# Disability weights for noise-related health states in the WHO European Region

World Health Organization

European Region

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**Abstract**
Following the publication of the 2018 *Environmental noise guidelines for the European Region*, WHO set out to update environmental noise related disability weights to enhance health risk assessment in the field. The "European noise disability weights measurement study", on which this report is based, aimed to derive disability weights for several environmental and non-environmental noise related health states using standardized and comparable methods. A nationally representative sample survey was administered in the general populations of four countries of the WHO European Region – Hungary, Italy, Netherlands (Kingdom of the) and Sweden. Disability weights for moderate and severe annoyance were estimated to be 0.006 and 0.011, respectively. The disability weight for sleep disturbance was estimated to be 0.009. The set of European noise disability weights is a valuable resource for use in future environment-related health risk assessments across the WHO European Region and beyond.

**Keywords**
NOISE; SURVEYS AND QUESTIONNAIRES; DISABILITY-ADJUSTED LIFE YEARS; RISK ASSESSMENT; GLOBAL BURDEN OF DISEASE

**Document number: WHO/EURO:2024-9196-48968-72969**



**Suggested citation.** Disability weights for noise-related health states in the WHO European Region. Copenhagen: WHO Regional Office for Europe; 2024. Licence: CC BY-NC-SA 3.0 IGO.

**Cataloguing-in-Publication (CIP) data.** CIP data are available at http://apps.who.int/iris.



Designed by: Pellegrini

# Contents

# Acknowledgements

This report was written by Periklis Charalampous and Juanita A. Haagsma (Erasmus University Medical Centre (Erasmus MC), Netherlands (Kingdom of the)), who also conducted the research for the "European noise disability weights measurement study" on which it is based.

A coordination group provided scientific guidance, technical inputs and review during the project, under the general oversight of the WHO Regional Office for Europe. The coordination group consisted of the following experts: Mathias Basner (University of Pennsylvania, United States); Mark Brink (Federal Office for the Environment, Switzerland); Brecht Devleesschauwer (Sciensano, Belgium); Petter Ljungman (Karolinska Institute, Sweden); Katarina Paunovic (University of Belgrade, Serbia); Dirk Schreckenberg (Centre for Applied Psychology, Environmental and Social Research– ZEUS GmbH, Germany); Irene van Kamp (National Institute for Public Health and the Environment, Netherlands (Kingdom of the)); and Jördis Wothge (Federal Environment Agency, Germany).

The project was coordinated by the WHO European Centre for Environment and Health, WHO Regional Office for Europe. Román Pérez Velasco contributed to conceptualization and review of the report, under the overall technical supervision of Dorota Jarosińska and Francesca Racioppi.

The WHO Regional Office for Europe would like to thank Stephen Stansfeld (Queen Mary University of London, United Kingdom) and Shuhei Nomura (Keio University, Japan) for reviewing the research protocol and Bochen Cao (WHO headquarters) for reviewing the report; Carolien CHM Maas (Erasmus MC) for contributing in data analysis; Crispijn van den Brand (Erasmus MC) for checking the newly developed health state descriptions; and Carlotta Di Bari (Sciensano), Matea Elmazi (Erasmus MC), Vanessa Gorasso (Sciensano), Elsa Jonsson Stenberg (Karolinska Institute) and Orsolya Varga (University of Debrecen, Hungary) for their valuable contributions in checking the translations of the questionnaire.

This report was produced with the financial and in-kind support of the Federal Office for the Environment (Switzerland) and the Federal Environment Agency (Germany).

# Abbreviations

| | |
|---|---|
| **DALY** | disability-adjusted life year |
| **GBD** | Global Burden of Disease |
| **IQR** | interquartile range |
| **UI** | uncertainty interval |
| **YLD** | years lived with disability |
| **YLL** | years of life lost (due to premature mortality) |

# 1. Background

Environmental noise ranks among the foremost environmental risks to physical and mental health and well-being, contributing significantly to the burden of disease in the WHO European Region *(1,2)*. Its adverse effects on human health and well-being have attracted increasing attention both from the general public and policy-makers in the Region.

Research on the effects of environmental noise investigates and quantifies the impact of noise on various health-related outcomes, such as annoyance, sleep disturbance and cardiovascular disease. The resulting exposure–response models are instrumental in underpinning various applications, including health risk assessments and the formulation of noise exposure guidelines and limits.

Recognizing this evidence, the WHO Regional Office for Europe embarked on addressing environmental noise in the 1990s. Over the years, WHO has produced guidelines on community noise, night noise, and environmental noise – covering transportation noise, wind turbines and leisure noise *(3–5)* and several reports covering different aspects of health risk assessment in the field of environmental noise *(1,6)*.

Environmental noise is also recognized in the Region-wide environment and health agenda. The *Declaration of the Seventh Ministerial Conference on Environment and Health* and its accompanying roadmap (Budapest Declaration, July 2023) outline a comprehensive strategy to address the health aspects of the triple crisis (environmental pollution, climate change and biodiversity loss). This includes the development and implementation of measures to reduce exposure to environmental noise *(7)*. In particular, the use of the *Environmental noise guidelines for the European Region* is promoted to accelerate progress *(5)*. An important aspect of the roadmap is the recognition of the importance of quantifying the health impacts of environmental pollution, including environmental noise, in shaping effective policies.

New findings, published shortly before the Budapest Conference, reveal a considerable level of adoption of health risk assessments in the field of environmental noise. This underlines the growing recognition of the value of health risk assessments and the need to refine the methods used to better support the implementation of the environmental noise guidelines and policy-making more broadly *(5,8)*.

In many situations, it has become helpful to "weight" the health effects of noise according to their severity; for example, for the prioritization of policy actions or health outcome measurements, such as those used in formulating environmental noise guidelines *(5)*. One approach to performing such weightings is the use of so-called disability weights.

In this approach, each cause of ill-health is assigned a disability weight value to determine how many years a population lives in less than optimal healthy life *(9,10)*. The disability weight is measured on a scale between 0 (corresponding to full health) and 1 (corresponding to death), and represents the severity of health loss associated with a given health state *(11)*. The disability weight is used in health risk assessments allowing computation of years lived with disability (YLD).

The YLD metric can be merged with years of life lost (YLL) into a single numerical index called disability-adjusted life year (DALY) *(10,12)*. The DALY – a summary measure of population health – has historically been used in guiding national and international decision-making and allocation of resources *(12)*. Methodological design choices to estimate the DALY and its components for several diseases and risk factors have been described elsewhere *(13–17)*.

Extensive efforts have been made to estimate disability weights at single- or multi-country level *(18–23)*, with the Global Burden of Disease (GBD) study being the largest multi-country study of its kind *(24)*. In 2011, WHO estimated DALYs resulting from environmental noise using disability weights for annoyance, sleep disturbance, cognitive impairment, ischemic heart disease and tinnitus *(1)*. The disability weights used had a strong impact on the calculated DALYs, with the largest fraction (roughly 900 000 DALYs) resulting from YLDs due to sleep disturbance. The validity of these disability weights values has been questioned on the basis of weakness in their empirical substantiation. In the GBD 2010 disability weights measurement study, disability weights for over 200 health states were derived, using novel methods and surveying techniques *(11)*.

To date, an empirical assessment to derive disability weights for noise-related health states has not been available. Although recent disability weight measurement studies have derived disability weights for a large range of health outcomes from population surveys in the European Region, these do not contain disability weights for noise-related health outcomes such as noise annoyance and sleep disturbance. It is therefore important to derive disability weights for noise-related health states (e.g. annoyance, sleep disturbance, cognitive impairments etc.) in close alignment with the GBD novel measurement techniques.

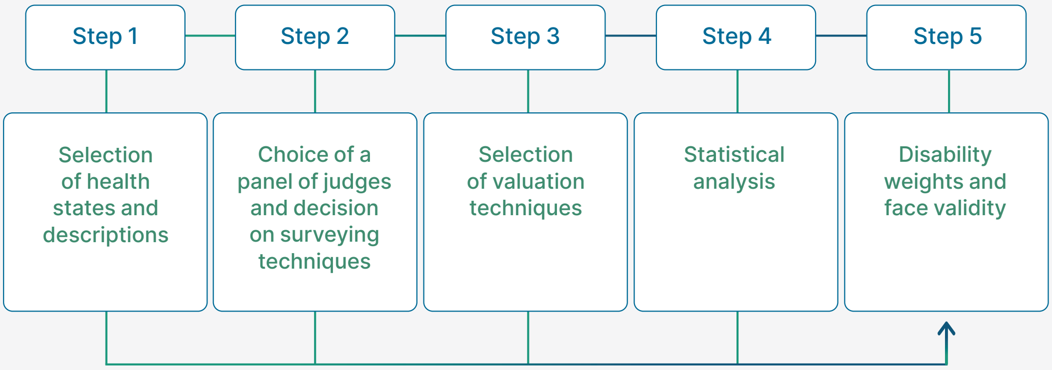
Against this background, the WHO Regional Office for Europe implemented a project aiming to fill a gap when estimating DALYs due to noise-related health states by deriving updated disability weights. To ensure successful implementation, a coordination group consisting of experts in the field was established to provide scientific guidance and technical input, while Erasmus University Medical Centre conducted the study. This effort led to the development of the "European noise disability weights measurement study" (NOISE study) which aimed to advance environmental noise DALY calculations across the European Region *(25)*. This report describes the methodological steps involved in estimating disability weights for environmental noise related health outcomes and presents major findings from the NOISE study, as well as implications for research, policy and practice. This report is intended to be used by national and local authorities responsible for noise action planning, academic institutions and others involved in estimating the environmental burden of disease in terms of DALYs.

Environmental noise ranks among the foremost environmental risks to physical and mental health and well-being, contributing significantly to the burden of disease in the WHO European Region *(1,2)*.

# 2. Methods used in the "European noise disability weights measurement study"

The methodological design choices used to derive disability weights for environmental noise related health states are closely aligned with the GBD standardized measurement approach *(11,24)*. The conceptual framework for estimating disability weights and their methodological steps is depicted in Fig. 1.

## Fig. 1. Conceptual framework for estimating disability weights




*Source*: authors.

The decisions made at each methodological step (steps 1–5, Fig. 1) are described below.

### Step 1. Selection of health states and descriptions

The WHO Regional Office for Europe commissioned a series of systematic reviews to address the connection between environmental noise and several health outcomes, comprising annoyance, sleep disturbance, cognitive impairments, permanent hearing loss, tinnitus, cardiovascular and metabolic effects, and mental health effects, in the context of the development of the *Environmental noise guidelines for the European Region (26)*.

For the purpose of this project, both so called "environmental" and "non-environmental" health outcomes were considered, which means health outcomes that "are in the causal pathway to environmental noise", and those that "may or may not be in the causal pathway to environmental noise", respectively. The decision to include both environmental and non-environmental health states was made to ensure that the whole severity and functional limitations spectrum of health states was covered, as well as to facilitate the comparison of the resulting disability weights with those of previous disability weight studies.

The set of European Region noise disability weights consists of 82 health states. Lay descriptions for most of these health states were adopted from the GBD 2010 disability weights measurement study *(11)* and/or based on the European disability weights measurement study *(23)*. Lay descriptions for nine unique health states, including annoyance (moderate and severe), sleep disturbance (with and without environmental noise as the source), cognitive impairments (mild, moderate and severe), tinnitus, and loss of smell/taste were developed by the project experts using simple and non-clinical vocabulary. The construction of these nine lay descriptions followed the same design principles used in the GBD 2010 and European disability weights measurement studies *(11,23)*.

## Step 2. Choice of a panel of judges and decision on surveying techniques

In the first GBD study, disability weights were based on the judgments made by health experts. However, significant differences were seen between studies with disability weights based on the judgments of medical experts and those with disability weights derived from the perceptions of members of the general public *(27–29)*. More recently, the incorporation of the views of the general public has been recommended when deriving disability weights *(11,30)* as those made by health experts may result in over- or underestimation of disability, which can impact YLD values. The accuracy of these values is important since health risk assessments are primarily used as a decision-making tool to prioritize resource allocation at the population level.

The NOISE study incorporated general populations' perceptions from four countries belonging to the WHO European Region: Hungary, Italy, Netherlands (Kingdom of the) and Sweden. The decision to consider these four European Region countries was made to allow comparability with previous European disability weights measurement studies *(23,31)*; these countries are also geographically representative of the European Union and the European Economic Area.

Participants aged 18–75 years old were included; those with insufficient command of the native language of the country of residence (i.e. Hungary, Italy, Netherlands (Kingdom of the) and Sweden) were excluded. Data collection was contracted out to a European market research company, which ensured national representativeness in terms of age, gender and level of education for the samples used. As in previous studies, the surveys were conducted online *(21,23)*.

## Step 3. Selection of valuation techniques

Several valuation techniques to derive disability weights exist *(18,19)*. The main mode of valuation measurement applied in the GBD disability weights measurement studies is the paired comparison *(11,24)*; its performance has been shown to be conceptually simple for web-based population samples. In the paired comparison, respondents need to consider two hypothetical people (i.e. person A and person B), each with a lay description of a certain health state, and are asked to choose which of these two people they regard as "being healthier". These simple questions allow input from wide range of participants encompassing diverse cultural, environmental and demographic backgrounds. Simple valuation techniques like the paired comparison can provide results that are highly reliable in test re-test analyses *(21–23,32)*. For this study, each respondent performed a total of 13 paired comparison valuation tasks. The health states depicted in each paired comparison task were selected completely randomly, so that every respondent had different choices to make. Fig. 2 depicts an example of the paired comparison valuation technique for illustrative purposes.

### Fig. 2. Sample paired comparison question

Imagine that both people will have these problems for the rest of their lives.
Who do you think is healthier overall, the person A or the person B?

Person A has difficulty falling or staying asleep.

Person B has some trouble remembering recent events, and finds it hard to concentrate and make decisions and plans.

*Source*: authors.

## Step 4. Statistical analysis

First, descriptive statistics were used to describe the sociodemographic and medical characteristics of the respondents. Second, paired comparison responses were analysed based on the extent of disagreement across the sample of respondents over the ordering of all possible pairs of health states. Thus, probit regression analyses on the paired comparison responses were run in both pooled (i.e. all countries) and country-specific (i.e. each country) datasets. To project the results from the probit regression model on a disability weight scale – anchoring between 0 and 1 – a locally weighted scatterplot smoothing regression model of the probit versus the logit transformed GBD 2010 disability weights *(11)* was run. Finally, to change the scale and obtain disability weight values ranging between 0 and 1, an inverse logistic transformation of the projected disability weights was run. Through a bootstrap procedure, 95% uncertainty intervals (95% UI) were estimated.

### Step 5. Disability weights and face validity

There are several methodological approaches to evaluating the validity of the resulting disability weights *(18,19)*. The NOISE study followed a simple face validity check: does the disability weight increase as the severity of a particular health state increases?

This means that the disability weight for mild health states (e.g. mild cognitive impairment) must be lower compared to moderate and severe health states (e.g. moderate and severe cognitive impairment). Face validity checks were performed for all the included health states.

This study aims to advance environmental noise DALYs estimation by deriving updated disability weights across the European Region

# 3. Findings

## Characteristics of the study population

A total of 4056 respondents from four countries filled in the survey questionnaire. The median age was 49 (interquartile range (IQR): 28), and 53.3% were female. Of respondents, 43.9% had a medium educational level, and slightly more than half were employed (56.2%). Around half of the respondents reported having no chronic medical conditions (48.9%), while around 4% reported having four or more chronic medical conditions (Table 1).

### Table 1. Sociodemographic and medical characteristics of the study population

| | | Study sample: N = 4056 |
|---|---|---|
| **Age** | Median (IQR) | 49 (28) |
| **Age group** | 18–34 years | 1019 (25.1%) |
| | 35–54 years | 1381 (34.0%) |
| | 55–75 years | 1656 (40.8%) |
| **Gender** | Male | 1884 (46.4%) |
| | Female | 2163 (53.3%) |
| | Other | 9 (0.2%) |
| **Education level[a]** | Low | 898 (22.1%) |
| | Medium | 1782 (43.9%) |
| | High | 1376 (33.9%) |
| **Occupation status** | Employed | 2279 (56.2%) |
| | Unemployed | 327 (8.1%) |
| | Student | 224 (5.5%) |
| | Retired | 902 (22.2%) |
| | Unable to work | 184 (4.5%) |
| | Other | 140 (3.5%) |

### Table 1. Sociodemographic and medical characteristics of the study population (contd)

| | | Study sample: N = 4056 |
|---|---|---|
| **Household income** | Low | 1252 (30.9%) |
| | Middle | 1044 (25.7%) |
| | High | 1245 (30.7%) |
| | Unwilling to tell or do not know | 515 (12.7%) |
| **Chronic conditions** | 0 | 1984 (48.9%) |
| | 1 | 1177 (29.0%) |
| | 2 | 522 (12.9%) |
| | 3 | 213 (5.3%) |
| | 4 or more | 160 (3.9%) |

[a] The education level of each respondent was determined using the International Standard Classification of Education (ISCED-2011), and categorized into three groups: low (ISCED: 0, 1, 2), medium (ISCED: 3, 4) and high (ISCED: 5 or higher).

## Self-reported annoyance

Following the recommendations of the International Commission on Biological Effects of Noise (ICBEN), participants were asked about the overall degree of noise annoyance in their living environment. Participants were required to answer the following question: "Thinking about the last 12 months, when you are here at home, how much does noise from air, road, rail traffic and industrial activity, bother, disturb, or annoy you?" *(33,34)*. Table 2 shows the self-reported annoyance results of the study population. Out of all the participants, 38% were not at all annoyed by noise, whereas approximately 8.3% were highly annoyed by noise. Between countries, the highest percentage of moderately and highly noise-annoyed respondents was reported in Italy (27.5% and 13.7%, respectively).

### Table 2. Self-reported annoyance of the study population

| | | Study sample: N = 4056 |
|---|---|---|
| **Noise annoyance (e.g. air traffic, road traffic, rail traffic and industrial activity)** | Not at all | 1540 (38.0%) |
| | Slightly | 1391 (34.3%) |
| | Moderately | 786 (19.4%) |
| | Highly | 339 (8.3%) |

## Disability weights for 82 health states

Table 3 shows the estimated disability weights and 95% UI for 82 health states. Mild impairment of distance vision (0.005, 0.002–0.009 95% UI) and mild anaemia (0.005, 0.003–0.009 95% UI) shared the lowest disability weights, whereas intensive care unit admission (0.761, 0.492–0.942 95% UI) had the highest disability weight across all the included European Region countries.

For all health states, a logical order in the estimated disability weights was observed. For example, mild motor impairment had a lower disability weight (0.010, 0.006–0.016 95% UI), compared to moderate (0.074, 0.053–0.098 95% UI) and severe motor impairment (0.382, 0.276–0.500 95% UI) (Table 3).

### Table 3. Disability weights for 82 health states

| | Disability weight (95% UI) | |
|---|---|---|
| **Cancer** | | |
| Cancer, diagnosis and primary therapy | 0.254 | (0.167–0.359) |
| Cancer, metastatic | 0.495 | (0.376–0.627) |
| Mastectomy | 0.081 | (0.059–0.106) |
| Stoma | 0.084 | (0.062–0.110) |
| Terminal phase: with medication (for cancers, end-stage kidney or liver disease) | 0.535 | (0.416–0.666) |
| Terminal phase: without medication (for cancers, end-stage kidney or liver disease) | 0.538 | (0.422–0.669) |
| **Cardiovascular and circulatory disease** | | |
| Acute myocardial infarction: days 1–2 | 0.374 | (0.267–0.492) |
| Acute myocardial infarction: days 3–28 | 0.076 | (0.055–0.101) |
| Angina pectoris: mild | 0.055 | (0.037–0.076) |
| Angina pectoris: moderate | 0.056 | (0.038–0.077) |
| Angina pectoris: severe | 0.116 | (0.081–0.166) |
| Cardiac conduction disorders and cardiac dysrhythmias | 0.186 | (0.119–0.272) |
| Claudication | 0.015 | (0.010–0.022) |
| Heart failure: mild | 0.046 | (0.031–0.065) |
| Heart failure: moderate | 0.076 | (0.055–0.100) |
| Heart failure: severe | 0.138 | (0.092–0.204) |
| Stroke: long-term consequences, mild | 0.023 | (0.015–0.033) |
| Stroke: long-term consequences, moderate | 0.072 | (0.052–0.096) |
| Stroke: long-term consequences, moderate plus cognitive problems | 0.279 | (0.188–0.384) |
| Stroke: long-term consequences, severe | 0.481 | (0.364–0.611) |
| Stroke: long-term consequences, severe plus cognitive problems | 0.654 | (0.510–0.796) |

Table 3. Disability weights for 82 health states (contd)

| | Disability weight (95% UI) | |
|---|---|---|
| **Diabetes, digestive and genitourinary disease** | | |
| Diabetic foot | 0.032 | (0.021–0.046) |
| Diabetic neuropathy | 0.101 | (0.074–0.137) |
| Chronic kidney disease (stage IV) | 0.090 | (0.067–0.120) |
| End-stage renal disease: with kidney transplant | 0.026 | (0.017–0.038) |
| End-stage renal disease: on dialysis | 0.452 | (0.335–0.576) |
| Infertility: primary | 0.008 | (0.004–0.012) |
| Infertility: secondary | 0.006 | (0.003–0.010) |
| **Chronic respiratory diseases** | | |
| Asthma, controlled | 0.011 | (0.007–0.017) |
| Asthma, partially controlled | 0.046 | (0.035–0.058) |
| COPD and other chronic respiratory disease, mild | 0.023 | (0.015–0.034) |
| COPD and other chronic respiratory disease, severe | 0.323 | (0.222–0.436) |
| **Neurological disorders** | | |
| Dementia: mild | 0.053 | (0.036–0.075) |
| Dementia: moderate | 0.284 | (0.190 0.389) |
| Dementia: severe | 0.298 | (0.201–0.407) |
| Multiple sclerosis, severe | 0.551 | (0.425–0.696) |
| Epilepsy: severe (seizures ≥ once per month) | 0.615 | (0.480–0.772) |
| Epilepsy: less severe (seizures < once per month) | 0.218 | (0.133–0.320) |
| Parkinson disease: mild | 0.023 | (0.015–0.034) |
| Parkinson disease: moderate | 0.215 | (0.137–0.310) |
| Parkinson disease: severe | 0.599 | (0.469–0.740) |
| **Mental, behavioural and substance use disorders** | | |
| Anxiety disorders: mild | 0.026 | (0.017–0.038) |
| Anxiety disorders: moderate | 0.082 | (0.060–0.108) |
| Anxiety disorders: severe | 0.390 | (0.281–0.509) |
| Major depressive disorder: mild episode | 0.066 | (0.046–0.089) |
| Major depressive disorder: moderate episode | 0.248 | (0.161–0.347) |
| Major depressive disorder: severe episode | 0.499 | (0.375–0.637) |
| Attention deficit hyperactivity disorder | 0.025 | (0.016–0.036) |
| Conduct disorder | 0.092 | (0.068–0.123) |

## Table 3. Disability weights for 82 health states (contd)

| | Disability weight (95% UI) |
|---|---|
| **Hearing and vision loss** | |
| Hearing loss: mild | 0.013 (0.008–0.020) |
| Hearing loss: moderate | 0.027 (0.018–0.040) |
| Hearing loss: severe | 0.089 (0.066–0.118) |
| Hearing loss: profound | 0.115 (0.080–0.169) |
| Hearing loss: complete | 0.137 (0.092–0.205) |
| Hearing loss: mild with ringing | 0.028 (0.018–0.041) |
| Hearing loss: moderate with ringing | 0.050 (0.033–0.070) |
| Hearing loss: severe with ringing | 0.124 (0.086–0.178) |
| Hearing loss: profound with ringing | 0.180 (0.114–0.270) |
| Hearing loss: complete with ringing | 0.220 (0.142–0.317) |
| Distance vision: mild impairment | 0.005 (0.002–0.009) |
| Distance vision: moderate impairment | 0.030 (0.020–0.045) |
| Distance vision: severe impairment | 0.111 (0.079–0.156) |
| Distance vision: blindness | 0.117 (0.082–0.167) |
| **Other** | |
| Anaemia: mild | 0.005 (0.003–0.009) |
| Anaemia: moderate | 0.052 (0.035–0.073) |
| Anaemia: severe | 0.098 (0.071–0.134) |
| **Annoyance: moderate** | **0.006 (0.003–0.010)** |
| **Annoyance: severe** | **0.011 (0.006–0.016)** |
| Cognitive impairments: mild | 0.013 (0.008–0.019) |
| Cognitive impairments: moderate | 0.080 (0.059–0.106) |
| Cognitive impairments: severe | 0.096 (0.070–0.131) |
| Generic uncomplicated disease: anxiety about diagnosis | 0.042 (0.028–0.061) |
| Generic uncomplicated disease: worry and daily medication | 0.051 (0.035–0.071) |
| Intensive care unit admission | 0.761 (0.492–0.946) |
| Loss of smell/taste | 0.017 (0.011–0.025) |
| Motor impairment: mild | 0.010 (0.006–0.016) |
| Motor impairment: moderate | 0.074 (0.053–0.098) |
| Motor impairment: severe | 0.382 (0.276–0.500) |
| **Sleep disturbance without environmental noise as the source** | **0.009 (0.006–0.014)** |
| **Sleep disturbance with environmental noise as the source** | **0.010 (0.006–0.015)** |
| Spinal cord lesion at neck level: treated | 0.536 (0.408–0.666) |
| Tinnitus | 0.044 (0.028–0.063) |

COPD: chronic obstructive pulmonary disease.
Note: Bold text indicates health outcomes for noise for which no previous disability weights were empirically derived, but which are measured in nearly all noise surveys.
*Source*: adapted with permission from Salomon et al. (2012) *(11)* and Haagsma et al. (2015) *(23)*.

## Disability weights for annoyance

Moderate annoyance had a disability weight of 0.006 (0.003–0.010 95% UI), and severe annoyance a disability weight of 0.011 (0.006–0.016 95% UI) (Table 4). In all countries, moderate annoyance was ranked lower compared to high annoyance.

### Table 4. Disability weights for annoyance

| Disability weights for annoyance | | |
|---|---|---|
| **Moderate annoyance** | 0.006 | (0.003–0.010 95% UI) |
| **Severe annoyance** | 0.011 | (0.006–0.016 95% UI) |

## Disability weights for sleep disturbance

Disability weights were estimated for sleep disturbance with and without source of environmental noise. Sleep disturbance with environmental noise as the source had a disability weight of 0.010 (0.006–0.015 95% UI), while sleep disturbance without environmental noise as the source had a disability weight of 0.009 (0.006–0.014 95% UI) (Table 5).

### Table 5. Disability weights for sleep disturbance

| Disability weights for sleep disturbance | | |
|---|---|---|
| **Sleep disturbance without environmental noise as the source** | 0.009 | (0.006–0.014 95% UI) |
| **Sleep disturbance with environmental noise as the source** | 0.010 | (0.006–0.015 95% UI) |

# 4. Implications for research, policy and practice

Disability weights estimated for 82 environmental and non-environmental noise related health outcomes can be used to generate internationally comparable results in DALY-calculation studies that focus on noise as an environmental risk factor. The presented set of disability weights includes not only the novel health outcomes, such as annoyance and noise-induced sleep disturbance, but a range of cardiovascular and mental health outcomes that have been associated with noise, such as stroke, depression, dementia and cognitive impairment. The European noise disability weights reported here allow for single- and multi-country assessments of environmental stressors and are based on societal health preferences rather than the judgment from one or more health experts. Health state valuations based on paired comparisons were found to be consistent across the four selected European countries.

Of particular interest are the disability weights for annoyance and (noise-induced) sleep disturbance, as these outcomes are measured in virtually all noise surveys. The disability weight for severe annoyance (0.011) is estimated to be much lower than the one used by the seminal WHO *Burden of disease from environmental noise study* (0.02) *(1)*. Even more pronounced is the difference between the old (0.07) and new (0.01) value for sleep disturbance *(1)*, but also between the value proposed by van Kamp et al. (2018) (0.02) *(35)* and this study's value (0.01). These differences might be explained by different methods (e.g. panel of judges, valuation techniques) used to derive these disability weights. Previous assessments were based on judgment from medical experts, whereas the WHO assessment presented here involved judgment from members of the general public.

The NOISE study is valuable to policy-makers and the public alike for several reasons. First, it relies on the health state preferences of the general population, rather than those derived from patients or medical experts, which may result in an over- or underestimation of disability and can, in turn, affect the YLD values. Second, it allows comparison of disability weights with other studies, such as the European disability weights measurement study *(23)*. If the same methodological design choices used in the present assessment are followed, comparability with other disability weights measurement studies will be maintained. Third, it provides disability weights for different levels of severity, for example for annoyance (i.e. moderate and severe), which can be used individually in health risk assessments and/or economic evaluations.

To determine the (attributable) burden of disease at population level, expressed as DALYs, the use of the same set of disability weights is crucial to compare impacts of various diseases and risk factors over time and locations. Methodological guidance in the quantitative risk assessment of environmental noise is provided by the WHO Regional Office for Europe (2012) *(36)*. More findings and comparison of the European noise disability weights with those estimated in the GBD 2010 and European disability weights measurement studies *(11,23)* are summarized by Charalampous, Maas & Haagsma (2024) *(25)*.

In summary, the newly estimated/derived robust disability weights hold high value as a resource for future environmental noise related health risk assessments not only in the European Region but also in broader contexts. These disability weights can serve as a foundation for more accurate evaluations of the impact of environmental noise on human health, aiding in the development of informed policies and interventions to mitigate the risks.

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