Aviation-related noise-induced annoyance and health-related quality of life

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ABSTRACT

Noise is an environmental nuisance that has the potential to degrade health and negatively impact the relationship between humans and their environment. The mode of transport effect stipulates that aviation noise is more annoying than either rail or road noise. While sleep disturbance and annoyance are the dominant health consequences of community noise exposure, cardiovascular disease and cognitive impairment in children also contribute. The WHO describe ideal health as "...a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity". While recent population-level studies demonstrate significant associations between aviation noise and risk of hospitalization for cardiovascular disease, few studies have engaged measures of wellbeing. This paper describes an epidemiological study undertaken to compare noise annoyance and health-related quality of life (HRQOL) of individuals residing close to a major international airport (n=87) with those in a demographically-matched area (n=91). Results indicate that domains of HRQOL may be degraded in those living in areas more likely to induce noise annoyance. Additionally, the addition of aviation noise to environments already encroached by road noise may induce further annoyance and degradations in HRQOL, indicating that unique sources of noise may not mask the impacts of other noises.

Keywords: Aviation, quality of life, annoyance Sound

1. INTRODUCTION

Noise is an environmental nuisance that has the potential to degrade health and negatively impact the relationship between humans and their environment. At high noise levels, exposure leads to hearing loss. However, even at low levels, noise has the potential to interfere with sleep and lead to adverse emotional responses. While individual responses to noise vary considerably amongst the population, the social context in which the noise exposure occurs has also been found to be important (1). These adverse impacts other than through hearing loss are referred to as non-auditory effects of noise (see (2) for a review). The WHO describing ideal health as "...a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (3). Environmental noise has been deemed to be sufficiently serious that the WHO has commissioned a number of documents specifically dedicated to community noise (4)-(6).

Environmental noise has many sources including transport (roads, rail and aviation), wind turbines and natural sources of noise. Many of these, those associated with transport in particular, are manmade and stem from activities deemed to be vital to human endeavor. As such, reducing noise levels is a significant challenge. Amongst the transport sources, the mode of transport effect (7) stipulates that aviation noise is more annoying than either rail or road noise (8). With respect to aviation noise, traditionally, studies have taken a biological approach to investigating its impact on health, and few studies have used health-related quality of life measures as is now common for other

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noise sources, including wind turbine noise.

Amongst the relevant publications is a meta-analysis of multiple European studies which predicted a prevalence of severe annoyance of between 17% and 25% for aircraft noise for 60 and 65 LDN (8), while a recent New Zealand study found that 17% of the population reported being severely annoyed when exposed to noise in the same range and from the same source. According to the WHO, an outdoor noise level of 55 LDN is considered to be 'seriously annoying' (4).

The current study adds to the existing literature by reporting health-related quality of life data in the aviation context by describing data from an epidemiological study undertaken to compare noise annoyance and health-related quality of life (HRQOL) of individuals residing close to a major international airport with those in a demographically-matched area for a city in New Zealand.

1.1 Participants

Participants for this study were adults who resided in Wellington, the capital of New Zealand. Those in the 'Airport' sample (n = 87) resided within 250 meters of Wellington's International Airport's runway, while the 'City' (n = 91) sample consisted of residents living on the city's urban border away from the airport's main flight path. The two samples were socioeconomically matched using the New Zealand Deprivation Index (10). Table 1 presents the demographic profiles of each of the samples.

1.2 Instrument

Two copies of a survey entitled "Wellbeing and Neighbourhood Survey" were hand delivered (in the postbox) to residents in the specific survey areas, along with a post-paid return envelope. The survey consisted of the standard WHO brief quality of life survey (WHOQOL-BREF) yielding four HRQOL domains: physical health (7 items), psychological well-being (6 items), social relationships (3 items) and environmental amenity (3 items). Several questions were asked regarding personal characteristics and one question was asked about noise sensitivity. Participants are presented with Likert-type scale items and asked to respond on a five-point scale as to how satisfied or dissatisfied they are with aspects of their health. The two amenity questions were also presented on five-point Likert-type scales; one was positively worded and the other negatively, and after the latter's reverse coding, summed to give a total score. Environmental nuisances included questions about annoyance due to air pollution ("air pollution from traffic", "air pollution from household chimneys", "other, specify") and noise ("noise from traffic", "noise from other neighbours", "other noise, please specify"). These were all presented on a five-point scale ranging from "not annoyed at all" to "extremely annoyed".

1.3 Statistical Analyses

The main focus was on the additive effects of transport-related noise annoyance to HRQOL. We anticipated that the two areas would not differ significantly in terms of road transport noise but would differ considerable in response to "Other (please specify)" noise or pollution sources. Independent t-tests were carried out to identify if the two matched sampled differed in their mean WHOQOL-BREF and Amenity scores. Preliminary tests assessing the degree of matching were carried out using a chi-square test and, if significant differences were found, were treated as covariates.

1.4 Ethical Approval

Institutional review and ethical approval was obtained from the AUT University Ethics committee.

2. RESULTS

Figure 1 presents the demographic profiles of the two areas (Airport and City). Chi-square (χ^2) tests indicated the quality of the matching between the Airport sample and the City sample. No significant differences were found in the gender or age profiles between groups, nor self-reported illness. However, education was found to be significant different between groups and was therefore controlled for in subsequent analyses. Importantly, no significant differences were found in the distribution of noise sensitivities between the Airport group and the City group.

No significant differences were found in annoyance in relation to traffic-related air pollution

($F(174,1) = 1.21$, $p = 0.228$) or noise ($F(174,1) = 1.575$, $p = 0.117$) between the two samples. However, for annoyance to "Other" sources of air pollution ($F(114,1) = 2.981$, p =0.004) and noise ($F(105,1) = 2.388$, $p = 0.019$), significant differences were found. The open-ended responses on air quality required participants, for those selecting it, to identify the source of the pollution. All but one in the Airport sample indicated aircraft-related fumes, as opposed to none from the City sample. For the noise case, only one for the City sample indicated aircraft noise while all but two from the Airport sample referred specifically to aircraft noise.

Table 1 – Demographic profile of the study sample (* $p < 0.05$)

	Airport (n = 87)	City (n = 91)	Chi-square Statistic
Gender		0	$\chi^2(1) = 0.01$
Male	28	29	
Female	58	62	
Age (years)			$\chi^2(6) = 4.896$
18-20	3	2	
21-30	7	8	
31-40	16	18	
41-50	16	19	
51-60	14	20	
61-70	16	16	
71 and above	14	8	
Education			$\chi^2(1) = 10.602$*
Secondary	29	18	
Polytechnic	20	16	
University	32	57	
Illness			$\chi^2(1) = 0.277$
Yes	36	35	
No	49	56	
Noise Sensitive			$\chi^2(2) = 0.981$
Not	40	38	
Moderate	33	41	
Yes	14	12	

Significant differences were found between the Physical Health ($F(166,1)= 5.109$, $p=0.025$) and Environmental ($F(166,1)=7.806$, $p=0.006$) WHOQOL domains, and Amenity ($F(173,1)= -2.082$, $p=0.039$), but not the Psychological ($F(170,1) – 3.173$, $p= 0.077$) or Social ($F(169, 1) = 0.98$, $p=0.755$) WHOQOL domains, as illustrated in Figure 1.

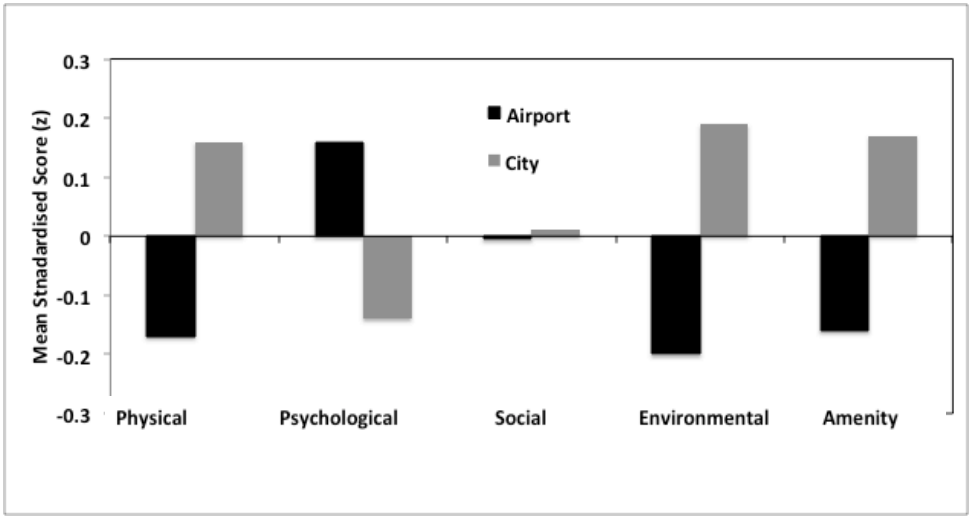

Figure 1 - Mean standardized WHOQOL domain scores and amenity total scores for the Airport and City areas. Greater scores indicate better health-related quality of life or amenity relative to lower scores.

DISCUSSION AND CONLCUSIONS

This study examined the relationship between noise-induced annoyance and HRQOL for areas where there is a similar mean annoyance rating for road traffic noise but different ratings with respect to aviation noise. Results indicate that the areas of different soundscape are associated with statistically different mean HRQOL scores. This is consistent with WHO findings, indicating that positive wellbeing and quality of life can be compromised by noise-induced annoyance and sleep disturbance.

The analysis also revealed differences between the Airport and City groups for the two composite variables estimating how the immediate living environment contributes directly to creating a stress-fee and healthy existence (the WHOQOL environmental domain) and to what degree it is considered restorative (the total amenity score). Results indicate that domains of HRQOL may be degraded in those living in areas more likely to induce noise annoyance. Additionally, the addition of aviation noise to environments already encroached by road noise may induce further annoyance and degradations in HRQOL, suggesting that unique sources of noise may not mask the impacts of other noises.

There are several limitations in this study that impact on our ability to interpret the findings. The design of the study is cross-sectional. As such it is not possible to infer causality. The sample sizes are also relatively small so the findings are more exploratory in nature. The fact that the results are largely consistent with other similar studies, consisting of much larger sample sizes, gives us confidence in our results. The use of aggregated noise metrics is a matter of ongoing debate (11). However, it is people, and not noise level meters, that exhibit the response to noise. As such, it is possible to argue that strategies that reduce noise annoyance, as opposed to noise, may be more effective in terms of protecting public health from the adverse impacts of noise.

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