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Contribution of occupational risk factors to the global burden of disease—a summary of findings [1]

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The World Health Organization conducted a comparative risk assessment to ascertain the contributions of 26 risk factors to the global burden of disease. Five occupational risk factors accounted for an estimated 37% of back pain, 16% of hearing loss, 13% of chronic obstructive pulmonary disease, 11% of asthma, 9% of lung cancer, 8% of injuries, and 2% of leukemia worldwide. Virtually all cases of silicosis, asbestosis, and coal workers' pneumoconiosis were work-related. Contaminated sharps injuries accounted for 40% of hepatitis B, 40% of hepatitis C, and 4% of HIV/AIDS infections among health care workers. Data limitations, primarily in developing countries, prevented the inclusion of other major occupational risk factors. These selected occupational risks accounted for about 850 000 deaths and 24 million years of healthy life lost each year. The deaths due to these selected occupational risk factors constitute only 43% of the International Labour Organization's estimate of 2 million deaths worldwide due to work-related risks.

Key terms asthma; back pain; chronic obstructive pulmonary disease; hearing loss; leukemia; lung cancer; needlesticks; occupational disease; occupational injuries; occupational carcinogens; risk assessment.

The World Health Organization (WHO) hosts an ongoing Global Burden of Disease (GBD) project that provides the most comprehensive and consistent estimates of mortality and morbidity for more than 135 causes of disease and injury. In its recent comparative risk assessment, WHO conducted an analysis, in a unified framework, of 26 major health risk factors contributing to the overall global burden of disease and injury (2, 3). The following seven major categories of risk factors were included: childhood and maternal undernutrition, other diet-related risk factors and physical inactivity, sexual and reproductive health, addictive substances, environmental risks, selected occupational risks, and other risks to health. The selected occupational risk factors were workplace carcinogens, airborne particulates, hazards for injuries, ergonomic stressors for back pain, and noise. A separate analysis was conducted within the global population of health care workers to assess the fraction of hepatitis B, hepatitis C and HIV/AIDS (human immunodeficiency virus/acquired immunodeficiency syndrome) infections due to contaminated sharps injuries.

1 The *American Journal of Industrial Medicine* is publishing a special issue (in press) dedicated to the contribution of occupational risks to the global burden of disease. It includes articles by each of the authors of this summary. In addition, the World Health Organization has published the results of the contribution of 26 risk factors, and this summary is based on that report (1).

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The absence of data in much of the developing world limited the range of occupational risk factors that could be measured by WHO, and the available data excluded children under the age of 15 years who work. Due to inadequate global data, the WHO comparative risk assessment also excluded important occupational risks for reproductive disorders, dermatitis, infectious disease, coronary heart disease, intentional injuries, musculoskeletal disorders of the upper extremities, and most cancers. Psychosocial risk factors, such as workplace stress, could not be studied, nor could pesticide, heavy metal, or solvent exposures.

Methods

The WHO comparative risk assessment used a common statistical model that allows a reader to compare the contribution (attributable fraction) of several risk factors with the global burden of a single outcome—lung cancer, for example. Stringent requirements for consistency in describing risk factors limited the number of occupational risk factors that could be included in the study. For all of the risk factors, it was necessary to estimate an exposed population and exposure levels for 224 age, gender, and country groups in the 14 WHO geographic regions of the world. Where possible, with the use of similarities in demographic, socioeconomic, or other relevant indicators as the basis, data could be extrapolated to age, gender, and country groups for which data were not available. It was also necessary to know the existing burden of disease and injury globally, so that only outcomes could be included for which WHO had rates of disease or injury calculated by International Classification of Disease (ICD) codes for all regions. Finally, estimates of the risk factor–burden relationships by age, gender, and WHO subregion were generated. Risk measures (relative risks or mortality rates) for the health outcomes resulting from exposure to the risk factors were determined primarily from studies published in peer-reviewed journals. Adjustments were made to account for differences in levels of exposure, exposure duration, and age, gender and subregion, as appropriate. The information about each risk factor was entered into the WHO common model for comparative analysis. The resulting burden was described as the attributable fraction of disease or injury, using both mortality and disability-adjusted life years (DALY) lost, with one DALY being equal to the loss of one healthy life year—a measure that includes both mortality and morbidity.

Because of the requirements for global data, only the following five occupational risk factors could be included: risks for injuries, carcinogens, airborne particulates, ergonomic risks for back pain, and noise.

The exposed-worker populations were estimated using an approach based on the International Standard Industrial Classification of All Economic Activities (ISIC), an economic classification system of the United Nations (UN) that organizes all economic activities by economic sectors and relevant subgroupings (4). The ISIC system is used almost universally by national and international statistical services to categorize economic activity and, therefore, allows global comparisons. The International Labour Organization (ILO) has developed estimates for the economically active population by applying economic activity rates, by gender and age group (greater than 15 years of age), to the population estimates and projections of the UN (5). The economically active population provides the most comprehensive global accounting of persons who may be exposed to occupational risks, as it includes people in paid employment, the self-employed, and people who work to produce goods and services for their own household consumption, both in the formal and informal sectors. For the WHO comparative risk assessment, the economically active population was further divided into nine economic subsectors (where people work) and seven occupational categories (what type of work people do) on the basis of country-level data for 31 countries (6).

Results

The WHO data provide the most current, yet still incomplete, picture of the global problem of occupational health risks. Altogether, these few occupational risk factors account for 850 000 deaths per year and for almost 24 million DALY lost. Figure 1 summarizes the occupational contribution to the global burden of injury and disease of the individual occupational risk factors. This substantial burden is due to largely preventable conditions, which need to be addressed in all countries.

We found that occupational injuries result in about 312 000 deaths per year for the world's 2.7 billion workers. As in the industrial world, high injury fatality rates in the developing countries are clustered in certain

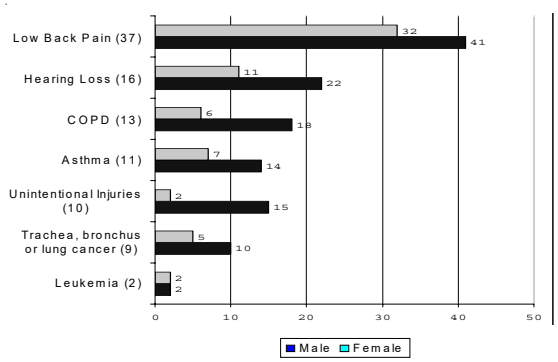

Figure 1. Attributable fraction (%) of global disease and injury due to occupational risk factors [Adapted from Concha-Barrientos et al (3)]. (COPD = chronic obstructive pulmonary disease)

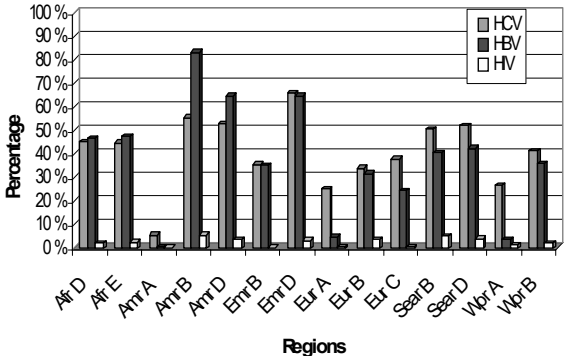

Figure 2. Attributable fraction of hepatitis C virus (HCV), hepatitis B virus (HBV), and human immunodeficiency virus (HIV) infections (overall about 40% HBV and HCV and 2% HIV/AID) due to injuries with contaminated sharps among health care workers 20 to 65 years of age by region [Source: World Health Organization (1)]. (Afr = Africa, Amr = America, Emr = Eastern Mediterranean, Eur = Europe, Sear = South-East Asia, Wpr = Western Pacific)

sectors, including agriculture, construction, and mining. Occupational injuries account for more than 10 million DALY and 8% of unintentional injuries worldwide.

The second occupational risk factor was exposure to workplace lung carcinogens (such as asbestos, diesel exhaust, and silica) and leukemogens (such as benzene, ionizing radiation, and ethylene oxide). We found that occupational exposures account for about 9% of all cancers of the lung, trachea, and bronchus and about 2% of all leukemias. Overall, about 102 000 deaths were due to these two occupational cancers and about 1 million DALY.

Estimates of the global burden of chronic nonmalignant lung disease demonstrate the significant contribution of occupational exposures, which account for about 13% of all cases of chronic obstructive pulmonary disease (COPD) and about 11% of asthma cases. Altogether, we found the annual worldwide burden of work-related COPD to be about 318 000 deaths per year and about 3.7 million DALY. The occupational risk contribution to the worldwide asthma burden was about 38 000 deaths and about 1.6 million DALY, reflecting the fact that much asthma occurs at younger ages and is nonfatal. Virtually all cases (100%) of pneumoconiosis are due to exposure at work. We found 7000 deaths (376 000 DALY) due to asbestosis, 9000 deaths (486 000 DALY) due to silicosis, and 14 000 deaths (366 000 DALY) due to coal workers' pneumoconiosis.

We found that 37% of all back pain worldwide is attributable to work (estimated 0.8 million DALY), significant loss of time from work, and high economic loss. In addition, worldwide, 16% of all hearing loss was attributable to workplace exposures (4.2 million DALY). Low-back pain and hearing loss have in common the fact that they do not directly produce premature mortality but do result in substantial disability. This feature differentiates these conditions from the others analyzed in the study.

Because of the critical role played by health care workers everywhere, we made a special risk analysis of hepatitis B, hepatitis C, and HIV infections due to contact with contaminated sharps, such as syringe needles, scalpels, and broken glass among, health care workers (2, 7). This analysis illustrates the general problem of high risks existing in the small worker population that is exposed. We found that, among the 35 million health workers worldwide, there were 3 million percutaneous exposures to bloodborne pathogens in 2000. This value is equivalent to between 0.1 and 4.7 sharps injuries per year per health worker. We concluded that about 40% of the hepatitis B and 40% of the hepatitis C present among health care workers were due to sharps injuries, with wide regional variation. Between 1% and 12% of the HIV/AIDS infections of health care workers was due to sharps injuries. As illustrated in figure 2, the distribution of results by region and type of infection indicates where special emphasis is needed.

In summary, the five occupational risk factors included in the WHO comparative risk assessment were responsible for about 850 000 deaths worldwide in 2000. Workers who developed outcomes related to these occupational risk factors lost about 24 million years of healthy life. Among the occupational factors analyzed in this study, injuries, hearing loss, and COPD together accounted for about 80% of the years of healthy life lost.

Discussion

The WHO comparative risk assessment has accounted for only about 850 000 (43%) of the 2 million deaths estimated by ILO to occur each year due to occupational illness and injury (8). Deaths due to a wide range of occupational exposures could not be included in the comparative risk assessment because of the strict requirements for global data. Missing are deaths due to asbestosis, silicosis, and other dust diseases; infectious diseases; cardiovascular diseases; and violence. Deaths due to workplace exposures to pesticides, heavy metals, solvents, and other chemicals are not included. Outcomes such as dermatitis, psychological disorders, and upper-extremity musculoskeletal disorders that cause little mortality but substantial disability are also not captured by the WHO comparative risk analysis. In addition, the consequences of underreporting in existing systems and the dearth of recordkeeping systems in developing nations lead to substantial undercounting by both ILO and WHO. Despite the deficiencies, these analyses provide important insights into the immense global burden of disease and injury due to occupational risk factors. WHO and ILO are currently reviewing approaches to estimating global burden due to occupational risk factors in order to enhance and improve these analyses (9).

In order to assist ministers and other policy makers, as well as scientists in the countries in question, WHO is making guidance available for performing national and local assessments of disease and injury burden due to the selected occupational risk factors. Already available are documents illustrating how to assess the national and local burden of disease from work-related noise, occupational carcinogens, and occupational particulate exposure (10–12).

Strategies for controlling injury and occupational disease, developed by occupational hygienists and others over many decades in industrial countries, are as fully applicable in developing countries. The strategies include the following hierarchy of controls, in decreasing order or preference: substitution of major hazards for less hazardous materials or processes; application of engineering controls to separate workers from hazards that remain; use of administrative controls to minimize contact uncontrollable by engineering; and, as the last line of defense, the use of personal protective equipment, such as respirators and protective garments. What differs in developing-country situations is the context in which the controls must be applied.

Solutions exist to address risks experienced by health care workers with respect to contaminated sharps, as illustrated in figure 2, in the countries and regions that have engaged in serious preventive efforts. Proper needle handling and waste management, substitutions for sharps, hepatitis B virus (HBV) immunization, postexposure prophylaxis, training, and legislative measures have been successful. Beyond the personal and workplace consequences, the potentially devastating societal impact of the loss of this critical worker group can be anticipated if preventive measures are not ensured in developing countries, where the proportion of health care workers in the population is already small.

Networks that provide for the cooperation of industrialized and developing countries in the design of solutions for workplace risks are very valuable. The WHO global network of about 70 collaborating centers in occupational health fosters such projects (13). The current 5-year workplan of the collaborating centers can be found at www.who.int/oeh.

The ILO/WHO Joint Committee on Occupational Health was formed in 1950 to provide periodic guidance to ILO and WHO in regard to international occupational health issues. At its 13th session, held in December 2003, the Committee recommended that WHO and ILO pursue the following priorities to reduce the burden of disease and injury due to occupational risk factors (13): (i) guiding and supporting national occupational safety and health programs (including providing models for organizing at national or subnational levels), providing basic occupational health services, promoting management systems and tools (including control banding), developing national profiles and indicators, assessing the cost-effectiveness of interventions, and establishing effective enforcement agencies; (ii) enhancing regional collaboration and coordination (including the development and dissemination of models for cooperation, such as the African Joint Effort); (iii) coordination and enhancing information and educational programs and materials (such as the development of a joint internet-based global portal) and statistics; (iv) providing awareness-raising activities and instruments, through campaigns, events, and special days.

Additional global partners are welcome to join us to advance the work fostered and facilitated by WHO and ILO to reduce the global burden due to occupational illness and injury. Contacts can be made directly with the authors.

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