

Burden of disease from exposure to low frequency noise: a Dutch inventory

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ABSTRACT

The level of concern and health complaints attributed to low frequency noise (LFN) seem to be increasing, not only in the Netherlands, but also at international level. There is evidence suggesting an association between LFN and symptomatic effects such as annoyance and sleep disturbances. A systematic evaluation of the literature which we recently performed, focusing on epidemiological studies on residential sources of LFN in relation to various symptoms and well-being indicators confirms these findings. However, it is still hard to make a valid estimate of the burden of disease due to LFN. Therefore, based on several Dutch datasets we estimated the prevalence of health complaints due to low frequency noise or attributed to it. Limiting factor is that, although we get a *feel for* the “extent” of the problem, the available data only concern perceived exposure rather than actual measurements of LFN, preventing to link the exposures to these health complaints. This is one of the main research gaps in the field. In this paper we discuss the preliminary findings.

INTRUDUCTION

The number of questions and complaints related to Low Frequency Noise (LFN) is increasing. The Ministry of Spatial Planning and the Environment (the Netherlands) has therefore asked the National Institute for Public Health and the Environment (RIVM) to build a knowledge base around the theme, within the framework of the Expertise Centre Noise. Various efforts have been undertaken to shed more light on this topic. Despite these efforts there are still many uncertainties and in many cases it is not possible to give a clear cut answer to the many questions regarding LFN sources, and their effects on people. In view of this, a symposium around LFN was organized in 2014 [1] to hear what we can learn from people who have been working in the field for a long time and with different backgrounds. In addition, a factsheet was prepared for the Ministry and a review was prepared [2] mapping the current evidence for an association between exposure to LFN from different sources, based on a meta-analysis of recent studies. For Municipal Health Services provisional guidelines were published in 2016 [3], provisional since a new approach for the GGD is proposed to decide whether an external source could be present and how to deal with complaints regarding low frequency sounds.

Experience with this new approach will be gained and evaluated systematically this year . And finally, we are preparing a manuscript for the Ministry for Infrastructure and the Environment in the Netherlands which gives an overview of what we know about the prevalence of complaints about LFN and annoyance attributed to low frequency noise in the Netherlands. This paper presents the first results of this inventory.

PREVALENCE OF HIGH ANNOYANCE ATTRIBUTED TO LOW FREQUENCY NOISE

An under-investigated noise component in relation to health effects is low frequency noise (LFN) (sound below 250 Hz), including infrasound (up to 20 Hz) [4] [5]. Although LFN is audible at sufficiently high pressure levels (decibels, dB), it can also occur below the human hearing threshold [6], considering that the human ear responds better to sound frequencies between 500 Hz and 8 kHz [7]. Sounds within the low-frequency sound spectrum comprise a common, everyday-life environmental exposure, produced by natural (sea waves, wind turbulence) as well as by man-made sources (industrial installations, domestic appliances, transportation) sources. Transport noise is the primary cause of LFN and a recent analysis in the Netherlands [8] showed that there seems to be a shift towards low frequency noise from road traffic. Other sources of transport did not show such a trend but it is possible that environmental sources potentially relevant to LFN such as wind turbines have been increasing in the past years (especially in NL) and possibly symptom attribution will increase in the near future. It has been shown that the rapid expansion of infrastructure has increased the attribution of symptoms to LFN and public concern [9]. According to earlier evidence from local environmental health authorities, annoyance is usually the first reaction to this type of noise, often accompanied by secondary effects, such as headache, concentration difficulties palpitations and sleep problems [10] [11]. A number of studies suggest an association between LFN and various physiological and psychological reactions such as annoyance, hearing threshold shift, concentration problems, lower sleep quality, mood effects [12] [13] [6] [14] and also controversial conditions such as the so-called vibro-acoustic disease [15] [16]. Additionally, adverse health effects from occupational exposure have been observed on memory, annoyance and performance [17] [18] [19] [20] [21]. Evidence on vascular and respiratory effects is inconclusive [22]. In our recent review [3] we concluded that systematic evaluation of observational studies suggests an association between exposure to LFN components and self-reported annoyance and various symptoms in the population. However, the number of studies is limited and only 7 studies were eligible for further consideration. Estimates of the prevalence of high annoyance in 4 of the studies varied between 2% and 34% with a pooled prevalence of 10.5%. An association with other health effects including sleep disturbance might exist, but evidence is still limited and inconclusive.

In order to expand the estimation of the burden of disease due to LFN in the Netherlands available registries and datasets were studied.

METHODS

Data sources

Several datasets and registries were used to estimate the prevalence of complaints attributed to low frequency noise in the Netherlands. Table 1 presents the sources we used for this inventory.

Table 1: Overview of data sources

Source/Year	<< 2012	2013	2014	2015	2016
Complaints registry data Municipal Health*	<< x	x	x	X	x
Municipal health Service Monitoring Groningen	x				x
National Inventory of Annoyance					x
TASTE**_project		x			
Panel study and survey about mechanical ventilation systems		x			

*2004/2005, 2006/2007, 2008/2009, 2010/2011, 2013/2014, 2015/2016

**Towards Acoustic SusTainable Environments (TASTE)

The analyses are strictly descriptive. As said, information is only available about registered complaints and self-reported annoyance, which people attribute to a whole range of sources of low frequency noise. No actual exposure data are available so no exposure-effect relations can be derived at this stage. The number (and percentage) of complaints and the percentage (highly) annoyed was compared between measurement points (in time), province, region and/or neighbourhoods where available.

RESULTS

Municipal registry of environmental health complaints. [23] [24]

Since 2004 the Local Municipal health offices uniformly register the environmental health complaints they receive. Causes are registered as presented by the complainant. This registry includes complaints about noise in general and low frequency noise in specific. The registry data are published every two years. For the period of 2011- 2016 noise is part of the top 10 of *agentia* in the environment with 4% of all registered complaints in both periods. The table below shows the number of filed complaints about low frequency noise since 2004 and number and percentage of people mentioning low frequency noise as cause of their annoyance.

Year	2004/2006	2007/2009	2009/2010	2011/2012	2013/2014	2015/2016
Number of LFG complaints (% of total number)	58 (1%)	62 (1%)	67 (1%)	69 (1%)	124 (1%)	186 (2%)

*Percentage of all people who mentioned low frequency noise as important agents of annoyance. In brackets the percentage of all complaints pertaining to annoyance is presented

Results show that the number of complaints in relation to low frequency noise, presented to the Local municipal health offices, has doubled since the 2011/2012 period and before. When people file a complaint about LFN, annoyance is mentioned as the key health outcome (in period 2015/2016 129).

GGD Monitor – Groningen 2012 , 2016 [25]

Every four years the Municipal health services in the Netherlands carry out a health survey. Questions about environment and health are optional and only a few Municipal Health services ask questions about low frequency noise. The Health service in Groningen did so in the years 2012 and 2016. Results show that in both years the percentage of people mentioning low frequency noise as an environmental problem was 2% of all participants and 4% of only those people who filled in at least 1 problem. Although annoyance was also included in the questionnaire, there is no specific information available for annoyance due to low frequency noise.

Towards Acoustic Sustainable Environments (TASTE) [26]

TASTE was a strategic project at RIVM (2012-2015) looking into determinants of perceived acoustic quality at neighbourhood level. Participants were people of 18 years and older, recruited from 33 neighbourhoods in three Dutch cities (Arnhem, Amsterdam and Rotterdam) which we aggregated into 31 neighbourhoods aiming to achieve approximately equal sample size. The selection and recruitment of these participants followed several steps: Neighbourhoods were selected according to level of urbanization, contrasting levels and variations in noise exposure and neighbourhood lay-out, and they were subsequently matched on socio-economic status to ensure variation. Per neighbourhood, a random sample of 500 inhabitants (15,508 in total) was drawn from the municipal population registries of the three cities. By means of a letter, participants were invited to fill out an online questionnaire. If the

participant preferred a postal questionnaire, this was provided on request. After two reminders, 3,972 respondents returned the questionnaire, which means a response percentage of 26. The questionnaire included a standard ISO question about annoyance from low frequency noise (*Thinking about the past 12 months how much were you annoyed, bothered or disturbed by the humming noise from e.g. ventilators, while at home on a scale of 0-10*). Results show that in total some 7% of the respondents indicated to be highly annoyed by the humming sound of e.g. ventilators, with the highest score in Amsterdam of over 8% and 6% in Arnhem and Rotterdam. Also at neighbourhood level a statistically significant difference was found in the percentage of highly annoyed by humming sounds, ranging from 1,5 to 15%. The distribution of the scores across neighbourhoods do not reveal a pattern which is immediately clear, so further analyses are needed to understand these differences.

National Inventory of Annoyance. [27] [28]

The national inventory of annoyance is performed every five to eight years and is aimed at monitoring disturbance from environmental factors in the residential situation. The ISO standard question was used to measure the percentage of annoyed in the past year, using an 11 point scale ranging from not at all to very much. Low frequency noise was described as a “low zooming or humming noise from e.g. a ventilation system or air conditioner”. In 2016 7956 people participated in the survey with a response rate of 35 percent. Results show that the percentage highly annoyed reaches nearly 2% and the percentage “at least slightly annoyed” nearly 5%. Preliminary findings indicate that there are differences in prevalence between provinces and regions. .

Studies into indoor noise from ventilation system, air conditioners and other installations [29][30]

In relation to climate change a literature study as well as a survey and panel study were performed to understand the association between energy saving measures and noise issues [2] [30]. Three noise problems emerged from the literature: a potential increase in the number of airconditioners, energy saving ventilation systems and finally the expansion of the wind turbine parks. In all cases a low frequency component plays an important role. Results from the surveys and Panel study showed that in newly built dwellings with mechanical ventilation systems 41% of the respondents indicated to be at least slightly annoyed by the noise of the system and 13% highly annoyed. The annoyance was not only due to their own ventilation system but also from the ventilation systems of their neighbours. Only 7 of the 161 respondents owned an airconditioner and 2 of them experience noise annoyance from them. Another ten people report an airconditioner from their neighbors and with 4 people experiencing severe annoyance from these. Other installations such as sun boilers, heat pumps installations were only rarely used.

CONCLUSIONS

This first orientation on the burden of disease from exposure to low frequency noise in the Netherlands is based on existing registry and survey data available on registered complaints about low frequency noise and self-reported annoyance attributed to different sources of LFN. Results show that in general some 2% of the general population of 18 years and older experiences problems from LFN (all sources) while at home. Annoyance comes forward as the most mentioned health complaint. The number of complaints seems to have increased or even doubled since 2012.

Where information was available, a strong geographical difference was found at city, region as well as neighbourhood level. It could even be argued that national estimates are not relevant since the distribution of sources is so unequal and thus it is more efficient to study this issue at a low geographic scale level. Harmonization of measures both at the exposure and outcome side are a prerequisite for further research. These form the basic research gaps to be addressed in the future. Further analysis of the role of contextual and personal variables such as noise sensitivity, attitudes and hearing impairment is warranted.

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