The need for and access to quiet areas in relation to annoyance, health and noise-sensitivity

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INTRODUCTION

This paper presents the findings of an explorative study into the association between annoyance, subjective health and medication use and access to, the need for and dissatisfaction with access to places usually referred to as "quiet areas". To this end, data from a neighborhood survey in 2006 among 3,607 persons of 18 years and older in The Netherlands (Kruize et al. 2011), were re-analyzed.

Due to the rapid urbanization in the Netherlands, the characteristics of (green) recreational areas within cities are changing and will increasingly become scarce. From a public health point of view this is an unwanted trend, since there is sufficient evidence that spending time in green places with relatively low levels of noise or preferably areas with high acoustic quality (Brown 2010) is beneficial for our health and well-being (Gezondheidsraad 2006). One of the mechanisms may be that spending time in areas with high acoustic quality can help restore or compensate for the adverse health effects of noise in the residential environment. The hypothesis is that health benefits can be obtained by spatial variation in noise levels (Gezondheidsraad 2006). But how large should this spatial variation in sound levels be in order to obtain health benefits and at what aggregation level (city-level, neighborhood level, and street level) does this spatial variation play a role? The very limited research into the health benefits of spending time in areas with high acoustic quality near their homes suggests that a quiet side of a home, but also access to quiet in the immediate home environment, reduces annoyance by noise (Gezondheidsraad 2006; Kleaboe 2001; Kleaboe et al. 2002; Gidlöf-Gunnarsson & Öhrström 2007).

One of the major obstacles for research and policy in this area is that it is hard to characterize and identify areas with high acoustic quality. The existing models describing the relation between noise exposure and health (Gezondheidsraad 1994) don't take restoration and compensation processes into account. Moreover, these models are focused on the effects of long-term exposure to noise. As has been demonstrated by a number of studies (Devilee et al. 2010), assessments based exclusively on noise levels provide only a limited information about what people experience as quiet and what can disturb such perceived quiet.

The importance of these findings is amplified by study results in which a high percentage of Dutch residents indicated the importance of quiet and the need for areas that are quiet and calm (Franssen et al. 2004). This does not necessarily mean that people actually visit these areas, since this actual behavior is determined by many factors. It has been shown that people's behavior affects their appreciation and perception: the more people make use of a recreational area, the more they find it attractive (Crommentuijn et al. 2007). Analogue to what is found in studies investigating

the relation between green and health (Maas 2009) it is suggested that people's perception of the attractiveness of quiet, and the perception of the acoustical quality of an area is associated with health.

METHODS

Participants were 3,607 persons of 18 years and older, who were recruited from more than 9,500 residents of 22 neighborhoods (including 947 postal code areas (6PPC)) across 14 municipalities in the Netherlands. The selection and recruitment of the participants has been described in detail elsewhere and contained several steps (Kruize et al. 2011). Neighborhoods were selected according to level of urbanization, and contrasting levels of accumulations of noise exposure, air pollution (NO_2), and availability of green and matched on socio-economic status. Within the selected neighborhoods, participants received an in-depth postal questionnaire that included questions on their living situation, health, wellbeing, perception and behavior, and potential confounding factors. The response rate was 40 %.

Measurement of the need for and access to areas with high acoustic quality

The use of areas with high acoustic quality was measured by asking how often the respondent visited a quiet area for relaxation purposes. Answers were indicated on a 5-point category scale ('almost every day', 'at least once a week', 'at least once a month but not every week', 'at least three times during the past year', 'but not every month', and 'less than three times a year'). Satisfaction with access to quiet areas was measured by asking whether the respondent is satisfied with the number of quiet areas within walking or biking distance from his/her dwelling. Answers were indicated on a 5-point category scale ('very satisfied', 'satisfied', 'not satisfied but also not dissatisfied', 'dissatisfied', and 'very dissatisfied'). The need for quiet was measured by asking whether the respondent had the need to visit a quiet area. Answers were indicated on a 4-point category scale ('never', 'seldom', 'sometimes', and 'often').

Measurement of annoyance and health

Annoyance due to road traffic noise at roads with a maximum speed of 50 km/h, > 50 km/h, and rail traffic noise, was measured by means of the standard ISO-question ISO 2001). Answers were indicated on an 11-point scale from 0 ('not at all annoyed') to 10 ('extremely annoyed').

Self-reported physical health was measured by a single general health question from the RAND-36 (van der Zee & Sanderman 1993) and by means of the 'Somatization'-scale of the Four-Dimensional Symptom Questionnaire (4DKL) (Terluijn & Duijsens 2006). Self-reported mental health was measured by means of the 'mental health scale' of the RAND-36 (van der Zee & Sanderman 1993). Self-reported high blood pressure, respondents was measured by means of a question about a (diagnosed) high blood pressure during the past 12 months and treatment by a specialist for high blood pressure. Medication use was inventoried for the past two weeks for (i) heart, blood vessels or blood pressure, (ii) sleep medicines or tranquilizers, and (iii) antidepressives.

Statistical analysis

To assess the association between annoyance, self-reported physical and mental health and medication use and need for, access to and dissatisfaction with access to

quiet areas, multi-level logistic regression analyses by means of generalized linear mixed models were carried out using the GLIMMIX procedure in SAS version 9.2. Multilevel modeling takes into account the hierarchical structure of the data and enables effects at several levels to be included into the same model. For the analyses the following levels showed to be important: municipality, postal code area (6PPC), and respondent level.

As a result of the multi-level logistic regression, Odds Ratio's (OR) and their 95% confidence interval were analyzed. The models included age (yrs), gender, Body Mass Index (kg/m^2), ethnicity, level of urbanization, cumulative noise exposure level, self-reported noise sensitivity, and indicators of socio-economic status (the respondents' employment status and education level) as potential confounders. Statistical significance was tested using a Wald Chi-square test.

RESULTS

Table 1 presents some general characteristics of the participants that were included in the analysis. Compared to Dutch national numbers where 32 % of the Dutch population of 16 years and older had sometimes or often the need to visit a quiet area (Franssen et al. 2004), the need to visit areas referred to as 'quiet' is high among the participants (more than 60 %).

Table 1: General characteristics of the participants included into the analysis (N = 3,607)

Characteristic	
% women	55.9
Average age in yrs (SD)	47.1 (16.1)
% employed[a)]	69.5
% high educated	57.3
% ethnic minority[b)]	20.3
% (very) strongly urban[c)]	54.2
Yearly averaged noise level (L_{den}) in dB(A) Road traffic noise Rail traffic noise	 55.9 (6.4) 48.2 (11.0)
% Visits often a quiet area	53.9
% Dissatisfied with access to quiet areas	9.2
% Need to visit a quiet area	60.5

a) Person with a payed job;
b) person from who at least one of the parents has not been born in the Netherlands (CBS-definition);
c) defined as an area with 1,500 addresses per km^2;
Abbreviations: N = population size, SD = Standard Deviation, L_{den} = Day-evening-night level

Use of areas with high acoustic quality

Annoyance due to road traffic noise at roads with a maximum speed of 50 km/h was significantly related to the use of areas with high acoustic quality (χ^2 = 6.9, df = 1, p = 0.009): in the severely annoyed group more persons reported that they often visited a quiet area than in the reference group. After adjustment for potential confounders, an OR of 1.43 (95%CI 1.07 – 1.92) was estimated. Persons who (moderately) agree with the statement 'I am sensitive to noise' more often reported that they visited a quiet area than the persons who did not agree at all with this statement (χ^2 =

17.8, df = 4, p = 0.001). Other confounders, that had a significant effect on the use of quiet areas, were the level of urbanization, education level and body mass index.

Figure 1 shows the fully-adjusted associations between annoyance, self-reported health, medication use and the use of areas with high acoustic quality. After correction for potential confounders, annoyance due to noise from rail traffic (OR: 1.64 (95% CI: 1.10 – 2.46)), and low self-reported mental health (OR: 1.33 (95% CI: 1.05 – 1.68)) were statistically related to the use of quiet areas. No associations were found between annoyance due to noise from road traffic at roads with a maximum speed higher than 50 km/h, self-reported physical health, self-reported hypertension and medication use.

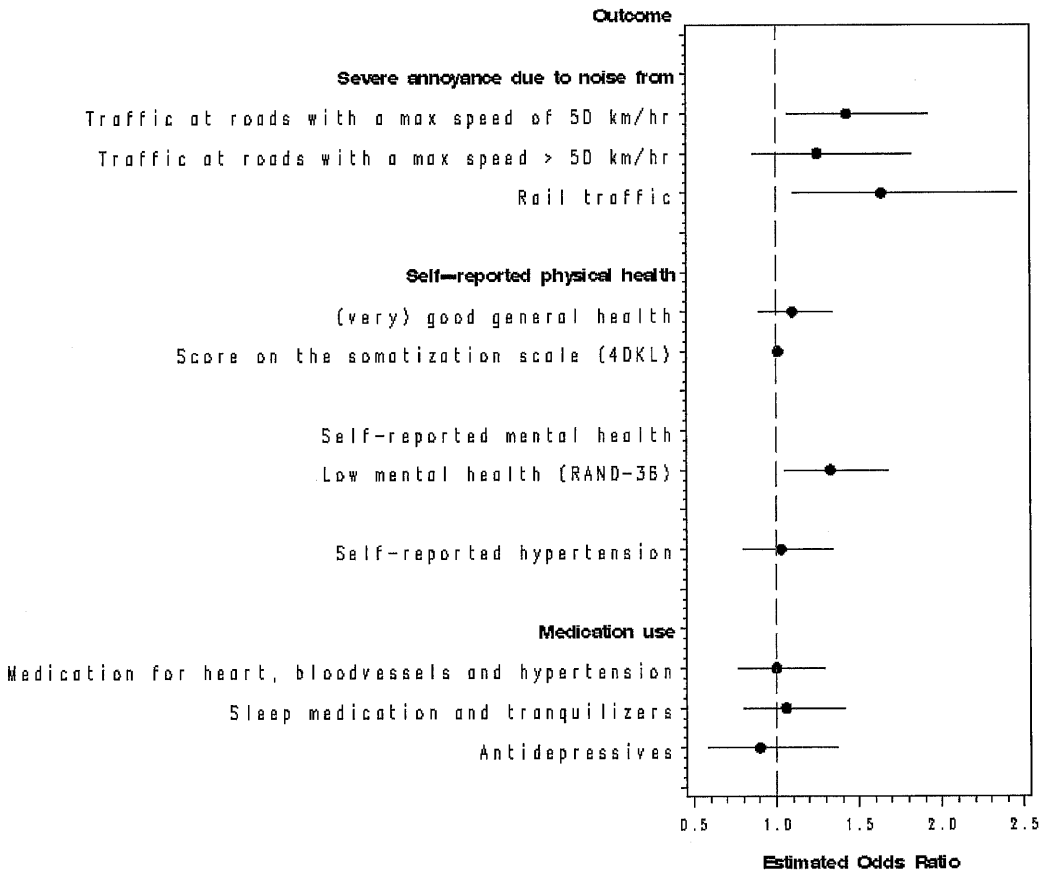

Figure 1: The association between annoyance, self-reported health, medication use and the use of areas with high acoustic quality, after adjustment for confounders. The circles correspond to the estimated difference between persons reporting that they often visited a quiet area and persons not reporting that they often visited a quiet area

The need to visit areas of high acoustic quality

Annoyance due to noise from road traffic at roads with a maximum speed of 50 km/h was significantly related to the need to visit areas with high acoustic quality (χ^2 = 52.3, df = 1, p<0.0001): in the group who were severely annoyed, more persons reported that they had a need to visit a quiet area than in the reference group. After adjustment for potential confounders, an OR of 3.46 (95% CI 2.38 – 5.01) was estimated. Persons who (moderately) agree with the statement 'I am sensitive to noise' more often reported that they had a need to visit a quiet area than the persons who

did not agree at all with this statement (χ^2 = 65.7, df = 4, p<0.001). Other confounders that had a significant effect on the need to visit quiet areas were the level of urbanization, ethnicity, education level, and body mass index.

Figure 2 shows the fully-adjusted associations between annoyance, self-reported health, medication use and the need to visit areas with high acoustic quality. After correction for potential confounders, annoyance due to noise from road traffic at roads with a maximum speed higher than 50 km/h (OR: 2.60 (95% CI: 1.67 – 4.05)), annoyance due to noise from rail traffic (OR: 2.16 (95% CI: 1.35 – 3.45)), the score on the somatization scale of the 4DKL (OR per increase of 1 unit on the somatization scale: 1.04 (95% CI: 1.02 – 1.06)), and a low self-reported mental health (OR: 1.59 (95% CI: 1.24 – 2.03)) were statistically related to the use of quiet areas. No associations were found between self-reported general health, self-reported hypertension and medication use.

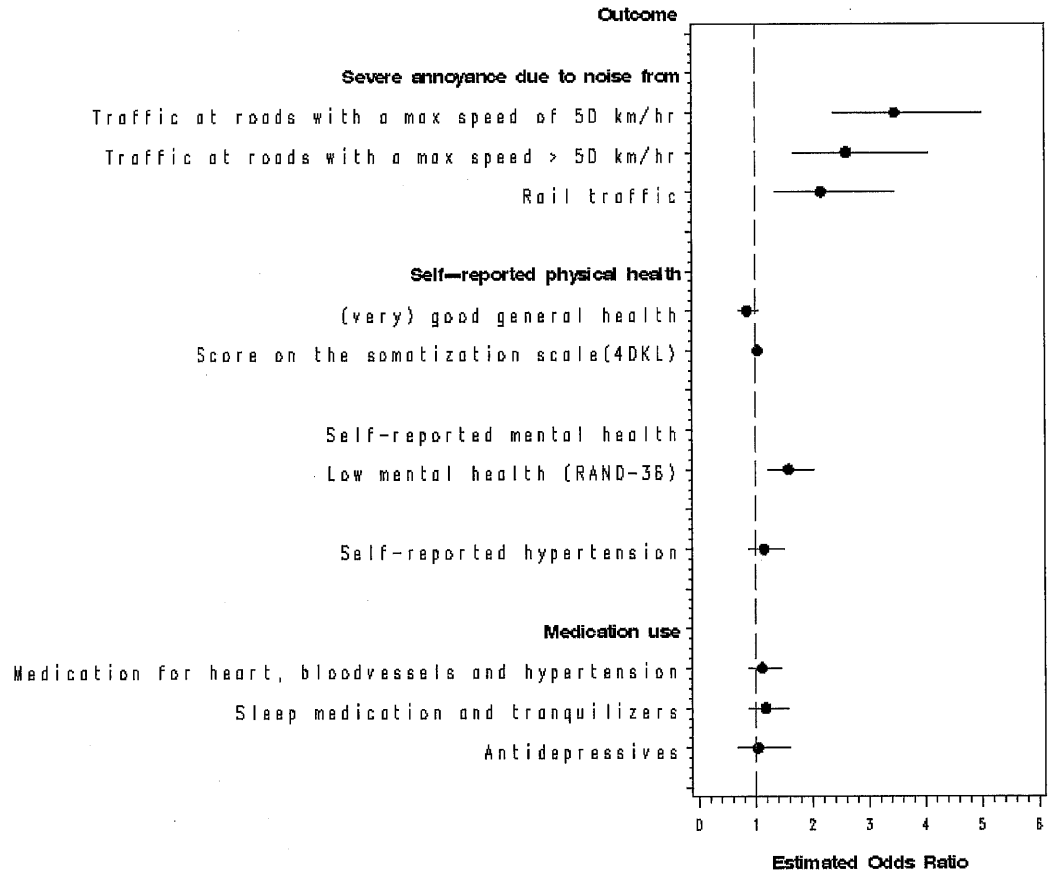

Figure 2: The association between annoyance, self-reported health, medication use and the need to visit areas with high acoustic quality, after adjustment for confounders. The circles correspond to the estimated difference between persons reporting that they often have the need to visit a quiet area and persons not reporting that they often have the need to visit a quiet area

Dissatisfaction with access to areas of high acoustic quality

Self-reported general health was significantly related to dissatisfaction with access to areas of high acoustic quality (χ^2 = 16.9, df = 1, p<0.0001): in the group who perceived their general health as (very) good, less persons reported that they were *dis-*

satisfied with the access to quiet areas than in the group who perceived their general health not as good or very good. After adjustment for potential confounders, an OR of 0.53 (95% CI: 0.38 – 0.74) was estimated. Confounders that were significantly associated with dissatisfaction with the access to quiet areas were noise exposure level and education level.

After correction for potential confounders, the score on the somatization-scale of the 4DKL (OR per increase of 1 unit on the somatization-scale 1.07 (95%CI: 1.04 – 1.09)) and a low self-reported mental health (OR: 1.61 (95%CI: 1.11 – 2.32)) were related to dissatisfaction with the access of areas with high acoustic quality. No associations were found between self-reported hypertension and medication use and dissatisfaction with the access to quiet areas.

Discussion and conclusion

In this paper we explored the association between annoyance, subjective health and medication use and the need for and access to places usually referred to as "quiet areas". After correction for possible confounding factors, we found statistically significant associations between annoyance due to noise from road- and rail traffic, self-reported mental and physical health, noise sensitivity and the need for and access to quiet areas. No significant associations were found between self-reported hypertension and medication use and the need for and access to quiet areas. Our results were in agreement with the results of Booi and colleagues (2010) using the data of more than 800 persons gathered during a survey in Amsterdam in 2008 (Booi et al. 2010). The analyses of Booi et al. (2010) showed that people who were annoyed due to road- and air traffic, people with a bad perceived health, and noise sensitive people, had a higher need for quietness in and around their home and neighborhood. Similar to our study, Booi et al. (2010) adjusted for several potential confounders. Unfortunately, no other studies have been published investigating the association between health and the need for and access to quiet areas in people's direct living environment. There are a few studies (Klaeboe 2001; Klaeboe et al. 2002; Berglund et al. 2004) investigating the effects of access to a quiet side at home. The Swedish project "Soundscape Support to Health" concluded that access to a nearby quiet area promotes health: it appeared that persons with a nearby quiet area reported less annoyance, were less often disturbed during rest and relaxation, and reported less stress-related symptoms, compared to persons without a nearby quiet area. However, access to a quiet side or a nearby quiet area cannot compensate for the effects of high levels of unwanted sounds ($L_{Aeq,\ 24h}$ equal or higher than 60 dB) at the most exposed façade (Berglund et al. 2004). In an earlier study Klaeboe found that a relative good quality of a person's direct living environment decreases the annoyance due to traffic noise (Klaeboe 2001; Klaeboe et al. 2002). Both Klaeboe and the "Soundscape Support to Health" project (Berglund et al. 2004) characterized the acoustic quality by means of objective noise measures; the latter also took into account the effects of a number of characteristics of the direct living environment.

An explorative factor analysis (not reported here) demonstrated that both the items measuring annoyance due to road- and rail traffic and dissatisfaction with access to quiet areas loaded high on the same component. Therefore, we only investigated the association between self-reported health and satisfaction with access to quiet areas. After correction for potential confounders, we found a statistically significant association between self-reported physical and mental health and satisfaction with access to

quiet areas. Finally, we found a statistically significant association between the yearly-averaged cumulated noise level and satisfaction with access to quiet areas.

At the moment, no studies have been published, investigating the association between health, noise and satisfaction with access to quiet areas. However, when a person has a negative perception about his or her direct living environment, this may contribute to the total stress which this person (already) has. As a consequence, the person's (mental) health might decrease (van Kamp 1990). It is also known that objective characteristics of our living environment (such as noise levels, odor levels, provisions etc.) together with personal characteristics, determine people's perception about their direct living environment and the characteristics of that living environment (van Poll et al. 2008).

Our findings suggest that severely annoyed people, people with low self-reported mental and physical health, and noise sensitive people may benefit most from spending time in quiet areas. Since there is only a limited number of studies available from the literature, it is too early to draw general and definite conclusions. On the base of this study it cannot be ruled out that self-reported health decreases, when a person during a longer time-period is dissatisfied with access to a quiet area. More research is needed to investigate the possible health effects of spending time in areas with high acoustic quality.

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