Noise annoyance, noise sensitivity and future risk of illness and mortality

S. A. Stansfeld[1], M. Shipley[2]

[1] Centre for Psychiatry, Wolfson Institute of Preventive Medicine, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, Charterhouse Square London EC1M 6BQ UK, s.a.stansfeld@qmul.ac.uk

[2] Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, London, WC1E 6BT, martin.shipley@ucl.ac.uk

ABSTRACT

Aircraft and road traffic noise exposure increase the risk of cardiovascular disease (CVD). Noise annoyance is the most frequent response to environmental noise. In some studies noise annoyance modifies the association of transport noise exposure on CVD. In cross-sectional studies noise annoyance is associated with both physical and mental health but the direction of association is unclear. This study uses prospective data from phases 1, 3, 5, 7 and 9 in 3630 male and female civil servants from the UK Whitehall II Study to examine whether a single question about annoyance to noise in general predicts physical and mental ill-health and mortality. Non-fatal myocardial infarction and stroke morbidity over the follow-up were defined by MONICA criteria based on study ECGs, hospital records, hospital admission statistics or General Practitioner confirmation. Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D) and psychological distress by the General Health questionnaire (GHQ). There was no association between noise annoyance and CVD morbidity or mortality. Noise annoyance was a consistent predictor of depressive symptoms and psychological distress at phases 3, 5 and 7. High annoyance at baseline predicted GHQ caseness at phase 3 adjusting for age, sex, employment grade, self-rated health and GHQ caseness at baseline (OR= 1.56 95%CI 1.29-1.88). A general annoyance question like this may be measuring noise sensitivity which has been identified as a predictor of mental ill-health. More longitudinal research is needed including measures of noise exposure.

INTRODUCTION

Recently there have been several studies linking prolonged aircraft noise exposure to increased risk of cardiovascular and stroke mortality (Huss et al. 2010; Hansell et al. 2013). These studies are part of accumulating evidence that both aircraft noise exposure and road traffic noise exposure are related to an increased risk of cardiovascular disease and mortality (Sorensen et al. 2011; Floud et al. 2013; Sorensen et al. 2012). The putative mechanism behind these associations is thought to relate to the stress hypothesis where prolonged noise exposure leads to increased stress responses, hypertension and increased risk of cardiovascular disease (Babisch 2008; Jarup et al. 2008).

The most frequent response to environmental noise is annoyance, which is a mixture of reported discomfort, anger and feelings of intrusion. Exposure response relationships have been found for road, rail and aircraft noise in which the degree of

annoyance elevates with increasing noise levels. Annoyance has also been suggested as a possible moderating factor of the effects of noise on cardiovascular disease - as a subjective indicator of the degree of disturbance from noise that amplifies the stress response to sound (Babisch et al. 2013). However, it is uncertain whether noise annoyance levels can be used as a proxy for noise level in associations with health outcomes. This is because there may be other factors that influence annoyance such as personality factors, attitudes to the noise source and perceptions of malfeasance related to the source of the noise (Job 1988). Despite this, noise annoyance is associated with health outcomes, especially psychiatric disorder. In cross sectional studies it has been suggested that prior ill-health may lead to increased levels of annoyance and not the other way round (Tarnopolsky et al. 1980; Stansfeld et al. 1993). This has been explained as people who feel unwell being likely to be less tolerant of environmental discomfort.

It is of interest to understand the directionality of the association between noise annoyance and physical and mental health, as this has implications for public health policy on reducing noise and reducing annoyance. This is best attempted in longitudinal analyses. We examined whether a single question on noise annoyance which was included in the first phase of the Whitehall II Study of British civil servants is a predictor of future cardiovascular morbidity and mortality and psychiatric disorder. We hypothesised that with increased levels of annoyance there would be a greater risk of both cardiovascular disease and psychiatric morbidity adjusting for ill-health at baseline.

METHODS

Participants

The Whitehall II study was established between 1985 and 1988 with a target population of all male and female civil servants, aged between 35 and 55 years, in twenty London based civil service departments. 10,308 civil servants were examined in phase 1 of the study– 6,895 men and 3,413 women with a response rate of 73%, the true response rate was higher because around 4% of the invited employees had moved before the study and were not eligible for inclusion. The annoyance question was only included in the first version of the questionnaire in a sample of 3630.We analyzed data from phase 1 (1985-88, self-report questionnaire and screening), phase 3 (1991-3), phase 5 (1997-9), phase 7 (2003-4) and phase 9 (2008-9) (Marmot, Brunner, 2005). Our analyses are based on participants for whom complete data on covariates were available. Although most study respondents were white-collar employees, a wide range of employment grades (and salaries) from office support staff to the most senior government servants were covered.

Measures

Annoyance was measured by a single question: ‘Taking all sorts of noise together how much are you bothered by noise in general? A great deal, somewhat, little, not at all’. Responding as either ‘a great deal’ or ‘somewhat annoyed’ was classified as highly annoyed.

Age was divided into four categories between 34 and 55 years. Ethnicity was classified as White, South Asian, Black or Other. Employment grade was classified

as high (administrative and professional), medium (executive), low (clerical and support grades). Self-rated health at baseline at Phase 1 was assessed by a single item on self-rated health 'very good, good, average, poor/very poor'.

Cardiovascular outcomes

Angina pectoris was measured by the Rose Angina Questionnaire between Phase 1 and Phase 9 (Rose, 1962). Definite Angina included ECG changes suggestive of ischaemia. Mortality was identified through linkage to the NHS Central Register. Morbidity measures included non-fatal myocardial infarction and stroke morbidity over the follow-up and were defined following MONICA criteria based on study ECGs, hospital records of ECGs and cardiac enzyme levels and validated using discharge diagnoses from NHS Hospital Episode Statistics data or General Practitioner confirmation, or retrieval of hospital medical records up to the end of Phase 9.

Psychiatric Morbidity

Psychological distress was measured by the 30-item General Health Questionnaire (GHQ) at baseline, Phase 3 and Phase 7 (Goldberg 1972). It was classified into non-cases and cases at threshold 4/5 based on a prior validation study. Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale at Phase 7 (Radloff 1977).

Analysis

Initially, the association between sociodemographic factors and the noise annoyance question was analysed at baseline. Baseline health was cross-sectionally related to noise annoyance, adjusting for age, sex, employment grade and self-rated health. Cox proportional hazard model was used to link annoyance and time to mortality adjusting for age, sex, employment grade and then additionally adjusting for self-rated health and psychological distress. Logistic regression analysis was used to examine whether annoyance at baseline predicted mental health outcomes at Phase 3, 5 and 7 adjusting for age, sex, low employment grade and subsequently additionally adjusting for self-rated health and GHQ caseness at baseline. Prediction of GHQ caseness at Phase 3 and Phase 7 was repeated in a sample from which baseline GHQ cases were excluded.

RESULTS

There were 3,630 individuals in the sample, 49% were men. Overall, 48% of participants were highly bothered by noise in general. Annoyance or being highly bothered by noise was more common in the 50-55 year age group (OR = 1.20 (95% CI 1.01-1.43)) relative to the 34-39 year age group. Women tend to be more annoyed relative to men (OR = 1.21 (95% CI 1.06-1.39)). Those in the lowest employment grade tend to be less annoyed than those in the highest employment grade (OR = 0.63 (95% CI 0.51-0.78)).

The odds of reporting high annoyance increased with reporting average and poor self-rated health (Table 1). High annoyance was cross-sectionally associated with increased odds of psychological distress which was maintained even after adjusting for self-rated health at baseline (OR=1.67 (95%CI 1.43-1.95) (Table 1).

Table 1: Cross-sectional association between noise annoyance and baseline ill-health

Risk factors	N	Bothered by noise[b], n (%)	OR (95% CI) Adjusted: age, sex	OR (95% CI) Adjusted: age, sex employment grade
Self-rated health (N=3609)				
Very good	1054	419 (39.8)	1.0	1.0
Good	1518	749 (49.3)	1.47 (1.25, 1.72)	1.49 (1.27, 1.75)
Average	854	455 (53.3)	1.69 (1.40, 2.03)	1.77 (1.47, 2.13)
Poor/very poor	183	114 (62.3)	2.44* (1.76, 3.37)	2.57* (1.85, 3.57)
GHQ caseness (N=3580)				
Non-cases	2612	1145 (43.8)	1.0	1.0
Cases	968	572 (59.1)	1.86 (1.60, 216)	1.82 (1.57, 2.12)

[b] Numbers given are those responding 'somewhat' or 'a great deal'

There was no association between noise annoyance and incident coronary heart disease outcomes, either morbidity, angina pectoris or mortality, adjusting for age, sex, low employment grade, self-rated health and psychological distress (Table 2).

Table 2: Association between noise annoyance and incident CVD outcomes and mortality[a]

Outcome	No. events / Total number	Bothered by noise[b], n (%)	HR (95%CI) Adjusted: age, sex, grade	HR (95% CI) Adjusted: + self-rated health, GHQ caseness
All cause mortality	493 / 3559	1708 (48.0)	0.96 (0.80, 1.15)	0.95 (0.79, 1.14)
CHD mortality/Non-fatal MI	184 / 3542	1703 (48.1)	1.13 (0.84, 1.51)	1.03 (0.77, 1.39)
CHD/Stroke mortality or morbidity	226 / 3541	1709 (48.1)	1.00 (0.77, 1.30)	0.92 (0.71, 1.21)
Definite angina	325 / 3537	1700 (48.1)	1.22 (0.98, 1.51)	1.09 (0.87, 1.36)

[a] Mortality is up to August 212 and morbidity is up to Phase 9. Combined mortality/morbidity outcomes are up to Phase 9.

[b] Numbers given are those responding 'somewhat' or 'a great deal'

In contrast, high noise annoyance was a consistent predictor of depressive symptoms and psychological distress at Phase 3, 5 and 7. There was a modest diminution in the odds ratios after adjusting for psychological distress at baseline (Table 3). There was little difference in the magnitude of the odds ratios comparing analyses from samples where GHQ cases at baseline had been excluded with samples where GHQ cases at baseline were still included.

Table 3: Association between noise annoyance and subsequent psychiatric disorder

Outcome	No. of cases / Total number	OR (95% CI) P-value Adjusted: age, sex, grade	OR (95% CI) P-value Adjusted: + self-rated health	OR (95% CI) P-value Adjusted: + GHQ caseness at baseline
CES-D and medication at Phase 7	329 / 2053	1.70 (1.33, 2.17) <0.001	1.53 (1.19, 1.97) <0.001	1.39 (1.08, 1.80) 0.011
GHQ caseness at Phase 3	642 / 2835	1.87 (1.56, 2.25) <0.001	1.76 (1.46, 2.11) <0.001	1.56 (1.29, 1.88) <0.001
GHQ caseness at Phase 7	451 / 2353	1.75 (1.41, 2.16) <0.001	1.60 (1.29, 1.99) <0.001	1.44 (1.15, 1.80) 0.001
GHQ caseness at Phase 7 among GHQ non-cases at baseline	222 / 1667	1.69 (1.27, 2.26) <0.001	1.64 (1.22, 2.20) 0.001	1.58 (1.17, 2.12) 0.003

CONCLUSIONS

Being highly annoyed by noise in general was more common in 50-55 year olds, women, and those of high employment grade. As has been found previously in the literature, there were cross-sectional associations between high noise annoyance and self-rated health and psychological distress (Tarnopolsky et al. 1980; Stansfeld et al. 1993). Being highly annoyed did not predict angina pectoris, non-fatal myocardial infarction/morbidity or stroke, CHD or all-cause mortality. These results were all consistently negative. By contrast, high annoyance did predict psychological distress in the short-term (Phase 3) and depressive symptoms and psychological distress in the longer-term (Phase 7). Moreover, although the odds-ratios for psychological distress reduced after adjustment for baseline psychological distress the associations still remained significant. Similarly, after removing GHQ cases at baseline, the association changed very little.

In contrast to associations of transport noise exposure and cardiovascular disease where a pattern of persistent associations is being built up, these analyses show no evidence that annoyance by itself is a predictor of coronary heart disease. This implies that this annoyance question is not a proxy measure for noise exposure where an association with CHD might be expected. This is not to say that a more detailed annoyance question might show a different result.

Annoyance, however, does seem to be a predictor of future psychiatric disorder. One possibility is that a single question asking, in general, about annoyance to noise without specifying noise sources may be closer to a measure of noise sensitivity than noise annoyance. Noise sensitivity has been identified as having a strong association with psychological distress and as a potential vulnerability factor for psychological disorders related to exposure to environmental stressors (Stansfeld et al. 1993). It has also been found, potentially, to be an indicator of a genetically linked proneness to disease (Heinonen-Guzejev et al. 2005) and has been linked to increased risk of disability pension award (Heinonen-Guzejev et al. 2013). Annoyance to a range of

environmental sources is associated with trait anxiety (Persson et al. 2007) and it may be that environmental annoyance responses are more frequent in people who are anxious and fearful about aspects of their environment (Osterberg et al. 2007).

There are many limitations to this study, the lack of objective noise measurement, the simplicity of the annoyance measure and the lack of generalizability to the general population from a white-collar occupational sample. The strengths of the study are the longitudinal measures of CVD morbidity and mortality and psychiatric disorder within a well-defined occupational cohort study.

Future research should examine the associations of both noise annoyance and noise sensitivity separately with future ill-health in other cohort studies taking into account interactions with noise exposure. A greater understanding of how annoyance and psychiatric disorder are linked is needed.

REFERENCES

Babisch W. (2008). Road traffic noise and cardiovascular risk. Noise Health. 10(38):27-33.

Babisch W, Pershagen G, Selander J et al. (2013). Noise annoyance--a modifier of the association between noise level and cardiovascular health? Sci Total Environ 452-453:50-7.

Floud S, Blangiardo M, Clark C, et al. (2013) Exposure to aircraft and road traffic noise and associations with heart disease and stroke in six European countries: a cross-sectional study. Environ Health 12:89.

Goldberg DP. (1972). The detection of psychiatric illness by questionnaire. London: Oxford University Press:

Hansell AL, Blangiardo M, Fortunato L, et al. (2013). Aircraft noise and cardiovascular disease near London Heathrow Airport. BMJ.347: f5432.

Heinonen-Guzejev M, Vuorinen HS, Mussalo-Rauhamaa H et al (2005) Genetic component of noise sensitivity. Twin Res Hum Genet. 8(3):245-9

Heinonen-Guzejev M, Koskenvuo M, Silventoinen K et al. (2013) Noise sensitivity and disability retirement: a longitudinal twin study.J Occup Environ Med 55(4):365-70.

Huss A, Spoerri A, Egger M, Röösli M for the Swiss National Cohort Study Group. (2010). Aircraft Noise, air pollution, and mortality from myocardial infarction. Epidemiology ;21: 829–836.

Jarup L, Babisch W, Houthuijs D, et al. (2008). Hypertension and exposure to noise near airports: the HYENA study. Environ Health Perspect 116:329-333.

Job RFS (1988). Community response to noise: a review of factors influencing the relationship between noise exposure and reaction. JASA 83: 991-1001.

Marmot M, Brunner E. (2005). Cohort profile: The Whitehall II study. Int J Epidemiol 34: 251-256.

Osterberg K, Persson R, Karlson B, et al. (2007). Personality, mental distress, and subjective health complaints among persons with environmental annoyance. Hum Exp Toxicol. 26(3):231-41.

Persson R, Björk J, Ardö J, et al.(2007).Trait anxiety and modeled exposure as determinants of self-reported annoyance to sound, air pollution and other environmental factors in the home. Int Arch Occup Environ Health.;81(2):179-91.

Radloff LS. (1977). The CES-D scale: a self-report depression scale for research in the general population. Applied Psychological Measurement 1:385-401.

Rose GA (1962). The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. Bulletin of the World Health Organisation 27, 645-658.

Sorensen M, Hvidberg M, Andersen ZJ, et al. (2011). Road traffic noise and stroke: a prospective cohort study. Eur Heart J ;32(6):737-44.

Sorensen M, Andersen ZJ, Nordsborg RB, et al. (2012). Road traffic noise and incident myocardial infarction: a prospective cohort study. PLoS One 7(6):e39283.

Stansfeld SA, Sharp D, Gallacher J et al. (1993). Road traffic noise, noise sensitivity and psychological disorder. Psychol Med 23: 977-985.

Tarnopolsky A, Watkins G, Hand DJ (1980).Aircraft noise and mental health: I. Prevalence of individual symptoms. Psychol Med 10:683-698.