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TOWARDS ESTIMATING THE BURDEN OF DISEASE ATTRIBUTABLE TO SECOND-HAND SMOKE EXPOSURE IN POLISH CHILDREN

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Abstract
Objectives: To estimate the burden of disease attributable to second-hand smoke (SHS) exposure in Polish children in terms of the number of deaths and disability adjusted life years (DALYs) due to lower respiratory infections (LRI), otitis media (OM), asthma, low birth weight (LBW) and sudden infant death syndrome (SIDS). **Materials and Methods:** Estimates of SHS exposure in children and in pregnant women as well as information concerning maternal smoking were derived from a national survey, the Global Youth Tobacco Survey, and the Global Adult Tobacco Survey in Poland. Mortality data (LRI, OM, asthma, and SIDS), the number of cases (LBW), and population data were obtained from national statistics (year 2010), and DALYs came from the WHO (year 2004). The burden of disease due to SHS was calculated by multiplying the total burden of a specific health outcome (deaths or DALYs) by a population attributable fraction. **Results:** Using two estimates of SHS exposure in children: 48% and 60%, at least 12 and 14 deaths from LRI in children aged up to 2 years were attributed to SHS, for the two exposure scenarios, respectively. The highest burden of DALYs was for asthma in children aged up to 15 years: 2412, and 2970 DALYs, for the two exposure scenarios, respectively. For LRI, 419 and 500 DALYs, and for OM, 61 and 77 DALYs were attributed to SHS, for the two exposure scenarios, respectively. Between 13% and 27% of SIDS cases and between 3% and 16% of the cases of LBW at term were attributed to SHS exposure. **Conclusions:** This study provides a conservative estimate of the public health impact of SHS exposure on Polish children. Lack of comprehensive, up to date health data concerning children, as well as lack of measures that would best reflect actual SHS exposure are major limitations of the study, likely to underestimate the burden of disease.

Key words:
Environmental burden of disease, Children, Second-hand smoke, Poland

INTRODUCTION

Environmental burden of disease (EBD) is a methodological approach that aims at estimating and quantifying proportion of the total burden of disease in a population that can be attributed to specific environmental factors [1]. The EBD approach allows for comparing health losses across different risk factors, setting priorities, and evaluating the benefits of specific measures, due to the use of common and comparable health metrics, such as deaths or disability adjusted life years (DALYs). DALYs combines

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information on quality and quantity of life and give an indication of the (potential) number of healthy life years lost due to the premature mortality or morbidity for a particular disease. Morbidity is weighted for the severity of the disorder. This concept, introduced by Murray and Lopez in 1996, as part of the Global Burden of Disease study, has been endorsed by the World Health Organization (WHO), and the DALYs approach has been used in various studies on a global, national and regional level [2].

WHO has developed guidance for EBD calculations for several environmental risk factors, including health effects of exposure to second-hand smoke (SHS) in children and in adults [3].

SHS, also known as environmental tobacco smoke (ETS), refers to the mixture of side stream smoke coming from the burning tip of a cigarette and exhaled mainstream smoke. Children can be exposed to SHS during prenatal and postnatal periods. Prenatal exposure refers to maternal smoking during pregnancy or maternal SHS exposure during pregnancy, whereas postnatal exposure is related mainly to parental tobacco smoking.

The WHO methodological guidance [3] summarizes the evidence on the exposure–risk relationships between SHS and various health outcomes, including low birth weight (LBW), sudden infant death syndrome (SIDS), lower respiratory infections (LRI), asthma and otitis media (OM) in children, reviews all the available exposure data and proposes a method for combining these into an estimate of the burden of disease. To estimate the disease burden due to SHS, the population attributable fraction is multiplied by the relevant disease burden of each health outcome in children [3]. Information about the magnitude and distribution of the burden of disease from SHS in children's population is particularly important for policy makers in order to plan preventive strategies.

The first worldwide assessment of deaths and DALYs attributable to SHS, by Öberg et al. [4] provides the burden of disease estimates in the WHO regions. Globally, exposure to SHS has been estimated to have caused about 603 000 premature deaths worldwide in 2004 [4]. That included 165 000 deaths from LRI in children below 5 years of age, 1150 from asthma in children younger than 15, and 71 from OM in children below 3 years of age. In Europe, out of the estimated 172 300 deaths caused by SHS, almost 6400 were deaths due to those 3 diseases [4].

In Poland, still about a half of children population is exposed to SHS. While adoption of a comprehensive legislation has led to a significant decline in tobacco smoke exposure in Poland, the legislation doesn't cover indoor environments where children spend much of their time or where the exposure is higher, i.e. at home and/or in the cars [5].

In order to gain a perspective on the scale of public health impact of exposure to SHS on children, we have calculated the number of deaths and DALYs for the selected health effects that could be attributed to SHS exposure of children in Poland.

MATERIAL AND METHODS

Data on children's exposure to SHS

We used two SHS exposure scenarios: one, based on the estimate of children's exposure from a national survey in adults, and another, based on the Global Youth Tobacco Survey (GYTS) and on conclusions of the recent report on the tobacco epidemic in Poland [6–8].

The national survey was conducted from 22nd to 26th November 2007 by the Department of Cancer Epidemiology and Prevention of the Maria Skłodowska-Curie Cancer Centre and the Institute of Oncology in Warsaw, in collaboration with the public opinion research center (TNS OBOP), within the National Cancer Prevention Programme. It was a face-to-face questionnaire in a nationwide representative sample (random-route) of 1004 individuals aged over 15 years. 48% of the surveyed adults admitted to smoking or having smoked in the presence of their children and this was used as exposure scenario I [6].

An alternative estimate of SHS exposure was based on the results of the GYTS in Poland [6,7]. GYTS is a worldwide school-based survey addressed to students aged 13–15 years. It inquires about children's exposure to SHS at home or in other places during the last 7 days and about current smoking habits of their parents [8]. GYTS survey revealed that more than 55% of children in urban settings, and almost 58% of children in rural areas were exposed to SHS at home. Overall, more than 60% of children were exposed to SHS in their households and in public places [7,8]. The WHO report from 2009 highlighted that still over 60% of children were exposed to involuntary tobacco smoke at home and in public places [6]. The given data were adopted as the second exposure scenario (scenario II).

An estimate of maternal exposure to SHS during pregnancy was based on the WHO report (2009) [6], which provided data about the percentage of adults admitting to smoking in the presence of pregnant women, and on the Global Adult Tobacco Survey (GATS), including data about the non-smoking females aged 20–45 years exposed to SHS at home [6,9]. 27% of adults admitted to smoking or having smoked in the presence of pregnant women and this estimate was used as a proxy for the SHS prenatal exposure [6,9].

An estimate of maternal smoking after child birth was derived from the GATS results, based on the percentage of women aged 20–39 who declared smoking. About 27% of women aged 20–29 years, and 25% of women aged 30–39 years reported smoking cigarettes; 26% were used for the assessment of SIDS attributed to SHS from smoking mothers [9].

Health data

We focused on the health outcomes with evidence sufficient to infer causal associations with SHS, with consistently reported positive findings, and plausible mechanisms [3]. For children, such outcomes include [3]:

1. LBW at term, defined as a birth weight less than 2500 g among live term births (≥ 37 weeks of gestation).
2. SIDS, defined as a sudden and unexpected death in the first 12 months of life, without any pre-existing health problems and without any explanations in autopsy (ICD-10 code R95).
3. LRI in children below 2 years of age – diseases with ICD-10 codes J10–J18 (influenza and pneumonia), and J20–J22 (other acute lower respiratory infections).
4. OM among children younger than 3 years of age – diseases with ICD-10 codes H65–H66 (non-suppurative otitis media and suppurative and unspecified otitis media).
5. Asthma in children younger than 15 years of age – diseases with ICD-10 codes J45–J46 (asthma and status asthmaticus).

The necessary health data were retrieved from the Demographic Yearbook 2011 [10] and provided by the National Institute of Public Health – National Institute of Hygiene (Table 1).

DALYs estimates for the selected diseases and health conditions in Polish children were retrieved from the spreadsheet to calculate EBD for SHS, provided by WHO (WHO-PHE), and summarized in Table 2.

Exposure-response functions

We applied effect estimates for the selected health outcomes according to a recent review of epidemiological evidence included in the WHO methodological guidance [3]. They are summarized in Table 3, with references to the primary sources.

Calculation of the disease burden attributable to SHS

To estimate the burden of disease attributable to SHS exposure in Polish children, expressed as the number of deaths and DALYs, we followed the WHO methodology [3].

The first step was to calculate the population attributable fraction (PAF), which is derived from the proportion of children exposed to SHS and the risk estimate of disease

Table 1. Health data for the selected outcomes in Polish children, 2010, according to the Central Statistical Office and the National Institute of Public Health – National Institute of Hygiene

Outcomes	Total (n)	Rate per 1000 population
LBW	8 528*	22.10[a]
SIDS, children < 1 year	39**	0.09[b]
LRI, children < 2 years	57**	0.07
OM, children < 3 years	0**	0.0
Asthma, children < 15 years	0**	0.0

LBW – low birth weight (< 2500 g) at term (live births ≥ 37 weeks of gestation).
SIDS – sudden infant death syndrome for children below 1 year of age.
LRI – lower respiratory infections.
OM – otitis media.
* Number of births.
** Number of deaths.
[a] Rate calculated for live births ≥ 37 weeks of gestation.
[b] Rate calculated per 1000 live births.

related to the exposure. PAF indicates a proportion of specific health outcome in a population that can be attributed to exposure to SHS. To estimate PAF_{SHS} for each health outcome the following formula was used:

$$PAF_{SHS} = [p(OR-1)]/[p(OR-1)+1] \quad (1)$$

where:

p – proportion of children exposed to SHS,

OR – odds ratio of mortality or morbidity related to SHS exposure.

Table 2. Total DALYs for the selected health endpoints in Polish children, 2004 (estimates obtained from WHO/PHE)

Health outcome	DALYs	
	males	females
LRI, children < 2 years	1 120	878
OM, children < 3 years	194	210
Asthma, children < 15 years	8 585	9 972

DALYs – disability adjusted life years.
Other abbreviations as in Table 1.

Then, PAF_{SHS} was applied to calculate the burden of disease attributable to SHS exposure (EBD_{SHS}):

$$EBD_{SHS} = PAF_{SHS} \times B \quad (2)$$

where:

B – the total burden of a given disease/health condition, expressed as the number of deaths or DALYs.

The attributable burden of disease was presented as a central, lower, and upper estimate of EBD_{SHS}.

RESULTS

Population attributable fraction (PAF_{SHS}) for LRI, OM, and asthma for the two SHS exposure scenarios (scenario I – 48% and scenario II – 60%) are presented in Table 4. The highest fraction attributable to SHS was estimated

Table 3. Effect estimates for the selected health outcomes associated with SHS exposure in children

Health endpoint	Risk point estimate	95% CI	Reference
LBW	OR = 1.38	(1.13–1.69)	Windham et al. (1999) [38]
SIDS, children < 1 year	OR = 1.94	(1.55–2.43)	Anderson & Cook (1997) [36]
LRI, children < 2 years	OR = 1.55	(1.42–1.69)	the United States Surgeon General (2006) [39]
OM, children < 3 years	IDR = 1.38	(1.21–1.56)	Etzel et al. 1992 [40]; Cal-EPA (2005) [41]
Asthma (onset), children < 15 years	OR = 1.32	(1.24–1.41)	Cal-EPA (2005) [41]
Asthma (prevalence), children < 15 years	OR = 1.23	(1.14–1.33)	the United States Surgeon General (2006) [39]

OR – odds ratio; IDR – incidence density ratio.
Other abbreviations as in Table 1.

for LRI in young children – roughly 21% and 25%, for exposure scenario I, and II, respectively. Twelve deaths (exposure scenario I) and 14 deaths (exposure scenario II) due to LRI were attributable to SHS in the year 2010. In the case of asthma in children aged up to 15 years, PAF_{SHS} was 13% and 16%, for the two exposure scenarios, respectively; and for OM among the children below 3 years of age it was 15% and 19%. The DALYs attributable to SHS exposure was derived from the DALYs estimates for Poland developed by the WHO for the year 2004 (Table 5). For the 3 conditions studied, the highest disease burden was for asthma in children aged up to 15 years, where DALYs estimates were 2412 and 2970 for exposure scenario I and II, respectively. DALYs burden for LRI was 419 (exposure scenario I) and 500 (exposure scenario II); for OM it was 61, and 77, for exposure scenarios I and II, respectively.

With the 26% estimate of SHS exposure from smoking mothers, between 13% and 27% of SIDS cases could be attributed to SHS exposure in the year 2010.

Based on the estimate of 27% of the non-smoking pregnant women exposed to SHS, between 3% and 16% cases of LBW at term could be attributed to exposure to SHS in the year 2010.

Table 4. Population attributable fraction (PAF_{SHS}) and burden of disease attributable to SHS exposure (EBD_{SHS}) – central (lower and upper) estimates for the selected health outcomes in children in Poland

Health outcome	PAF_{SHS}			EBD_{SHS}		
	SHS exposure scenario I (48%)	SHS exposure scenario II (60%)	SHS exposure 27% for LBW or 26% for SIDS estimates	SHS exposure scenario I (48%)	SHS exposure scenario II (60%)	SHS exposure 27% for LBW or 26% for SIDS estimates
LBW	–	–	9 (3–16)	–	–	768 (256–1364)
SIDS, children < 1 year	–	–	20 (13–27)	–	–	8 (5–11)
LRI, children < 2 years	21 (17–25)	25 (20–29)	–	12 (10–14)	14 (11–17)	–
OM, children < 3 years	15 (9–21)	19 (11–25)	–	0	0	–
Asthma (onset), children < 15 years	13 (10–16)	16 (13–20)	–	0	0	–

SHS – second-hand smoke exposure.
Other abbreviations as in Table 1.

Table 5. DALYs attributable to SHS exposure for the selected health outcomes in Polish children; central (lower and upper) estimates for the 2 SHS exposure scenarios

Health outcome	SHS attributable DALYs	
	SHS exposure scenario I (48%)	SHS exposure scenario II (60%)
LRI, children < 2 years		
total	419 (339–500)	500 (400–580)
male	235 (190–280)	280 (224–325)
female	184 (149–220)	220 (176–255)
OM, children < 3 years		
total	61 (36–85)	77 (44–102)
male	29 (17–41)	37 (21–49)
female	32 (19–44)	40 (23–53)

Table 5. DALYs attributable to SHS exposure for the selected health outcomes in Polish children; central, (lower and upper) estimates for the 2 SHS exposure scenarios – cont.

Health outcome	SHS attributable DALYs	
	SHS exposure scenario I (48%)	SHS exposure scenario II (60%)
Asthma (onset), children < 15 years		
total	2 412 (1 856–2 970)	2 970 (2 412–3 711)
male	1 116 (859–1 374)	1 374 (1 116–1 717)
female	1 296 (997–1 596)	1 596 (1 296–1 994)

Abbreviations as in Table 1 and 4.

DISCUSSION

This first attempt at assessment of the burden of disease attributable to SHS exposure in Polish children showed that even under very conservative assumptions, between 2231 (lower estimate) and 3555 (upper estimate) DALYs could be attributed to SHS exposure under exposure scenario I, and between 2856 (lower estimate) and 4393 (upper estimate) DALYs under the exposure scenario II, for asthma, OM, and LRI. Overall, SHS exposure could account for, at least, almost 14% (SHS exposure scenario I) and almost 17% (SHS exposure scenario II) of the total DALYs (20 959) for the 3 conditions considered (LRI, OM, asthma), based on the WHO estimate for 2004. The number of deaths due to LRI in children attributable to SHS would be in range of 10–14, and 11–17, for the two exposure scenarios, respectively; between 5 and 11 cases of SIDS could be attributed to postnatal SHS from smoking mothers, and between 256 and 1364 cases of LBW at term due to maternal exposure to SHS during pregnancy (year 2010).

While several studies on the health effects of SHS exposure have followed the same methodological approach and applied the same exposure-response functions [4,11,12], direct comparisons are limited due to the differences and uncertainties in exposure estimates and health outcome/disease burden data. A number of limitations of this study are linked to the assumptions made, concerning estimates of SHS exposure in children, health outcomes, and risk estimates used to calculate the burden of disease.

Exposure estimate

The two SHS exposure scenarios (48% and 60%) used in this study reflect the uncertainty of the assessment of SHS exposure in Polish children. We assumed that these estimates can represent parental smoking and can be considered a valid surrogate of relevant SHS exposure in children. Additionally, we used an estimate of 27% of women being exposed to SHS during pregnancy [6], and of 26% of mothers smoking after child birth [9].

Comparable estimates (38–59%) were reported in a European study assessing health effects of SHS exposure in children [11]. An estimate of 46% of postnatal SHS exposure in children was reported in a study from Poland, based on a questionnaire survey and cotinine determination in urine [13]. Other studies report lower proportions of children exposed to SHS, within the range from 24% to 33% in children aged between 6 and 14 years [14,15].

While questionnaires constitute the most commonly used tool to assess SHS exposure, formulation of the questions and underlying definitions need to be taken into account when comparing different survey data. Additional measures, such as determination of air nicotine indoors, and human biomarkers (i.e. cotinine) allow for assessing specific levels of SHS exposure [16,17]. In general, different methods of SHS exposure characterization have been shown to provide similar results. However, an issue of underreporting cannot be ignored. For example, in the US study in almost 500 infants and young children a 55% exposure to SHS was detected using a plasma cotinine level, while only 13% exposure was reported by parents [17]. The use of national level estimates of SHS exposure to calculate the disease burden assumes an equal distribution of exposure of children to SHS in a society, while both smoking rates and SHS exposure tend to be higher among the people with a lower socio-economic status [18–20]. In Poland, less educated and poor people smoke much more frequently than the more affluent individuals with university education [6]. Evidence from many countries shows persistent social inequalities in SHS exposure in children [19–21], and some studies even suggest an increasing gap in social inequality [22].

Changing societal attitudes towards SHS, also in Poland, may influence indoor smoking behavior. While smoke-free legislation has been suggested not to increase smoking at home [23], a 'stigmatisation' of smoking in public can make the feeling of freedom to smoke at one's own home increasingly important [24].

Studied health outcomes and availability of the health data

DALYs gives an indication of the (potential) number of healthy life years lost in a population due to premature mortality or morbidity due to a specific health condition. In DALYs calculations, the number of people with a certain disease is multiplied by the duration of the disease (or loss of life expectancy in the case of mortality) and the disability weight, reflecting the severity of the disorder [1,12].

Use of DALYs derived from the international data sources is linked to additional uncertainty in our assessment. The revised estimates of disability weights for a range of diseases available through the Global Burden of Disease 2010 project [25], create an opportunity to update regional and national DALYs estimates. In Poland, the comprehensive prevalence and incidence data for many diseases are not available. In recent years there have been no large-scale, national epidemiological studies to provide a comprehensive picture of health effects associated with SHS exposure in Polish children [6,7], though available clinical and regional epidemiological studies demonstrate similarities with international observations concerning the impact of smoking on children's health [7]. Limited availability of the relevant health outcome data results in a conservative picture, potentially introducing a large underestimate of the burden of disease linked with SHS in Poland.

Lack of representative morbidity data hinders development of more reliable estimates of the magnitude of SHS related health challenges, which, consequently might affect setting priorities for action. That's of importance, given that health outcomes related to exposure to SHS in children are in general characterized by small mortality, but pose a substantial burden of distress for children and their families, and a considerable burden on the health care system.

We estimated that 61 and 77 DALYs due to OM could be attributed to SHS exposure in children aged up to 3 years in Poland for the two exposure scenarios (48% and 60%, respectively). In the study of 6 European countries, 654 DALYs for OM were attributable to SHS exposure in children (with the total population of 240 million people) [12]. The US national estimates of annual pediatric morbidity and mortality rates associated with SHS exposure include 0.7 to 1.6 million pediatric office visits for treatment of OM among infants and toddlers [26]. A population level study showed a decrease in the rate of pediatric visits for OM, attributable to changes in the US household smoke-free policies and pneumococcal vaccination [27]. Although OM is one of the most common diseases of childhood for which medical advice is sought, reliable incidence data from Poland and other countries are lacking [27,28], and this affects the reliability of the DALYs estimate.

We estimated that over 2410 and over 2970 DALYs due to asthma were attributable to SHS exposure in children aged up to 15 years, for the two SHS exposure scenarios. In 6 European countries, almost 10 500 DALYs due to asthma induction were attributed to SHS in children below 14 years of age [12]. In a European study on health impacts of SHS on children, the calculated PAF_{SHS} for asthma episodes in Poland was 8% and 11.9%, for SHS exposure estimates of 38% and 59%, respectively [11]. This was comparable with PAF_{SHS} estimated for asthma onset in our study – 13% and 16%, for the two exposure scenarios, respectively. SHS has been linked both, to the onset and the exacerbation of childhood asthma [3,11]. The US national estimates of annual pediatric morbidity rates associated with SHS exposure include 8000 to 26 000 new cases of asthma, and 400 000 to 1 000 000 asthma exacerbations [26].

In our study, the disease burden in DALYs was the highest for asthma, as compared with the other studied health outcomes. Similarly, it ranked first in a European study concerning 6 countries [12], and in the WHO Europe A region, comprising mostly of the EU member states, whereas in Europe B region, where Poland belongs, asthma ranked second, after lower respiratory infections [4].

Estimates of asthma prevalence in children in Poland coming from different studies, using different approaches and definitions, affect interpretation of the DALYs attributable to SHS exposure and suggest an underestimation of the burden of this disease. A study, aiming at obtaining representative population estimates in Polish children aged 3 to 16 years, produced an overall prevalence of asthma of 8.6% [29]. Based on the multicentre Central European Study of Air Pollution and Respiratory Health (CESAR), in Poland the prevalence of doctor diagnosed asthma, asthmatic spastic or obstructive bronchitis in children aged 7–11 years was 10.4% [30]. In urban children aged 12–16 years, the prevalence of asthma, based on the questionnaire and doctor's diagnosis was 16.4% [31]. In a large study involving more than 4500 children from several areas of Poland, the self-reported prevalence of asthma in children aged 6–7 years was 4.5%, and in children aged 13–14 years it was 6.2%. However, medically diagnosed asthma reached 11% in both age groups [32]. Under-reporting / under-diagnosis of asthma in young children was also reported in other studies [33,34].

Lower respiratory infections are probably the major health outcomes associated with SHS exposure among children globally, especially in the first 2 years of life [3]. In our study, 21% up to 25% of LRI could be attributed to SHS exposure. Depending on the exposure scenario, 12 to 14 deaths of children aged up to 2 years could be attributed to SHS in the year 2010. The disease burden in DALYs was 419 and 500, for the two SHS exposure scenarios, respectively. Also for the year 2004, the disease burden for LRI in children below 2 years of age was 1414 DALYs in 6 European countries [12]. In Öberg et al. [4] 2267 DALYs for LRI were estimated for Europe A region, while in Europe B region, it was almost 185 000 DALYs.

SIDS, which affects infants in the first 12 months of life, may reflect multiple interacting risk factors, including prenatal and postnatal exposure to SHS. Sleeping position plays an important role thus, improved infant sleep position practices have been indicated to contribute to the observed declines in SIDS rates [26,35]. The increasing implementation of smoke-free homes with infants has been shown to present public health benefits [35].

We estimated that 20% of SIDS, meaning 8 cases, could be attributed to SHS exposure in children in Poland in the year 2010. The rate of SIDS per 100 000 live births was 9.4, in 2010, while in 2000 it was 12.7. We calculated the number of SIDS attributable to SHS exposure, using pooled OR for postnatal maternal exposure [3], as a proxy of all infant exposure. This approach might have introduced underestimation of actual risk, as maternal smoking has been estimated to double the risk of SIDS [36], and has probably a greater impact on SHS exposure in children than smoking of other household members. Both postnatal and prenatal SHS exposure are risk factors, and this is another uncertainty in the assessment, as it was not possible to control smoking exposure in mothers during pregnancy.

For comparison, in an European study assessing health impact of SHS on SIDS in children, between 24% (N = 310) and 32% (N = 420) of SIDS cases could be attributed to exposure to SHS, depending on the exposure estimate. Based on Boldo et al. [11] analysis, in Poland, 11 to 15 cases of SIDS could be attributed to SHS, for the two exposure scenarios (38% and 59%) [11]. The US national estimates associated with SHS exposure include 1900 to 2700 SIDS deaths [26]; in Maine, approximately 18.5% of SIDS cases were attributable to in utero SHS exposure [37].

LBW is defined as a birth weight less than 2500 g and can be a result of a preterm delivery or intrauterine growth restriction. That distinction is important for EBD calculations in order to avoid double-counting [3]. In this study we used the data on LBW at term from the national statistics. An estimated population attributable fraction for LBW due to SHS exposure was 9%, meaning that roughly one-tenth of LBW cases could be attributed to SHS exposure. Under this assumption, 786 cases of low birth weight (between 256 and 1364) could be attributed to the SHS exposure in Poland in 2010. For comparison, in the US, 12.8% of LBW cases in Maine were attributable to in utero SHS exposure [37].

We used the 27% estimate of the proportion of pregnant women exposed to SHS. The national survey from 1999 reported over 30% of adults smoking daily in the presence of pregnant women [7]. We did not address the impact of active smoking on low birth weight, as it was not possible to fully control smoking during pregnancy. As assessed in the Pregnancy-related Assessment Monitoring Survey (PrAMS), more than 12% of pregnant women in Poland do not discontinue smoking in pregnancy [18].

Exposure-response relationships

As no country specific risk estimates are available, we applied risk estimates based on the review of epidemiological evidence and assessment of the strength of the evidence for SHS exposure in children and specific health outcomes, summarized in WHO methodological guidance [3]. These estimates were applied in several studies aiming at assessment of EBD due to SHS exposure in European countries [4,11,12].

CONCLUSIONS

The very conservative estimate, focused on these health outcomes for which the evidence linking them with SHS exposure is the strongest, confirms a substantial burden of disease in Polish children. Between 2892 and 3547 DALYs could be attributed to SHS, under the two exposure scenarios, 48% and 60%, respectively. Depending on the exposure scenario, it is roughly 14% and 17% of the total DALYs burden for those diseases. At least 20 deaths from SIDS and LRI, and about 800 cases of LBW could be linked to SHS exposure in 2010. More accurate estimates of the magnitude of health impact of SHS exposure on children, based on the recent comprehensive epidemiological data, would help to guide and prioritize public health actions better so as to eliminate health consequences of this still prevalent environmental exposure.

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