Editorial Manager(tm) for International Archives of Occupational and Enviromental Health
Manuscript Draft

Manuscript Number: IAOEH52R1

Title: Trait Anxiety and Modeled Exposure as Determinants of Self-Reported Annoyance to Sound, Air Pollution and Other Environmental Factors in the Home

Article Type: Original Article

Section/Category:

Keywords: Asthma, air pollution, noise, noise sensitivity, Swedish universities Scales of Personality (SSP)

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Manuscript Region of Origin:

Abstract: Abstract
Objectives: We examined to what degree annoyance ratings to noise, air pollution and other common environmental factors in the home environment could be considered to mirror personality disposition in terms of habitual anxiety level and, when appropriate, objectively modeled noise and nitrogen emission (NOx).

Methods: A trait anxiety scale was introduced in a cross-sectional public health survey with 2856 respondents. Of these, 705 had self-reported asthma and the rest constituted gender-matched referents. Annoyance to 10 specific factors in the residential environment, mainly focusing on source specific noise and air pollution, was assessed on a 6-point likert scale. A-weighted energy equivalent continuous sound pressure level during a full day (24 hr; $L_{Aeq,24}$) as well as annual average NOx levels (µg/m3) at the residential address were modeled with high resolution, using a road data base and a detailed emission data base for NOx.

Results: The two most prevalent complaints were annoyance to traffic noise and sounds from neighbors, which was reported of about 8 % of the participants. Unadjusted logistic regression analyses using the continuous trait anxiety score as a predictor showed positive associations with ratings of annoyance from total traffic noise, sounds from neighbors, sound from ventilation, exhaust fumes from traffic, sounds from other installations, and vibrations from traffic (OR's between 1.37 to 2.14). Modeled noise and NOx exposure were positively related with annoyance to traffic noise and exhaust fumes, respectively. Adjustment of the trait anxiety scores for other individual characteristics and potential determinants did not change the overall pattern of results.

Conclusion: Trait anxiety scores were often mirrored in ratings of annoyance, which suggests caution when using annoyance reports either as a surrogate measure for environmental exposure on the individual-level in epidemiologic studies or when studying the moderating effects of annoyance on health outcomes.

Response to Reviewers: Please find below our responses to the reviewers. The reviewer’s comments have been welcome and they have helped us to improve the paper. In response to the comments we have now also included modeled air pollution and noise sensitivity as well as an Appendix.

The following revisions have been made:

Reviewer #1 - comments and answers:

Q 1: Skip the sentence with the methodological aspect that only traffic noise and neighbor noise were reasonable to subject to logistic regression. Skip "as expected" for the noise vs traffic annoyance association.
A 1: This has been rectified.

Q 2:The introduction could be shortened a bit, sometimes explaining too much on basic things. The last paragraph in the introduction (page 2) actually belongs partly to material and methods. The discussion should be a bit shorter.
A 2: The introduction and discussion has now been altered as to comply with the referee comments. Unfortunately, this did not markedly affect the length. However, we do think that both the introduction and discussion has been made more to the point and improved substantially.

Q 3: Is there any question on if the subject perceive them self as a noise sensitive person.
Is there any data on education level or occupation, which could be used to calculate socio-economic status. If not, maybe this should be mentioned in the text.
How is asthma defined for the 820 subjects, doctor's diagnosed asthma or some kind of symptoms (clarify in the text).
The column with numbers of individuals for each item is too detailed, it is enough to give total number of participants in the heading, and mention that there was a small number of non-responders on each question.
A 3: We have now included this in the paper. We do have information on educational level and type of ownership for ones residence (see table 1). We performed some additional analyses including these variables. The results do not indicate that the association between personality and annoyance is confounded by socioeconomic status. Thus, we did not include them in the final model. We have also added a brief comment on this in the statistics section (p. 9).
Asthma cases were defined according to their responses to one question. We have now slightly rephrased the text and supplemented the specific question in an Appendix.
As regards the column of numbers this has been rectified.

Q 4: As I understand, there were two annoyance scales used, in the initial survey one asking about frequency of annoyance (4 steps), last 3 months. This data was only used to evaluate selection effects (non-participants v.'s. participants), but could have been analysed as well, since both anxiety (a personality trait) and modelled noise levels should be mostly the same one year ago. I would suggest that traffic noise and sound from neighbours from this initial survey is analysed as well for association with anxiety and modelled noise, to see if similar results would be obtained with a frequency scale as compared to the later intensity scale.
The table 2 is too detailed I think, it is enough to give dichotomised data (one column for daily or weekly annoyance, another for more seldom or never). Use this dichotomization also in the analysis of associations.
A 4: Supplementary analyses between trait anxiety scores, modeled noise/air pollution and the frequency scale from the initial survey 2004 have now been conducted.
The table 2 has now been dichotomized and presented according to suggestions.

Q 5: As I understand the SSP contains many different scales. Did you only include trait anxiety in the questionnaire, or was the complete SSP used, but only anxiety was analysed. Clarify in the text. Also give a background why you pick just anxiety among all personality scales? Please clarify initially if you were using crude score (not normalised scales), and give range and median and quartiles of the score in the text from the beginning.
A 5: As mentioned in the introduction one trait anxiety scale (the SSP psychic trait anxiety scale) was included in the questionnaire concerning asthma (p. 4-5). We have now reformulated the text to avoid

confusion on this point and shifted the heading describing the personality trait scale (p.6). As regards the background for selecting anxiety, we do think the motive is made clear already in the introduction.
We have used crude scores and not t-scores or any other form of normalized scores, as described in the statistics section. Information as regards the median and quartiles have now been supplied in text (p.10).

Q 6: Page 9: Why did you decide to analyse only annoyance scores with at least 130-140 cases, in the logistic regression? I would suggest you also analyse the association between anxiety and street and nightlife, sound from ventilation system and other installations (eventually combining ventilation and other installation). This would give an indication if anxiety is related to different types of noise perceptions, not just traffic noise. From table 5, it is clear that the other noise perceptions (except noise from neighbours) are not related to traffic noise, so they are interesting to analyze as well.
A 6: We have now examined the relationship between the anxiety score and all annoyance scores (p.10-11) and tables 5, 6 and 7.

Q 7: Page 10. Clarify initially that the dichotomised trait anxiety variable was only used in the descriptive table, not in the analysis of associations.
A 7: This has been rectified (p.11) and it is now clearly stated in the results section that it is the continuous score that has been used in the logistic regression analyses.

Q 8: It should be noted that even if there is a significant association between trait anxiety and different annoyance scores, the association is rather week (low explanatory value), this aspect should be mentioned more in the discussion. Is it because the real association is weak, or because of lack of power. You mention that both annoyance and anxiety were truncated at the lower end of the scale, which would reduce power, but on the other hand the study is very large and would have a good chance to detect a practically relevant association.
A 8: The loss of power associated with truncated scores is not automatically compensated by the fairly large study sample. Large study samples do not necessarily increase the possibilities of finding practically relevant associations. On the contrary, a large study sample is more likely to find associations that are irrelevant. Large study samples do however increase the possibility to feel more certain that there is no association in cases when we fail to find associations (even if we are well aware that absence of evidence is not evidence of absence) (see also point 9, below).

Q 9: A general aspect is that since you showed that adjustment for individual characteristics etc did not change the overall pattern, you could base conclusions more on the rank correlation results that have the advantage that they are more sensitive since there not based on dichotomization of the annoyance scales.
A 9: Drawing conclusions based on the rank correlations is not recommended as these coefficients' will not reveal the independent contribution from specific variables.

Second, and as stated in the text, the reason for dichotomizing is that we are primarily interested in those expressing substantial annoyance reactions. Hence the scores typically are truncated in the lower end of the scale any conclusion based on the correlation coefficients' would not really reflect annoyance.

Q 10: Is there any significant interaction between anxiety and modelled 24-h dBA, with respect to annoyance to traffic noise?
A 10: No. This has been added in the results section (p.11).

Q 11: Page 12: You discuss that modelled noise level predicts sounds from neighbours as well as anxiety and asthma. One problem with GIS-modelled exposure is that such models are not specific, they are based on traffic flow data that are associated with both noise NO2, particles etc. This limitation should be mentioned. Asthma can be triggered by traffic pollution. Also, if you live high up you are less exposed to both noise and traffic exhausts. Does the model account for the height over ground, and if not then in high rise buildings (with more noise from neighbours probably) you are actually less exposed than the model estimate.
A 11: There is an association between exposure to traffic noise and air pollution, since road traffic is the major source for both of those exposures. For feasibility reasons we had to simplify the model, so that it does not take the topography into account. We have added a comment on this to the paper (p 7). The estimated exposure corresponds to living on the first floor (p.7).

Q 12: In the last paragraph you mention that further comparisons between the two different surveys are troublesome, but as I mentioned earlier both personality, modelled noise level and some other parameters should be comparable (more or less constant).
A 12: Yes, we agree. This issue has now been dealt with (see also point 6 above).

Q 13: Page 13. Why have a long discussion of coping here, when coping has not been studied?
A 13: This has been rectified. The coping discussion has now been discarded.

Q 14: Page 13, final conclusion. One conclusion is that since both disease status (asthma) and personality (anxiety) is associated with annoyance, annoyance rating is problematic as an indicator of exposure. But this does not rule out that mean annoyance rating on a group level (leveling out personality influence and disease status) could be used as exposure indicator for subject living in a certain area. This should be mentioned
A 14: We have now clarified this issue in the text (p. 13).

Q 15: Tables. A general comment is that they are too detained in many cases, especially the descriptive tables, which makes them a bit difficult to read.

A 15: We have now tried to increase the readability of the tables and make them more to the point.

Q 16: Table 1, skip the two columns with N for each variable, just give total N in the heading.
A 16: See point 15.

Q 17: Table 2, give only two columns (daily or weekly vs. more seldom or never), skip(n)
A 17: This has been rectified.

Q 18: Table 3, there are no indication on which differences that are significant!
A 18: The intention with table 3 was not to test any hypotheses but rather to illustrate the distribution of scores across various groups. However, we have now added tests for statistical significance so that the interested reader can see which differences also are statistically significant.

Q 19: Table 4, skip annoyance rating(continuous score 1-6), just give dichotomised ratings
A 19: This has been rectified.

Q 20: Table 6 skip constant and R square, give OR for age by 10 years.
A 20: Because the Nagelkerke R-square static tend to underestimate the effect when compared with ordinary least square (OLS) estimates, and that we have no question concerning the performance of the total model we have now abandoned this mode of presentation. Also the fact that most predictor variables are dichotomous makes this presentation mode less relevant.

Reviewer #2 - comments and answers:

Q 1: The study appears to be a part of a study designed to study prevalence and risk factors for asthma in a general population, and for each asthmatic case three non-asthmatic controls were selected. However, in this study this sample is used for validating methods to study different environmental disturbances of which the majority are not known to be related to asthma. The authors should discuss more what consequences this design may have on the topic under study. It is likely that disease or poor health affect the reporting of environmental disturbances, e.g. it is well-known that individuals with asthma more often report annoyance with smells or air pollutants. Do the authors regard that such a tendency to report more annoyance can be generalized also to environmental factors not known to be related to the actual disease?
A 1: Because we could not exclude the possibility that disease status could be associated with a more widespread complaint pattern, we decided to incorporate the disease status in the statistical analyses. As it turns out (and which is now presented in table 4 and table 6) disease status correlates less with smells and exhaust than other environmental factors.

We have previously observed people expressing annoyance to environmental stimuli exhibit a wide array of other somatic complaints.
We have now supplemented the discussion with a paragraph about the potential consequences of the study design (p. 14-15).

Q 2: Of the annoyance factors, 3 concerned traffic exposure (noise, exhaust fumes and vibration), 5 noise from other sources than traffic, and 2 air pollution other than traffic fumes. When estimating the impact of personal factors on reports of annoyance to environmental factors, the "true" exposure should be an important factor to be included. In this study, only exposure road traffic noise is calculated. It is not obvious that modelled road traffic noise can be used as a "golden standard" for all of the environmental factors studied. The authors should justify how it is possible to study the validity of annoyance reports without knowing the actual exposure.
A 2: We have now supplemented the discussion with some comments on this topic. Importantly, and which is argued for (p.13-15), is that the actual exposure is not likely to co-vary with trait anxiety levels.

Q 3: Significant is not the same as substantial. The correlations between anxiety score and the different annoyance reports were very low. Of 10 environmental factors, correlations were not significant in 3 cases, significant but below 0,1 in 6, and 0.111 in 1 (sound from neighbours). Similarly, correlations between age and annoyance reports were low: 4 were not significant, 2 were below 0.1, and 4 were between 0.100 and 0.185 (negative: street and nightlife, sound from neighbours, sound from installations; positive: wood burning). Together with a negative correlation to modelled noise levels, the results concerning age, rather than an independent age effect on tendency to report annoyance, imply that older participants tended to live in more rural environments.
A 4: We agree.

Q 4: The authors state that calculated road traffic noise levels are effective in predicting annoyance to road traffic noise, but that individual annoyance ratings to traffic noise should not be used as surrogate measures for traffic noise exposure. They generalize onto other environmental factors, although being somewhat more cautious in the conclusions paragraph. It is well-known that annoyance is affected by a number of factors. The data confirms that actual exposure is more important than the personal factors recorded in the study. Before recommending subjective annoyance reports not to be used as surrogate measures for exposures, some kind of quantitative analysis on the relative importance of these other, eventually confounding, factors should be made. Odds ratios are given for two of the annoyance factors, but are not sufficient.
A 4: We have now provided a possibility for a more exhaustive comparison of covariates (Table 5, 6 and 7).

Q 5: P3 Introduction. It should be stated that the exposure to traffic noise above 55 db(A) concerns the home, if that is what is meant.

A 5: This has been rectified.

Q 6: P 5 Materials and methods, participants. The participants were selected among persons aged 18-65 who had participated in a previous study. However, the previous study included persons aged 18-80. The authors should comment on why they chose a different age range.
A 6: This has been rectified (p. 5).

Q 7: As I understand, 24 % (705/2880) or the participants were asthmatics. That makes it hard to understand the figures given: 21 % women and 18 % men.
A 7: This has been reformulated (p. 5).

Q 8: The 7 items consisting the trait anxiety scale should be given.
A 8: The items have now been provided in an appendix.

Q 9: Table 5. Since the participants are chosen according to asthmatic status, it would be valuable to see some more data on the importance of the disease, for instance be included in table 5.
A 9: We have now as requested supplied the spearman rank correlations between asthma and the other variables (table 4).

Reviewer #3 - comments and answers:

Q 1: On the whole it can be said the objective is worthwile; nevertheless in face of an explained variance of 6% it is questionable whether the authors conclusion "trait anxiety as well as age and disease status are mirrored in ratings of annoyance" are not a bit too optimistic. In fact investigators of noise annoyance in the 1970s and 1980s draw -subject to their data- the conclusion that noise related personal features like noise sensitivity are more apt to explain the existing variance in noise annoyance ratings. The small proportion of explained variance in the data should be related to this existing knowledge.
A 1: We have now included data on noise sensitivity and the associations with annoyance.

Q 2: Abstract: The first paragraph is difficult to understand (among others: noise exposure modeled with .....). When the objective is, to which degree annoyance ratings mirror personality disposition etc. it should be mentioned in the discussion paragraph that this was done to a very low degree.
A 2: This has been rectified.

Q 3: Introduction: Is there any reasonable explanation why asthma should modify the noise annoyance ratings? Was the influence of asthma investigated just by chance?

A 3: There was a general suspicion that disease status could be associated with a more widespread complaint pattern (see also comments to reviewer 2 point 1). The influence of asthma was decided by the context; which we think is made clear in the introduction when we state that a trait anxiety scale was introduced in a public health survey concerning asthma.

Q 4: Materials and methods: The numerous numbers at the beginning are difficult to understand, the informatin n> adds to this confusion. Additionally the numbers on page 5 are not consistent with the numbers in Table 1.
A 4: This has been clarified.

Q 5: It is unacceptable that there is no information how the asthmatic problems were inquired. By which questions were they registered? Can these data be considered as reliable?
A 5: It is clearly stated that asthmatic problems were inquired by responding to one question (p. 5). We have now added the inclusion question to an Appendix, and provided a reference that shows that such questions have a high specificity.

Q 6: Neither is the meaning of the abbreviation GIS given, nor did I understand what precisely it means/comprises.
A 6: The abbreviation of GIS was explained in the last paragraph in the introduction. Now the abbreviation and further details are explained in the methods section (p. 6).

Q 7: The noise exposure data seem to contain several uncertainties (their meaning for floors above the first ic unclear, number of vehicles is given only for (a greater) part of road segments, data about number of vehicles are partly pretty old). Their reliability should be discussed.
A 7: This has been rectified. And we emphasize that that GIS modeled exposure is not equivalent to actual measurements in the discussion section (p.14).

Q 8: Generally information is used as detailed as available. To calculate noise and then transform that information to a dichotomous scale means a considerable loss of information. It is not transparent why this was done. If the results changed markedly by this operation the results should be contrasted and the implications discussed.
A 8: We have now estimated OR’s for both continuous and dichotomized GIS estimates. This did not affect the other estimates in a way that undermines the results. However we have chosen to go with the dichotomized scale in the final models. This seems to be the most relevant from a community perspective as well as it provides comparability with previous studies. However, we have also made this clear in the presentation of results.

Q 9: Discussion: The data for the "somewhat lower" in the first paragraph should be given.
A 9: The discussion has been made more to the point. And this phrasing has been discarded in the process.

Q 10: It should be critically discussed that the considered variables did not contribute more strongly to the retrospective annoyance ratings. Assuming the appropriateness of the hypothesis about the influence of trait anxiety, one would expect a greater influence of it for a retrospective rating referring to a period of one year. A rating for this period of time is certainly not mainly based on facts but more on attitudes.
A 10: We agree. We have now provided an additional analysis made on data that was obtained one year earlier. The same pattern emerges.

Q 11: With respect to the proposal, not to use ratings of annoyance as a surrogate measure for exposure: if anybody has ever done that, the publication should be mentioned here.
A 11: This issue has now been clarified (p. 13).

Q 12: The use of the verbs after the word "scores" is inconsistent, sometimes the singular is used (p.4) sometimes the plural is used (p.8).
A 12: This has been rectified.

# Trait Anxiety and Modeled Exposure as Determinants of Self-Reported Annoyance to Sound, Air Pollution and Other Environmental Factors in the Home

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Estimated number of words: 3830 (abstract and acknowledgment excluded)

Number of tables: 7

Figure plates: None

Running head: Trait anxiety and annoyance to environmental factors

**Abstract**

**Objectives:** We examined to what degree annoyance ratings to noise, air pollution and other common environmental factors in the home environment could be considered to mirror personality disposition in terms of habitual anxiety level and, when appropriate, objectively modeled noise and nitrogen emission (NOx).

**Methods:** A trait anxiety scale was introduced in a cross-sectional public health survey with 2856 respondents. Of these, 705 had self-reported asthma and the rest constituted gender-matched referents. Annoyance to 10 specific factors in the residential environment, mainly focusing on source specific noise and air pollution, was assessed on a 6-point likert scale. A-weighted energy equivalent continuous sound pressure level during a full day (24 hr; $L_{Aeq,24}$) as well as annual average NOx levels (µg/m3) at the residential address were modeled with high resolution, using a road data base and a detailed emission data base for NOx.

**Results:** The two most prevalent complaints were annoyance to traffic noise and sounds from neighbors, which was reported of about 8 % of the participants. Unadjusted logistic regression analyses using the continuous trait anxiety score as a predictor showed positive associations with ratings of annoyance from total traffic noise, sounds from neighbors, sound from ventilation, exhaust fumes from traffic, sounds from other installations, and vibrations from traffic (OR's between 1.37 to 2.14). Modeled noise and NOx exposure were positively related with annoyance to traffic noise and exhaust fumes, respectively. Adjustment of the trait anxiety scores for other individual characteristics and potential determinants did not change the overall pattern of results.

**Conclusion:** Trait anxiety scores were often mirrored in ratings of annoyance, which suggests caution when using annoyance reports either as a surrogate measure for environmental exposure on the individual-level in epidemiologic studies or when studying the moderating effects of annoyance on health outcomes.

*Key Words:* Asthma, air pollution, noise, noise sensitivity, Swedish universities Scales of Personality (SSP)

## Introduction

The escalating urbanization has created a complex sound environment where quiet spots in rural and metropolitan areas are more and more rarely to be found. For example, it has been estimated that the exposure to road traffic noise above 55 dB(A) at the home address concerns about 29 % of the population in Scania, the southernmost county of Sweden (Björk et al. 2006). Even if most everyday sound exposure occurs at levels far below levels and exposure circumstances that are known to induce hearing impairment due to mechanical injury there is reason to be concerned. For example, several epidemiological studies show a linkage between high exposure to traffic noise and cardiovascular diseases such as hypertension and ischemic heart disease (Babisch et al. 2005; Bluhm et al. 2004; Miedema and Vos 1998). The epidemiological evidence is well supported by established biological plausibility, but less is known about which psychological processes are involved and how they may moderate disease risk. Still, most researchers believe that one important determinant for non-auditory biological effects of sound exposure is the individual perception of sound as something negative and unwanted, that is, annoying. Hence annoyance seems not only to be most widespread and well-documented consequence of unwanted sound exposure, but also a key factor for understanding the more serious long-term health effects of everyday sound exposure (Stansfeld and Matheson 2003). It is, for example, known that annoyance increases with the equivalent sound level but also that annoyance to some extent is determined by fear and individual noise sensitivity (Bluhm et al. 2004; Reijneveld 1994; Stansfeld and Matheson 2003).

Another consequence of urbanization is air pollution, which may originate from traffic, shipping, aviation, railroads, industries, and small scale heating etc. Nitrogen oxides have rendered a special interest as a marker of traffic generated air pollution (WHO 2003). The concentration of nitrogen oxides is typically largest in densely populated areas where the emission sources cluster together, but long-distance transportation is also of concern. Just as with road traffic noise it is assumed that air pollution may affect health via direct and indirect pathways and it has been suggested that peoples beliefs and perceptions over pollution may negatively affect health (Hunter et al. 2003). From this perspective annoyance attributed to air pollution may be considered both as an indicator of a stress reaction and as an indicator for a complex environmental condition that lacks pollutant specific information (Oglesby et al. 2000).

However, one associated problem that has received little or no attention, but which arises when measuring subjective complaints to environmental sound and air pollution exposure, is to determine to what degree a complaint represents a unique psychological reaction to the exposure or just an inherent quality of the respondent. It is well known that some people have a habitually increased propensity to experience aversive emotions, such as anxiety, worry, depression, tension, stress, and low self-esteem (Watson and Pennebaker 1989). This propensity is often thought to represent a broad personality construct that sometimes is labeled negative affectivity, trait anxiety, neuroticism, or emotionality. No gold standard for differentiating between the different conceptualizations exist and many researchers regard the concepts as roughly interchangeable (Eysenck 1997). The knowledge that this broad personality dimension is known to affect subjective complaints estimates, for example, of stress and health (Aldwin et al. 1989; Persson and Orbaek 2003; Seeber et al. 2000; Watson and Pennebaker 1989) have led to suggestions to screen for, or to routinely measure and control for, participants' degree of negative affectivity, neuroticism, or trait anxiety (Costa, Jr. and McCrae 1987; Pieters et al. 1992). In addition, trait anxiety has also rendered interest as an etiological factor in the study of the development of Idiopathic Environmental Intolerances (Lessof 1997; Orbaek et al. 2005; Österberg et al. 2007). Experimental studies have shown that high trait anxiety facilitates the acquisition of aversive responses to odours (Van den Bergh et al. 2001). Higher trait anxiety scores has also been found among non-patients which express annoyance toward smells and electrical devices but are otherwise healthy (Österberg et al. 2007). Moreover, environmental annoyance ratings may also be influenced by disease status, especially if disease potentially can be attributed to, or aggravated by environmental factors.

The aim of our study was to examine to what degree annoyance ratings to various environmental factors in the residential area (e.g. road traffic noise, sounds from neighbors, smells and vibrations) could be considered to mirror this basic personality disposition. A trait anxiety scale was therefore introduced in a health survey that concerned asthma. We hypothesized that people with higher trait anxiety scores should express more annoyance when asked about their annoyance reactions to exposures from specific environmental elements. The relationship between trait anxiety, annoyance and objectively modeled noise and emissions were studied, and the relationship between environmental annoyance ratings and disease status (asthma), age and gender were explored.

## Materials and Methods

*Participants*

The identification of participants was based on a population based public health survey from 2004, encompassing 47 621 persons 18 to 80 years old in Scania, Sweden (Rosvall et al. 2005). The total response rate was 59% (n=27 963). From this initial survey, all 22 693 persons in occupationally active ages (i.e. between 18 to 65 years of age) who had positively responded to a item asking whether they could be contacted for supplementary questioning, constituted the present sampling frame (n=7 980; 17% of the 47 621 originally included). In 2005, the 820 persons who in 2004 had responded positively to a question asking for asthmatic health problems (see Appendix) were selected as cases and invited to take part in a study concerning asthma. This identification of asthmatics tend to be reliable and specific (Toren et al. 1993). For each case 3 control persons were selected, frequency matched for gender (n=2460). Of the invited persons, 705 asthmatic cases agreed to participate (86 %) as did 2175 control persons (88 %), constituting 2880 persons (87 % of all invited persons). The distribution of men and women among asthmatics were fairly equal. All but nine persons responded to the personality trait scale. Fifteen persons with addresses outside the Scania region were excluded. The final study sample thus comprised 2856 persons.

We examined the impact of the selection process as regards overall demographic composition, perceived health and current mental-distress as well as environmental annoyance, using data from the initial public health survey in 2004. Perceived health was measured on a 5-point scale. Current mental distress was measured with the general health questionnaire-12 (GHQ-12) (Goldberg and Williams 1988). A higher proportion were women and had higher education in the 2005 survey, while age, perceived health and current mental distress were similar, as were reports of annoyance to specific environmental factors in the residential area (Table 1).

*Rating scales*

The *Psychic Trait Anxiety scale* from the Swedish universities Scales of Personality *(*SSP*),* was used to assess trait anxiety (Gustavsson et al. 2000). SSP is a revised version of the Karolinska Scales of Personality (Schalling et al. 1987) and consists of 13 seven-item scales. The items of the Psychic Trait Anxiety scale (see Appendix) measures intellectual manifestations of trait anxiety such as worrying, anticipating and lacking self-confidence. The score was calculated as the mean score of the seven items. A high score indicates a more pronounced anxious personality (Cronbach's alpha = 0.88).

*Noise sensitivity* was measured with one item asking the respondent to judge the habitual response when exposed to noise/sound (see Appendix) on a four point scale. A high score indicate an increased sensitivity for noise/sound.

*Environmental annoyance* was measured in the initial public health survey 2004 by asking the respondents to rate their degree of perceived annoyance during the last 3-months from seven sources of environmental exposure in the residential area (Rosvall et al. 2005). The items were responded to on a four point frequency scale (see Appendix).

The *Lund Environmental Annoyance (LEA*) inventory was compiled for the 2005 survey by the authors. The items were partially derived from an investigation conducted by the Swedish National Institute for Public Health (Linell and Thuvander 2005) and the public health survey from 2004. The respondents were asked to rate their degree of perceived annoyance during the last 12-months from ten sources of environmental exposure in the residential area on 6-point intensity scale (see Appendix).

*Assessment of road traffic noise and air emissions*

We assessed individual exposure with high resolution, using Geographical Information Systems (GIS) as a tool to link the individual geocoded residential addresses at the end of year 2003 with available exposure data attributed this address (geocoded, or grid data).

*Road traffic noise:* In short, she simplified Nordic prediction method for road traffic noise was used to estimated the A-weighted energy equivalent continuous sound pressure level during full day (24 hr; $L_{Aeq,24}$) (Bendtsen 1999). The road traffic data included 21397 road segments, of which17339 were administrated by Swedish Road Administration and 4058 by local municipalities. The number of vehicles was available for 82% of the road segments. Speed limits were available for >95% of the segments. Some of the traffic data are not updated but 93% percent are from 1985 or newer and 71% are from 1995 or newer. For road segments without traffic data mean values were assigned to each segment based on existing data for included road types (Ardö 2005).

$L_{Aeq,24}$ was calculated for each 25 meter zone up to 300 meter from the road center, using the number of vehicles (light and heavy) and the speed limit for each road segment. The prediction method includes only noise reductions due to distance and due to ground type (soft or hard) but excludes reduction due to noise barriers. We assumed soft ground between the residence and the roads for the participants living on the countryside while hard ground was assumed for the participants living in more densely populated areas. We had no data indicating the floor of the apartment building on which the residences were located, and we therefore estimated the noise level on the ground floor for all residences.

*Nitrogen emissions:* Modeled air pollution exposure was obtained from a pollutant database based on the year 2001, covering the county of Scania. The database, which has been validated, has been described in detail elsewhere (Stroh et al. 2005). A bottom-up approach was adopted which utilized emission data based on detailed information concerning road traffic, shipping, aviation, railroads, industries and other heat producers, small scale heating, construction machinery, and long-range transportation and emissions from neighboring regions (i.e. Zealand in Denmark). A modified Gaussian dispersion model was used (ENVIMAN), with actual meteorological data. The annual average level of nitrogen emissions (NOx, $\mu g/m^3$) in 2003 was modelled with a spatial resolution of 1000x1000m.

*Ethics*

All participants gave written informed consent to participate. The study was performed according to the Act concerning the Ethical Review of Research Involving Humans (2003:460).

*Statistical Analysis and Data Management*

Statistical computations were made with the SPSS computer software, version 15.0. P-values below 0.05 were considered statistically significant. A visual inspection of the raw scores revealed that most scale scores were positively skewed. For this reason, a non-linear approach was adopted. Spearman rank correlations were used to describe the correlations between the study variables. To identify participants with pronounced annoyance a dichotomization of the annoyance ratings were performed. In the public health survey from 2004 annoyance scores were dichotomized as follows: 0= No, never to yes, but more seldom, and 1= daily or at least once a week. Correspondingly, annoyance scores in the LEA inventory were dichotomized: 0 = not annoyed at all, to not especially annoyed, and 1 = fairly annoyed, to extremely annoyed. NOx data was evaluated as a continuous predictor.

GIS estimated traffic noise was evaluated both as a continuous predictor and as a categorized variable (high if >= 55 dB(A)). The cut point was selected to gain comparability with previous studies and to agree with the Swedish target value for outdoor environment in inhabited areas (Björk et al. 2006). The relationship between trait anxiety and annoyance was first analyzed with bi-variate logistic regressions. Provided a bi-variate logistic regression showed statistical significance, it was followed up with a multiple logistic regression in which relevant co-variates were entered. Accordingly, we used the psychic trait anxiety score, age, gender, disease status (asthma versus no asthma) as forced entry predictors, and the dichotomized annoyance scores as outcomes. For traffic noise annoyance also modeled noise was entered, as was modeled NOx exposure for traffic exhausts. The interaction between the psychic trait anxiety score and gender was included to test whether men and women responded differently, as were the interactions between the psychic trait anxiety score and disease status (asthma) and modeled exposure. Because no interaction was near statistical significance, main effects models were presented. For comparison, we also evaluated the effect of noise sensitivity on annoyance using the same criteria and covariates as in the logistic regression analyses for trait anxiety above. Adjustment for markers related to socioeconomic status (i.e. type of ownership of ones own residence and educational background) did not affect the overall pattern of the results and is therefore not presented. There was also a marked dependency between gender and education making the small differences between models adjusted for education, versus models not adjusted for education, difficult to interpret.

## Results

Crude means and standard deviations for the study variables are presented in table 2. The two most prevalent annoyance complaints were traffic noise and sounds from neighbors, which was reported of about 8% of the participants (Table 3). The median score for trait anxiety was 1.57 (Q1=1.28, Q3= 2.14). In total, 67 % (n=1918) had mean trait anxiety scores between 1.00 and 1.99; 28% (n=807) had mean scores between 2.00 and 2.99, and 5 % (n=131) had mean scores between 3.00 and 4.00. Crude prevalences of environmental annoyance ratings across the three trait anxiety categories are presented in Table 3. Spearman rank correlations between the study variables are presented in Table 4.

*Relationships between trait anxiety and environmental annoyance*

Unadjusted logistic regression analyses using the continuous trait anxiety score as a predictor showed positive associations with ratings of annoyance from total traffic noise, sounds from neighbors, sound from ventilation, exhaust fumes from traffic, sounds from other installations, and vibrations from traffic (Table 5). Typically, unadjusted odds following a 1 point increase in the mean trait anxiety score, increased between 37 % and 114 % (i.e. OR's between 1.37 to 2.14).

The noise sensitivity score was positively related to the trait anxiety score (Table 3 and 4) and showed the similar positive relationship with annoyance ratings as trait anxiety did. In addition the noise sensitivity score also showed positive relationships with street and night life and industrial noise (Table 5). Typically, unadjusted odds following a 1 point increase in the noise sensitivity score, increased between 57 % and 111 % (i.e. OR's between 1.57 to 2.11).

Modeled noise exposure ($L_{Aeq,24}$) was positively related with annoyance to traffic noise irrespective whether it was entered as a continuous predictor variable or as an dichotomized predictor variable (Table 5). Modeled NOx levels were positively related with annoyance to exhaust fumes (Table 5).

Adjustment of the trait anxiety scores for other individual characteristics and potential determinants of annoyance such as age, gender, disease status (asthma), and when appropriate modeled noise exposure ($L_{Aeq,24}$) or NOx, did not change the overall pattern of results (Table 6). Only for sounds from ventilations did adjustment remove the previously observed positive association with the trait anxiety score.

There was no interaction between anxiety scores and gender (interaction p's > 0.5), or between anxiety scores and disease status (interaction p's > 0.8), or between anxiety scores and modeled noise exposure (interaction p=0.15) or NOx exposure (interaction p=0.69). Only very minor changes in the OR's for trait anxiety were observed if replacing the dichotomized modeled noise exposure with the continuous levels (data not shown).

Using noise sensitivity instead of the trait anxiety score in the multiple regression analyses generally resulted in more pronounced OR's (Table 7).

*Reliability of the relationship between trait anxiety, noise sensitivity and annoyance ratings*

Because both personality trait scores, habitual noise sensitivity and GIS-modeled exposures ought to be fairly stable across a one-year period, it was decided to verify our observations by also examining the retrospective relationships between trait anxiety and noise sensitivity scores from 2005 and annoyance ratings from the initial public health survey in 2004. These analyses yielded essentially similar pattern of results but with weaker effects of trait anxiety scores and noise sensitivity scores (Table 5, 6 and 7).

## Discussion

We investigated to what degree trait anxiety scores were related to reports of annoyance to source specific environmental factors in the home environment. As expected, an increased probability for acknowledging annoyance was often observed with increasing trait anxiety scores. Statistically significant relationships were observed between trait anxiety scores and annoyance scores on 6 of the 10 environmental studied, after controlling for other potential determinants of annoyance ratings such as age, gender and disease status (asthma). The retrospective verification, which entailed the use of trait anxiety scores from 2005 and annoyance scores from 2004, essentially confirmed this pattern. Comparison between the 2004 and 2005 surveys should however be made with caution due to the different phrasings of the questions, the frequency vs. intensity response modes, and the time frames asked for. Observably, the trait anxiety scores were fairly truncated to the lower end of the scale. This is to some extent verified when comparing the current trait anxiety scores ( Mean = 1.74, SD = 0.61) with the SSP norm data from a randomized selection of 741 participants (360 men/ 381 women) between the ages 20 to 64 (Mean = 2.02, SD = 0.61) (Gustavsson et al. 2000). Hence, the present study sample seems not to be especially inclined to extensive worry or foreboding.

The present study sample seem however rather apt to express noise sensitivity. Almost 39 % percent could be classified as fairly sensitive to very sensitive. However, because of the phrasing of the noise sensitivity question, asking for both noise and sound, gives the respondent room to unreservedly recall exposures and reactions to them, one could suspect that it favors responses towards the higher end of the scale. Despite this shortcoming, this question is likely to capture a basic attitude towards noise, which to some degree overlaps with trait anxiety. Compared with the trait anxiety score, the noise sensitivity score showed more pronounced relationships with several of the annoyance ratings. Because both the trait anxiety and the noise sensitivity score reflect partly overlapping aspects of the persons self image we did not include them simultaneously in the statistical analyses. To what degree the personal inclination towards worrying, anticipating and lacking self-confidence, or disliking noise, substantially relate to each other is another question. It should also be noted that since the interpretations of odds ratios are dependent on the underlying quantification of the statistical predictor variables, effect comparisons with other predictor variables should be made with caution.

Although relatively few persons expressed serious annoyance, the observed rank ordering of annoyance to specific environmental factors in the residential area agrees well with a previous nationwide Swedish survey reporting the 3-months prevalence of annoyance among 19 to 81 year olds of both sexes (Linell and Thuvander 2005).

Irrespective whether one considers trait anxiety as a potential confounding factor, or as a vulnerability factor of a psychological or biological nature, the fact that a statistical relationship exist between trait anxiety and annoyance scores suggest that these measures partly mirror each other. Because there is no lingual content overlap among trait anxiety items and annoyance items there is reason to assume that the observed relationship is beyond trivial. In view of the truncated and positively skewed distributions of annoyance and trait anxiety scores, it seems also plausible that we have underestimated the true population scores as well as the relationship between them.

As expected, the objectively modeled noise and emission exposures were positively related to ratings of annoyance from traffic noise and exhaust fumes, respectively. However, the importance of other factors than GIS-modeled exposure for determining traffic annoyance or annoyance to exhaust fumes implies that individual annoyance ratings should not be used as a surrogate measure of exposure. Doing so in epidemiologic studies may yield confounded results. A Swiss study reported similar individual-level associations between individual-level factors and annoyance from air pollution that seemed to persist after adjustment for objective measure of air quality (Oglesby et al. 2000). Notably, this does not rule out the possibility to use aggregated annoyance ratings on a group level, for example, a specific geographical area, as a proxy measure for exposure. As regards noise exposure, the use of annoyance ratings as proxies for exposure have primarily been utilized when assessing noise in the work places (Babisch 1998).

Disease status (asthma) also showed statistically significant relationships with annoyance from several environmental factors in the home environment. Higher age seems to decrease the probability for annoyance to noise not only from traffic but also from most other sources. Whether this is due to a difference in sensitivity between ages or in exposure is not all clear from our data. Few gender differences were observed.

Before reaching conclusions some cautionary remarks are necessary. A weakness with the present study design is the absence of more objective measures and metrics other than modeled sound and NOx levels, both highly dependent on road traffic intensity. Strictly speaking modeled exposure is not equivalent to field measurements, which probably would be the best way to characterize each individual's actual exposure. This is however not feasible in a large study. From this perspective modeled exposure with high resolution is probably the best estimation of actual exposure that is possible to make.

Importantly, there are few reasons to believe that personality traits such as trait anxiety should be related to actual differences in source specific environmental exposures. Indeed, the absence of relationships between trait anxiety and modeled exposures support this claim, at least as regards total traffic noise and exhaust fumes from traffic and to these associated exposures. Thus, the observed co-variation is not likely to be explained by differences in actual exposure.

Because the selection of the participants was governed by a specific disease (asthma) one might also have some concerns that this would have biased the results. However, apart from that the selection procedure seems to have favored inclusion of highly educated women, it is clear that most demographic factors and living circumstances were fairly equally distributed between the participants in the 2005 survey when compared with the rest of the population in the 2004 public health survey. As the proportion of men and women were fairly similar among asthmatics and non-asthmatics it is not likely that the study design and selection of asthmatics and associated controls have created sample that is very different from the general population.

Appropriate caution is also warranted in view of the sometimes very low prevalence's of environmental annoyance which makes it difficult to statistically reject the stated null-hypotheses.

In conclusion, that trait anxiety scores is mirrored in ratings of annoyance from several environmental sources suggests caution when using annoyance rating as a surrogate measure for exposure on the individual-level in epidemiologic studies, or when studying the moderating effects of annoyance on health outcomes. Annoyance reactions at the individual-level may however be measured and analyzed in their own right, and as possible mediators of ill health. It seems prudent to include not only measures of annoyance but also other individual characteristics such as trait anxiety in future studies of environmental exposures and health.

**Acknowledgements**

We are grateful to Per-Olof Östergren, Department of Health Sciences, Division of Social Medicine and Global Health, Malmö University Hospital for giving access to the initial survey data. Susanna Gustafsson and Emilie Stroh at the GIS Centre, Lund University, assisted in the assessment of road traffic noise and air pollution. Åke Boalt at the county council of the Scania region gave assistance as regards the geocoding. The project was financially supported by grants within the National Air Pollution Programme at the Swedish Environmental Protection Agency, the Swedish Emission Research Programme and the Faculty of Medicine, Lund University.

# References


Aldwin CM, Levenson MR, Spiro A, III, Bosse R (1989) Does emotionality predict stress? Findings from the normative aging study. J Pers Soc Psychol 56:618-624

Ardö J (2005) Traffic, people and the environment in Scania (Trafik, människor och miljö i Skåne; in Swedish), GIS centre at Lund University, Lund

Babisch W (1998) Epidemiological Studies of the Cardiovascular effects of Occupational Noise - A Critical Appraisal. Noise Health 1:24-39

Babisch W, Beule B, Schust M, Kersten N, Ising H (2005) Traffic noise and risk of myocardial infarction. Epidemiology 16:33-40

Bendtsen H (1999) The nordic prediction method for road traffic noise. Sci Total Environ 235:331-338

Björk J, Ardö J, Stroh E, Lövkvist H, Östergren PO, Albin M (2006) Road traffic noise in southern Sweden and its relation to annoyance, disturbance of daily activities and health. Scand J Work Environ Health 32:392-401

Bluhm G, Nordling E, Berglind N (2004) Road traffic noise and annoyance--an increasing environmental health problem. Noise Health 6:43-49

Costa PT, Jr., McCrae RR (1987) Neuroticism, somatic complaints, and disease: is the bark worse than the bite? J Pers 55:299-316

Eysenck M (1997) Anxiety and cognition. A unified theory., Psychology Press, Hove

Goldberg D, Williams P (1988) User's guide to the general health questionnaire, NFER-Nelson, Oxford

Gustavsson JP, Bergman H, Edman G, Ekselius L, von Knorring L, Linder J (2000) Swedish universities Scales of Personality (SSP): construction, internal consistency and normative data. Acta Psychiatr Scand 102:217-225

Hunter PR, Davies MA, Hill H, Whittaker M, Sufi F (2003) The prevalence of self-reported symptoms of respiratory disease and community belief about the severity of pollution from various sources. Int J Environ Health Res 13:227-238

Lessof M (1997) Report of Multiple Chemical Sensitivities (MCS) Workshop, Berlin, Germany, 21-23 February 1996. PCS/96.29 IPCS, Geneva, Switzerland. Hum Exp Toxicol 16:233-234

Linell A and Thuvander A (2005) Upplevda besvär av luftföroreningar, buller och inomhusmiljö- Socioekonomisk analys baserad på Nationella miljöhälsoenkäten, Statens Folkhälsoinstitut, 12

Miedema HM, Vos H (1998) Exposure-response relationships for transportation noise. J Acoust Soc Am 104:3432-3445

Oglesby L, Kunzli N, Monn C, Schindler C, Ackermann-Liebrich U, Leuenberger P (2000) Validity of annoyance scores for estimation of long term air pollution exposure in epidemiologic studies: the Swiss Study on Air Pollution and Lung Diseases in Adults (SAPALDIA). Am J Epidemiol 152:75-83

Orbaek P, Persson R, Osterberg K (2005) Impact of trait anxiety and social conformity on responses to experimental chemical challenge. Environmental Toxicology and Pharmacology 19:659-664

Österberg K, Persson R, Karlson B, Carlsson Eek F, Ørbæk P (2007) Personality, mental distress, and subjective health complaints among persons with environmental annoyance. Human & Experimental Toxicology 26:231-241

Persson R, Orbaek P (2003) The influence of personality traits on neuropsychological test performance and self-reported health and social context in women. Personality and Individual Differences 34:295-313

Pieters MS, Jennekens-Schinkel A, Schoemaker HC, Cohen AF (1992) Self-selection for personality variables among healthy volunteers. Br J Clin Pharmacol 33:101-106

Reijneveld SA (1994) The impact of the Amsterdam aircraft disaster on reported annoyance by aircraft noise and on psychiatric disorders. Int J Epidemiol 23:333-340

Rosvall M, Ali Khan F, Nilsson M, Östergren P (2005) Hälsoförhållanden i Skåne. Folhälsoenkät Skåne 2004., Socialmedicinska enheten, Region Skåne, Universitetssjukhuset MAS, Malmö

Schalling D, Åsberg M, Edman G, Oreland L (1987) Markers for vulnerability to psychopathology: temperament traits associated with platelet MAO activity. Acta Psychiatr Scand 76:172-182

Seeber A, Demes P, Golka K, Kiesswetter E, Schaper M, van Thriel C, Zupanic M (2000) Subjective symptoms due to solvent mixtures, dioxin, and toluene: impact of exposure versus personality factors. Neurotoxicology 21:677-684

Stansfeld SA, Matheson MP (2003) Noise pollution: non-auditory effects on health. Br Med Bull 68:243-257

Stroh E, Oudin A, Gustafsson S, Pilesjo P, Harrie L, Stromberg U, Jakobsson K (2005) Are associations between socio-economic characteristics and exposure to air pollution a question of study area size? An example from Scania, Sweden. Int J Health Geogr 4:30

Toren K, Brisman J, Jarvholm B (1993) Asthma and asthma-like symptoms in adults assessed by questionnaires. A literature review. Chest 104:600-608

Van den Bergh O, Devriese S, Winters W, Veulemans H, Nemery B, Eelen P, Van de Woestijne KP (2001) Acquiring symptoms in response to odors: a learning perspective on multiple chemical sensitivity. Ann N Y Acad Sci 933:278-290

Watson D, Pennebaker JW (1989) Health complaints, stress, and distress: exploring the central role of negative affectivity. Psychol Rev 96:234-254

WHO (2003) Health Aspects of Air Pollution with Partculate Matter, Ozone and Nitrogen Dioxide. Report on a WHO Working Group, Bonn, Germany, 13-15 January

Table 1.Comparison between the present study sample (asthma 2005), and the remaining participants in the public health survey 2004 (people in occupationally active ages 18 to 65 years).

| | Non-selected participants from the 2004 public health survey (N=19837) | Selected participants for the asthma 2005 survey (N=2856) |
|---|---|---|
| Age [years; M (SD)] | 43 (14) | 43 (13) |
| Height [cm; M(SD)] | 172 (11) | 172 (10) |
| Weight [kg, M(SD)] | 75 (15) | 75 (15) |
| General Health (1-5; M(SD)] | 3.87 (0.86) | 3.88 (0.90) |
| GHQ-12 * [1-4; M(SD)] | 1.83 (0.42) | 1.84 (0.45) |
| *Women / Men* (%) | 54 / 46 | 61 / 39 |
| *Employment status** (%)* | | |
| Employed | 70 | 70 |
| Retired or sick-leave | 12 | 15 |
| Student | 11 | 12 |
| Unemployed | 7 | 7 |
| On leave | 3 | 4 |
| Own household work | 5 | 6 |
| Other | 6 | 8 |
| *Social status (%)* | | |
| Married | 71 | 70 |
| Single | 20 | 19 |
| Divorced | 8 | 9 |
| Widower / widow | 1 | 2 |
| *Smoking* (%) | | |
| Yes, daily | 17 | 17 |
| Yes, occasionally | 5 | 5 |
| No | 77 | 78 |
| *Education (%)* | | |
| Beyond upper secondary school | 36 | 43 |
| *Type of ownership for ones residence (%)* | | |
| Private house | 57 | 55 |
| Tenant-ownership | 13 | 15 |
| Rental apartments | 30 | 30 |
| *Annoyance* (Daily, or at least once a week; %) | | |
| Traffic noise | 18 | 18 |
| Sound from neighbours | 13 | 13 |
| Exhaust fumes from traffic | 8 | 8 |
| Pollution from wood burning | 5 | 4 |
| Smells from industrial production | 2 | 2 |

Note: General Health: 1= very poor, 5 = very good; GHQ-12 = General Health Questionnaire-12; * = Lower scores are better. All values except the general health and GHQ-12 score are rounded to nearest full figure. **Employment status: several response alternatives were possible. There were no statistically significant differences between groups as regards annoyance (Fisher exact probability test (two-sided), $p > 0.227$). Due to internal missing values the numbers of persons responding to each question typically deviates from the total N.

Table 2. Crude means and standard deviations for the study variables.

| | Total | | Gender | | | | Asthmatic | | | | Mann Whitney U-test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Women | | Men | | No | | Yes | | Gender | Asthmatic |
| | (n=2856) | | (n=1745) | | (n=1111) | | (n=2162) | | (n=694) | | Women Vs. Men | No Vs. Yes |
| | M | SD | M | SD | M | SD | M | SD | M | SD | P-value | P-value |
| Age (years) | 43 | 13 | 42 | 13 | 45 | 13 | 43 | 13 | 43 | 13 | <.001 | .612 |
| Psychic Trait anxiety (1-4) | 1.74 | 0.61 | 1.82 | 0.62 | 1.60 | 0.55 | 1.71 | 0.60 | 1.82 | 0.63 | <.001 | <.001 |
| Noise sensitivity (1-4) | 2.38 | 0.80 | 2.49 | 0.81 | 2.20 | 0.74 | 2.38 | 0.79 | 2.38 | 0.81 | <.001 | .947 |
| GIS-modelled exposures | | | | | | | | | | | | |
| $L_{Aeq,24}$ dB(A) (range 22-71 dB(A)) | 50.77 | 7.08 | 50.81 | 7.00 | 50.70 | 7.21 | 50.68 | 7.09 | 51.05 | 7.06 | .902 | .351 |
| NOx (µg/m3) (range 3-23 µg/m3) | 12.24 | 6.19 | 12.35 | 6.22 | 12.05 | 6.14 | 12.21 | 6.13 | 12.33 | 6.37 | .233 | .952 |
| Annoyance ratings (1-6) | | | | | | | | | | | | |
| Traffic noise | 2.17 | 1.00 | 2.21 | 1.05 | 2.11 | 0.93 | 2.13 | 0.98 | 2.26 | 1.04 | .089 | .004 |
| Sound from neighbours | 2.02 | 1.02 | 2.08 | 1.05 | 1.94 | 0.99 | 1.97 | 0.98 | 2.16 | 1.14 | .001 | <.001 |
| Sounds from ventilation systems | 1.51 | 0.88 | 1.55 | 0.93 | 1.46 | 0.81 | 1.48 | 0.84 | 1.58 | 0.97 | .063 | .047 |
| Exhaust fumes from traffic | 1.44 | 0.88 | 1.49 | 0.93 | 1.37 | 0.80 | 1.40 | 0.84 | 1.56 | 0.97 | .003 | <.001 |
| Vibrations from traffic | 1.45 | 0.89 | 1.49 | 0.94 | 1.39 | 0.81 | 1.42 | 0.87 | 1.50 | 0.93 | .004 | .034 |
| Street and nightlife | 1.43 | 0.86 | 1.43 | 0.87 | 1.43 | 0.85 | 1.42 | 0.86 | 1.45 | 0.87 | .744 | .223 |
| Pollution from wood burning | 1.41 | 0.82 | 1.39 | 0.80 | 1.43 | 0.85 | 1.39 | 0.78 | 1.47 | 0.93 | .360 | .320 |
| Sounds from other installations | 1.44 | 0.77 | 1.48 | 0.83 | 1.38 | 0.68 | 1.40 | 0.73 | 1.54 | 0.90 | .027 | .002 |
| Smells from industrial production | 1.23 | 0.68 | 1.22 | 0.69 | 1.23 | 0.66 | 1.21 | 0.65 | 1.28 | 0.75 | .156 | .020 |
| Industrial Noise | 1.14 | 0.54 | 1.14 | 0.54 | 1.14 | 0.52 | 1.13 | 0.50 | 1.20 | 0.63 | .411 | .003 |

Note: Figures in brackets indicate scale range. Due to internal missing values the numbers of persons responding to each question typically slightly deviates from the total N.
$L_{Aeq,24}$ = A weighted average energy equivalent 24-hour sound level,
NOx=Nitrogen oxide

Table 3.Proportion of participants reporting annoyance and annoyance in relation to anxiety category.

| Dichotomized annoyance ratings | Number of responses | Percent annoyed | Percent annoyed in relation to anxiety category | | | OR increase with 95 % CI | |
|---|---|---|---|---|---|---|---|
| | | | Low anxiety (n=1918) | Medium anxiety (n=807) | High anxiety (n=131) | Medium anxiety Vs. Low Anxiety | High anxiety Vs. Low Anxiety |
| Traffic noise | 2847 | 8.7 | 7.8 | 10.4 | 13.2 | 1.38 (1.04-1.82)* | 1.81 (1.06-3.09)* |
| Sound from neighbours | 2842 | 7.8 | 6.8 | 7.9 | 20.9 | 1.17 (0.86-1.60) | 3.64 (2.30-5.77)* |
| Sounds from ventilation systems | 2826 | 3.9 | 3.7 | 3.9 | 8.5 | 1.07 (0.69-1.64) | 2.46 (1.27-4.77)* |
| Exhaust fumes from traffic | 2833 | 3.8 | 3.1 | 5.3 | 5.4 | 1.77 (1.18-2.65)* | 1.82 (0.81-4.08) |
| Vibrations from traffic | 2832 | 3.8 | 3.3 | 4.6 | 7.0 | 1.44 (0.95-2.18) | 2.24 (1.09-4.62)* |
| Street and nightlife | 2819 | 3.4 | 3.2 | 3.6 | 4.7 | 1.15 (0.74-1.81) | 1.49 (0.64-3.54) |
| Pollution from wood burning | 2823 | 3.0 | 2.8 | 3.3 | 5.5 | 1.17 (0.79-1.89) | 2.00 (0.89-4.51) |
| Sounds from other installations | 2820 | 2.4 | 1.7 | 3.4 | 6.3 | 2.04 (1.22-3.44)* | 3.87 (1.75-8.58)* |
| Smells from industrial production | 2817 | 2.2 | 2.0 | 1.9 | 7.8 | 0.96 (0.52-1.76) | 4.23 (2.05-8.72)* |
| Industrial Noise | 2808 | 1.1 | 1.1 | 0.9 | 3.1 | 0.83 (0.35-1.98) | 2.98 (1.00-8.85)* |
| Noise Sensitivity | 2847 | 38.7 | 34.2 | 47.0 | 53.8 | 1.70 (1.44-2.01) | 2.24 (1.57-3.21) |

Note: Annoyance scores: 1= not aware, 2 = aware, but it does not annoy me, 3 = not especially annoyed, 4 = fairly annoyed, 5 =very annoyed, 6= extremely annoyed. Scores are dichotomized as 1 to 3 and 4 to 6. Low anxiety = Mean scores between 1.00 and 1.99. Medium anxiety = Mean scores between 2.00 and 2.99. High Anxiety = Mean scores between 3.00 and 4.00. *Increase in odds ratio is statistically significant, $p<0.05$. OR = Odds ratio; CI = confidence interval. Noise sensitivity scores: 1= Not at all sensitive, 2 = Not especially sensitive, 3 = Fairly sensitive, 4 = Very sensitive. Scores are dichotomized as 1 to 2 and 3 to 4.

Table 4. Spearman rank correlations (Rho's) between the study variables. Star (*)indicates p<0.05.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Age (years) | 1 | | | | | | | | | | | | | | | |
| 2 Psychic trait anxiety score | -.09* | 1 | | | | | | | | | | | | | | |
| 3 Noise sensitivity | -.01 | .22* | 1 | | | | | | | | | | | | | |
| 4 Asthma | .02 | .08* | -.00 | 1 | | | | | | | | | | | | |
| 5 NOx | -.08* | -.02 | .05* | -.00 | 1 | | | | | | | | | | | |
| 6 24-hour average dB(A) | -.11* | .01 | .00 | .02 | .50* | 1 | | | | | | | | | | |
| 7 Traffic noise | -.07* | .10* | .17* | .05* | .12* | .20* | 1 | | | | | | | | | |
| 8 Sounds from neighbours | -.19* | .11* | .12* | .07* | .20* | .15* | .25* | 1 | | | | | | | | |
| 9 Sounds from ventilation | -.04* | .06* | .13* | .04* | .08* | .00 | .12* | .20* | 1 | | | | | | | |
| 10 Exhaust fumes, traffic | .00 | .07* | .13* | .09* | .15* | .22* | .44* | .21* | .15* | 1 | | | | | | |
| 11 Vibrations, traffic | -.02 | .07* | .09* | .04* | .05* | .18* | .46* | .17* | .10* | .56* | 1 | | | | | |
| 12 Street and nightlife | -.10* | .08* | .08* | .02 | .25* | .24* | .30* | .27* | .10* | .34* | .29* | 1 | | | | |
| 13 Pollution, wood burning | .15* | .003 | .04* | .02 | -.23* | -.15* | .10* | .07* | .05* | .16* | .12* | -.04* | 1 | | | |
| 14 Sound, other installations | -.17* | .09* | .09* | .06* | .16* | .12* | .14* | .32* | .28* | .18* | .13* | .19* | -.02 | 1 | | |
| 15 Smells, industry | .03 | .01 | .03 | .05* | .02 | .02 | .13* | .12* | .14* | .21* | .18* | .10* | .20* | .10* | 1 | |
| 16 Industrial noise | .00 | .02 | .08* | .06* | .01 | .05* | .22* | .13* | .14* | .25* | .21* | .16* | .15* | .09* | .35* | 1 |

Note: The figures have been rounded to two decimals. Age, n=2856; psychic trait anxiety, n= 2856; Noise sensitivity, =2847; Asthma, n=2856; NOx (nitrogen oxides), n=2856; 24-hour average dB(A), n= 2430; Traffic Noise, n=2854; Sounds from neighbours, n=2848; Sounds from ventilation, n=2833; Exhaust fumes from traffic, n =2840; Vibration from traffic, n=2839; Street and nightlife, n=2827; Pollution from wood burning, n= 2830; Sounds other installations, n=2827; Smells from industrial production, n= 2824; Industrial Noise, n=2815.

Table 5. Unadjusted logistic regression analyses between the continuous trait anxiety and noise sensitivity score, GIS-estimated sound and NOx levels and the dichotomised environmental annoyance scores.

| | Trait anxiety, effect per unit increase in mean score (1-4) | | | | | |
|---|---|---|---|---|---|---|
| | Public health survey 2004 | | | Asthma survey 2005 | | |
| Outcome variable | OR | 95 % CI | P-value | OR | 95 % CI | P-value |
| Traffic noise* | 1.25 | 1.07-1.45 | .004 | 1.45 | 1.18-1.77 | <.001 |
| Train noise | 1.28 | 1.00-1.65 | .050 | -- | -- | -- |
| Aircraft noise | 1.26 | 0.96-1.65 | .101 | -- | -- | -- |
| Sounds from neighbours | 1.56 | 1.32-1.84 | <.001 | 1.65 | 1.34-2.03 | <.001 |
| Sounds from ventilation | -- | -- | -- | 1.37 | 1.02-1.84 | .034 |
| Exhaust fumes from traffic | 1.25 | 1.01-1.56 | .044 | 1.71 | 1.29-2.28 | <.001 |
| Vibrations, traffic | -- | -- | -- | 1.48 | 1.10-1.98 | .009 |
| Street and nightlife | -- | -- | -- | 1.21 | 0.87-1.67 | .258 |
| Pollution from wood burning | 1.24 | 0.94-1.65 | .129 | 1.18 | 0.84-1.66 | .346 |
| Sound, other installations | -- | -- | -- | 2.14 | 1.52-3.02 | <.001 |
| Smells from industrial production | 1.39 | 0.95-2.03 | .090 | 1.38 | 0.94-2.03 | .100 |
| Industrial noise | -- | -- | -- | 1.44 | 0.84-2.46 | .184 |

| | Noise sensitivity, effect per unit increase in score (1-4) | | | | | |
|---|---|---|---|---|---|---|
| | Public health survey 2004 | | | Asthma survey 2005 | | |
| Outcome variable | OR | 95 % CI | P-value | OR | 95 % CI | P-value |
| Traffic noise* | 1.52 | 1.35-1.71 | <.001 | 2.09 | 1.78-2.45 | <.001 |
| Train noise | 1.14 | 0.93-1.38 | .204 | -- | -- | -- |
| Aircraft noise | 1.37 | 1.11-1.70 | .003 | -- | -- | -- |
| Sounds from neighbours | 1.46 | 1.27-1.66 | <.001 | 1.57 | 1.33-1.86 | <.001 |
| Sounds from ventilation | -- | -- | -- | 1.93 | 1.54-2.43 | <.001 |
| Exhaust fumes from traffic | 1.53 | 1.29-1.81 | | 2.11 | 1.67-2.66 | <.001 |
| Vibrations, traffic | -- | -- | -- | 2.04 | 1.62-2.56 | <.001 |
| Street and nightlife | -- | -- | -- | 1.63 | 1.28-2.09 | <.001 |
| Pollution from wood burning | 0.97 | 0.77-1.21 | .763 | 1.07 | 0.82-1.40 | .606 |
| Sound, other installations | -- | -- | -- | 2.00 | 1.49-2.68 | <.001 |
| Smells from industrial production | 1.10 | 0.81-1.49 | .549 | 1.08 | 0.79-1.47 | .625 |
| Industrial noise | -- | -- | -- | 2.07 | 1.35-3.18 | .001 |

| | GIS estimated sound level, effect per unit increase in dB(A) | | | | | |
|---|---|---|---|---|---|---|
| | Public health survey 2004 | | | Asthma survey 2005 | | |
| Outcome variable | OR | 95 % CI | P-value | OR | 95 % CI | P-value |
| Traffic noise* | 1.10 | 1.08-1.12 | <.001 | 1.08 | 1.06-1.11 | <.001 |
| Train noise | 1.02 | 0.99-1.04 | .244 | -- | -- | -- |
| Aircraft noise | 0.96 | 0.93-0.99 | .004 | -- | -- | -- |

| | GIS estimated sound level, dichotomized at >=55dB (A) | | | | | |
|---|---|---|---|---|---|---|
| | Public health survey 2004 | | | Asthma survey 2005 | | |
| Outcome variable | OR | 95 % CI | P-value | OR | 95 % CI | P-value |
| Traffic noise* | 2.93 | 2.40-3.58 | <.001 | 2.56 | 1.97-3.34 | <.001 |
| Train noise | 0.98 | 0.68-1.41 | .900 | -- | -- | -- |
| Aircraft noise | 0.43 | 0.26-0.70 | .001 | -- | -- | -- |

| | GIS estimated average yearly NOx, effect per unit increase in µg/m3 | | | | | |
|---|---|---|---|---|---|---|
| | Public health survey 2004 | | | Asthma survey 2005 | | |
| Outcome variable | OR | 95 % CI | P-value | OR | 95 % CI | P-value |
| Exhaust fumes from traffic | 1.10 | 1.08-1.13 | <.001 | 1.11 | 1.08-1.14 | <.001 |
| Pollution from wood burning | 0.92 | 0.89-0.96 | <.001 | 0.93 | 0.89-0.97 | .001 |
| Smells from industrial production | 1.05 | 1.01-1.09 | .008 | 1.02 | 0.98-1.06 | .286 |

Note: OR = Odds ratio; CI = confidence interval. GIS= Geographical Information System. NOx= Nitrogen oxides. Dashes indicate that the questions were not included. *In the asthma survey 2005 traffic noise refers to total traffic noise including noise from roads, trains and aircrafts. Noise sensitivity was measured with one item with four response alternatives.

Table 6. Multiple logistic regression analyses: Trait anxiety

| *Outcome variable* | Public health survey 2004 | | | Asthma survey 2005 | | |
|---|---|---|---|---|---|---|
| Independent variables | OR | 95% CI | P-value | OR | 95% CI | P-value |
| *Total traffic noise* | | | | | | |
| Psychic trait anxiety score | 1.22 | 1.07-1.39 | .003 | 1.32 | 1.07-1.64 | .009 |
| Gender | 1.09 | 0.92-1.28 | .325 | 1.49 | 1.11-2.00 | .008 |
| Age | 1.00 | 0.99-1.00 | .162 | 0.99 | 0.97-1.00 | .025 |
| Asthma | 1.25 | 1.04-1.49 | .015 | 1.45 | 1.08-1.93 | .012 |
| GIS estimated sound >=55 dB (A) | 2.90 | 2.44-3.46 | <.001 | 2.49 | 1.91-3.26 | <.001 |
| *Sound from neighbours* | | | | | | |
| Psychic trait anxiety score | 1.29 | 1.14-1.47 | <.001 | 1.47 | 1.18-1.82 | .001 |
| Gender | 0.99 | 0.84-1.16 | .888 | 1.13 | 0.84-1.53 | .428 |
| Age | 0.99 | 0.98-0.99 | .000 | 0.97 | 0.96-0.98 | <.001 |
| Asthma | 1.30 | 1.09-1.55 | .003 | 1.74 | 1.29-2.34 | <.001 |
| *Sound, from ventilation* | | | | | | |
| Psychic trait anxiety score | -- | -- | -- | 1.22 | 0.90-1.65 | .200 |
| Gender | -- | -- | -- | 1.24 | 0.82-1.88 | .316 |
| Age | -- | -- | -- | 0.98 | 0.96-0.99 | .001 |
| Asthma | -- | -- | -- | 1.64 | 1.09-2.46 | .017 |
| *Exhaust fumes from traffic* | | | | | | |
| Psychic trait anxiety score | 1.23 | 0.98-1.55 | .074 | 1.66 | 1.23-2.25 | .001 |
| Gender | 1.71 | 1.24-2.35 | .001 | 1.49 | 0.96-2.31 | .079 |
| Age | 1.01 | 1.00-1.03 | .010 | 1.00 | 0.99-1.02 | .912 |
| Asthma | 1.36 | 0.99-1.86 | .056 | 1.51 | 0.99-2.29 | .056 |
| GIS estimated NOx levels (µg/m3) | 1.18 | 1.14-1.22 | <.001 | 1.17 | 1.12-1.23 | <.001 |
| *Vibrations, traffic* | | | | | | |
| Psychic trait anxiety score | -- | -- | -- | 1.37 | 1.01-1.84 | .042 |
| Gender | -- | -- | -- | 1.19 | 0.78-1.81 | .421 |
| Age | -- | -- | -- | 0.98 | 0.97-1.00 | .021 |
| Asthma | -- | -- | -- | 1.30 | 0.85-1.98 | .233 |
| *Sound, other installations* | | | | | | |
| Psychic trait anxiety score | -- | -- | -- | 1.72 | 1.20-2.47 | .003 |
| Gender | -- | -- | -- | 1.55 | 0.87-2.78 | .140 |
| Age | -- | -- | -- | 0.95 | 0.93-0.97 | <.001 |
| Asthma | -- | -- | -- | 2.19 | 1.33-3.62 | .002 |

OR = Odds ratio; CI = confidence interval. GIS= Geographical Information System. NOx= Nitrogen oxides. Dashes indicate that the questions were not included. *In the asthma survey 2005 traffic noise refers to total traffic noise including noise from roads, trains and aircrafts. Gender: 0=male, 1=female; Asthma: 0=No, 1=yes; GIS estimated sound: 0= below 55dB (A), 1= higher or equal to 55 dB(A). GIS estimated average yearly NOx (effect per unit increase in µg/m3). Trait anxiety was measured as a mean of 7-items (effect per unit increase in mean score (1-4)).

Table 7. Multiple logistic regression analyses: Noise sensitivity

| *Outcome variable* | Public health survey 2004 | | | Asthma survey 2005 | | |
|---|---|---|---|---|---|---|
| Independent variables | OR | 95% CI | P-value | OR | 95% CI | P-value |
| *Total traffic noise* | | | | | | |
| Noise sensitivity score | 1.33 | 1.20-1.47 | <.001 | 2.02 | 1.71-2.38 | <.001 |
| Gender | 1.04 | 0.88-1.22 | .640 | 1.26 | 0.94-1.70 | .127 |
| Age | 1.00 | 0.99-1.00 | .073 | 0.99 | 0.98-1.00 | .016 |
| Asthma | 1.29 | 1.08-1.54 | .006 | 1.51 | 1.13-2.03 | .005 |
| GIS estimated sound >=55 dB (A) | 2.88 | 2.42-3.43 | <.001 | 2.48 | 1.88-3.26 | <.001 |
| *Aircraft noise* | | | | | | |
| Noise sensitivity score | 1.44 | 1.26-1.64 | <.001 | -- | -- | -- |
| Gender | 0.79 | 0.64-0.98 | .031 | -- | -- | -- |
| Age | 1.01 | 1.01-1.02 | .001 | -- | -- | -- |
| Asthma | 1.28 | 1.02-1.61 | .037 | -- | -- | -- |
| *Sound from neighbours* | | | | | | |
| Noise sensitivity score | 1.46 | 1.27-1.67 | <.001 | 1.55 | 1.30-1.84 | <.001 |
| Gender | 1.00 | 0.79-1.26 | .979 | 1.08 | 0.79-1.47 | .635 |
| Age | 0.97 | 0.96-0.98 | <.001 | 0.97 | 0.96-0.98 | <.001 |
| Asthma | 1.53 | 1.20-1.95 | .001 | 1.85 | 1.37-2.49 | <.001 |
| *Sound, from ventilation* | | | | | | |
| Noise sensitivity score | -- | -- | -- | 1.90 | 1.51-2.41 | <.001 |
| Gender | -- | -- | -- | 1.03 | 0.67-1.57 | .900 |
| Age | -- | -- | -- | 0.97 | 0.96-0.99 | <.001 |
| Asthma | -- | -- | -- | 1.70 | 1.13-2.56 | .011 |
| *Exhaust fumes from traffic* | | | | | | |
| Noise sensitivity score | 1.35 | 1.20-1.52 | <.001 | 1.98 | 1.55-2.53 | <.001 |
| Gender | 1.25 | 1.02-1.52 | .030 | 1.35 | 0.86-2.11 | .190 |
| Age | 1.01 | 1.00-1.02 | .006 | 1.00 | 0.98-1.01 | .893 |
| Asthma | 1.52 | 1.23-1.86 | <.001 | 1.60 | 1.05-2.45 | .028 |
| GIS estimated NOX levels (µg/m3) | 1.08 | 1.06-1.09 | <.001 | 1.10 | 1.07-1.14 | <.001 |
| *Vibrations, traffic* | | | | | | |
| Noise sensitivity score | -- | -- | -- | 1.98 | 1.56-2.51 | <.001 |
| Gender | -- | -- | -- | 1.01 | 0.66-1.55 | .951 |
| Age | -- | -- | -- | 0.98 | 0.97-1.00 | .010 |
| Asthma | -- | -- | -- | 1.33 | 0.87-2.04 | .185 |
| *Street and nightlife* | | | | | | |
| Noise sensitivity score | -- | -- | -- | 1.62 | 1.26-2.08 | <.001 |
| Gender | -- | -- | -- | 1.08 | 0.69-1.70 | .736 |
| Age | -- | -- | -- | 0.97 | 0.95-0.98 | <.001 |
| Asthma | -- | -- | -- | 0.89 | 0.54-1.46 | .647 |
| *Sound, other installations* | | | | | | |
| Noise sensitivity score | -- | -- | -- | 1.87 | 1.39-2.52 | <.001 |
| Gender | -- | -- | -- | 1.41 | 0.78-2.54 | .253 |
| Age | -- | -- | -- | 0.95 | 0.93-0.97 | <.001 |
| Asthma | -- | -- | -- | 2.44 | 1.47-4.03 | .001 |
| *Industrial noise* | | | | | | |
| Noise sensitivity score | -- | -- | -- | 2.02 | 1.31-3.12 | .001 |
| Gender | -- | -- | -- | 1.25 | 0.56-2.78 | .585 |
| Age | -- | -- | -- | 1.00 | 0.97-1.03 | .991 |
| Asthma | -- | -- | -- | 1.71 | 0.82-3.60 | .156 |

OR = Odds ratio; CI = confidence interval. GIS= Geographical Information System. NOx= Nitrogen oxides Dashes indicate that the questions were not included. *In the asthma survey 2005 traffic noise refers to total traffic noise including noise from roads, trains and aircrafts. Gender: 0=male, 1=female; Asthma: 0=No, 1=yes; GIS estimated sound: 0= below 55dB (A), 1= higher or equal to 55 dB(A). GIS estimated average yearly NOx (effect per unit increase in µg/m3). Noise sensitivity was measured with one item (1-4; effect per unit increase).

## APPENDIX

Overview of survey questions.

**1. Asthma question**
Asthma was measured with one item.

Do you have asthma?

The response alternatives were: 1=No, 2= Yes, but it is no problem, 3=Yes, it is a slight problem, 4=Yes, it is a severe problem.

**2. Noise sensitivity question**
Noise sensitivity was measured with one item.

Fix on which answer best describes your usual way to feel when you're exposed to noise/sound?

The response alternatives were: 1= Not at all sensitive, 2 = Not especially sensitive, 3 = Fairly sensitive, 4 = Very sensitive.

**3. Trait anxiety questions**
Trait anxiety was measured with 7-items. The items, formulated as statements, were derived from the psychic trait anxiety scale from the Swedish universities Scales of Personality (SSP).

a) I have a rather poor self-confidence
b) I'm the kind of person who is excessively sensitive and easily hurt
c) I seldom dare to speak up when in a discussion; because I believe that that other people don't think my opinion matter.
d) I think it takes an unusually long time for me to get over distressing experiences
e) I often feel insecure when I meet people that I don't know that well
f) I often worry over things that other people experience as insignificant
g) I get worried far in advance when I'm about to get started with something

The items were responded on a four point scale: 1=does not apply at all, 2=does not apply particularly well, 3=applies fairly well, 4=applies completely.

**4. Annoyance questions in the asthma survey 2005**
In a residential are there might be a number of annoying factors. Some of the more common are listed below. If you reflect on the conditions as you have perceived them during the last 12-months to what degree would you consider your self annoyed when you are in your home?

a) Traffic noise
b) Industrial noise
c) Street and night life
d) Sound from neighbours
e) Sound from ventilation systems
f) Sounds from other installations (e.g. elevators, drainage, laundry room etc.)
g) Smells from industrial production
h) Pollution from wood burning
i) Exhaust fumes from traffic
j) Vibration from traffic

All items were responded to on six point scales: 1 = not aware, 2=aware, but it does not annoy me, 3=not especially annoyed, 4=fairly annoyed, 5=very annoyed, 6=extremely annoyed.

**5. Annoyance questions in the public health survey 2004**
Have you during the last 3 months experienced annoyance from the following factors in your residential area?

a) Traffic noise
b) Sound from neighbours
c) Smells from industrial production
d) Pollution from wood burning
e) Exhaust fumes from traffic
f) Train noise
g) Aircraft noise

All items were responded to on four point scales: 1=Yes, at least once daily, 2=Yes, at least once a week, 3=Yes, but more seldom, 4=No, never.