European Environment Agency

Noise

Health risks caused by environmental noise in Europe

This briefing assesses the health risks due to exposure to environmental noise in Europe using three indicators to measure, monitor and communicate the impacts of noise pollution on health: (1) exposure to noise above recommended levels established by the World Health Organization; (2) number of people suffering health effects from exposure to noise; (3) burden of disease from noise. The indicators are derived from data submitted to the EEA under the EU Environmental Noise Directive and will be used to inform the development of future targets to reduce the health impacts of noise.

Key messages

- More than 100 million people in Europe are exposed to harmful levels of environmental noise pollution. Road traffic noise is a particular public health problem across many urban areas.
- Long-term exposure to environmental noise contributes to 48 000 new cases of heart disease and 12 000 premature deaths every year in Europe. In addition, 22 million people suffer chronic high annoyance, and 6.5 million suffer chronic high sleep disturbance.
- One million healthy years of life are lost every year due to the effects of noise on health, including annoyance, sleep disturbance and ischaemic heart disease. Annoyance and sleep disturbance account for the bulk of the burden of disease linked to noise.

Quantifying the health impacts of exposure to noise pollution

Noise health risk assessments are used to estimate and communicate the risks to health of exposure to noise pollution. They can also be used to estimate the health benefits of changes in exposure resulting from the introduction of policies, mitigation measures or other initiatives. Box 1 outlines the key steps in conducting a noise health risk assessment at the European level using noise data submitted under the Environmental Noise Directive (END).

Box 1 Key steps in conducting a noise health risk assessment at the European level

1. **Assessing the exposure of the population to environmental noise pollution**

   Data on population exposure to environmental noise generally come from noise modelling by local, regional and national institutions. The number of people exposed to various levels of road, rail, aircraft and industrial noise in urban areas and to levels of road, rail and aircraft noise in non-urban areas across Europe is officially reported by countries as legally required by the Environmental Noise Directive (END).

2. **Estimating the health risks associated with noise exposure**

   The European noise health risk assessment is based on exposure-response functions presented in the Environmental noise guidelines for the European region (WHO Europe, 2018), which allow negative health outcomes, including annoyance, sleep disturbance and incidence of ischaemic heart disease, to be quantified. Premature mortality due to ischaemic heart disease and the effects of aircraft noise on children's reading comprehension are included in the health risk assessment following a recommendation made by van Kamp et

al. (2018). Baseline health statistics, such as incidence of and mortality rates from ischaemic heart disease per country, are used to estimate the number of cases of ischaemic heart disease and the number of premature deaths attributable to noise per year.

Health risks can also be expressed in terms of disability-adjusted life-years (DALYs). Expressing health risks using this indicator adds another step to calculating the number of people affected by the health outcomes described above. The calculation requires the use of disability weights as well as data on years of life lost and years lived with disability due to ischaemic heart disease per country. These data are available from the Institute for Health Metrics and Evaluation.

3. **Evaluating the uncertainties of the estimation**

   Important sources of uncertainties that need to be considered include the following:

   - **Uncertainties in the exposure level.** Data collected under the END do not comprehensively cover all sources, urban areas, roads, railways and airports across Europe, nor do they cover populations exposed to levels of noise below 50 dB L_{night} and 55 dB L_{den}. Noise data from different countries, regions or cities may be modelled using different methodologies, which introduces some inconsistencies into the EU wide combined dataset.
   - **Uncertainties in the population exposed.** Different countries use different methodologies to assign the population to dwellings, which creates differences. In addition, the exact distribution of the population per decibel level is not known, as reporting is done in 5 dB bands.

- **Uncertainties arising from the baseline and health data.** Baseline morbidity and mortality data are based on national statistics. Therefore, using national health data for other sub-national units (e.g. urban areas) may bring about uncertainties, as health baseline data may not apply to the territory uniformly.
- **Uncertainties arising from the exposure response functions used.** Using the generalised exposure-response functions from the World Health Organization may introduce uncertainties if the population in different countries is different with regard to factors influencing the magnitude of the exposure response estimate, such as age and gender distributions (van Kamp et al., 2018).

Various environmental health indicators can be used to quantify the health risks of exposure to noise pollution. They range from a simple indicator of the number of people exposed above the World Health Organization (WHO) recommended noise levels to more complex indicators that show the number of people suffering specific health outcomes or that integrate several health effects into a single number.

The suitability of one indicator over another depends on the policy questions to be answered, the audience to which the results will be communicated, and the uncertainties associated with each indicator, as well as the availability of data, resources and expertise (van Kamp et al., 2018).

This briefing applies three indicators (Table 1) to assess the health risks of environmental noise at the European level using END data and the methodology described in Implications of environmental noise on health and well-being (ETC/ACM, 2018). The indicators can be used to inform the development of future targets aiming to reduce the health impacts of noise.

Table 1 Indicators for monitoring the health impacts of noise at European level.

Population exposed to noise levels harmful to health	
Impacts	113 million people exposed to road noise; 22 million to rail traffic noise; 4 million to aircraft noise; and 1 million to industry noise.
Uncertainties	European data do not cover all sources, urban areas, roads, railways and airports across Europe, nor do they capture exposure to noise levels below the END reporting thresholds.
Communication	This health indicator is simple to implement, relevant for policy purposes and easily understood by the public. However, it does not give information on the specific health effects of noise and does not estimate the health benefits of changes in exposure (van Kamp et al., 2018).
Number of people affected by the specific health effects of noise	
Impacts	High annoyance 22 million; high sleep disturbance 6.5 million; cases of heart disease a year 48 000; premature deaths a year 12 000; and learning impairments in children 12 000.
Uncertainties	Same as for previous indicator. There are uncertainties associated with using generalised exposure response functions and extrapolating baseline health data to different territorial units and populations.
Communication	Provides a good compromise between scientific rigour and simplicity. Results quantify the concrete health effects of noise in Europe and are easily understood by the public and other stakeholders (van Kamp et al., 2018).
Burden of disease due to environmental noise	
Impacts	One million healthy years of life are lost every year due to health effects including annoyance, sleep disturbance and ischaemic heart disease. Annoyance and sleep disturbance make up the bulk of the burden of disease linked to noise.
Uncertainties	Same as for previous indicators. The methodology for calculating the burden of disease for noise is not well established. There is no guidance on which health effects should be included and which disability weights need to be used for high annoyance and high sleep disturbance.
Communication	Using disability-adjusted life-years (DALYs) can help visualise the impact of noise on the health and well-being of the population compared with the impact of other environmental stressors. The different health effects of noise may be ranked using DALYs, and they are routinely used to estimate the economic cost of noise. However, DALYs are difficult for non-experts to interpret and understand (van Kamp et al., 2018).

Number of people above WHO recommended noise levels

The Environmental noise guidelines for the European region (WHO Europe, 2018), define long-term noise exposure levels above which a relevant increase in negative health effects occur, expressed in terms of the indicators L_{den} and L_{night} for road, rail and aircraft sources.

The WHO recommendations provide a basis for estimating the number of people exposed to unhealthy noise levels from different sources of environmental noise (Table 2). The numbers

presented at European level correspond to the number of people above the END reporting thresholds (i.e. 55 dB L_{den} and 50 dB L_{night}). This means that in reality there may be more people exposed to unhealthy noise levels than those that can be assessed with the current END thresholds.

This indicator highlights that noise from road traffic remains a major environmental health problem in Europe: more than 100 million people are exposed to day-evening-night noise levels above the WHO recommended levels. The major proportion of the people affected live in urban areas.

Table 2 Number of people exposed to harmful noise levels based on the number exposed above the END thresholds, i.e. 55 dB L_{den} and 50 dB L_{night}, EEA-33 (excluding Turkey)

Source		Number of people exposed to harmful noise levels (millions)		
		Inside urban areas	Outside urban areas	Total
Road	L_{den}	81.7	31.1	112.8
	L_{night}	57.4	21.1	78.6
Rail	L_{den}	10.7	10.9	21.6
	L_{night}	8.1	9.0	17.1
Aircraft	L_{den}	3.1	1.0	4.1
	L_{night}	0.9	0.4	1.3
Industry	L_{den}	0.8	No data	0.8
	L_{night}	0.4	No data	0.4

Note: Negative health effects start to occur below the END thresholds. WHO recommends reducing noise levels to 53 dB L_{den} and 45 dB L_{night} for road traffic, 54 dB L_{den} and 44 dB L_{night} for rail traffic, and 45 dB L_{den} and 40 dB L_{night} for air traffic.
Source: EEA (2020).

Number of people affected by the specific health effects of noise

The WHO environmental noise guidelines (WHO Europe, 2018) also provide exposure response functions for health outcomes, including annoyance and sleep disturbance, as well as risk ratios for

cardiovascular health outcomes. These provide the basis for quantifying the number of people suffering from specific health effects due to noise.

The range and magnitude of negative health impacts of noise in Europe are significant, with many suffering effects such as annoyance, sleep disturbance, ischaemic heart disease, mortality due to ischaemic heart disease and even learning impairments in children (Table 3). People in urban areas are most badly affected, and the main source contributing to negative health effects is road traffic noise.

Long-term exposure to environmental noise is estimated to contribute to 48 000 new cases of heart disease and 12 000 premature deaths every year in Europe. In addition, 22 million people suffer high annoyance and 6.5 million people suffer high sleep disturbance. It is estimated that more than 12 000 schoolchildren suffer learning impairments due to aircraft noise.

Table 3 Estimated number of people suffering from various health effects due to environmental noise in 2017, EEA-33 (excluding Turkey)

	High annoyance	High sleep disturbance	Ischaemic heart disease	Premature mortality ([a])	Reading impairment in children
Road					
Inside urban areas	12 525 000	3 242 400	29 500	7 600	
Outside urban areas	4 625 500	795 500	10 900	2 500	
Railway					
Inside urban areas	1 694 700	795 500	3 100	800	
Outside urban areas	1 802 400	962 900	3 400	900	
Aircraft					
Inside urban areas	848 300	168 500	700	200	9500
Outside urban areas	276 000	84 600	200	50	2800
Industry					
Inside urban areas	87 200	23 400	200	50	
Outside urban areas	No data	No data	No data	No data	
All ([b])	**21 859 100**	**6 478 300**	**47 900**	**12 100**	**12 300**

Notes: Based on number of people exposed above the END thresholds and areas covered under the END.
([a]) Refers to mortality due to ischaemic heart disease. Premature mortality refers to deaths occurring before a person reaches an expected age.
([b]) There may be double counting for annoyance and sleep disturbance because of combined effects of multiple sources. Double counting is estimated to be no more than 13 % for annoyance and 16 % for sleep disturbance. Double counting for ischaemic heart disease and mortality is estimated to be negligible (ETC/ACM, 2018).
Source: EEA (2020).

Burden of disease

The WHO has developed methods to quantify the burden of disease from environmental noise using DALYs (WHO and JRC, 2011). The DALY estimates how much disease affects the life of the population by combining the burden from:

- mortality, in terms of years lost because of premature death due to disease
- morbidity, in terms of years of life lived adversely affected by disease.

One DALY corresponds to one lost year of healthy life, attributable to morbidity, mortality or both (see Box 2). The sum of DALYs across a population provides a measurement of the gap between actual health status and an ideal situation in which the entire population lives to an advanced age, free of disease and disability (WHO Europe, 2016).

Box 2 Disability-adjusted life-years (DALYs) for environmental noise

Because diseases affect health and quality of life in different ways, the severity of each condition or disease is weighted differently. To count the number of life-years lost due to disability, each life-year is weighted by a number that corresponds to the severity of the disability suffered, ranging from 0 (full health) to 1 (death). The disability weights used for noise are:

Health condition	Disability weight (i.e. severity of health impact) ([a])	
Long-term high annoyance	0.01 (van Kamp et al., 2018)	0.02 (WHO Europe, 2018)
Long-term high sleep disturbance	0.0175 (van Kamp et al., 2018)	0.07 (WHO Europe, 2018)

([a]) Disability weights for high annoyance and sleep disturbance are currently being revised and may change

For example, using the more conservative disability weight estimate (0.0175), living with high sleep disturbance due to noise for 57 years is equivalent in terms of DALYs to dying 1 year earlier than expected (0.0175 x 57 = 1).

The most important causes of disability due to environmental noise are annoyance and sleep disturbance. High annoyance account for 30-50 % of all years lived with disability, and high sleep disturbance account for 20-55 %, depending on the source and disability weight used (Table 4). While annoyance and sleep disturbance are not severe health outcomes, the large number of people affected, illustrated by the use of DALYs, demonstrates the relevance of this indicator.

Table 4 Estimated number of DALYs due to road, rail and aircraft in areas covered under the END, EEA-33 (excluding Turkey)

Source	Health effect	Years lived with disability	Years of life lost	DALYs/year
Road	High annoyance	172 000-343 000	0	172 000-343 000
	High sleep disturbance	78 000-311 000	0	78 000-311 000
	Ischaemic heart disease	15 000	117 000	131 000
Rail	High annoyance	35 000-70 000	0	35 000-70 000
	High sleep disturbance	31 000-123 000	0	31 000-123 000
	Ischaemic heart disease	2 457	18 643	21 100
Aircraft	High annoyance	11 000-22 000	0	11 000-22 000
	High sleep disturbance	4 000-18 000	0	4 000-18 000
	Ischaemic heart disease	308	2 271	2 579
Industry	High annoyance	874-1 744	0	874-1 744
	High sleep disturbance	409-1 643	0	409-1 643
	Ischaemic heart disease	77	689	766

Notes: Light orange shading indicates the type of disease is included in the International Statistical Classification of Diseases (WHO, 2019). The disability weights used for calculating high annoyance and high sleep disturbance are those specified by the JRC and WHO (2011) and van Kamp et al. (2018) and are indicated as ranges.
Source: EEA (2020).

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