisfaction, worry about their health more and rate their health status as worse when compared to those not sensitive to noise. Income was found to be the only predictor of good general health, indicating that being satisfied with one's income is an important predictor of one's perception of their health. This is consistent with research conducted by Ettner (1996) who found that income had a positive association with good physical and mental health (Kawachi & Kennedy, 1999). According to Marmot (2002) a good income is a necessary aspect of good health, with it enabling the individual to have assess to material conditions and be able to participate in social situations. Thereby the lower the income the worse ones' health is, due to the relationship with material conditions, and the inability to participate in social activities has an impact on how fulfilling one perceives their life and the amount of control they have over it (Marmot, 2002) and subsequently their health.

Noise Sensitivity as predictor for aspects of Quality of life

The findings also suggested that the noise sensitivity variables significantly predicted for physical, psychological, social and environmental quality of life. This suggests that those individuals who are more sensitive to noise are more likely to have it impact on all aspects of their quality of life. These findings were similar to those found by Sandrock, Schutte & Griefahn (2009) who found that noise sensitive individuals were under more strain when compared to those who were not sensitive to noise. It appears that noise sensitive individuals are more likely to have high noise annoyance and poorer quality of life. This could be partially explained by the connection between noise sensitivity and neuroticism, which as mentioned previously are linked. It has been established that those individuals who are considered neurotic are often found to be anxious and subsequently prone to increase in arousal levels, when encountered by stress (Belojevic, Jakovljevic & Slepcevic, 2003). Thereby those low-arousal individuals are more likely to seek external stimulation and be more tolerable of stress (e.g. chronic aircraft noise exposure) compared to those individuals who are considered neurotic. Thereby neurotic individuals are more likely to experience stress contributed by exposure to aircraft noise and have it impact on their overall health and quality of life. Another possible explanation is that subjective noise-sensitivity might be linked to intelligence and lack of confidence in social situations (Weinstein, 1978), which explains the link between noise sensitivity and social relationships. Fuller and Robinson (1973 as cited in Belojevic et al., 1997) found that noise sensitive individuals were predominantly introverted and show a high level of psychological arousal (Bond et al., 1974 as cited in Belojevic et al., 1997).

This might explain the impact of noise sensitivity on an individual's social relationships.

Social Relationships

With regard to social relationships, depression was found to contribute negatively to one's social relationships. Depression can have a negative impact on the quality of one's social relationships, since the nature of depression involves feeling low, lacking motivation and feeling a sense of hopelessness which will invariably have an impact on one's social relationships. Findings from Kohen, Burgess, Catalan and Lant (1998) suggested that depression in particular, depressive affect was significantly associated with poor self-reported quality of life after controlling for physical health. Similar findings were also reported by Wells et al (1989) who reported depressive symptoms had a major impact on social functioning and overall quality of life (Ruo et al., 2003). The findings from this study also suggest that income is an important aspect of social relationships. In the current economic condition, it appears that one's income is imperative since it impacts on access to social recreational activities, lack of which might affect one's social relationships.

Psychological Well-being

Depression was found to significantly predict for psychological health, with the findings from this study suggesting that depression has a negative impact on psychological wellbeing. Thereby feeling depressed or low can result in poor psychological wellbeing and subsequently health. Quality of sleep was found to have an impact on psychological wellbeing, with sleep being an important aspect contributing to a healthy psychological wellbeing (Jakovljevic, Belojevic, Paunovic & Stojanov, 2006; Griefahn, 1991). Sleep is necessary part of restoration of biological processes and loss of sleep can result in reduction of cognitive functioning, subsequently affecting physiology, behaviour and health (EnHealth, 2004). Good quality sleep is a necessary prerequisite for good psychological health and wellbeing, lack of which can significantly impact on one's overall health resulting in changes to one's mood, decrease in ones performance and long term effects on health and wellbeing (Goines & Hagler, 2007; Jakovljevic et al., 2006; Passchier-Vermeer &

Passchier, 2000). It appears that subjective noise sensitivity, neuroticism and annoyance towards noise has a modifying effect on sleep (Jakovljevic et al., 2006). Thereby those individuals who are sensitive to noise are more likely to have it impact on the quality of their sleep and subsequently their psychological wellbeing.

Environment

In relation to the quality of life in regard to one's environment, the findings suggest that income and depression are significant predictors. Thereby the findings suggest that a good income is a necessary prerequisite for one to be satisfied with one's own environment, which includes their home, access to heath and social care, transport. Depression was found to have a significant impact on the quality of one's environment.

Physical Health

In relation to physical health, the findings signify that income and depression were the only two predictors for physical health with income found to have a positive impact while depression was found to have a negative impact. In relation to depression, it appears that depressed mood might result in physical fatigue possibly due to low energy levels and depressed mood has been found to be a predictor of quality of life (Visser & Smets, 1998). Though another factor that might be important is the issue of causality, with poor physical health likely to result in depression (Visser & Smets, 1998).It appears that being satisfied with one's household income is an important aspect for good quality of physical health. It was also found that feeling depressed negatively affects one's physical health, with depression known to result in psychomotor slowing; poor motivation and poor sleep quality. When one is depressed it is difficult to find the energy or motivation to initiate any kind of physical activity, thereby contributing to poor physical health.

Noise sensitivity and noise annoyance

Noise sensitivity appears to be an important moderating factor for the psychological effects of noise, with noise sensitive people likely to experience more subjective reactions of annoyance and dissatisfaction (Fields, 1992 as cited in Belojevic, Jackovljevic & Aleksic, 1997; Stansfeld, 1992). Noise annoyance appears to be influenced by acoustical factors like level, frequency and by non-acoustical factors like personal and social factors such as neuroticism, introversion and mood (Paunovic et al., 2009). In relation to the link between noise sensitivity and annoyance, the findings suggested that the noise sensitivity variables were the only significant predictors of general annoyance with habitation being the only variable that was found to negatively predict for annoyance. The finding thereby suggests that one's household or their living environment is the most important variable that predicts for annoyance, with physical environment playing an important role in "creating a sense of meaning, order and stability in our lives" (McAndrew, 1998, p. 409), disruption to one's home environment can result in negative emotions like annoyance.

The finding that those that are sensitive to noise are more likely to be annoyed by noise in consistent with other research that has found similar findings (Ohrstrom, Bjorkman & Rylander, 1988; Stansfeld et al., 1993; Miedema & Vos, 2003; Jakovljevic et al., 2009; Paunovic et al., 2009). Pedersen and Persson Waye (2004) found a similar finding in their study on wind turbine noise with annoyance found to be related to attitude towards noise and noise sensitivity. Another likely factor is neuroticism; with Ohrstrom et al (1988) finding neuroticism was positively correlated with subjective noise sensitivity and annoyance towards noise, possibly implying that noise sensitivity might be an aspect of neuroticism (Miedema & Vos, 2003; Stansfeld, 1992). Neurotic individuals are found to show enhanced arousability as well as high levels of worry and anxiety which prevent them from successfully coping with stressors like noise (Belojevic et al., 2003).

In regard to whether one perceives their neighbourhood to be noisy, the results from this study suggest that those more sensitive to noise were more likely to consider their neighbourhood noisy with work and one's living environment being the two predictors of perceived noisiness. It appears that those that are sensitive to noise from their workplace as well as their household are more likely to perceive their neighbourhood to be noisy. Another personal factor that might impact on one's perception of noise is introversion and extroversion, with Eysenck (1970 as cited in

Belojevic et al, 2003) suggesting that introverts and extroverts differ in tolerance and preference to noise levels. According to Eysenck (1970 as cited in Belojevic et al, 2003) introverts have lower optimum arousal thresholds when compared to extroverts and thereby are more likely to perceive their neighbourhood as noisy.

Noise level and annoyance

The findings from this study did not find any significant results in relation to noise level. The results indicated that noise level did not have an impact on an individual’s health and wellbeing, and is consistent with findings from Nivison and Endresen (1997) who found no differences between groups of individuals living in quiet and noisy areas. Paunovic et al (2009) found noise-related characteristics were less significant predictors of noise annoyance than personal or social factors, though noise level was found to be a predictor for annoyance only in noisy streets. Belojevic et al(1997) in their study that compared noisy areas with quiet areas found differences in relation to sleep quality, difficulties falling asleep, consumption of sleeping pills and also in relation to psychological disturbance with the individuals in the noisy area showing more fatigue, depression, nervousness and headaches when compared to the quiet area. In the current study, analysis of differences between the three groups did not find any considerable differences between the three areas of different noise levels which enable us to conclude that noise level is less important than the character of the noise produced (Harry, 2007) and does not have a significant impact on one’s health and wellbeing.

Noise annoyance and psychological wellbeing

The findings from the study indicated that annoyance towards noise did not have a relationship to psychological wellbeing, with none of the psychological wellbeing variables of depression, anxiety and stress adequately predicting for noise annoyance. This supports our hypothesis that clinical syndromes of depression, anxiety and stress would not impact on annoyance. There has been some research that indicates that there might be a relationship between noise annoyance and mental illness (Goines & Hagler, 2007) though this relationship is not evident in the current study.

Length of stay and annoyance towards noise

The findings from this study found evidence of a negative relationship between length of stay and aviation annoyance with longer length of stay associated with higher aviation annoyance. This is contrary to Pedersen & Persson Waye's (2007) research findings on annoyance towards wind turbine noise which found that length of stay was not related to annoyance though they did find that 'looking at their current living environment as a place of recovery' was negatively associated with noise annoyance. There has been some research that has considered one's home as being a place one is attached to, a foundation of one's roots and a place where one feels a sense of belonging (McAndrew, 1998). However with the interference of an environmental stressor, one's relationship with his or her home environment is disrupted and could subsequently predisposes an individual to increased annoyance (Tognoli, 1987 as cited in Pedersen & Persson Waye, 2007), which was evident in the current study. It appears that evident from the current study, some individuals might not habituate to noise and chronic noise can evoke body movements, cardiovascular and other autonomic responses, impairment of performance and self reported sleep quality (Griefahn, 1991). A similar finding was also reported by Belojevic et al(1997) who found high level of annoyance in their sample of individuals who had been living in the noisy area for a relatively long period of time. Belojevic et al (1997) concluded that the lack of perceived control of the noise and frustration and displeasure associated with it might have contributed to the psychological difficulties evidenced in their sample.

Limitations

The primary limitation of the current study is in relation to the small sample size, which was a result of low response rate. A good response rate is an important part of obtaining a representative sample and prevents sample bias (Jackson, 2006). The current study had a low return rate of about 8 percent which is considerably lower than what was expected from mailed surveys which was between 25-30 % (Jackson, 2006). However the low response rate does not indicate that the data is less accurate, with recent findings, suggesting that mailed surveys with low response rates were more accurate than that of telephone surveys, which depicted a significantly higher response rates in comparison (Krosnick, 1999). The study sample was acquired from areas in South Auckland that consisted of predominantly low income individuals and families. There are a number of possible explanations for this low return rate such as language barriers, failure to send out reminder letters or scepticism about the project. The language barrier might have contribute to the low return rate with the sample being ethnically diverse, it is likely that those that did not respond to the questionnaire had English as their second language and would have found responding to the questionnaire to be challenging. It has been established that mailing out reminder letters increases the response rate up to 50 % (Jackson, 2006) this was not undertaken in the current study to protect the confidentiality of the research participants. Feedback from the respondents (Appendix ..) indicated that some respondents misunderstood the nature of the research, which might have lead to some respondents not completing the questionnaire.

The length of the questionnaire might have contributed to the low return rate with the predicted time needed to complete the questionnaire varying between 20 and 25 minutes. In the public health field, measurement typically involves the use of questionnaires, which are either in the form of a self-report or interview. The self report is generally administered through direct distribution or mail for the respondents to complete and return, which is consistent with the current study's method of data collection. Due to the voluntary nature of the study, information is often limited by the subject's co-operation and ability to provide the information (Wang, 2002).Thereby it was important that the participants understood that providing a true answer would be most beneficial to himself/herself and to society as well (Wang, 2002). This was conveyed in the participant information sheet, which though lengthy attempted to provide the potential respondent with enough information about the study to make an informed decision about their participation.

Another limitation in this study was that the respondents were not offered any incentive to participate in the research. This might have had an impact on the return rate with respondents more likely to return the questionnaires if there was some incentive to do so. Another limitation in this pilot study is that due to the need to protect the confidentiality of the respondents, the limited time frame and the random distribution of questionnaires, the researcher was unable to distribute reminder letters to the respondents which might have aided the return of some questionnaires. This was evident with the return of a couple of questionnaires after the cut off date and comments from the respondents to this effect.

Directions for further research

The current study was a pilot study and consisted of a small sample size, future research should consist of a larger sample to investigate the heath effects of environmental noise.

It might be important to look at attitudinal factors and personality variables in terms of how they impact on noise annoyance. In relation to the personality variables, neuroticism and extroversion to examine this link with annoyance towards noise.

Future studies could also test for the impact of noise on mental performance with studies finding that individuals exposed to high aircraft noise reporting decreased attention and problems with memory. It might also be important to explore the risks in relation to cognitive impairment for children, who appear to be the most vulnerable group, more susceptible to the effects of environmental noise (Neiman et ., 2006). It has been shown that chronic noise can result in a number of difficulties for these children, with research finding that they depicted less persistence in challenging tasks, problems in relation to recall of information and reported being annoyed and having poorer quality of life (Evans, Hygge & Bullinger, 1995). The current study did not assess the effect of noise on children and longitudinal research might be appropriate to assess the long term effects of chronic noise on health and well-being.

Though there is still more research needed in relation to the effect of noise and health, the available research suggests that noise disturbs sleep, it leads to impairment of mood, of well-being and of performance and it contributes to long term health problems (Griefahn, 1991).

References:

Abbey, A., & Andrews, F. M. (1985). Modeling the psychological determinants of life quality. *Social Indicators Research, 16*(1), 1-34.

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric Properties of the 42-Item and 21-Item Versions of the Depression Anxiety Stress Scales in Clinical Groups and a Community Sample. *Psychological Assessment, 10*(2), 176-181.

Berglund, B., Lindvall, T., & Nordin, S. (1990). Adverse effects of aircraft noise. *Environment International, 16*, 315-338.

Belojevic, G., Jakovljevic, B., & Aleksic, O. (1997). Subjective reactions to traffic noise with regard to some personality traits. *Environment International, 23*(2), 221-226.

Belojevic, G., Jakovljevic, B., & Slepcevic, V. (2003). Noise and mental performance: Personality attributes and noise sensitivity. *Noise & Health, 6*(21), 77-89.

Carter, S., Williams, M., Paterson, J., & Lusitini, L. (2009). Do perceptions of neighbourhood problems contribute to maternal health:Findings from the Pacific Islands Families study. *Health & Place, 15*, 622-630.

Cohen, J. (1988). *Statistical power analysis for behavioural sciences* (2nd ed.). New Jersey: Lawrence Erlbaum Associates, Inc.

Dischinger, P. C., Ryb, G. E., Kufera, J. A., & Auman, K. M. (2009). Early Predictors of Postconcussive Syndrome in a Population of Trauma Patients with Mild Traumatic Brain Injury. *The Journal of Trauma: Injury, Infection and Critical Care, 66*(2), 289-297.

ENHealth Council. (2004). The health effects of environmental noise-other than hearing loss. 1-83. Retrieved 15 Jan 2009, from http://enhealth.nphp.gov.au/council/pubs/pubs.htm

Evans, G. W., Hygge, S., & Bullinger, M. (1995). Chronic Noise and Psychological Stress. *Psychological Science, 6*(6), 333-338.

Ettner, S. L. (1996). New evidence on the relationship between income and health. *Journal of Health Economics, 15*(1), 67-85.

Fields, J. M. (1993). Effect of personal and situational variables on noise annoyance in residential areas. Journal of the Acoustical Society of America, 93, 2753-2763

Gloag, D. (1980). Noise: hearing loss and psychological effects. *British Medical Journal, 281*(6251), 1325-1327.

Griefahn, B. (1991). Environmental Noise and Sleep:Review-Need for Further Research. *Applied Acoustics, 32,* 255-268.

Guyatt, G. H., Feeny, D. H., & Patrick, D. L. (1993). Measuring Health-related Quality of Life. *Annals of Internal Medicine, 118*(8), 622-629.

Guski, R. (1999). Personal and social variables as co-determinants of noise annoyance. *Noise & Health, 3,* 45-56.

Guski, R., Felscher-Suhr, U., & Schuemer, R. (1999). The Concept of Noise Annoyance: How International Experts See It. *Journal of Sound and Vibration, 223*(4), 513-527.

Haines, M. M., Stansfeld, S. A., Job, R. S., Berglund, B., & Head, J. (2001). Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children. *Psychological Medicine, 31*, 265-277.

Haines, M. M., Stansfeld, S. A., Job, R. S., Berglund, B., & Head, J. (2001). A follow-up study of effects of chronic aircraft noise exposure on stress responses and cognition. *International Journal of Epidemiology, 30*(839-845).

Harry, A. (2007). Wind Turbines, Noise and Health. Unpublished Research study.

Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 44*(2), 227-239.

Hygge, S., Evans, G. W., & Bullinger, M. (1996). *The Munich Airport Noise Study: Cognitive Effects on Children From Before To After The Change Over Of Airports.* Paper presented at the Internoise, Liverpool.

Ingebrigtsen, T., Waterloo, K., Marup-Jensen, S., Attner, E., & Romner, B. (1998). Quantification of post-concussion symptoms 3 months after minor head injury in 100 consecutive patients. *Journal of Neurology*, *245*, 609–612.

Ising, H., & Kruppa, B. (2004). Health effects caused by noise: Evidence in the literature from the past 25 years. *Noise and Health*, *6*(22).

Jackson, S. L. (2006). *Research Methods and Statistics: A Critical Thinking Approach* (2nd ed.). Belmont: Thomson Wadsworth.

Jakovljevic, B., Belojevic, G., Paunovic, K., & Stojanov, V. (2006). Road Traffic Noise and Sleep Disturbance in an Urban Population: Cross-sectional Study. *Croatian Medical Journal*, *47*, 125-133.

Jakovljevic, B., Paunovic, K., & Belojevic, G. (2009). Road-traffic noise and factors influencing noise annoyance in an urban population. *Environment International, 35*(3), 552-556.

Job, R. F. S. (1999). Noise Sensitivity as a factor influencing human reaction to noise. *Noise & Health, 3,* 57-68.

Kamp, I. V. (2001). Indicators of Annoyance: A psychometeric approach; the measurement of anooyance and interrelations of different measures. *Inter-noise*.

Kawachi, I., & Kennedy, B. P. (1999). Income inequality and health: pathways and mechanisms. *Health Services Research, 34*(1), 215(211).

Kim, D.-Y., Lee, S.-H., Lee, H.-Y., Lee, H.-J. R. N., Chang, S.-B., Chung, S.-K., et al. (2005). Validation of the Korean Version of the Oswestry Disability Index. *Spine, 30*(5), 123-127.

Kohen, D., Burgess, A., Catalán, J., & Lant, A. (1998). The Role of Anxiety and Depression in Quality of Life and Symptom Reporting in People with Diabetes Mellitus. *Quality of Life Research, 7*(3), 197-204.

Krosnick, J. A. (1999). Survey Research. *Annual Review of Psychology, 50*(1), 537-567.

Kroesen, M., Molin, E. J. E & van Wee, B (2008). *Testing a theory of aircraft noise annoyance: A structural equation analysis.* Journal of Acoustical Society of America. 123, 6, pgs 4250- 4260

Lercher, P., & Kofler, W. W. (1996). Behavioural and health responses associated with road traffic noise exposure along alpine through-traffic routes. *Science of the Total Environment, 189-190,* 85-89.

Lloyd, K. M., & Auld, C. (2002). The role of leisure in determining quality of life: Issues of content and measurement. *Social Indicators Research, 57,* 43-71.

Martin, W. H. (1929). Decibel: The New Name for the Transmission Unit. *Bell System Technical Journal*.

Manzo, L. C. (2003). Beyond house and haven: toward a revisioning of emotional relationships with places. *Journal of Environmental Psychology, 23*(1), 47-61.

McAndrew, F. T. (1998). The Measurement of Rootedness and the Prediction of Attachment to Home-Towns in college Students. *Journal of Environmental Psychology, 18*(4), 409-417.

Matthews, G., Deary, I. J., & Whiteman, M. C. (2003). *Personality Traits* (2nd ed.). Cambridge: Cambridge University Press.

Marmot, M. (2002). The influence of income on health: Views of an epidemiologist. *Health Affairs, 21*(2), 31.

Miedema, H. M. E., & Vos, H. (2003). Noise sensitivity and reactions to noise and other environmental conditions. *Journal of Acoustical Society of America, 113*(3), 1492-1504.

Miedema, H. M. E., & Vos, H. (1999). Demographic and Attitudinal factors that modify annoyance from transportation noise. *Acoustical Society of America, 105*(6).

Miedema, H. M. E., & Vos, H. (2003). Noise sensitivity and reactions to noise and other environmental conditions. *Journal of the Acoustical Society of America, 113*(3), 1492-1504.

Miedema, H. M. E. (2007). Annoyance Caused by Environmental Noise: Elements for Evidence-Based Noise Policies. *Journal of Social Issues, 63*(1), 41-57.

Morrell, S., Taylor, R., & Lyle, D. (1997). A review of the health effects of aircraft noise. *Australian and New Zealand Journal of Public Health, 21*(2), 221-236.

Naumann, V. J., & Byrne, G. J. A. (2004). WHOQOL-BREF as a measure of quality of life in older patients with depression. *International Psychogeriatric Association, 16*(2), 159-173.

New Zealand Noise Standards. (1991). *Noise Standards*. Retrieved. from www.bullerdc.govt.nz/content/library/part78.pdf

Niemann, H., Bonnefoy, X., Braubach, M., Hecht, K., Maschke, C., Rodrigues, C., et al. (2006). Noise-induced annoyance and morbidity results from the pan-European LARES study. *Noise & Health, 8*(31), 63-79.

Nivison, M. E & Endresen, I . M (1997). An Analysis of Relationships among Environmental Noise, Annoyance and Sensitivity to Noise, and the Consequences for Health and Sleep. *Journal of Behavioral Medicine,* 16 (3), 257-276.

Öhrström, E., Bjorkman, M., & Rylander, R. (1988). Noise annoyance with regard to neurophysiological sensitivity, subjective noise sensitivity and personality variables. *Psychological Medicine, 18*(3), 605-613.

Ouis, D. (2001). Annoyance from road traffic noise:A review. *Journal of Environmental Psychology, 21*(1), 101-120.

Paunovic, K., Jakovljević, B., & Belojević, G. (2009). Predictors of noise annoyance in noisy and quiet urban streets. *Science of The Total Environment, 407*, 3707–3711.

Pedersen, E., & Persson-Waye, K. (2004). Perception and annoyance due to wind turbine noise-a dose-response relationship. *Journal of Acoustical Society of America, 116*(6), 3460-3470.

Pedersen, E., & Persson-Waye, K. (2007). Wind turbine noise, annoyance and self-reported health and well-being in different living environments. *Occupation Environmental Medicine, 64*(7), 480-486.

Pedersen, E., & Persson-Waye, K. (2008). Wind Turbines- Low level noise sources interfering with restoration? *Environment Research Letters, 3,* 1-5.

Punch, K. F. (2005). *Introduction to Social Research Methods: Quantitative and Qualitative Approach* (2nd ed.). London: Sage Publications Ltd.

Rylander, R. (2004). Physiological aspects of noise-induced stress and annoyance. *Journal of Sound and Vibration, 277*, 471-478.

Schutte, M., Marks, A., Wenning, E., & Griefahn, B. (2007). The development of the noise sensitivity questionnaire. *Noise & Health, 9,* 15-24.

Selye, H. (1976). The Stress Concept. *Canadian Medical Association Journal, 115*(8).

Selye, H. (1950). Stress and the General Adaptation Syndrome. *British Medical Journal*, 1383-1392.

Stansfeld, S. A. (1992). Noise, noise sensitivity and psychiatric disorder:epidemiological and psychophysical studies. *Psychological Medicine, 22*.

Stansfeld, S., Sharp, D. S., Gallacher, J., & Babisch, W. (1993). Road traffic noise, noise sensitivity and psychological disorder. *Psychological Medicine, 23,* 977-985.

Stansfeld, S., Gallacher, J., Babisch, W., & Shipley, M. (1996). Road traffic noise and psychiatric disorder: prospective findings from the Caerphilly study. *British Medical Journal, 313*.

Stansfeld, S. A., & Matheson, M. P. (2003). Noise pollution: non-auditory effects on health. *British Medical Bulletin, 68*(1), 243-257.

Stansfeld, S. A., Berglund, B., Clark, C., Lopez-Barrio, I., Fische, P., Öhrström, E., et al. (2005). Aircraft and road traffic noise and children's cognition and health: a cross-national study. *The Lancet, 365*(9475), 1942-1949.

Smith-Seemiller, L., Fow, N. R., Kant, R., & Franzen, M. D. (2003). Presence of post-concussion syndrome symptoms in patients with chronic pain vs mild traumatic brain injury. *Brain Injury, 17*(3), 199-206.

Schutte, M., Marks, A., Wenning, E., & Griefahn, B. (2007). The development of the noise sensitivity questionnaire. *Noise & Health, 9,* 15-24.

Tarnopolsky, A., Barker, S. M., Wiggins, R. D., & McLean, E. K. (1978). The effect of aircraft noise on the mental health of a community sample: a pilot study. *Psychological Medicine, 8,* 219-233.

Thorne, R. (2008). *Assessing Low Amplitude Sound And Intrusive Noise.* Unpublished Doctorate, Massey University, Wellington.

Vaus, D. A. D. (2002). *Surveys in social research* (5th ed.). New South Wales: Allen & Unwin.

Visser, M. R. M., & Smets, E. M. A. (1998). Fatigue, depression and quality of life in cancer patients: how are they related? *Supportive Care in Cancer, 6*(2), 101-108.

Wang, J (2002). *Basic Principles and Practical Applications in Epidemiological Research*. Singapore: World Scientific Publishing Co. Pte, Ltd.

Westman, J. C., & Walters, J. R. (1981). Noise and stress: a comprehensive approach. *Environmental Health Perspectives, 41*, 291-309.

Weiten, W. (2004). *Psychology: Themes and Variations* (6 ed.). Belmont: Thomson Learning, Inc.

Weinstein, N. D. (1978). Individual Differences in Reactions to Noise: A Longitudinal Study in a College Dormitory. *Journal of Applied Psychology, 63*(4), 458-466.

Wells, K. B., Stewart, A., Hays, R. D., Burnam, M. A., Rogers, W., Daniels, M., et al. (1989). The functioning and Well-being of Depressed Patients: Results From the Medical Outcome Study. *Jama, 262*(7), 914-919.

WHO. (1995). Community Noise. *Archives of the Center for Sensory Research, 2*(1), 1-195.

WHOQOL Group. (1996). *WHOQOL-BREF: Field Trial Version. Program on Mental Health*. Geneva: World Health Organisation.