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Kristien Ria Stassen, Pieter Collier and Rudi Torfs

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Hogeschool - Universiteit Brussel

Stormstraat 2, 1000 Brussel, Belgium
T: +32 2 210 12 11 F: + 32 2 217 64 64

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Corresponding Author: Ms Kristien Ria Stassen, Drs

Corresponding Author's Institution: University College Brussels

First Author: Kristien Ria Stassen, Drs

Order of Authors: Kristien Ria Stassen, Drs; Pieter Collier; Rudi Torfs, Ir

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Abstract

Exposure to environmental noise due to rail, road and air traffic affects public health. Cardiovascular diseases, sleep disturbance and annoyance are the most-reported harmful effects of noise exposure in scientific literature. In this article, the transportation noise burden of disease in Flanders is quantified based on the disability adjusted life year methodology (DALY), combining the burden due to premature death and disability in a single index. The estimation relies on relevant health statistics, exposure-response relationships and the distribution of exposure. The estimated number of DALYs due to environmental noise in Flanders 2004 was 20 517, corresponding to 1.7% of the total burden of disease in Flanders or 21.8% of the total environmental burden of disease in Flanders due to particular matter, ozone, carcinogenic air pollutants (i.e. lead, ultra violet radiation, benzene, radon, nickel, arsenic and polyaromatic hydrocarbons) and noise. The results establish that traffic-related noise exposure has a large impact on public health. Nevertheless, the results must be interpreted carefully because of the rather large uncertainty range attributable to the variety in exposure level, the uncertainty in exposure-response functions and the choice of severity weight.

1. Introduction

Due to urbanization, economic growth and motorized traffic, noise is widespread in the present day society. Environmental noise, caused by traffic, industrial and recreational activities is one of the main local environmental problems in Europe and the source of an increasing number of complaints from the public (Berglund et al., 1999). In a review article Passchier-Vermeer and Passchier (2000) concluded that there was sufficient evidence for a causal relationship between noise exposure and hearing impairment, hypertension, ischemic heart disease, annoyance and sleep disturbance. In an updated review, Babisch (2006) concluded that “the evidence for a causal relationship between transportation noise and cardiovascular risk, appears to have increased throughout the recent years”. The European Directive on Environmental Noise (Directive 2002/49/EC 2002) provides a common basis for tackling the noise problem across the European Union based on avoiding, preventing or reducing the harmful effects on a prioritised basis due to exposure to environmental noise. To that end harmonised exposure indicators are necessary to determine the noise exposure. The European Directive also obliges Member States to inform the public on harmful effects due to environmental noise. Impact indicators, based on dose-effect relationships are one way to assess and communicate the effects of noise exposure. Hofstetter and Hammitt (2002) argue strongly for aggregated, one-dimensional environmental health indicators, incorporating health effects like mortality, morbidity and less of well-being. After all, a myriad of different health effects exists (Hofstetter et al., 2002) and given the restricted resources available to protect health, there is a need to weight different risks and to allocate resources to get the maximum benefit (Künzli et al., 2000). Experiences with aggregated health metrics in environmental decision-support tools are limited to the use of monetized estimates of health impacts like Willingness to Pay and health metrics that transform any type of morbidity or mortality into an equivalent number

of life years such as Quality Adjusted Life Years or Disability Adjusted Life Years (Hofstetter et al., 2002). This paper further focuses on the most widely-used indicator 'Disability Adjusted Life Years' (DALYs) (Prüss-Üstün et al., 2003). In Flanders, DALYs are used to support environmental health policy and are yearly published in the State of the Environment Report.

The DALY was introduced by the World Bank and WHO in the "Global Burden of Disease" study to quantify the loss of health in different regions of the world and to allow a comparison and a ranking between regions and continents (Murray & Lopez, 1996). This initial approach has prompted a series of country-level studies, national burden of disease studies (Mathers et al., 2001; McKenna et al., 2005) and risk-based environmental burden of disease studies (de Hollander et al., 1999; Prüss-Üstün et al., 2001, Valent et al., 2004). The latest mentioned studies describe the fractions of national or subnational disease burden attributable to an environmental risk factor to better determinate priorities for action. Environmental Burden of Disease studies allow policy actions or interventions to be based on estimated health gains and allow research to be prioritized. Notwithstanding the growing influence of the DALY in population health, the DALY has not been without its critics (Allotey & Reidpath, 2002; Fox-Rushby, 2002; Anand & Hanson, 1998). Many criticisms have focused on the specific assumptions concerning approaches to weighting DALYs, the notion of values, the quality of data and the inequity as a result of age-weighting and discounting. Nevertheless, the DALY concept has been widely used. Key advantages of the DALY are its aggregate nature, a common health unit combining quantity (premature mortality) and quality of life (time spent with disability), as well as its possibility to compare various risk factors and diseases with the burden of disease in other areas (de Hollander, 2004). Furthermore, Hofstetter & Hammit (2001) noticed that the

DALY concept benefits from the most comprehensible publicly available database. Anand et al. (1998) argued that “efficiency of resource allocation will be enhanced by using DALYs to reorient expenditure from high- to low-cost per DALY interventions”.

The burden of disease related to environmental noise exposure has been rarely estimated in non-occupational settings in Europe (WHO, 2005b). Estimates of the transportation noise burden of disease were only reported in the Netherlands and Switzerland. Knol and Staatsen (2005) calculated the environmental burden of disease in the Netherlands due to exposure to air pollution, transportation noise, radiation and indoor dampness. Knol et al. (2005) estimated the potential DALYs of transportation noise exposure in 2000, taken into account the health effects hypertension, cardiovascular diseases, severe annoyance and sleep disturbance, at 2 300 DALYs per million people (CI_{90%}: 1 100 to 4 700 DALYs per million people). During a WHO expert consultation on environmental noise burden of disease in 2005, Müller-Wenk reported the perceived sleep disturbance due to noise in Switzerland in 1995 at 20 160 DALYs or 2 800 DALYs per million people (WHO, 2005a). The WHO expert consultation fit in with the attempts of the WHO Europe to harmonize the methodology used to assess the environmental burden of disease due to environmental noise exposure in terms of Disability Adjusted Life Years. The final report of WHO Europe is expected to be released in December 2008.

In the meanwhile in Flanders (Belgium), Torfs (2003) quantified the environmental burden of disease due to health effects caused by air pollutants. Torfs added in his study a rough estimation for transportation noise, 1 093 DALYs per million people. Due to the European Union Directive on assessment and management of environmental noise (Directive 2002/49/EC 2002), the Flemish government was interested in more detailed figures on the health impact of environmental noise. In this paper, the environmental noise burden of

disease due to transport and expressed in DALYs is calculated for Flanders and compared with the data in the Netherlands, Switzerland and the estimated total burden of disease in Flanders.

2. Methodology

In this paper, environmental noise is defined as noise emitted from road traffic, trains and aircraft. Consequently, in this paper environmental noise is synonym to transportation noise. Noise caused by industrial and recreational activities is excluded because these sources are too location specific. Before clarifying in detail the DALY methodology used for estimating the environmental noise burden of disease in Flanders, the DALY methodology is shortly described in general.

DALYs are the aggregation of the number of life years lost due to premature mortality (YLL) and the number of years lived with disability (YLD) (Prüss-Üstün et al., 2003). To estimate YLL the number of deaths must be multiplied by the standard life expectancy at the age at which death occurs. Health loss (YLD) attributable to environmental exposures can be assessed by multiplying the number of people affected, the average duration of the response and a severity weight. The severity weight refers to a set of disease specific empirical weights, based on public health and medical experts' judgments using Person Trade-Off methods, to value the level of disability on a scale from 0 (perfect health) to 1 (death) (Murray & Lopez, 1996). In the original Burden of Disease Studies, DALYs were age-weighted and discounted (Arnesen & Kipiriri, 2004). Age-weighting implies a higher value of a life year in adulthood due to the critical role played by adults in society (Nelson, 2003). The discount rate, usually about 3%, refers to the annual loss of social preference for a year of healthy life now rather than in the future (Nelson, 2003).

In this paper, the transportation noise burden of disease in Flanders is estimated, based on the DALY methodology applied in the Dutch environmental noise burden of disease (Knol & Staatsen, 2005) and the preliminary WHO studies (WHO, 2005a/2005b), without age adjusting and time discounting. This choice is based on the ethical discourse of Anand et al. (1998). Moreover, for the DALY estimation of air pollution in Flanders Torfs (2003) also ignored age weighting and time discounting. Consequently, calculating DALYs without age adjusting and time discounting allows a comparison of the results.

2.1. Associated health effects attributable to noise exposure

The health effects and well-being impacts due to environmental noise exposure are selected based on epidemiological studies and the available exposure data in Flanders. In a review, de Hollander et al. (2004) distinguished two types of end-points: social-psychological effects or well-being effects and clinical end-points or well-defined diseases. Social-psychological effects that have been studied in epidemiological literature include annoyance, psychosocial well-being, psychiatric hospitalization, impairment of cognitive performance and sleep disturbance (de Hollander et al., 2004; Passchier-Vermeer et al., 2000). Miedema (2007) also distinguished communication and concentration disturbance and fear or anger. In this paper, only severe annoyance and highly sleep disturbance are taken into account. Despite the preliminary estimation of Hygge (2005) to calculate DALYs for cognitive impairment in Sweden and the conclusions of Stansfeld et al. (2005) that there is a positive linear exposure-effect association between aircraft noise and impaired reading comprehension and recognition memory in children, and a negative linear association between road traffic noise and increased functioning of episodic memory, cognitive impairment is not incorporated in this paper because appropriate data do not exist in Flanders. Psychosocial well-being and psychiatric hospitalization are not taken into

account due to inconsistent results and inherent methodological shortcomings in scientific literature (de Hollander et al., 2004). Although noise makes conversations uncomfortable or impossible, communication disturbance is also excluded from the analysis because it is difficult to quantify. The irritation or anger reactions due to noise exposure depend on coping style, personal factors and situational variables (Miedema, 2007). Consequently, fear and anger reactions are not taken into account. The limited number of well-being effects taken into account will lead to an underestimation of the calculated disability adjusted life years.

Clinical effects related to environmental noise exposure taken into account are morbidity due to cardiovascular diseases, more precisely hypertension and ischemic heart diseases. Noise-induced hearing impairment is not included. Most studies estimate the relationship between hearing impairment and occupational exposure. Although Passchier-Vermeer et al. (2000) argue that the methodology to estimate noise-induced hearing impairment in occupational populations can be applied to estimate hearing impairment due to environmental noise, the risk of hearing loss at the typical environmental levels of exposure would be low (de Hollander et al., 2004).

2.2. Exposure Assessment

The exposure data concern the Flemish population exposed to traffic noise (road traffic, aircraft due to Brussels National Airport and railway traffic) on Flemish territory in 2004. The noise exposure metrics used in this study are the day-evening-night level (L_{den}) and the night level (L_{night}) (Botteldooren et al., 2005). Population exposure is based on residential address and stratified in 5 dB groups.

2.3. Prevalence and exposure-response functions

In order to assess the fraction highly annoyed people the World Health Organization recommends to use the exposure-response relationships derived by Miedema and Oudshoorn (2001) (WHO, 2005). The relationships have been derived for noise due to road traffic, railway and aircraft (Table 1). Besides these exposure-response functions, the prevalence can also be determined by survey. Self-reported annoyance derived by the Belgian National Health Interview Survey 2004 (Bayingana et al., 2006) and the Written Environmental Investigation SLO-1 (Aminabel & M.A.S., 2004) is used as an alternative to calculate the prevalence.

Miedema, Passchier-Vermeer and Vos (2003) calculated the relationship between L_{night} and sleep disturbance for transportation noise due to road traffic and railway (Table 2). The relationship between L_{night} and self-reported sleep disturbance caused by aircraft noise is studied in more detail by Miedema & Vos (2004, 2007). According to the large individual variance at a given exposure level, the uncertainty with respect to the presented functions for nighttime aircraft noise is large and can only be used indicatively (Miedema & Vos, 2004/2007). Consequently, the relationship between sleep disturbance and aircraft is not taken into account.

The prevalence data for hypertension and ischemic heart diseases, in Flanders are based on the Intego database, a central database of diagnoses, laboratory results and drug prescriptions of family practices in Flanders (www.intego.be). The prevalence of hypertension is also estimated on the results of the Belgian National Health Interview Survey in 2004 (Bayingana et al., 2006). The exposure-response functions for noise and hypertension and ischemic heart diseases (IHD) are derived from a meta-analysis of van Kempen et al. (2002), combined with Flemish L_{den} . The relative risk of hypertension ($RR_{5\text{dB(A)}} = 1.26$ (1.14-1.39)) valid between the measurement range from 55 to 72 dB(A)

due to exposure to air traffic (L_{Aeq} 7-19h) is also used for the relationship between hypertension and road or rail traffic (Knol et al., 2005). The relative risk for ischemic heart diseases ($RR_{5dB(A)} = 1.09$ (1.05-1.13)) is valid between a measurement range from 51 to 70 dB(A)) (van Kempen et al. 2002). This relative risk is only applicable for IHD attributable to road traffic. Levels of exposure above 70 dB(A) were recalculated to the threshold value of 70 dB(A). In a next step, for IHD as well as hypertension, the population attributable risk (PAR) is calculated per 5 dB(A) derived by de Hollander et al. (2004). PARs combine population exposure distributions with quantitative exposure-response information. The noise attributable prevalence of cardiovascular endpoints is estimated by multiplying the PAR with the prevalence data (de Hollander et al., 2004).

2.4. Duration and severity

The duration of a health effect is based on the number of healthy life years lost. Assuming that people will be annoyed and sleep disturbed throughout the year (WHO, 2005b) and comparable to other studies (de Hollander et al., 1999; Knol et al., 2005; Torfs, 2003) the duration of severe annoyance and highly sleep disturbance is set on 1. Due to the assumption of chronic exposure, also the duration of hypertension and IHD was considered to be 1 year (S. Bartholomeeusen, personal communication, February 27, 2007).

The original disability weights, used in the global burden of disease studies to differentiate different degrees of incapacity, only cover a wide range of general diseases. Small health effects or well-being effects were not taken into account. In 1997, Stouthard et al. measured disability weights for 53 diseases in the Netherlands. The Australian Victorian Burden of Disease study (Mathers et al., 1999) added some weights for small health effects. The disability weight for hypertension is set on 0.352, derived by the Australian

weights (Mathers et al., 1999). For IHD, a disability weight of 0.35 is taken into account based on the Dutch disability weight for hospital admissions (de Hollander et al., 1999). Lacking a disability weight for sleep and communication disturbance, Müller-Wenk established Swiss disability weights based on the methodology of Murray et al. (1996) resulting in an average disability weight of 0.055 for noise-related sleep disturbance and 0.033 for communication disturbance (WHO, 2005a). For highly sleep disturbance and severe annoyance in this study, a severity factor of 0.01 with a large uncertainty interval (0.002-0.012 for severe annoyance and 0.002-0.10 for highly sleep disturbed) is selected. The minimum value is based on recommendations of Botteldooren (D. Botteldooren, personal communication, January 29, 2007), the maximum values are based on van Kempen (cited in Knol et al., 2005) and the value 0.01 is based on de Hollander et al. (1999).

3. Results

This section is divided into the four studied health effects. According to the methodological section, first, the attributable number of cases will be presented. Second, the number of disability adjusted life years due to exposure to transportation noise will be estimated for each health effect. At the end of this section, the total environmental (transportation) noise burden of disease is calculated and compared to the total Flemish burden of disease, the environmental burden of disease due to particulate matter in Flanders and the Dutch environmental noise burden of disease study.

3.1.1. Severe annoyance

Table 3 presents the number of severe annoyed people due to transportation noise exposure. As explained in the methodological section, the exposure-response

relationships of Miedema et al. (2001) were used as well as the Belgian Health Interview Survey (HIS) and the Written Environmental Investigation (SLO). The SLO survey only allows calculating the total number of severe annoyed people caused by transportation noise in Flanders as opposed to the interview survey and the exposure-response functions. The variance between the results is relatively small. Based on Miedema et al. (2001), the number of people severely annoyed attributable to environmental noise exposure is 627 838 corresponding to 10.57% of the Flemish population. The results based on the Health Interview Survey and the SLO survey are respectively 9.30% and 11.80%. Notable is the difference between noise sources. The calculated number of annoyed people due to air traffic is ten times higher using the data from the Health Interview Survey. The variance can be attributable to differences in methodology. While the survey took into account aircraft noise in the whole Flemish region (the regional airports inclusive), the exposure-response function for air traffic was only used in the area of Brussels National Airport.

Table 3 also presents the number of healthy life years lost due to severe annoyance attributable to transportation noise. Road traffic has the highest impact on severe annoyance: 91 600 DALYs per million habitants when using the exposure-response relationships or 73 000 when using the Belgian Health Interview Survey. The total years of healthy life lost varies from 93 000 to 118 000 DALYs per million habitants. The relatively large variance between the lowest and highest estimation can be ascribed to the large variance of the disability weight and the methodology used to calculate the prevalence of severely annoyed people in Flanders due to transportation noise.

3.1.2. Highly sleep disturbance

Table 4 presents the number of highly sleep disturbed people based on the exposure-response relationships of Miedema et al. (2003) and the total years of healthy life lost due to sleep disturbance attributable to transportation noise exposure. In Flanders, 391 894 people highly suffer from sleep disturbance due to road and railway traffic, corresponding to 6.6% of the total Flemish population. The total healthy life years lost due to sleep disturbance varies between 784 and 39 189 years or 132 and 6 597 DALYs per million inhabitants. Road traffic has the highest contribution to these DALYs (81%).

3.1.3. Hypertension

The total number of Flemish people suffering from hypertension attributable to environmental noise exposure in 2004 is presented in table 5. 3.71% of the total number of hypertension cases in Flanders is attributable to exposure to transportation noise. Dependent on the relative risk and the data source, the total attributable number of cases varies from 12 526 to 34 369 using the Intego databank and from 14 714 to 40 372 calculating the prevalence based on the Belgian Health Interview Survey. The data source also influence largely the years of healthy life lost due to noise exposure. The total number of DALYs attributable to noise caused hypertension in 2004 varies from 4 384 to 5 150 DALYs based on the Intego database and from 12 029 to 14 130 DALYs using the Health Interview Survey. Road traffic has the highest contribution to the total healthy life years lost (93%).

3.1.4. Ischemic Heart Disease

The attributable number of cases ischemic heart disease to road noise exposure varies between 1 304 and 3 377 in Flanders 2004. The number of healthy life years lost due to IHD attributable to road noise exposure varies between 456 and 1 182 DALYs or between 77 and 199 DALYs per million habitants in Flanders (table 6).

3.1.5. Total environmental noise burden of disease in Flanders

To calculate the total environmental noise burden of disease in Flanders 2004, the DALYs based on the exposure-response relationships of Miedema et al. (2001, 2003) were selected for severe annoyance. For hypertension, the DALYs based on the prevalence data in the Health Interview Survey were taken into account. The mean number of healthy life years lost due to exposure to transportation noise is 20 517 DALYs (lowest 7 646 - highest 129 842) or 3 420 DALYs per million habitants (lowest 1 274 – highest 21 640). Consequently, the proportion of the environmental noise burden of disease related to the total burden of disease (Baert et al., 2002 cited in Bossuyt et al., 2007) in Flanders corresponds to 1.71% (0.63%-10.75%). Torfs calculated in the Flemish State of the Environment Report 2007 (Bossuyt et al., 2007) that outdoor air pollution caused by PM₁₀, PM_{2.5}, ozone, Pb, Rn, Ni, As, PAHs, benzene and UV, in Flanders was responsible to 73 278 healthy life years lost in 2004. In the total environmental burden of disease attributable to air and noise pollution, the contribution of transport noise amounts to 21.8%.

4. Discussion and conclusion

The environmental noise burden of disease in Flanders in 2004 amounts 20 517 DALYs, corresponding to 1.7% of the total burden of disease in Flanders and 21.8% of the environmental burden of disease caused by air and noise pollution. The results establish

that traffic-related noise exposure has a large impact on public health. Nevertheless, the results must be interpreted carefully because of the rather large uncertainty range attributable to the selected health effects, the variety in exposure level, the uncertainty in exposure-response functions and the choice of severity weight.

In this paper, only the health effects for which sufficient quantitative scientific information was available are included. Contrary to the Dutch environmental noise burden of disease study, hypertension based mortality is not included in the analysis to avoid overestimation. Moreover, hypertension and IHD are not only attributable to noise exposure, and can not be studied independently from other sources like stress, way of life, genetic aspects etc. Nevertheless, it must be clear that the calculated disability adjusted life years correspond to the attributable fraction of noise exposure which is not equal to the avoiding fraction because of competing risks. According to the large individual variance of effects at a given exposure level, the uncertainty with respect to the relationship between noise and self-reported sleep disturbance caused by aircraft noise is large and can only used indicatively (Miedema & Vos, 2004/2007). Consequently, the relationship between sleep disturbance and aircraft is not taken into account although the problem is real in a densely populated region like Flanders. The topic of night flights has been on the Belgian political agenda for years. Furthermore, air traffic results are incomplete because air traffic-related annoyance is only based on exposure data from the area around Brussels National Airport, the regional airports of Antwerp, Ostend ... were not taken into account.

The restriction to the four health and well-being effects calculated in this paper gives of course an incomplete picture, and perhaps an underestimation, of the influence of noise on public health. It is recommended to add data about decreased cognition performance with children, hear impairment due to noise exposure etc. in the future when more Flemish prevalence data will be available and when there is more agreement on exposure-

response relationships in scientific literature. The DALY range related to annoyance and sleep disturbance is mainly due to the different disability weights available in other environmental noise burden of disease studies. Also the prevalence determines the uncertainty range. The Belgian Health Interview Survey reports the lowest prevalence data for annoyance in Flanders, while the Written Environmental Investigation reports the highest prevalence data. The DALY range related to IHD and hypertension is influenced by multiple factors. First, in this study the assumption was made that people suffering from ischemic heart disease or hypertension do not recover and will suffer from it throughout the year (duration = 1). This is plausible when assuming that the exposure is chronic as well. Second, the assumption was made that the exposure-response relationships of van Kempen et al. (2002) were applicable to the Flemish situation. Third, in this study L_{den} exposure values were used according to the European Directive on Environmental Noise together with the relative risks estimated by van Kempen et al. (2002). However, these estimated relative risks are based on different noise exposure measures: $L_{Aeq, 6-22h}$ for road traffic noise exposure and air traffic noise exposure is expressed in $L_{Aeq, 7-19h}$. Fourth, the DALY range of IHD and hypertension is also attributable to the prevalence data. The Intego database is composed of registrations of general practitioners. Consequently, only the patients treated are taken in the dataset, which will lead to an underestimation. The prevalence data calculated on data of the Health Interview Survey will be probably more appropriate, since it is based on a random sample of the population. Fifth, different definitions of hypertension are used in the scientific literature and datasets. In the meta-analysis of van Kempen et al. (2002) hypertension is defined as a systolic blood pressure ≥ 95 mmHg and/or diastolic blood pressure ≥ 160 mmHg and/or use of antihypertensives. The surveys on the contrary (Bayingana et al., 2006; Aminabel et al., 2004) defined hypertension as a systolic blood pressure ≥ 90 mmHg and/or diastolic blood pressure $\geq$

140 mmHg. Using the survey data can lead to an overestimation of the results. A last remark refers to the Australian disability weight for IHD hospitalization that was used (Mathers et al., 1999) and that corresponds to the Dutch environmental noise burden of disease studies (de Hollander et al., 1999; Knol et al., 2005). Torfs (2003) however used a disability weight of 0.7 corresponding to hospitalization due to cardiovascular diseases due to air pollution exposure.

To summarize we have shown that the impact of noise on health in Flanders can be calculated using existing exposure, prevalence and health data. The burden of disease attributable to noise is not insignificant but the confidence range of the calculated impact on population health is very large. The DALY indicator has a large potential to compare different environmental health risks and to prioritize policy actions, but more agreement and a uniform methodology will ameliorate the usability of the DALY-indicator in environmental health policy.

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Table 1: Exposure-response relationships by Miedema & Oudshoorn (2001) for severe annoyance (SA).

Aircraft	% SA = $-9.199 \cdot 10^{-5} (\text{LDEN-42})^3 + 3.932 \cdot 10^{-2} (\text{LDEN-42})^2 + 0.2939 (\text{LDEN-42})$
Road traffic	% SA = $9.868 \cdot 10^{-4} (\text{LDEN-42})^3 - 1.436 \cdot 10^{-2} (\text{LDEN-42})^2 + 0.5118 (\text{LDEN-42})$
Railways	% SA = $7.239 \cdot 10^{-4} (\text{LDEN-42})^3 - 7.851 \cdot 10^{-3} (\text{LDEN-42})^2 + 0.1695 (\text{LDEN-42})$

Table 1: exposure-response relationships by Miedema, Passchier-Vermeer and Vos (2003) for highly sleep disturbance due to transportation noise exposure.

Road traffic	% HSD	$= 20.8 - 1.05L_{night} + 0.01486L_{night}^2$
Railway traffic	% HSD	$= 11.3 - 0.55L_{night} + 0.00759L_{night}^2$

Table 1: Severe annoyance attributable to environmental noise: Number of cases and disability adjusted life years (in absolute figures) in Flanders 2004

	Exposure-response relationships (Miedema et al., 2001)				Belgian Health Interview Survey 2004 (Bayingana et al., 2006)				Written Environmental Investigation SLO-1 (Aminabel et al., 2004)			
	# Cases	DALYs			# Cases	DALYs			# Cases	DALYs		
		central ^a	lowest ^b	highest ^c		central ^a	lowest ^b	highest ^c		central ^a	lowest ^b	highest ^c
Road traffic	544 088	5 440.88	1 088.18	65 290.60	433 630	4 336.30	867.26	52 035.60				
Rail traffic	76 695	766.95	153.39	9 203.43	47 521	475.21	95.04	5 702.52				
Air traffic	7 054	70.54	14.11	846.49	71 282	712.82	142.56	8 553.84				
Total	627 838	6 278.38	1 255.68	75 340.52	552 433	5 524.33	1 104.87	66 291.96	700 936	7 009.36	1 401.87	84 112.32

^a S = 0.01

^b S = 0.002

^c S = 0.12

Table 1: Highly sleep disturbance attributable to environmental noise: Number of cases and disability adjusted life years (in absolute figures) in Flanders 2004

	<i>Attributable number of cases</i>	<i>DALYs (in absolute figures)</i>		
		<i>Central estimate^a</i>	<i>Lowest estimate^b</i>	<i>Highest estimate^c</i>
<i>Road traffic</i>	318,157	3 181.57	636.31	31 815.71
<i>Railway traffic</i>	73,736	737.36	147.47	7 373.64
<i>Total</i>	391,894	3 918.94	783.79	39 189.35

^a S = 0.01

^b S = 0.002

^c S = 0.10

Table 1: Hypertension attributable to environmental noise: number of cases and disability adjusted life years (in absolute figures) in Flanders in 2004

		Central estimate: RR = 1.26		Lowest estimate: RR = 1.14		Highest estimate: RR = 1.39	
		Cases	DALYs	Cases	DALYs	Cases	DALYs
Road traffic	<i>Intego</i> ^a	21 553	7 543.72	11 687	4 090.54	32 047	11 216.30
	<i>H.I.S.</i> ^b	25 318	8 861.30	13 729	4 805.15	37 644	13 175.40
Railway traffic	<i>Intego</i> ^a	1 548	541.64	836	292.64	2 316	810.44
	<i>H.I.S.</i> ^b	1 818	636.30	982	343.70	2 720	952.00
Air traffic	<i>Intego</i> ^a	5	1.58	2	0.86	7	2.34
	<i>H.I.S.</i> ^b	5	1.75	3	1.05	8	2.80
Total	<i>Intego</i> ^a	23 106	8 086.94	12 526	4 384.03	34 369	12 029.07
	<i>H.I.S.</i> ^b	27 141	9 499.35	14 714	5 149.90	40 372	14 130.20

^a Intego, 2004

^b Health Interview Survey, Belgium, 1997-2001-2004

Table 1: IHD attributable to environmental noise: number of cases and disability adjusted life years (in absolute figures) in Flanders 2004

	Central estimate: RR = 1.09		Lowest estimate: RR = 1.05		Highest estimate: RR = 1.13	
	Cases	DALYs	Cases	DALYs	Cases	DALYs
Road Traffic	2 343	819.97	1 304	456.44	3 377	1 181.94