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Global estimates of occupational accidents

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Abstract

Information of occupational accidents is not standardized worldwide. Especially, developing countries do not have reliable information on their occupational accidents due to lack of proper recording and notification systems. The number of accidents is under-reported but figures are still used as a baseline for occupational safety work. In this paper global estimates of occupational accidents are presented for 175 countries. These estimates are based on figures from selected countries in eight different regions. Global estimates help to compare different countries and regions to each other to detect improvements in safety and safety work. In 1998 the average estimated number of fatal occupational accidents was 350 000 and there were 264 million non-fatal accidents. Global estimates are needed to guide national policies and decision-making.

Keywords: Occupational accidents; Global estimates

1. Introduction

The figures of occupational accidents are published annually in many countries but reliable data is available only in a limited number of countries, and the information is not standardized. Figures of accidents in developing countries are not based on proper

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accident recording and notification systems. Global figures for occupational accidents are missing while some regions such as the European Union have successfully combined accident figures of member states of EU. In 1999 the International Labour Organization (ILO) published estimates of occupational accidents that where based on the figures gathered from selected ILO member states. These estimates were based on year 1994 figures. The average estimated fatal occupational accident rate was 14.0/100 000 workers and the number of fatal accidents was 335 000 (Takala, 1999).

Global estimates by ILO show that the occupational problems are bigger than earlier believed. Especially, figures of occupational fatal and non-fatal accidents in developing countries were greatly underestimated. Also a recent study from US has shown that between 33% and 69% of all occupational injuries were missed of the reported injuries (Leigh et al., 2004). Previous global estimates have been based on existing information from industrialized countries. The fatality rate and absolute number of fatalities for developing countries were calculated based on regional estimates. However, studies from different countries have shown that a ratio between fatal and non-fatal accident is quite constant if accurate recording systems exist (Dupré, 2001; Takala, 1999).

The difference in accident rates between developed and developing countries is remarkable. While many enterprises in developed countries are taking zero accident policy for their goal, construction of infrastructure and industrialization in developing countries bring new situations to surface. Enterprises in developing countries are unable to identify their hazards. Furthermore, nowadays many enterprises operate in several regions and countries and this often makes accident prevention programmes more challenging and occupational safety and health management systems in corporate context should take into account cultural differences (Larsson, 2000).

Occupational accidents cause direct and indirect or hidden costs for the whole society. A popular way to demonstrate this is the iceberg model. There are many variations of the proportion of the costs but usually the proportion of indirect costs is much bigger than direct costs. On the other hand, these economic calculations are made in industrialized countries that have established specific compensation and social security systems. Often in developing countries an accident which occurs in the work place does not cause direct costs. Also in small and middle size enterprises the proportion of hidden costs is not so big (Andreoni, 1986; Larsson and Betts, 1996).

A commonly used argument is also that poor countries and companies cannot afford safety and health measures. There is no evidence that any country or company in the long run would have benefited from a low level of safety and health. On the contrary, recent studies by the ILO based on information from the World Economic Forum (2002) and the Lausanne Institute of Management IMD demonstrate that the most competitive countries are also the safest. Selecting a low-safety, low-health and low-income survival strategy is not likely to lead to high competitiveness or sustainability (ILO Safety in numbers, 2003).

The research presented in this paper was carried out during years 2001–2002. The aim was to update the latest ILO estimates regarding occupational accidents and to add estimates of work-related diseases. These estimates are based on accident figures from the year 1998. The results can be used as a guide for national policy and decision-making. Countries can compare their figures to their own calculations or estimates as well as the figures of other countries in the same region. The estimates should motivate for better occupational safety work. One aim for this research was to revise and correct the figures for each

individual country. Moreover, ILO supports member states to develop and improve their recording systems. There is also a need for international standardization of accident recording system. In this article only results of occupational accidents are dealt with.

2. Methods and materials

In this article occupational accident is defined as an occurrence arising out of or in the course of work which result in: (a) fatal occupational injury, or (b) non-fatal occupational injury (ILO Code of Practice, 1996). Occupational injury means death, any personal injury or disease resulting from an occupational accident. Often the term occupational accident is understood as a sudden, external and involuntary event. In this study occupational accidents are divided into fatal accidents and accidents causing at least 3 days' absence from work.

During the project the main attention was focused on data collection as all following figures or estimates are based on that information. The article presents only selected results of the data collection (Tables 2–9). More specific information can be found on ILO website (www.ilo.org/safework). The base of calculations was the economically active population and total employment information (covers both paid employment and self-employment) which was collected mainly from three sources: the country's own statistics centre, from ILO yearbook and Laborsta of labour statistics and the website information of Population Statistics. The labour structure was divided into three categories: agriculture, industry and service. This information, gathered from Central Intelligence Agency (CIA) World Factbook and Population Statistics, was used for calculations. Results do not consist of results of separate sectors because in the research so much information was produced that it was impossible to include all in this article. In industrialized countries more employees work in the service sector, while in many developing countries people work mainly in agriculture and the industry sector is growing. Construction sector is included in the industry sector. Fishing and forestry are included in agriculture.

2.1. Fatal occupational accidents

Estimates of occupational accidents were made by regions so that in each region some countries were chosen to represent the whole region in terms of accident rates in the three economic sectors. The Established Market Economies was an exception for which necessary information was found by country level. Also, when estimates were made for India and China sectoral accident rates from other regions were utilized. Regions were divided by using the World Bank divisions (The World Bank Group, 2001):

- Established Market Economies (EME),
- Formerly Socialist Economies (FSE),
- India (IND),
- China (CHN),
- Other Asia and Islands (OAI),
- Sub-Saharan Africa (SSA),
- Latin America and the Caribbean (LAC) and
- Middle Eastern Crescent (MEC).

2.1.1. Established Market Economies

The accident figures of EME are based on figures reported to ILO or to the statistics centers of these countries. The EU has its own statistics office the information of which was used in this study for the EU countries. Still, accident figures of the EU member states are not totally reported. They are often smaller than those reported to ILO. This may be caused by later reporting and different survey questionnaire. Still, even those figures reported to ILO might be incorrect. For example, the figures for Finland reported to ILO did not cover accidents occurring to farmers in agriculture and to self-employed person. This is because there is a separate recording system for these accidents. Figures were adjusted as follows.

In EU the number of fatal and other accidents are based on the total employment number of 136 500 000 (Dupré, 2001). In this study the total employment in the EU is calculated to be 153 364 323 (Table 3). The difference is expected to be due to the fact that the number for EU total employment does not cover self-employed persons and self-employed agricultural workers. The figures of fatal accidents were corrected using the ratio: total employment reported to ILO per total employment reported to EU (153 364 323/136 500 000 = 1.126). When the number of accidents reported was multiplied with the ratio 1.126, the revised number of fatal accident was obtained.

2.1.2. Other regions

Information which was needed from each individual country were (a) number of fatal occupational accidents by insured/covered employees and (b) fatality rate per 100 000 insured/covered employees. However, only a few countries in each region have reliable information available. To make the calculations for regions, countries that best represent the region were chosen. In the next section phases of calculations are presented in more detail.

Phase 1: The number of the insured/covered employees by sector was calculated for the selected countries. Accident rates per 100 000 insured/covered employees and the number of fatal accidents for insured/covered people at the country level were taken from ILO yearbook (2001).

Phase 2: Number of fatal occupational accidents and fatality rate per 100 000 for fully employed persons by sector was calculated when total employment figure was known (data collection mentioned above). Total employment figure for each separate country is presented in Tables 4–9. In the case that the figure was missing, the figure of economically active population was used.

Phase 3: The rates were revised. From each region at least one country, which can be assumed to have data reliably reported by sector, was obtained. However, in each region several countries that have reliable total accident rate were discovered. The mean value of rates from years 1997–1999 was used if possible. By using proportionality final revised rates were calculated.

Finally, by using the rates obtained from calculations the number of fatal accidents by sector (agriculture, industry and service) could be calculated for each country. The total number of fatal occupational accidents was obtained by summarizing the fatal accidents in each sector. Phases of calculations are shown as an example below.

The example is based on the area of Formerly Socialist Economies (FSE) and steps 1–3 were carried out for Kazakhstan. When the revised accident rates of the three sectors for the region were calculated, also the total rate for Russia was used. Table 1 presents rates

Table 1
Fatal accident rates by the region

	Agriculture[a]	Industry[a]	Service[a]	Countries used on calculations
FSE	8.4	21.9	5.7	Kazakhstan, Russia
IND	10.2	26.4	6.9	Kazakhstan, Malaysia
CHN	8.1	21.0	5.5	Kazakhstan, China[b]
OAI	34.9	13.4	7.9	The Republic of Korea, Malaysia, Thailand
SSA	22.5	16.0	18.7	Zimbabwe, Ethiopia
LAC	33.3	13.4	10.8	Argentina, Brazil, El Salvador, Nicaragua and Panama
MEC	21.2	21.2	12.4	Turkey, Egypt, Morocco and Tunisia

[a] Per 100 000 employees.
[b] Based on new development area in China (Xia et al., 2000). The years are 1995–1997.

and countries of each regions that were used on calculation. The first country mentioned in the list is used on phases 1–3, and others to make revision.

Because only the fatality rate and amount of fatal accidents for insured/covered worker were known, number of insured/covered employees had to be calculated (phase 1). The information was taken from ILO yearbook of labour statistics, 1998. In the case of Kazakhstan the economic activities are classified by using International Standard Industrial Classification of all Economic Activities (ISIC-Rev.3). Classification have categories from A to Q and category X for not classifiable economic activity. Categories A–B comprise the sector of agriculture and respectively categories C–D the sector of industry. Categories G–Q form the sector of service.

$$\text{Employees}_{\text{insured in industry}} = \frac{\text{Fatal accident}_{\text{insured}} * 100\,000}{\text{Fatality rate}_{\text{insured}}} \tag{1}$$

$\text{Fatal accident}_{\text{insured}}$ is the number of fatal accident for insured/covered worker (from ILO yearbook); Fatality rate is accident rate for insured/covered worker (from ILO yearbook); $\text{Employees}_{\text{insured in industry}}$ is number of insured/covered employees by sector.

For Kazakhstan the number of insured/covered employees in agriculture was 464 339, in industry 805 960 and in service 1 326 260. Figure of insured/covered employees was much less than the official number of employees working in these three sectors. Using proportionality the number of fatal accidents (2) and fatality rates (3) for Kazakhstan were calculated for the industry sector (phase 2). Similar calculations were done for the agriculture and service sectors.

$$\begin{aligned}\text{Fatal}_{\text{industry}} &= \frac{\text{Fatal accident}_{\text{insured}} * \text{Total employment}_{\text{industry}}}{\text{Employees}_{\text{insured in industry}}} \\ &= \frac{157 * 1\,654\,290}{805\,960} \approx 322\end{aligned} \tag{2}$$

$\text{Fatal accident}_{\text{insured}}$ is the number of fatal accident for insured/covered worker (from ILO yearbook); $\text{Total employment}_{\text{industry}}$ is total employment in industry (can be found on ILO website); $\text{Fatal}_{\text{industry}}$ is number of fatal accidents in the field of industry.

$$\text{Rate}_{\text{industry}} = \frac{\text{Fatal}_{\text{industry}} * 100\,000}{\text{Total employment}_{\text{industry}}} = \frac{322 * 100\,000}{1\,654\,290} \approx 19.5 \tag{3}$$

$\text{Rate}_{\text{industry}}$ is the fatality rate in the field of industry.

To correct the rates, information of Russia was used (from ILO yearbook). Then, by using the results of Eqs. (1)–(3) revised fatal accident rates by sector were calculated (4).

$$\frac{\mathrm{Rate}_{\mathrm{revised}}}{\mathrm{Rate}_{\mathrm{countries}}} = \frac{\mathrm{Rate}_{\mathrm{phase\ 2\ by\ sector}}}{\mathrm{Rate}_{\mathrm{total\ from\ phase\ 2}}} \Rightarrow \mathrm{Rate}_{\mathrm{revised}} = \frac{\mathrm{Rate}_{\mathrm{countries}} * \mathrm{Rate}_{\mathrm{phase\ 2\ by\ sector}}}{\mathrm{Rate}_{\mathrm{total\ from\ phase\ 2}}} = \frac{12.0 * 19.5}{10.7} \approx 21.9 \tag{4}$$

$\mathrm{Rate}_{\mathrm{countries}}$ is the mean rate Russia (1997–1999) and Kazakhstan (1997–1998) (from ILO yearbook); $\mathrm{Rate}_{\mathrm{phase\ 2\ by\ sector}}$ is rate from phase 2 by individual sector; $\mathrm{Rate}_{\mathrm{total\ from\ phase\ 2}}$ is mean rate (agriculture, industry and service) from phase 2.

Calculations above were done for all three sectors. Number of fatal accidents can now be calculated and results are presented in Table 4.

Accident rates for India were formulated by using the rates for Kazakhstan and the total rates for Malaysia. India by itself does not keep authentic recording system or does not report information for all industries, so Kazakhstan and Malaysia figures represent missing gaps. The figures for China are equally based on the sectoral figures for Kazakhstan. They were revised by using data by Xia et al. (2000) in a new development area in Shanghai as no other published information from China was found. In the case of Sub-Saharan Africa, the total employment figures were not available in most countries. The accident figures are therefore based on the figures for the economically active population. This may cause some inaccuracy.

2.2. Non-fatal accidents

Accidents causing at least 3 days' absence from work were calculated by using lower and upper limit estimates. The lower limit (0.19%) was calculated using the proportions of fatalities for each EME country with the accidents causing 3 days' absence and obtaining the average of these proportions

$$\mathrm{limit} = \frac{\sum_{i \to n} \left(\frac{F * 100\%}{\mathrm{accident}} \right)}{n} \tag{5}$$

i is the individual country, n is number of countries, F is number of fatal accidents.

In the EU the declaration rate of only a couple of countries is estimated to be 100% (Dupré, 2001). The upper limit (0.10%) is formulated by using the proportion of fatal accidents in Finland, France, Germany and Luxemburg with the figures for accidents causing 3 days' absence (Eq. (5)). Accidents causing 3 days' absence for each country in all regions were then calculated by using lower and upper limits (Eq. (6)).

$$\mathrm{Accident} = \frac{F_{\mathrm{country}} * 100\%}{\mathrm{limit}} \tag{6}$$

F_{country} is number of fatal accident in separate country.

The average is formulated by calculating the mean value of lower and upper limits. In all other regions accidents causing 3 days' absence are also calculated using the ratio of EME countries.

3. Results

Estimates show that occupational accidents are a big problem in the world. There were near 350 000 fatalities in 1998 (Table 2). Every day some 970 people die because of occupational accidents. It was estimated that over 260 million occupational accidents took place during the year 1998. Thus, for every fatal occupational accident over 760 accidents occur that cause at least 3 days' absence from work.

The accidents reported to ILO comprised only 3.9% for the estimated accidents that took place in the world. However, the reported accidents amount varies between different regions. When the EME region reported 62% of their occupational accidents to ILO, India or the OAI region reported close to 0%. However, there is a difference in reporting between different countries in the same region.

The upper and lower limits for non-fatal accidents differ remarkable from each other. The upper limit is almost double compared to the lower limit. From this point on the figures discussed below are the number of fatalities or the average number of accidents.

3.1. Established Market Economies

Occupational accidents in the EME region are presented by dividing the countries into two categories: EU15 countries and other EME countries. Yearly more than 16 000 fatal occupational accidents happen and the average for all accidents is over 12 million accidents. The fatality rate is 4.2 and accident rate is 3240 per 100 000 workers (Table 3). The EME countries reported to ILO 62% of the cases that were expected, except the EU member states that reported the figure as high as 95%.

The fatality and accident rates per 100 000 workers in Canada, United States, Ireland, Italy, Portugal and Spain are clearly higher than average. The rates of Greece and especially United Kingdom are low. In United Kingdom the real rate figures might be near the figures of France. Total employment figure of United Kingdom is higher than in France but more people are working in service sector.

3.2. Former Socialistic Economies

Countries of Former Socialistic Economies have 21 000 fatal accidents and the average number for all occupational accidents is estimated to be about 16 million cases. The fatality rate in this area is 13 per 100 000 workers and the accident rate is 10 000 per 100 000 workers. Thus, every tenth worker has an occupational accident during one year. The cases reported to ILO comprise only 3.6% of the expected number of accidents (Table 4).

The fatality rate seems to be higher in the eastern part of the region. It varies between 14 and 18 per 100 000 workers, while for most of the other countries the rate is under 12 per 100 000 workers. The same direction can be seen also in the accident rates.

3.3. India and China

Yearly over 48 000 workers die because of occupational accidents in India, and almost 37 million occupational accidents occur which cause at least 3 days' absence from work. The fatality rate is 11.4 per 100 000 workers and accident rate is 8700 per 100 000 workers. India did not actually report any occupational accidents to ILO (Table 5).

Table 2
Occupational accidents by regions

	Economically active population	Total employment	Estimated number of fatal accidents	Non-fatal accidents, at least 3 days' absence			Accidents reported to ILO	
				Lower limit	Fatal upper limit	At least 3 average	Accidents	Days' absence
EME	409 141 496	380 833 643	16 170	8 510 494	16 169 938	12 340 216	14 608	7 631 977
FSE	184 717 127	162 120 341	21 425	11 276 461	21 425 275	16 350 868	8 665	582 287
IND	458 720 000	419 560 000	48 176	25 355 777	48 175 977	36 765 877	211	0
CHN	708 218 102	699 771 000	73 615	38 744 649	73 614 834	56 179 742	17 804	75 773
OAI	404 487 050	328 673 800	83 048	43 709 538	83 048 122	63 378 830	5 631	252 499
SSA	260 725 947	10 540 604	54 705	28 792 223	54 705 223	41 748 723	1675	47 105
LAC	193 426 602	11 460 496	29 594	15 575 673	29 593 778	22 584 726	6998	1 699 107
MEC	112 906 300	48 635 240	18 986	9 992 504	18 985 757	14 489 130	1876	191 164
WORLD	2 732 342 624	2 164 739 590	345 719	181 957 318	345 718 904	263 838 111	57 468	10 479 912

EME = Established Market Economies, FSE = Formerly Socialist Economies, IND = India, CHN = China, OAI = Other Asia and Islands, SSA = Sub-Saharan Africa, LAC = Latin America and the Caribbean, and MEC = Middle Eastern Crescent.

Table 3
Occupational accidents by country in the EME region

Country	Economically active population	Total employment	Estimated number of fatal accidents (revised using ratio 1.126)	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Australia	9220500	8617000	275	3.2	144658	274850	209754	2434
Canada	15631500	14139000	899	6.4	473103	898896	686000	4852
Iceland	147800	133000	2	1.7	1186	2253	1719	1293
Japan	67870000	65140000	2077	3.2	1093236	2077149	1585193	2434
Malta	143937	137390	1	0.8	593	1126	860	626
New Zealand	1814200	1725000	61	3.5	32105	61000	46553	2699
Norway	2285000	2249000	72	3.2	37943	72092	55018	2446
Switzerland	3928000	3848000	118	3.1	62 250	118276	90263	2346
United States	137674000	131463000	6821	5.2	3589775	6820573	5205174	3959
Austria	4200000	3962000	158	4.0	83001	157701	120351	3038
Belgium	4260000	4241323	155	3.7	81815	155448	118632	2797
Denmark	2867000	2685000	90	3.4	47429	90115	68772	2561
Finland	2508000	2222000	65	2.9	34211	65000	49606	2232
France	26435100	22842000	683	3.0	359474	683000	521237	2282
Germany	39694000	35994000	1287	3.6	677368	1287000	982184	2729
Greece	4400000	3921000	88	2.2	46243	87862	67053	1710
Ireland	1538900	1521000	79	5.2	41500	78851	60175	3956
Italy	22849000	20242000	1388	6.9	730405	1387770	1059087	5232
Luxembourg	242000	237000	7	3.0	3684	7000	5342	2254
Netherlands	7616000	6609000	99	1.5	52172	99126	75649	1145
Portugal	4395690	4493000	266	5.9	139915	265839	202877	4515
Spain	16441000	13205000	1177	8.9	619540	1177126	898333	6803
Sweden	4264000	3978000	77	1.9	40315	76598	58456	1469
United Kingdom	28715869	27212000	225	0.8	118572	225287	171930	632
Total	409141496	380833643	16170	4.2	8510494	16169938	12340216	3240

Table 4
Occupational accidents by country in the FSE region

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Albania	2000000	1078000	108	10.0	56850	108016	82433	7647
Armenia	1476400	739900	70	9.5	37075	70442	53759	7266
Azerbaijan	2927300	3701500	619	16.7	325576	618595	472085	12754
Georgia	2367000	1731100	306	17.7	161083	306058	233571	13493
Belarus	5000000	4416600	496	11.2	261161	496205	378683	8574
Bulgaria	4000000	3030000	346	11.4	182183	346147	264165	8718
Croatia	2039833	1384841	178	12.9	93713	178055	135884	9812
Czech Republic	5153000	4818000	593	12.3	312282	593337	452810	9398
Estonia	710400	640200	59	9.2	31124	59135	45130	7049
Hungary	4048200	3619000	372	10.3	195997	372395	284196	7853
Kazakhstan	7000000	6127000	655	10.7	344886	655283	500084	8162
Kyrgyzstan	1762539	1704900	316	18.6	166542	316429	241486	14164
Latvia	1043000		105	10.1	55005	104509	79757	7647
Lithuania	1819800	1656000	184	11.1	96745	183816	140281	871
Makedonia	1000000	310000	43	13.9	22599	42938	32769	10571
Moldova	1700000	1496400	135	9.0	71260	135394	103327	6905
Poland	17100000	15849000	1588	10.0	836051	1588498	1212275	7649
Roumanie	11756495	10845000	1564	14.4	823290	1564250	1193770	11008
Russian Federation	68264225	63600000	6974	11.0	3670389	6973740	5322065	8368
Slovakia	2617935	2167000	229	10.6	120440	228835	174637	8059
Slovenia	983000	907000	112	12.3	58852	111819	85336	9409
Tajikistan	1778000	1143000	212	18.6	111653	212141	161897	14164
Turkmenistan	2340000		420	17.9	220995	419890	320442	13694
Ukraine	22300000	22998400	3985	17.3	2097454	3985163	3041308	13224
Uzbekistan	10000000	8157500	1471	18.0	774190	1470960	1122575	13761
Yugoslavia	2504000		283	11.3	149066	283225	216145	8632
Total	184717127	162120341	21425	12.9	11276461	21425275	16350868	9864

Table 5
Occupational accidents in India and China

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
India	458 720 000	419 560 000	48 176	11.5	25 355 777	48 175 977	36 765 877	8763
China	708 218 102	699 771 000	73 615	10.5	38 744 649	73 614 834	56 179 742	8028

In China both rates are close to those in India. The fatality rate is 10.5 per 100 000 workers and the accident rate is 8028 per 100 000 workers. Annually over 73 000 fatal accidents happen and the number of occupational accidents with at least 3 day's absence from work is 56 million. Also China reported to ILO less than 1% of the estimated number of accidents. Agriculture is expected to be less mechanized than, for example in Republic of Korea or Thailand, and therefore lower agricultural risk rate from Kazakhstan for calculations was considered better.

3.4. Other Asia and Islands

In the countries of other Asia and Islands annually 83 000 fatal occupational accidents take place and the number of occupational accidents with at least 3 day's absence from work is 63 million. The fatality rate per 100 000 workers is 21.5 and the accident rate per 100 000 workers is over 16 000. In the whole region the cases reported to ILO are almost 0%. Some countries like Malaysia report approximately 7% of their occupational accidents (Table 6).

Fatality and accident rates are quite low for Brunei, Cook Islands and Singapore compared to the figures of Bangladesh, Cambodia, Kiribati, Laos, Nepal, Papua New Guinea and Vietnam. Labour structure and natural environment may vary considerably from each other.

3.5. Sub-Saharan Africa

In Sub-Saharan Africa countries slightly more than 54 000 fatal occupational accidents happen annually. Approximately 42 million work-related accidents took place that cause at least 3 days' absence from work. The fatality rate of the region is 21 per 100 000 workers and the accident rate per 100 000 workers is 16 000. Occupational accidents reported to ILO by the SSA countries is close to 0% of the estimated number of accidents (Table 7).

The fatality and accident rates are almost the same in every country. As real reliable information was obtained from very few countries only most figures are based on proxy figures.

3.6. Latin America and the Caribbean

In the area of Latin America and the Caribbean 29 600 fatalities happen in work places yearly and the number of occupational accidents causing at least 3 days' absence from

Table 6
Occupational accidents by country in the OAI region

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Afghanistan	10000000		1988	19.9	1046316	1988000	1517158	15172
Bangladesh	56014000	54597000	14403	26.4	7580362	14402689	10991526	20132
Brunei	111955		11	10.0	5913	11235	8574	7658
Cambodia	6000000		1696	28.3	892579	1695900	1294239	21571
Cook Islands	5994		1	11.4	359	682	520	8679
Fiji	235000	235000	48	20.2	25009	47517	36263	15431
Indonesia	91324911	87050000	18220	20.9	9589245	18219565	13904405	15973
Kiribati	7870		2	27.2	1128	2143	1636	20785
Laos	3040041		876	28.8	460886	875684	668285	21983
Malaysia	8569200	8599600	1578	18.3	830314	1577597	1203955	14000
Mongolia	1300000	792500	157	19.9	82816	157351	120084	15153
Myanmar (Burma)	24000000	18359000	4773	26.0	2512284	4773340	3642812	19842
Nepal	11000000		3293	29.9	1733079	3292850	2512964	22845
Pakistan	35230000	35934000	7444	20.7	3917752	7443728	5680740	15809
Papua New Guinea	2000000	2000000	579	29.0	304947	579400	442174	22109
Philippines	53272000	30109000	6019	20.0	3167942	6019090	4593516	15256
Republic of Korea	21604000	19994000	3148	15.7	1656713	3147755	2402234	12015
Singapore	1931800	1869700	183	9.8	96093	182576	139334	7452
Solomon Islands	26842		6	20.8	2941	5587	4264	15885
Sri Lanka	6218304	5946200	1139	18.3	599471	1138995	869233	13979
Thailand	33560100	32140000	7490	23.3	3942225	7490227	5716226	17785
Tonga	35033		8	23.4	4317	8202	6259	17866
Viet Nam	39000000	36994000	9988	27.0	5256847	9988010	7622429	20605
Total	404487050	328673800	83048	21.5	43709538	83048122	63378830	16434

Table 7
Occupational accidents by country in the SSA region

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Angola	6000000	475200	1272	21.2	669600	1272240	970920	16182
Benin	2085446		442	21.2	232374	441510	336942	16157
Botswana	235000	225900	44	18.6	22966	43636	33301	14171
Burkina Faso	5000000	163070	1095	21.9	576263	1094900	835582	16712
Burundi	4000000		886	22.1	466147	885680	675914	16898
Cameroon	6000000		1261	21.0	663442	1260540	961991	16033
Cape Verde	120565		24	20.1	12726	24179	18453	15305
Central African Rep.	1186972		261	22.0	137426	261110	199268	16788
Chad	2293641	14522	500	21.8	262970	499642	381306	16624
Comoros	144500		30	20.5	15568	29579	22574	15622
Côte d'Ivoire	1850000		388	21.0	204026	387649	295837	15991
Republic of Congo	20000000		4 148	20.7	2182947	4147600	3165274	15826
Djibouti	282000		60	21.3	31544	59933	45739	16219
Equatorial Guinea	102565		21	20.9	11288	21447	16368	15958
Eritrea		57800	12		6531	12410	9471	16385
Ethiopia	26000000		5596	21.5	2945389	5596240	4270815	16426
Gabon	600000	57800	123	20.6	64974	123450	94212	15702
Gambia	400000		87	21.7	45691	86812	66251	16563
Ghana	9000000		1852	20.6	974605	1851750	1413178	15702
Guinea	3000000		644	21.5	339000	644100	491550	16385
Guinea-Bissau	480000		104	21.7	54841	104198	79520	16567
Kenya	15000000		3238	21.6	1704395	3238350	2471372	16476
Lesotho	700000		131	18.7	68832	130781	99807	14258
Liberia	704321		149	21.1	78380	148922	113651	16136
Madagascar	7000000		1513	21.6	796379	1513120	1154749	16496
Malawi	5000000		1087	21.7	571974	1086750	829362	16587
Mali	5000000		1105	22.1	581605	1105050	843328	16867
Mauritania	750000		151	20.1	79374	150810	115092	15346
Mauritius	514000	436312	94	18.3	49398	93856	71627	13935
Mozambique	9000000		1945	21.6	1023916	1945440	1484678	16496
Namibia	500000		100	19.9	52489	99730	76110	15222

(*continued on next page*)

Table 7 (*continued*)

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Niger	5000000		1092	21.8	574974	1092450	833712	16674
Nigeria	48000000		9631	20.1	5068800	9630720	7349760	15312
Rwanda	4000000		886	22.2	466379	886120	676249	16906
Sao Tome and Principe	30607		6	20.6	3317	6302	4809	15713
Senegal	4000000		865	21.6	455074	864640	659857	16496
Seychelles	30900		6	18.6	3020	5737	4378	14170
Sierra Leone	1369000		287	21.0	151181	287244	219212	16013
Somalia	3700000		791	21.4	416192	790764	603478	16310
South Africa	13790000	9110000	2643	19.2	1390976	2642854	2016915	14626
Sudan	11000000		2308	21.0	1214979	2308460	1761719	16016
Swaziland	116430		22	18.9	11552	21948	16750	14386
Togo	1740000		366	21.0	192636	366009	279323	16053
Uganda	10000000		2168	21.7	1141105	2168100	1654603	16546
Tanzania	16000000		3435	21.5	1808000	3435200	2621600	16385
Zambia	4000000		792	19.8	416979	792260	604619	15115
Zimbabwe	5000000		1045	20.9	550000	1045000	797500	15950
Total	260725947	10540604	54705	21.0	28792223	54705223	41748723	16012

work is 22.6 million. The number of accidents reported to ILO is 7.6% of the estimated number of accidents. The fatality rate per 100 000 workers is 24.9 and the accident rate per 100 000 workers is 18 000 (Table 8).

The fatality rate for almost all countries varies from 15 to 20 per 100 000 workers and the accident rate from 10 000 to 15 000 per 100 000 workers. A couple of countries, like Guatemala, Haiti and Paraguay, have quite high rates.

3.7. Middle Eastern Crescent

In the region of the Middle Eastern Crescent 19 000 fatal occupational accidents happen yearly and more than 14 million work-related accidents cause at least 3 days' absence from work. The fatality rate is 20.0 per 100 000 workers and the accident rate per 100 000 workers is 15 000. The number of occupational accidents reported to ILO is only 0.9% of the expected number of accidents (Table 9).

The rate of Morocco is more than double when comparing the figures with the other countries. Total employment figure of Morocco is probably too low. If economically active population figure was used, the fatality rate would be 18.1 and the accident rate near 14 000. Also, Egypt and Tunisia have high rates.

4. Discussion

New estimates show that more occupational accidents happen yearly than were estimated earlier. However, figures for fatal accidents (350 000) were fairly stable and only slightly rising: rising in developing and decreasing in industrialized countries. The average figure for occupational accidents was estimated to be 264 million accidents yearly, so more than 700 000 workers a day suffer an accident which causes absence of three days or more. The proportion of reported accidents to ILO is only 3.9% of the estimated number of occupational accidents. Otherwise, if the updated fatality rate (13.8 per 100 000 worker) is compared with the fatality rate of the first estimate (14.0 per 100 000) it is slightly lower than the previous one. The difference is probably due to more accurate employment counting.

The fatalities and the average figures shown might be lower than the genuine situation. New estimations are based on information from ILO and the proportion of reported accidents is very low. The number of fatal occupational accident for insured/covered workers is the basis for the calculations, and this figure is probably lower than the real number. As was seen in the case of EME region, countries do not report all their cases. Therefore, the number of fatal occupational accidents is not believed to be an overestimate. Also, the average figure of accidents causing at least 3 days' absence from work might be somewhat higher but under the upper limit. On the other hand, Leigh et al. (2004) estimated that in the US the number of occupational injuries is greatly underreported. Though the lower and upper limits are based on the proportion of fatal accident in EME countries, the proportion of fatal accidents versus accidents causing at least 3 days' absence are probably not overestimated. The proportion was quite near each other in every EME country. The first aid and health care system is better in most industrial countries and the threshold to use it is lower than in developing countries. In developing countries workers go to work after the occupational accident in the situations where workers in developed country stay on sick leave. Each country could improve their own estimates.

Table 8
Occupational accidents by country in the LAC region

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Anguilla	4400		1	22.7	288	548	418	9504
Antigua and Barbuda	30000		4	1.3	2125	4037	3081	10270
Argentina	13270000	11670000	1705	14.6	897300	1704870	1301085	11149
Bahamas		144360	17	11.8	9159	17403	13281	9200
Barbados	136000	119600	16	13.4	8460	16074	12267	10257
Belize		85595	17	20.2	9092	17275	13183	15402
Bolivia	3645165	2017000	441	21.9	232157	441098	336627	16689
Brazil	75213283	68040000	11304	16.6	5949453	11303961	8626707	12679
Chile	5851510	5370000	787	14.7	414112	786812	600462	11182
Colombia	6653171	5654900	1028	18.2	540906	1027722	784314	13870
Costa Rica	1376540	1300100	206	15.9	108606	206352	157479	12113
Cuba	5000000		890	17.8	468553	890250	679401	13588
Dominica	25000		5	20.0	2715	5158	3936	15745
Dominican Republic	3594308	2652000	405	15.3	212953	404610	308782	11643
Ecuador	3560485	3151200	574	18.2	301852	573518	437685	13889
El Salvador	3000000	2227500	400	18.0	210323	399614	304968	13691
Grenada	42300		7	16.5	3688	7007	5347	12641
Guatemala	3488924	3201000	718	22.4	378055	718304	548180	17125
Guayana	245492		43	17.5	22677	43086	32882	13394
Haiti	3000000		777	25.9	408695	776520	592607	19754
Honduras		2134992	382	17.9	200813	381544	291179	13638
Jamaica	1735125	1119075	179	16.0	94350	179265	136807	12225
Mexico	39507063	38617500	6149	15.9	3236553	6149451	4693002	12153
Nicaragua	1630200	1441800	298	20.7	156625	297588	227106	15752
Panama	1049007	936500	149	15.9	78607	149353	113980	12171
Paraguay	2000000	1190400	264	22.1	138751	263626	201188	16901
Peru	7407280	6929300	1316	19.0	692456	1315666	1004061	14490
Saint Kitts and Nevis	18172		4	22.0	2081	3953	3017	16603
Saint Lucia	43800		8	18.3	3970	7543	5757	13143
Saint Vincent and the Grenadines	67000		11	16.4	6027	11452	8739	13044
Suriname	100000	88244	14	15.9	7348	13960	10654	12073
Trinidad and Tobago		479300	65	13.5	33981	64564	49273	10280
Uruguay	1239400	1103700	164	14.9	86295	163960	125127	11337
Venezuela	9507125	8710700	1248	14.3	656649	1247634	952141	10931
Total	193426602	114604962	29594	17.2	15575673	29593778	22584726	13192

Table 9
Occupational accidents by country in the MEC region

Country	Economically active population	Total employment	Estimated number of fatal accidents	Fatality rate	Non-fatal accidents, ⩽3 days' absence			Accident rate
					Lower limit (0.19%)	Upper limit (0.10%)	Average	
Bahrain	295000	147740	23	15.7	12242	23260	17751	12015
Cyprus	309300	287000	45	15.5	23423	44503	33963	11834
Egypt	23000000	16183000	3884	24.0	2044337	3884240	2964288	18317
Iran	19000000		3198	16.8	1683158	3198000	2440579	12845
Iraq	6000000		850	14.2	447158	849600	648379	10806
Israel	2210000	1761900	257	14.6	135388	257237	196313	11142
Jordan	1150000		179	15.6	94227	179032	136630	11881
Kuwait	1300000	1243126	165	13.3	86888	165087	125987	10135
Lebanon	1300000		206	15.9	108680	206492	157586	12122
Libyan	1500000		247	16.4	129853	246720	188286	12552
Morocco	11000000	4168400	1993	47.8	1049053	1993200	1521126	36492
Oman	850000	79200	15	18.9	7862	14937	11399	14393
Qatar	233000		35	15.1	18552	35248	26900	11545
Saudi Arabia	7000000		1096	15.7	576800	1095920	836360	11948
Syrian	5000000		884	17.7	465263	884000	674632	13493
Tunisia	4000000	2635000	654	24.8	344421	654400	499411	18953
Turkey	22359000	21594000	4122	19.1	2169401	4121863	3145632	14567
United Arab Emirates	1400000	1779000	283	15.9	149061	283217	216139	12149
Yemen	5000000		849	17.0	446737	848800	647768	12955
Total	112906300	48635240	18986	18.6	9992504	18985757	14489130	14218

Though calculated estimates include many inaccuracies, they are at the moment the only estimates worldwide that have been produced. It is difficult to get accurate information and data from separate countries. Calculations should be done for each country by using its own information. The underreporting is the main problem and complicates the process. In this paper the calculations for each country are based on the information in the same region or a similar country. This was assumed to be feasible and reliable enough. Information from separate countries varies inside the same region. For example, number of occupational accidents and/or differences between countries can result from differences in structural industry distribution or educational and training background of workers (Feyer et al., 2001; Spangenberg et al., 2003).

The difficulty of finding reliable information and deciding on the criteria to make new estimates was most challenging. Decisions had to be made concerning what data was the most reliable and representative. In many cases, the information from the statistics offices of the countries was not found to be reliable. In the case of occupational accidents, mainly ILO yearbook figures were considered useful to calculate the estimates. The same problem appeared in gathering employment data. The data was chosen from well-known sources. Occupational accident figures were also problematic: for example some countries include commuting accidents in occupational accidents while others do not. However, in this study those accidents were not separated because information was usually not available. Quite often accidents that occur in agriculture for self-employed persons are not included in the official records at all. This may be another reason for lower official occupational accident figures.

Regions can be divided into three groups based on the rates: region of EME is one group, FSE, India and China form the second group and the third one includes in OAI, SSA, LAC and MEC. For decades almost all countries of Established Market Economies have entered into comprehensive accident prevention programmes and taken occupational safety management as part of their legislation. Their labour structure has changed. The proportion of workers in industrial sector is low and, correspondingly, the proportion of workers in service sector is high and increasing. Inside the industrial sector work has changed more to control operations. These facts explain why rates of EME are relatively low. Within the EME some countries (Spain, Italy and Portugal) have equally high rates as countries of Former Socialistic Economies although for different reasons. Especially, new member states of EU may have to take a more serious approach and improve their legislation and safety system. Figures of India and China are likely to be less reliable. China has taken an enormous leap towards modern society. Still, China has much of its manpower in physically demanding jobs and in crafts intensive work, which are more dangerous. Estimates of China are partly based on rates calculated for a new development area in China where the proportion of agriculture may be lower than in the whole country. Also, the real amount of labour force and therefore the number of occupational accidents is less reliable.

In the third group are regions that are under industrialization and/or still agriculture-based societies. Above all, this is the case for countries of SSA where main problems are different industrial societies. It appears that industrialization that involves building of roads, infrastructure, telecommunications, factory construction, increased traffic and untrained workers in totally new tasks, increases fatal and other accident rates rapidly. These will increase until a certain level is reached. Gradually, prevention policies and programs will then gain momentum and together with the structural shift to service industries will

begin to have a positive effect. However, this rapid increase in accidents due to industrialization may also be partially explained by better recording and compensation systems. Rural and informal working populations are practically outside any protection measures. This applies to both legal and compensation coverage as well as to inspection and occupational health service coverage. Industrial and service sectors are better covered and thus recording systems produce more realistic figures for them.

Countries of the region of MEC differ the most. In this region prosperity, religion, well-being and women's position differ considerably inside the region. Definite figures are hard to get. The rates of MEC (based on Turkey's rates revised with the rates from Egypt, Morocco and Tunisia) stress agriculture and the service sector is small. Still, in some countries the proportion of the workers in service sector is much higher. The aim for future research on updated figures could be to obtain more accurate information for individual countries. Countries need to first establish a better and more reliable recording system covering the entire workforce.

Global occupational safety and health programmes should be focused on the developing countries and be supported by developed countries. Many enterprises in high-income countries move to work in low-income countries: multinational corporations might move to labour intensive and often more dangerous work to low-income countries where salaries are low and regulatory measures poor. The workers in developed and developing countries are entitled to the same human dignity and decent work.

A wide, comprehensive aim for occupational safety and health is to change attitudes globally. Consumer pressure may be useful to eliminate both hazardous child labour and hazardous tasks for adults.

References

Andreoni, D., 1986. Cost of occupational accidents and diseases. Geneva, International Labour Organisation, Occupational Safety and Health Series 54.

Central Intelligence Agency CIA–The World Factbook (used during years 2001–2002). Available from: <http://www.cia.gov/cia/publications/factbook/>.

Dupré, D., 2001. Accidents at work in the EU 1998–1999. Statistics in focus, theme 3-16/2001, 7.

Feyer, A.-M., Williamson, A., Stout, N., Driscoll, T., Usher, H., Langley, J., 2001. Comparison of work related fatal injuries in the United States, Australia, and New Zealand: method and overall findings. Injury Prevention 7, 22–28.

ILO, 2001. Alphabetical list of ILO member states: (used during year 2001). Available from: <http://www.ilo.org/public/english/standards/relm/country.htm>.

ILO Code of Practice, 1996. Recording and notification of occupational accidents and diseases. Geneva, International Labour Office. 96pp.

ILO Laborsta, Yearly Data: Table 2A Employment, general level; Table 2B Total employment, by economic activity; Table 8A Cases of injury with lost workdays, by economic activity; Table 8B Rates of occupational injuries, by economic activity (used during years 2001–2002). Available from: <http://laborsta.ilo.org/>.

ILO Safety in numbers, 2003. Pointers for a global safety culture at work. Geneva, International Labour Office. 27pp.

ILO yearbook of labour statistics 1998 and 2001.

Larsson, T., 2000. The diffusion of employer responsibility. In: Frick, K., Langaa Jensen, P., Quinlan, M., Wilthagen, T. (Eds.), Systematic Occupational Health and Safety Management—Perspectives on an International Development. Elsevier Science Ltd., Oxford.

Larsson, T., Betts, N., 1996. The variation of occupational injury cost in Australia: estimates based on a small empirical study. Safety Science 24, 143–155.

Leigh, J.P., Marcin, J.P., Miller, T.R, 2004. An estimate of the US government's undercount of nonfatal occupational injuries. The Journal of Occupational and Environmental Medicine 46, 10–18.

Spangenberg, S., Baarts, C., Dyreborg, J., Jensen, L., Kines, P., Mikkelsen, K., 2003. Factors contributing to the differences in work related injury rates between Danish and Swedish construction workers. Safety Science 41, 517–530.

Population Statistics, 2001. University of Utrecht, Universiteitsbibliotheek (used during years 2001–2002). Available from: <http://www.library.uu.nl/wesp/populstat/frame-pop1.html>.

Takala, J., 1999. Global estimates of fatal occupational accidents. Epidemiology 10, 640–646.

The World Bank Group, 2001. Countries & Regions (used during year 2001). Available from: <http://www.worldbank.org/>.

World Economic Forum, 2002. Responding to the Leadership Challenge: Findings of a CEO Survey on Global Corporate Citizenship. 30pp. Available from: <http://www.weforum.org/pdf/GCCI/Findings_of_CEO_survey_on_GCCI.pdf>.

Xia, Z.-I., Courtney, T.K., Sorock, G.S., Zhu, J.-I., Fu, H., Liang, Y.-X., Christiani, D.C., 2000. Fatal occupational injuries in a new development area in the People's Republic of China. JOEM 42 (9), 917–922.