

Environmental noise and mental health: Five year review and future directions

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INTRODUCTION

Since the previous review of Stansfeld and Lercher (2003) there has been modest but continuing interest in the mental health effects of noise over the last five years (2003-2008). In particular the aspect of noise sensitivity has been studied more extensively in this period. Also recent results of longitudinal studies around major airports and the so called LARES (Large Analysis and Review of European housing and health Status) study shed more light on the relationship between noise and mental health, and the role of mediating factors. In children the effect of noise on hyperactive symptoms was confirmed and an effect of noise on subjective health symptoms found in several studies. A few studies placed - both theoretically and empirically - the relationship between noise and mental health in a broader context of soundscapes and environmental quality. Especially of interest is the increasing attention for the restorative function of quiet and green areas in particular, where mental health effects are concerned.

NOISE AND MENTAL HEALTH: EVIDENCE

Mental health effects in adults

Mental health is a general term referring to a state of emotional and psychological well being allowing someone to function in society and cope with the demands of daily living. The effect of environmental noise on mental health has not been mapped extensively. Results from recent international surveys suggest that long term noise exposure is associated with mental health problems such as anxiety and depression without seriously affecting psychological functioning in the sense of clinically-defined psychiatric disorders. But chronic noise exposure does influence the stress response and psychological well being (Stansfeld et al. 2000; Stansfeld & Matheson 2003). Smith et al. (2001) report a statistical significant relationship between noise exposure and depression and cognitive failures, but several other studies in the field show inconsistent results (Stansfeld & Lercher 2003). A recent Sardinian study (Hardoy et al. 2005) compared subjects living close to an airport with control subjects living in other areas matched by sex, age and employment status. Subjects living in the proximity of an airport reported higher levels of 'generalized anxiety disorder' and 'anxiety disorder not otherwise specified' on the Composite International Diagnostic Interview than did their counterparts living further away from the airport. This is one of the first studies finding an association between aircraft noise exposure and psychiatric diagnoses rather than psychological symptoms but there is a problem with this study as it only measured noise exposure in terms of distance from the airport. In an earlier study Devroey et al. (2002) reported that among a group of general practitioner patients who attributed their complaints to noise exposure around a Belgium airport, tinnitus ($p=0,02$), depression ($p<0,001$), tiredness ($p=0,02$), sleeplessness ($p=0,001$), inexpli-

cable muscular pain ($p < 0,001$), anxiety, nervousness and irritability ($p < 0,001$) were more prevalent in patients living in the vicinity of an airport than in patients living further away from the airport.

A longitudinal study around Schiphol airport in Amsterdam found no association between noise exposure levels and mental health either prior to or after the opening of a fifth runway (van Kamp et al. 2007). With the exception of the GHQ-12 the prevalence of mental health indicators remained stable in the area after the opening of a new runway in 2003. The number of people with two or more mental health complaints increased from 22 % to 26 % but these percentages are comparable with those found elsewhere in the Netherlands. No data were available to draw further conclusions about this trend. A panel study likewise did not show an association between (changes in) noise and mental health. However, people who were severely annoyed by aircraft noise reported more mental health complaints than others. This result has also been reported elsewhere based on a cross sectional study (Meister & Donatelle 2002). No conclusions can be drawn about the direction of the association; on the one hand people who are severely annoyed might be more at risk for the onset of mental health effects due to aircraft noise, but it is also possible that mental health problems enhance annoyance or annoyed persons might be more prone to attribute their problems to noise (Babisch et al. 2003) a phenomenon referred to as 'recall bias'. It is also possible that people with mental health problems stay more at home and thus have fewer possibilities to avoid exposure to aircraft noise. These findings were confirmed in the Frankfurt study (Meis & Schreckenberg 2007) that found no relationship between noise levels and mental health indicators as measured by the Vitality and Mental health subscales of the SF36. For the results on health-related quality of life, all scales and subscales reached standardized values. This is in contrast to a recent study performed around Sydney Airport (Issarayangyun et al. 2005) which did report effects of noise exposure on the score of the SF-36 Mental Health Scale, but only when extreme exposure groups were compared. Results of Wallenius (2004) reveal an interactive effect of noise-related stress and personal stress on self-rated general health and somatic symptoms as adaptive costs of coping with multiple stressors. Annoyance especially interacts with personal stress. The annoyance might be due to noise inside the house as well as disturbed daily activities providing restoration or demanding concentration (e.g. sleeping, relaxing, reading or studying). An important finding is that these relations are independent of neuroticism. Within the context of the LARES-survey, noise annoyance in the housing environment was evaluated in connection with several medically diagnosed illnesses (Niemann et al. 2006). Adults who indicated chronic severe annoyance by neighborhood noise were found to have an increased risk of depression and migraine.

Mental health effects in children

The previous finding of inconsistent mental health results were confirmed in three studies examining the impact of aircraft noise on child health around Heathrow airport. In the West London Schools Study aircraft noise was weakly associated with hyperactivity and psychological morbidity as measured by the Strengths and Difficulties Questionnaire (SDQ5) completed by parents (Haines & Stansfeld 2003). The RANCH study (Stansfeld et al. 2005) confirmed no effects of aircraft noise or road traffic noise on children's overall mental health measured by the Strengths and Difficulties Questionnaire (Goodman 2001). The rates of psychological distress reported by the RANCH sample were comparable with UK national data drawn from a health population sample (Meltzer et al. 2000). However, higher levels of aircraft noise were associated with higher scores on the hyperactivity subscale and there was an inverse

association between road traffic noise exposure and the conduct problems subscale (Stansfeld et al. 2005). In the RANCH data set no direct association was found between noise exposure and a quality of life index including a set of symptoms such as fatigue, sleep complaints, belly aches, dizziness and headache (van Kempen et al. 2008). As in adults noise annoyance appears to be an important predictor of subjective health complaints such as fatigue, headaches etc. in children. Likewise Wålinder et al. (2007) reported that in a study among schoolchildren (3 classes), equivalent sound-levels were significantly related to an increased prevalence of symptoms of fatigue and headache and a reduced diurnal cortisol variability, but no direct relation of blood pressure and emotional indicators were found with respect to sound levels.

NOISE AND MENTAL HEALTH IN CONTEXT

Environmental quality

Housing type and quality, neighborhood quality, noise, crowding, indoor air quality, and light have all been linked to personal mental health (Evans 2003). Loud exterior noise sources (e.g., airports) elevate psychological distress but do not produce serious mental illness. A recent study of Guite et al. (2006) confirmed an association between the physical environment and mental well-being across a range of domains. The most important factors that operated independently were neighbor noise, sense of over-crowding in the home and escape facilities such as green spaces and community facilities, and fear of crime. This study highlighted the need to intervene on both design and social features of residential areas to promote mental well-being.

The role of noise sensitivity

The current discussion regarding policy-making around major noise sources is aimed at a two-pronged approach, combining acoustical and non-acoustical factors (RIVM en RIGO 2005). Noise sensitivity is generally accepted as one of the most important non-acoustical modifier of the noise-reaction relationship (van Kamp et al. 2004; Miedema & Vos 2003). People differ strongly in their sensitivity to noise; some people are just more responsive to noise than others, depending on personal as well as contextual factors. Noise sensitivity (NS) refers to internal states – biological, psychological, or lifestyle determined – of an individual, that increase their degree of reactivity to noise in general (Job 1999). In the general population the percentage of people estimated to be extremely sensitive to noise varies between 12-15 %. Meta-analysis of three international datasets (van Kamp et al. 2004) revealed that the prevalence and influence of NS is generic across a range of cultures and climates. Noise sensitivity has been shown in the past to be associated with higher levels of noise annoyance (sleep) disturbance, as well as psychological distress, and psychiatric disorders (see van Kamp et al. 2004). Results of the Caerphilly study (Stansfeld et al. 2000) showed an association between NS and psychiatric disorder, but this influence was confounded by anxiety. Anxious people might be more aware of threatening aspects of the environment (including noise) and more prone to psychiatric disorders. A parallel can be drawn with syndromes referred to as environmental sensitivity, environmental or modern worries, electromagnetic sensitivity (EMS), multi chemical sensitivity (MCS). Perhaps people reporting environmental sensitivity have a distinctive physiological predisposition for sensitivity to physical and psychosocial environmental stressors as was suggested by Lyskov et al. (2001). The association between noise sensitivity and general environmental sensitivity has not been studied in the past. A recent experiment (White 2008) which was carried out in the framework of a doctoral study at the University of Amsterdam showed a strong association between noise

sensitivity and depression, anger, fatigue, stress, neuroticism extraversion (negative association), annoyance, mental health (subscale SF36) and general environmental sensitivity. The findings regarding the association with extraversion support previous findings (Dornic & Ekehammar 1990; Campbell 1992).

The importance of quiet in mental restoration

Research carried out in Sweden (Nilsson & Berglund 2006) has examined how adverse health effects of noise are related to individual exposure and perceived soundscapes in residential areas with and without access to quiet areas. Their results show that access to a quiet façade of a dwelling reduces annoyance to noise by 10-20 %, depending on the sound level from road traffic at the most exposed side. Results suggest that a good urban outdoor soundscape should (a) be dominated by positive sounds from nature, and (b) have an overall equivalent sound level below 50 dB(A) during the daytime. Klæboe (2005) examined the differential effect of noisy and quiet areas within a neighborhood on noise annoyance in Oslo. Results indicate that noisy neighborhoods have the potential to increase residential noise annoyance primarily for apartments exposed to low residential noise levels whereas quiet neighborhood areas have the potential to reduce residential noise annoyance primarily at intermediate and high residential noise levels.

In the Netherlands, a review of current research (Health Council of the Netherlands 2006) has concluded that the percentage of time during which a disturbance is present (or the duration of a quiet period at acceptable levels) is generally more important than the actual noise level (van den Berg & van den Berg 2006). Alongside these acoustic criteria, additional criteria are also important pertaining to the appropriateness of noise for a given context (Brown & Muhar 2004). A similar approach was used in Italy by Licitra and Memoli (2006) to identify indicators which describe perceived soundscapes although the method was more complex. Temporal variations in noise showed to be more important than distinct noise levels in predicting perceptions.

In general, nature could have an important restorative function in recovering from work related pressures, urban noise and other (daily) stressors, but so far only one field study in the USA was performed (Hartig et al. 2003), indicating greater stress reduction in a natural environment than in an urban environment. The role in this restorative process of other environmental aspects such as noise/quiet, clean air, is still unclear. Furthermore, most studies address the restorative effects of natural recreational areas outside the urban environment. The question is whether natural and quiet areas within and in the vicinity of the urban environment contribute to psychophysiological and mental restoration after stress as well. Does restoration require the absence of urban noise? Beside the immediate restorative effects, there may be long-term effects of access to environmental amenities in the immediate living environment. One Dutch cross-sectional study (Groenewegen et al. 2006; Maas et al. 2006) found that residents in green neighborhoods report a better general health. Do natural and quiet environments (micro/macro) positively influence long-term general health and well being, and which environmental aspects are important?

On the basis of the scarce evidence the Health Council of the Netherlands (2006) suggests that people who are sensitive to sound will probably benefit most from quiet areas inside and outside cities. People who describe themselves as sensitive to sound are not only more annoyed by noise, but are often also more sensitive to other stress factors. People with mental disorders (such as autism, schizophrenia and

ADHD) are sometimes also extremely sensitive to sound, often without themselves being aware (Miedema & Vos 2003).

CONCLUSION

New evidence leans towards the conclusion that there is no direct association between environmental noise and mental health. However, anxiety and depressive symptoms seem to be more prevalent in people living in the vicinity of large airports than people who live further away. However, there are some methodological problems related to the operationalization of noise and subject selection for analysis. Noise annoyance is consistently found to be an important mediator. A conclusion of no overall mental health effect of noise in children was confirmed in new data. Subjective health symptoms such as fatigue and headaches are consistently more frequently reported by children living near an airport or going to school in a noisy area. There is an increasing notion that noise sensitivity is highly correlated with a more general sensitivity for environmental stressors, but also with a vulnerability to mental health problems. Although evidence is still anecdotal it could be hypothesized that noise sensitive individuals could profit most from a balanced variation of noisy and quiet areas in urban environments, but not exclusively one or the other.

Future directions

The trend of a more integral and contextual approach of the issue of noise and (mental) health is considered promising (see also Vlek 2005). Studies into the positive and restorative effects of quiet areas are recommended, including both sensitive and non sensitive subjects. In view of the given fact that environmental stressors tend to cluster in certain areas, the relationship between general environmental sensitivity and noise sensitivity is worthwhile studying more in depth in children as well as adults. Conceptual issues should get more explicit attention and be aimed at reaching a more clear distinction between diagnosed mental health, medically unexplained symptoms and indicators of well being and quality of life as well as the development of standardized instruments to measure these.

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