European Agency for Safety and Health at Work

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The value of occupational safety and health and the societal costs of work-related injuries and diseases

European Risk Observatory
Executive Summary

European Agency for Safety and Health at Work

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Executive summary

The need to improve working life in the European Union (EU) is still urgent today. In 2016, approximately 2.4 million non-fatal accidents requiring at least 4 days of absence from work and 3,182 fatal accidents were reported in EU Member States. In addition to these accident rates, figures from 2013 show that 7.9 % of the workforce suffered from occupational health problems, of which 36 % resulted in absence from work for at least 4 days (Eurostat, 2018a).

These occupational injuries, diseases and deaths result in high economic costs to individuals, employers, governments and society. Negative effects may include costly early retirement, the loss of skilled staff, absenteeism as well as presenteeism (when employees go to work despite illness, increasing the likelihood of mistakes) and high medical costs and insurance premiums. In a previous project, the European Agency for Safety and Health at Work (EU-OSHA) estimated that 3.9 % of global gross domestic product (GDP) and 3.3 % of European GDP is spent on dealing with occupational injuries and diseases (EU-OSHA, 2017a). This percentage may vary widely between countries, in particular between western and non-western countries, depending on the industrial mix, legislative context and prevention incentives.

Understanding the magnitude of the problem calls for a reliable and comprehensive estimate of occupational injury and disease costs to society. It is vital for policy-makers to be aware of these costs to help them to set priorities. Insight into the financial consequences of occupational injury and disease provides governments, policy-makers and employers' organisations with relevant data for the purpose of developing occupational safety and health (OSH) policies and agreements. Moreover, insight into these costs will help to raise awareness of the magnitude of the problem and will contribute to a more efficient allocation of resources for OSH.

Earlier attempts have been made to estimate the financial burden of occupational injuries and diseases. Often, they are limited to one or more diseases, or to the consequences of a specific type of exposure. Only a few studies address the full burden of occupational diseases. EU-OSHA decided to address this large research gap in the field of OSH and initiated a project to estimate the costs of occupational injuries, diseases and deaths at a European level. The project involved a two-stage approach. The first stage started in 2015 and resulted in an overview of the availability and quality of the national and international data sources required for the development of cost estimation at a European level. It was concluded that in many countries the available data sources were insufficient for a reliable estimation of the economic burden of occupational injury and disease. However, in some countries the availability appears to be reasonably sound and may be sufficient to carry out a cautious estimation (EU-OSHA, 2017b). This was carried out in the second stage of the project, which is described in this report. The objective of this project was:

to estimate the cost of work-related injuries, diseases and deaths for five countries out of the EU-28 countries, Norway and Iceland.

For the country selection, the following criteria were taken into account:

- data availability and quality;
- geographical coverage;
- main type of industry (services, industry, agriculture);
- insurance system (healthcare, social security).

The first criterion is the most important; data of sufficient quality must be available to enable the estimation of economic burden. Since we also wanted to represent the diversity of countries in the EU, we took into account three other criteria: geographical coverage, economic structure (dominant industry types) and the national insurance system. For geographical coverage, we distinguished between 'north', 'west', 'central' and 'south'. For economic structure, we distinguished between countries with a higher or lower percentage of people employed in services than the EU average (= 73.1 %). For insurance system, we distinguish between Beveridgean, Bismarckian and mixed systems. Table 1 presents the final country selection.

Table 1: Selected countries and their characteristics

Countries	Data availability/quality ([a])	Geographical location	Insurance system ([a])	% employed in services ([b])
Finland	Good	North	Mixed	73.1
Germany	Good but no friction costs	West	Bismarckian	73.9
The Netherlands	Good	West	Bismarckian	82.9
Italy	Good, limited on friction costs	South	Beveridgean	72.4
Poland	Good but no friction costs	Central	Bismarckian	58.3

([a]) EU-OSHA (2017b).; ([b]) Labour Force Survey 2015 (Eurostat).

Injuries, diseases and deaths are associated with different sorts of costs. First, there are direct costs, such as healthcare costs. Next, there are costs associated with productivity and output losses. In addition, there are costs associated with the impact on human well-being, that is, the impact on people's lives and health, that can be quantified and included in the burden estimate. In each case of occupational injury or disease, these elements are involved and the sum of the costs of all cases would produce an estimate of the total occupational burden of injury and disease. This way of arriving at a cost estimation is often known as a '*bottom-up approach*', building up from the individual components of costs to total costs.

In addition to a bottom-up approach, it is also possible to take a '*top-down*' approach. In such an approach, total costs are estimated by considering the total burden of injury and disease, and estimating the fraction that was caused by occupational factors. Subsequently, the costs associated with this occupational burden of injury and disease can be estimated. These costs are often expressed in terms of existing summary measures of health, such as disability-adjusted life years (DALYs).

In the present study, both approaches are taken. A bottom-up model is built, taking into account direct costs, indirect costs and intangible costs (life and health impacts), and a top-down model is also built, based on the monetary value of 1 DALY. For both models, 2015 was used as the reference year, to enable the comparability of data across countries and between approaches.

Bottom-up model

The first step of the bottom-up approach is the estimation of the numbers of occupational injury cases and occupational disease cases, which is quite a challenge due to the high rates of underreporting associated with most data sources. Several sources served as input for the estimation. The estimation of the count of occupational injuries was based on European Statistics on Accidents at Work (ESAW) 2015, while the severity distribution (number of workdays lost) was based on the Labour Force Survey (LFS) 2013 ad hoc module. In some countries (in this study, Italy and Poland), a very high rate of underreporting was assumed, in particular for cases of non-fatal injuries. For those countries, we estimated the number of non-fatal cases based on the fatal to non-fatal ratio from countries where we expected more reliable data on non-fatal cases.

For the estimation of numbers of non-fatal occupational disease cases, different data sources were consulted leading to different scenarios for case counts. In the baseline scenario, we started with the count of compensated (accepted, recognised) and non-compensated (suspected) non-fatal cases for each country for most types of diseases, with the following exceptions: cancers, circulatory diseases, respiratory diseases and musculoskeletal diseases, for which we estimated case counts from the database of the Global Burden of Disease (GBD) Study as registered by the Institute for Health Metrics

and Evaluation (IHME), and used the attributable fractions derived from this database. We also defined a low-limit scenario (that is, compensated cases only), and a high-limit scenario (that is, all types of occupational disease estimated using attributable fractions). Data from the LFS 2013 ad hoc module (Eurostat, 2018b) were used to estimate the distribution of the non-fatal occupational disease cases by age, as well as severity (number of workdays lost). Finally, the estimation of the number of fatal occupational disease cases was also based on the IHME database and attributable fractions derived from this database. The figures presented in this summary are based on the baseline scenario.

In the model, three high-level cost categories were considered: *direct costs*, *indirect costs* and *intangible costs*. Direct costs include all healthcare-related products and services, whether paid for by the public sector, insurer, employer, worker or other stakeholder. We focused on four direct cost items: 1) healthcare costs paid for by the public sector/insurer; 2) public sector/insurer administration/overhead costs; 3) informal caregiving time from family and community; and 4) worker out-of-pocket costs for healthcare products and services, including costs associated with seeking care. We estimated six key subcomponents of indirect costs: 1) market output losses due to absenteeism and reduced work ability associated with permanent impairment; 2) payroll/fringe benefits associated with wages and salaries; 3) employer adjustment costs; 4) insurance administration costs associated with disability insurance/workers' compensation; 5) home production losses; and 6) presenteeism associated with paid employment activity. Finally, intangible costs refer to losses associated with health-related quality of life. Health-related quality of life is estimated in terms of quality-adjusted life years (QALYs) and then monetised.

The cost estimations began with incidence counts (cases) of work-related injuries and diseases to estimate the total costs in a particular cost category, which were then multiplied by the costs of the resources associated with the work-related injury or disease or a price weight, if the resources are measured in non-monetary units (for example months lost from paid employment due to work disability). Incidence counts have been stratified by sex, age bracket, type of injury (high-level ESAW categories) and severity (based on days absent from work). A representation of the formula is as follows:

Total (sub)category costs for a stratum = number of cases in the stratum × per case cost for the stratum

The results are presented below. Table 2 shows the estimation of the number of cases in each country and Table 3 presents the estimates of the costs. Finally, Table 4 presents the economic burden of occupational injury and disease by stakeholder.

Table 2: Estimation of numbers of cases of occupational injuries and diseases (2015 or closest year available)

	Occupational injuries		Occupational diseases	
Countries	**Non-fatal ([a]) (> 1 workday lost)**	**Fatal ([a])**	**Non-fatal ([b])([c])**	**Fatal ([b])**
Finland	63,407	35	67,795	628
Germany	1,158,865	450	1,088,793	13,924
The Netherlands	99,880	35	220,368	3,262
Italy	1,257,987	543	638,448	10,524
Poland	697,337	301	454,090	4,663

([a]) ESAW 2015 (the non-fatal cases in Poland and Italy are adjusted based on the fatal to non-fatal ratio). To estimate the number of non-fatal cases with 1-3 workdays lost, the severity distribution of the LFS 2013 was applied.
([b]) IHME (2016).
([c]) National sources: Finland — Finnish Institute of Occupational Health (2012); Germany — DGUV (2013); the Netherlands — NCvB statistiek (2015); Italy — Banche dati static (2015); Poland — Choroby Zawodowe W Polsce W (2014), in Szeszenia-Dąbrowska and Wilczyńska (2016).

Table 3: Estimated total economic burden for occupational injuries and diseases (2015)

Country		Finland	Germany	The Netherlands	Italy	Poland
Number of cases		131,867	2,262,031	323,544	1,907,504	1,156,394
Direct costs	In million EUR	484	10,914	2,137	8,491	1,882
Direct cost, % total		8	10	9	8	4
Indirect costs	In million EUR	4,362	70,658	6,468	58,961	19,588
Indirect cost, % total		72	66	69	56	45
Intangible costs	In million EUR	1,196	25,557	5,147	37,392	22,311
Intangible cost, % total		20	24	22	36	51
Total economic burden	In million EUR	6,042	107,129	23,751	104,844	43,781
Percentage of GDP		2.9	3.5	3.5	6.3	10.2
Per case cost	In million EUR	45,816	47,360	73,410	54,964	37,860
Per employed person	In million EUR	2,479	2,664	2,855	4,667	2,722
GDP per employed person	In million EUR	86,016	75,692	82,159	73,565	26,738

Table 4: Economic burden of occupational injury and disease distribution by stakeholder

Country	Employer		Worker		System/society	
	In million EUR	%	In million EUR	%	In million EUR	%
Finland	1,325	22	3,800	63	916	15
Germany	21,534	20	64,813	61	20,782	19
The Netherlands	3,484	15	17,235	73	3,032	13

Country	Employer		Worker		System/society	
Italy	20,632	20	70,391	67	13,821	13
Poland	5,007	11	34,421	79	4,353	10

Top-down model

The top-down model in the present study is based on DALYs, that is, disability-adjusted life years. The DALY is a measure of overall disease burden, expressed as the number of healthy years lost due to early death or due to living with ill health. DALYs are calculated by disease category and are the sum of life years lost due to premature mortality and 'healthy' life years lost due to disability. The latter is calculated by multiplying the number of cases by duration and the disease-specific disability weight. A disability weight is a weighting factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (equivalent to death). The baseline variant in the present study is based on DALYs by cause, sex, age and country taken from the World Health Organization (WHO) Global Health Estimates: Global burden of disease estimates 2000-2016, as published by the WHO Department of Information, Evidence and Research in June 2018 (WHO, 2018a).

To determine the economic burden of occupational injury and disease, it is necessary to estimate which part of the total burden is caused by occupational exposures. Therefore, it is necessary to estimate the attributable fraction by injury/disease category, that is, the fraction of cases caused by occupational exposures. Since many diseases are not caused by, or at the most are only partly caused by, work exposures, we included some diseases at a higher level of aggregation than others in the assessment of the attributable fraction. In the present study, we used attributable fractions that were derived from the 2015 Global Burden of Disease (GBD) Study (IHME, 2016). In the 2015 GBD Study, risk factors were included, as well as an estimation of disease burden attributable to risk factors, including occupational risk factors (IHME, 2016). From these data, it was possible to deduce the attributable fraction by comparing the number of DALYsoccupational risks x cause with the total number of $DALYs_{cause}$ (year 2016 data). In the final step of our cost estimation model, we assigned a monetary value to DALYs. The value of DALYs lost to occupational exposure represents the economic burden of occupational injury and disease.

In the literature, three broad methodological approaches to estimating the monetary value of 1 DALY can be identified: 1) the human capital approach, 2) the willingness-to-pay (WTP) approach and 3) the value of a statistical life year (VSLY) approach. In the human capital approach, the monetary value of 1 DALY is based on the loss of economic productivity due to ill health, disability or premature mortality. A drawback of the human capital monetisation approach is that only part of an individual's welfare is measured. Life beyond paid work is not valued. Theoretically, the two other monetisation approaches considered in this report, the WTP and the VSLY approaches, do include valuations for broader aspects of life. The WTP approach is based on the preferences of survey respondents to pay for health gains. The value of statistical life (VSL) represents a total monetary value of an average adult towards the life expectancy age; hence, it is a value for the total remaining lifetime of an average person in case of no accident or illness, which in fact is often also obtained with WTP surveys. The drawback of both the WTP and the VSLY approaches is that values are based on surveys and valuation methods that are highly sensitive to the questions asked. As a result of the sensitivity to the methods used, the variance in values found across studies is quite wide. Variance in values is also wide in the human capital approach. For example, according to the recommendations of the WHO Commission on Macroeconomics and Health, the monetary indicator varies between one time GDP per capita and three times GDP per capita (Harvard School of Public Health and World Economic Forum, 2011).

In conclusion, within each monetisation approach, the range of monetary values found in the literature was wide. Therefore, we worked with the minimum, mean, median and maximum of these values in our models. Table 5 contains the results based on the top-down approach by country, according to different monetisation approaches.

Table 5: Estimation of the total costs by country according to the central scenario

	Germany	Finland	Italy	The Netherlands	Poland
DALYs					
Total occupational DALYs	1,236.855	64,516	853,817	248,464	507,068
Percentage of total DALYs	4.9	4.2	5.1	5.7	4.0
Occupational DALYs per 10,000 employed persons	308	265	380	299	315

	Million EUR	% of GDP	Million EUR	% of GDP	Million EUR	% of GDP	Million EUR	% of GDP	Million EUR	% of GDP
COSTS										
Human capital approach										
Minimum	24,597	0.8	1,419	0.7	13,530	0.8	5,290	0.8	2,692	0.6
Average	55,429	1.8	3,106	1.5	31,475	1.9	11,879	1.7	6,929	1.6
Median	39,712	1.3	2,291	1.1	23,865	1.4	8,708	1.3	4,656	1.1
Maximum	138,404	4.5	7,393	3.5	69,671	4.2	30,114	4.4	17,037	4.0
WTP approach										
Minimum	32,324	1.1	1,637	0.8	20,929	1.3	3,276	0.5	5,118	1.2
Average	66,251	2.2	5,814	2.8	42,895	2.6	14,613	2.1	9,676	2.3
Median ([a])	66,251	2.2	4,335	2.1	42,895	2.6	13,953	2.0	8,863	2.1
Maximum	100,177	3.3	17,453	8.3	64,861	3.9	30,767	4.5	15,861	3.7
VSLY/VOLY approach										
Minimum	60,609	2.0	4,214	2.0	52,304	3.2	9,649	1.4	12,790	3.0
Average	191,939	6.3	9,345	4.5	133,789	8.1	38,016	5.6	43,836	10.2
Median	166,943	5.5	8,633	4.1	126,876	7.7	33,248	4.9	31,026	7.2
Maximum	420,489	13.8	19,425	9.3	256,120	15.5	77,016	11.3	119,149	27.7

([a]) Median and average WTP approach values are the same for Germany and Italy because, for these two countries, we could include only two European central reference values, hence the minimum and maximum values as reported in the table.

Results of both models compared

In the bottom-up model, the total estimated economic burden of work-related injuries and diseases — including fatal and non-fatal cases — ranges from 2.9 % of GDP in Finland to 10.2 % in Poland. In the top-down model, the economic burden is highly dependent on the monetisation approach used. In the human capital approach, the work-related economic burden varies from 0.6 % to 4.5 %, dependent on the monetisation method, with less variance among countries. In the WTP approach, percentages are higher and vary from 0.5 % to 8.3%. The VSLY approach yields the highest values, with estimates of the economic burden of occupational injury and disease at 1.4 % of GDP at the minimum and 27.7 % at the maximum. In this approach, variance among countries is also higher. The approach that comes closest to the results of the bottom-up approach is the VSLY approach if we consider the average or median value of the different studies. In addition, the rank ordering of countries in terms of magnitude of economic burden relative to their GDP is similar to that derived from the bottom-up model, with the highest value for Poland (average 10.2 % and median 7.2 % of GDP) and the lowest value for Finland (average 4.5 % and median 4.1 % of GDP). The similarity between the VSLY approach in the top-down model and the bottom-up model may be explained by the inclusion of health and life impacts in the VSLY approach. Health and life impacts, described as 'intangible costs' in the bottom-up approach, are a substantial part of the total costs in the bottom-up model, varying from 20 % to almost 51 %.

In comparing the outcomes of the two cost estimation models, it is important to realise that they do not estimate identical phenomena. Although they were both used to provide estimates of the economic burden of occupational injury and disease, the components of these models are very different. The bottom-up model provides more detailed information for policy-makers, such as direct, indirect and intangible costs, as well as costs by stakeholder. However, the top-down model has the advantages that far less time is needed to construct the model, and country and regional comparisons are easier since internationally harmonised sources can be used.

Country comparison

In comparing the countries, we see in most scenarios that the economic burden of occupational injury and disease is relatively high in Poland and Italy, compared with Germany, Finland and the Netherlands. In Poland, at least part of this may be explained by the sector structure. The workforce in Poland consists of a relatively high number of people working in agriculture or industry. Although the percentage of people working in industry in Italy is above average, the explanation for the relatively high burden is less clear than in Poland. The relatively high burden is partly attributable to the number of DALYs lost to occupational lung cancer. However, the main difference from the other countries under study is the number of DALYs lost to injuries, 'unintentional injuries' as well as 'transport injuries'.

Implications for future projects

In this project on the economic burden of occupational injury and disease, countries were selected based on the expectation that they had sufficient data of good quality to enable an estimation to be made. However, data were often lacking, the quality of data was poor and alternative sources had to be explored to allow a reasonable estimation. In particular, for the bottom-up model, which consists of several components, the search for appropriate data was quite a challenge, particularly for formal healthcare costs. Therefore, the first step to enable a cost estimation of this sort in all European countries would be to build up and harmonise the data collected. There are a number of issues to be considered in order to achieve this. First, the count of occupational injuries and diseases should be improved for all economic burden estimation models, whether they are inputs for a bottom-up approach or used to estimate DALYs. In the present project, it was not possible to base the bottom-up model on incident cases of occupational diseases from country reporting. However, data on the cases of injuries and diseases has to come from somewhere for both the top-down and bottom-up models, ideally from reliable, country-specific sources so that meaningful cross-country comparisons can be made. If they are approximated through generic, international sources, then cross-country comparison is less meaningful for both models. Moreover, country-specific data on the healthcare costs of injuries and diseases appeared to be very difficult to obtain. Finally, it would be helpful to come to a consensus on the way to value life and health impacts for both the top-down and bottom-up models.

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The European Agency for Safety and Health at Work (EU-OSHA) contributes to making Europe a safer, healthier and more productive place to work. The Agency researches, develops, and distributes reliable, balanced, and impartial safety and health information and organises pan-European awareness raising campaigns. Set up by the European Union in 1994 and based in Bilbao, Spain, the Agency brings together representatives from the European Commission, Member State governments, employers' and workers' organisations, as well as leading experts in each of the EU Member States and beyond.

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