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Neighbour and traffic noise annoyance at home - prevalence and trends among Danish adults

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Summary

Neighbour and traffic noise are affecting many people in their everyday life, implying adverse effects on quality of life and health. In many countries, the most dominant noise sources disturbing people in their homes are traffic and neighbours. The aims of the present study were to examine the prevalence of adult Danes that are annoyed in their home by noise from neighbours and traffic, respectively, and to examine the trends over time. Data are derived from the Danish Health and Morbidity Surveys in 2000, 2005, 2010 and 2013. The sample sizes were quite large (approx. 25 000 individuals per survey) with adequate response rates varying from 57% to 74%. All samples were drawn at random from the adult Danish population (16 years or older). The purpose of the surveys was to describe the status and trends in health and morbidity in the adult Danish population and the factors that influence health status. Noise annoyance was assessed by asking the respondent whether they had been annoyed by noise from traffic or noise from neighbours, respectively, in their home during the past two weeks. The possible answer categories were: ‘Yes, very annoyed’, ‘yes, slightly annoyed’, ‘no’. The prevalence of adult Danes that have been very or slightly annoyed by traffic noise have increased from 6.3% in 2000 to 9.6% in 2013. During the same period, noise annoyance from neighbours seemed to have increased significantly, but due to different survey modes, quantification is not possible. However, the prevalence varies strikingly between house types. Thus, the prevalence was 32.7% among individuals living in multi-storey housing and less than 10% among individuals living in row, double and detached houses. The paper compares the Danish results with findings from surveys in a few other European countries, and the methodologies will be discussed.

1. Introduction

Noise annoyance is included in many national health surveys aiming at providing a national overview of the health situation, and the results of health surveys are useful for planning and prioritizing public health services, disease prevention and health policy.

The adverse effects of noise has had the attention of WHO for decades, and several reports are published, e.g. an assessment report [1] addressing the environmental health inequalities in Europe and pointing out noise exposure at home as one of the environmental health inequality indicators.

Due to the influence of noise on health, the European Environmental Agency has analyzed the traffic noise situation and published a report

“Noise in Europe 2014” [2]. Some of the key messages are that road traffic is the most dominant source of environmental noise with an estimated 125 million people affected by noise levels exceeding 55 dB L_{den} as defined in [3], almost 20 million adults are annoyed, further 8 million suffer sleep disturbance, and the noise causes at least 10 000 premature deaths in Europe each year, over 900 000 cases of hypertension and 43 000 hospital admissions. Unfortunately, a similar report does not exist for neighbour noise, maybe because it’s a topic even more difficult to deal with than traffic noise.

The Danish Environmental Protection Agency has published a report [4] stating that 724 000 dwellings in Denmark are exposed to road traffic noise above the recommended limit L_{den} 58 dB, mapping based on [3].

This paper presents the results from a national health survey carried out in Denmark in 2013 that included questions about neighbour and traffic noise annoyance and compares results to previous surveys.

2. Housing stock in Denmark

In Denmark there are about 2.7 million dwellings in total, of these about 1 million in multi-storey housing. In Figure 1 are found graphs for number of dwellings according to year of construction and dwelling types. Buildings from different periods have different construction characteristics, and thus expectedly different sound insulation and protection against neighbour noise. For brief information about these issues, see [6] and [7], where the building types have been denoted E1, E2 and E3. The period, No. of dwellings, and typical constructions for each of these building types are:

E1: < 1950; 500 000; Timber floors and various walls

E2: 1930-1960; 100 000; In-situ concrete floors or other materials

E3: 1960-2009; 400 000; Concrete elements

From the 1950s, general regulatory sound insulation requirements were introduced in Denmark, and the dwellings built before then (about 500 000) have in general a poor sound insulation. Until 2008 the regulations were unchanged, see [6] and [7]. In 2008, the sound insulation requirements were tightened, estimated implementation in practice in 2010.

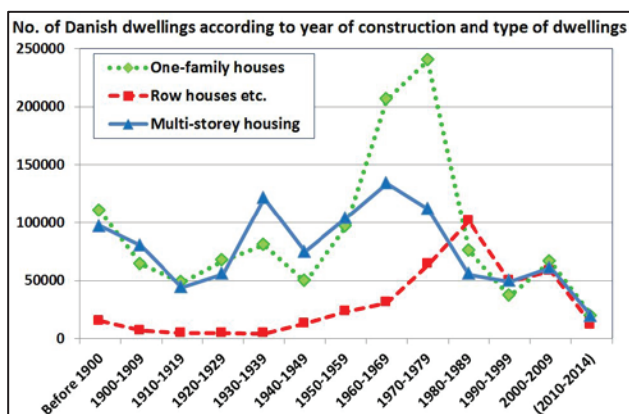


Figure 1. Number of Danish dwellings according to year of construction and type of dwellings – 10 year periods from 1900-2009. Source: Statistics Denmark 2015 [5]. Note: Data for 1900-1919 and 2014 are estimated.

During the latest decades, numerous refurbishment and renovation projects have taken place in Denmark, most of these focusing on upgrading technical installations, kitchen and bath rooms and not least at energy savings. Unfortunately, sound

insulation improvement is almost never addressed, not even in cases where sound insulation is known to be a problem. Better and verified knowledge and public information about the extent of the problem might change the situation. Surveys could support such changes. Regulatory sound insulation requirements in several European countries are described in [8], which also – inspired by the END [3] with key elements *Harmonization/mapping, Information, Action* – proposes a strategy for improving sound insulation of homes by three steps: *Sound insulation mapping of housing in Europe, Information, Action*.

3. Noise in Danish health and morbidity surveys 2000-2013

Data derives from the Danish health and morbidity surveys in 2000, 2005, 2010 and 2013. The purpose of the surveys is to describe the status and trends in health and morbidity in the adult Danish population (16 years or older) and the factors that influence health status, including health behaviour and health habits, lifestyles, environmental and occupational health risks and health resources. The results can be used in national, regional and municipal planning and monitoring as well as in research and analysis. All samples were drawn at random from the adult Danish population (including institutionalized persons) using the Danish Civil Registration System. Data were in 2000 and 2005 collected via face-to-face interview at the respondent's home. However, in 2010, the mode was changed from face-to-face interviews to self-administered questionnaires. The letter of introduction invited the selected individuals either to fill in the web questionnaire or to complete the mailed questionnaire. The invited individuals received a unique username and password to access the web questionnaire. In addition, the target population in 2010 and 2013 included all individuals living in Denmark, whereas the target population in 2000 and 2005 only were Danish citizens. Table I shows some study characteristics for the four surveys, respectively.

In these surveys, noise annoyance was assessed by asking the respondent whether they had been annoyed by noise from traffic or noise from neighbours, respectively, in their home during the past two weeks. The possible answer categories and examples of results are found in Table II. The respondents were also asked about other indoor environment exposures. For questions in 2013 and results, see Table III. Information on dwelling type was also obtained for all respondents.

Table I. Main characteristics for the Danish health and morbidity surveys 2000-2013 and indication of noise questions.

Year	Survey mode	Sample size	No. of respondents Response rate (%)	Questions on noise annoyance included in survey
2000 [9]	Face-to face interview	22 484	16 688 / 74%	Noise from traffic; Noise from installations (e.g. pipe, radiator, refrigerator); Noise from neighbours; Noise from nearby business activities; Infrasound or low frequency noise
2005 [10]	Face-to face interview	21 832	14 566 / 67%	Noise from traffic; Noise from installations (e.g. pipe, radiator, refrigerator); Noise from neighbours; Noise from nearby business activities
2010 [11]	Self-administered	25 000	15 165 / 61%	Noise from traffic; Noise from service equipment (e.g. pipe, radiator, refrigerator); Noise from neighbours; Noise from nearby business activities
2013 [12]	Self-administered	25 000	14 265 / 57%	Noise from traffic; Noise from neighbours

Table II. Traffic and neighbour noise: Percentage who were very or slightly annoyed in their home during the past two weeks. Results from 2013.

Type of noise	'Yes, very annoyed'	'Yes, slightly annoyed'	'No'	In all	Total Very or slightly annoyed
Neighbour	2.5	12.8	84.6	100.0	15.4
Traffic	1.2	8.4	90.4	100.0	9.6

Table III. Percentage who were annoyed in their home by various indoor environment exposures within the past two weeks according to type of dwelling. Results from 2013 survey [12].

Exposure	One-family houses	Row and double houses	Multi-storey housing	Other*	All housing types
Smell of mould	2.2	2.3	3.9	0.8	2.8
Noise from traffic	6.6	5.7	15.6	13.7	9.6
Noise from neighbours	5.8	9.0	32.7	20.2	15.4
Odour from nearby wood stoves	12.5	10.1	3.9	7.6	9.1
Smell of tobacco smoke from neighbours	1.9	3.5	13.9	4.9	6.0
Odour from other known sources (such as garbage, wastewater and manure)	7.7	7.3	9.6	8.7	8.3

* Other = e.g. nursing homes, institutions

From Table III, it is clearly seen that the prevalence of annoyance depends on the type of exposure and housing. For traffic noise, the highest prevalence is seen among individuals living in multi-storey houses (15.6%). For neighbour noise, in all, 15.4% of adult Danes have been very or slightly annoyed during the past two weeks in 2013. However, the prevalence varies strikingly between house types. Thus, the prevalence was 32.7% among individuals living in multi-storey housing and less than 10% among individuals living in row, double and detached houses. Figure 2 and 3 show the results for additional analyses of traffic and neighbour noise annoyance according to age. Diagrams including all types of housing are found to the left (a) and for multi-storey housing only to the right (b). All four diagrams show the percentages for Metropolitan Copenhagen, the rest of the country and the entire country. For both traffic noise and neighbour noise, and considering all types of housing together, see Figures 2a and 3a, the noise annoyance is in general higher in the Metropolitan

Copenhagen than in the rest of Denmark. For example, for traffic noise the prevalence is 15.5% in the Metropolitan Copenhagen and 8.1% in other parts of Denmark, see Figure 2a. For neighbour noise annoyance, the figures are 29.3% and 11.8%, see Figure 3a. For traffic noise, the annoyance does not seem to depend on age. For neighbour noise, it is noteworthy that the annoyance is highest for young people, and the prevalence decreases with increasing age, see Figure 3. The reason is unknown, but a hypothesis could be that younger people tend to live in the oldest part of the building stock with poor sound insulation in general (see Section 2), which could explain the surprising results. The Danish health and morbidity surveys are carried out to find the actual status of the situation, but also to monitor trends over time, and for that reason it is important that methods applied provide reproducible results, and that any changes in methods are checked. In Table IV, noise results from the four surveys 2000-2013 are shown.

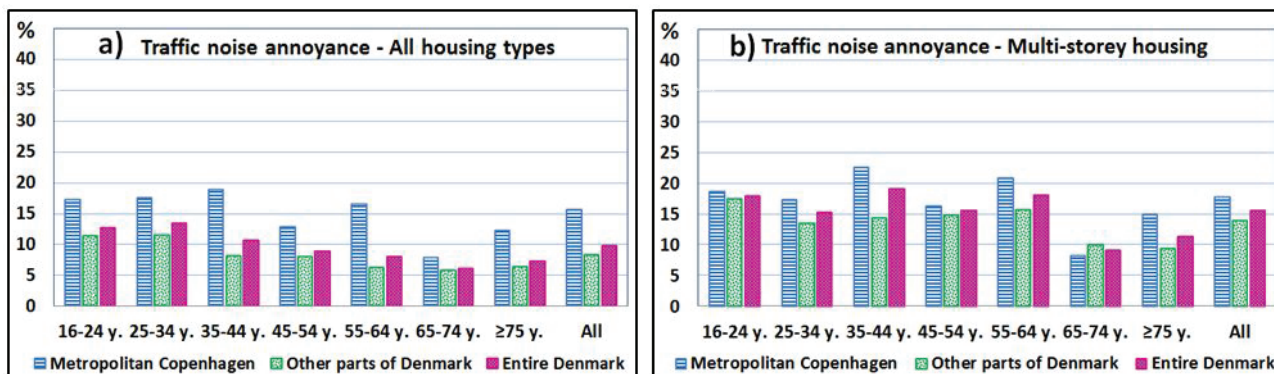


Figure 2. Traffic noise annoyance. Percentage who have been annoyed in their home during the past two weeks according to age and geographic “region”. Further analysis of 2013 data.

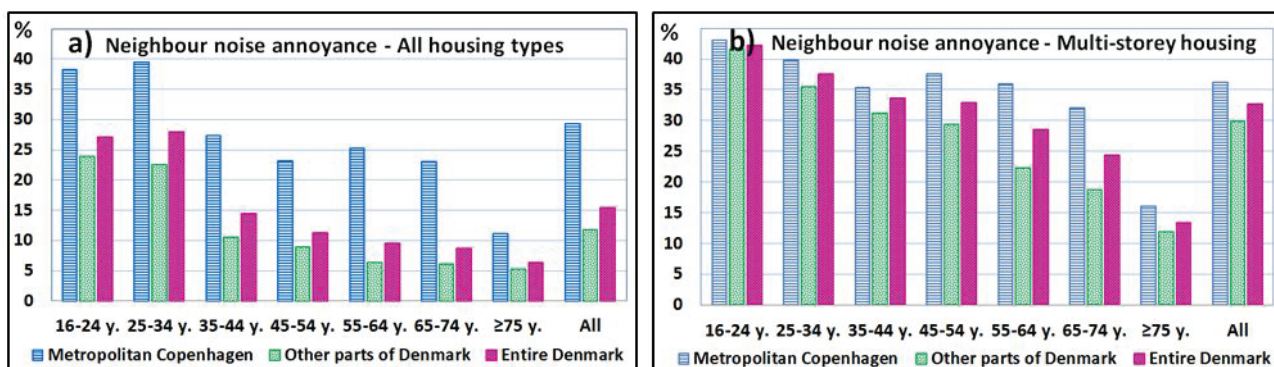


Figure 3. Neighbour noise annoyance. Percentage who have been annoyed in their home during the past two weeks according to age and geographic “region”. Further analysis of 2013 data.

Table IV. Percentage who were annoyed in their home by traffic and neighbour noise, respectively, during the past two weeks. Main results from Danish health and morbidity surveys 2000-2013.

Year	Traffic noise Total	Traffic noise Multi-storey	Neighbour noise Total	Neighbour noise Multi-storey
2000 [9]	6.3	11.5	(7.7)*	(19.1)*
2005 [10]	8.1	15.6	(9.0)*	(21.2)*
2010 [11]	9.6	18.3	15.6	35.3
2013 [12]	9.6	15.6	15.4	32.7

*Change in methodology suggests that pre-2010 survey estimates are not comparable to results from 2010 and 2013.

The prevalence of adult Danes that have been very or slightly annoyed by traffic noise have increased from 6.3% in 2000 to 9.6% in 2013, see Table IV. It is known that any change in survey mode can influence response patterns. Thus, it is difficult to know if a change over time is real or the result of change of mode. In order to disentangle the effect played by mode a face-to-face interview survey was carried out simultaneously with the self-administered survey in 2010 in the Region of Southern Denmark, see [13]. The study showed that the results on annoyance by noise from traffic were comparable according to mode (i.e. the prevalence was not significantly different between the survey modes). However, the prevalence of adults who have been annoyed by neighbour noise was significantly higher in the self-administrated mode than in the face-to-

face interview. Thus, in this case it is impossible to decide, if a change over time is real or caused by change of survey mode.

4. Surveys in Sweden, Germany, EU

A Swedish study showed that the prevalence of individuals that have been annoyed by road traffic noise increased from 8.8% in 1999 to 12.0% in 2007 [14], in both cases self-administered survey mode. The study also showed that the prevalence of people being annoyed by neighbour noise was stable in the same period (9.4% in 1999 and 9.0% in 2007). The sample sizes were 15 750 individuals aged 19-81 years and 43 905 individuals aged 18-80 years (response rates: 73%.and 59%), respectively. A study in the Skåne

County in Sweden in 2013, [15], found very similar prevalences as the national survey in 2007. The sample size was 54 250 adults aged 18-80 years (response rate: 52%), self-administered survey mode.

In a German study made by the Federal Environment Agency in 2012 [16], 2000 persons were interviewed face-to-face. The prevalence was 54% annoyed by traffic noise and 42% by neighbour noise (60% and 47%, respectively, for multi-storey housing, see note to [16]). In *Bauphysikkalender* [17], the above-mentioned main results for 2012 from [16] are shown together with previous data for 2004, 2006, 2008 for several noise sources, implying the possibility to observe trends in the period 2004-2012. The comparison of data for neighbour noise and road traffic noise annoyance did not show clear trends during the period. For rail traffic and industry noise, the prevalence seemed to indicate an increase, and for air traffic a decrease. In another German survey, [18], about 8000 participated, with combined face-to-face interviews and self-administered questionnaires. Results showed 37% annoyed by traffic noise and 26% by neighbour noise.

The WHO assessment report for Europe, [1], includes compiled main data for 30 countries, based on Eurostat's EU-SILC data (http://ec.europa.eu/eurostat/web/products-datasets/-/ilc_mddw01). There was only one noise question combining all types of noise in one question with answer options Yes and No: "*Do you have any of the following problems related to the place where you live?*", including answer category "*Too much noise in your dwelling from neighbours or from outside (traffic, business, factory, etc.)*". Different survey modes were applied for the interviews. The prevalence for EU (28 countries) was 19% for 2013, with country results in the range 10-30%, and 16.5% for Denmark. Although providing an indication of the overall noise problem subjectively evaluated, such simplification lead to results that are insufficient as a basis for qualified decisions on relevant actions for improvements.

In general, it seems difficult to quantify and monitor noise annoyance in single countries as well as comparing countries due to lack of consistency in methods over time and differences in methodologies.

5. Conclusions and recommendations

For both traffic and neighbour noise, the highest prevalence of annoyance in the Danish health survey in 2013 is found for individuals in multi-storey housing, being 15.6% and 32.7%, respectively, compared to less than 10% for other types of housing. For neighbour noise, it is noteworthy that the annoyance is highest for young people, and the prevalence decreases with increasing age.

Considering the ongoing and expected extensive renovation of housing all over Europe, much more attention to improvement of sound insulation between dwellings should be promoted, as it now appears to be a non-topic in spite of the importance to occupants of dwellings, evaluated from the prevalence of neighbour noise annoyance in several surveys.

When looking for enhancements of applicability of results, it should be noticed that all survey analyses are based on subjective responses. However, it would be possible to strengthen and enhance findings considerably by establishing more objective noise exposure data and extend data on building characteristics (e.g. construction year), both linked to individual responses. It is also important to discuss and make qualified decisions on which types of noise to include in surveys and how to split up in separate questions

For the Danish survey data from 2013, it is recommended to analyze the correlation between construction year and neighbour noise annoyance, especially for multi-storey housing. It should also be investigated, whether younger people tend to live in older multi-storey housing with poor sound insulation, which might explain the increased neighbour noise annoyance among younger people. Findings from such further studies could provide basis for change of policies for renovation, leading to a more holistic approach, implying that sound insulation gets much more attention than until now.

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