



National and subnational mortality and disability-adjusted life years (DALYs) attributable to 17 occupational risk factors in Iran, 1990–2015

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ARTICLE INFO

Keywords:

Occupational diseases
Relative risk
Risk exposure
Summary exposure value
Spatial inequality

ABSTRACT

We estimated age-sex specific and cause-specific mortality, years of life lost due to premature mortality (YLLs), years lived with disability (YLDs) and disability-adjusted life years (DALYs) attributable to 17 individual occupational risks in Iran at the national and subnational levels in 1990–2015 based on the Global Burden of Disease Study 2015 (GBD 2015). The burden of disease attributable to occupational risk factors was calculated using the comparative risk assessment methodology based on 10 outcomes and 21 risk-outcome pairs. The temporal changes in the attributable burden of disease were decomposed into the contribution of population growth, population ageing, risk-deleted DALY rate, and risk exposure. National DALYs attributable to occupational risks at the national level in 1990, 2005, and 2015 were 138,210 (95% uncertainty interval 64,429–223,028), 193,243 (91,645–310,281), and 228,310 (106,782–371,709), respectively indicating a total increase of 65% (65–67) during the study period. Between 1990 and 2015, the share of the attributable DALYs for women rose by 55% (51–58) from 13% (12–14) to 20% (19–21). The proportion of YLLs in national DALYs attributable to occupational risks during the study period slightly decreased from 24% in 1990 to 23% in 2015. The five occupational risks with the highest contributions in the national attributable DALYs in 2015 were ergonomic factors (107,490), noise (52,122), exposure to particulate matter, gases, and fumes (26,847), asthmagens (19,347), and exposure to asbestos (7842). From 1990 to 2015, the increase in total DALYs attributable to occupational carcinogens (112%) was higher than that for other occupational risks. During the study period, changes in risk deleted DALY rate and risk exposure led to decreases in total DALYs attributable to occupational risks by 14% and 30%, respectively. Based on the Gini coefficient, spatial inequality in DALY rate attributable to occupational risks at the provincial level decreased during 1990–2015. A comprehensive plan for management of exposure to occupational risks, especially occupational carcinogens can cause an important effect for control of the increasing trend of occupational health losses.

1. Introduction

Work and occupation as a fundamental necessity in human life play a vital role in the economic, physical, mental, and social well-being of human as well as sustainable development of countries so that in

Persian proverbs, work has been interpreted as the “eternal wealth” and the “human footprint”. Along with the important beneficial effects of work on human health, workers may be also exposed to a wide variety of health and hazard risks in the workplace environment, including toxic chemicals, physical agents, allergens, biological and pathogenic

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<https://doi.org/10.1016/j.envres.2018.04.023>

Received 28 December 2017; Received in revised form 17 April 2018; Accepted 20 April 2018
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agents, ergonomic factors, adverse psychological conditions, and safety risks. As a part of environmental risk factors, occupational risks cause a wide variety of adverse health effects from asymptomatic outcomes to death, including over 100 occupational diseases and a range of injuries such as cardiovascular, musculoskeletal, neurotoxic, psychological, reproductive, respiratory, and skin disorders, hearing loss, cancers, amputations, etc. (Ezzati et al., 2004; Hutchings and Rushton, 2017; International Labour Organization, 2010; Mosavi-Jarrahi et al., 2009; Punnett et al., 2005; Trupin et al., 2003).

Exposure to occupational risks and related health losses differ between subpopulations (such as by age or gender) and often exhibit spatiotemporal trends. In order to organize an integrated attempt for preventing adverse health effects of workplaces, a primary step is to determine and analyze disease burden of each occupational risk apportioned by sex, age group, location and year. Occupational burden of disease study provides valuable information for prioritizing actions, planning preventive interventions, assessing health service performance, identifying high-risk groups, assessing future scenarios, and setting priorities in health research. The most important determinants of the occupational burden of disease are rate and level of exposure to the risks and total disease burden of related causes for the population. Factors affecting rate and level of exposure to occupational risks are where the work is performed (economic subsector), the type of work they do (occupation), laws and regulations, and occupational health and safety practices, including identification and control of health and hazard risks, ventilation, personal protective equipment, training and promotion of awareness, health and safety culture, etc. (GBD 2015 Risk Factors Collaborators, 2016; Kauppinen et al., 2000; Kelsh et al., 2010; Nelson et al., 2005a; Nelson et al., 2005b; Prüss-Üstün et al., 2005; Takala et al., 2014).

Due to widespread exposure of most people to occupational risks as well as a relatively high prevalence of occupational diseases and injuries at the global level, occupational risk factors were included in the first effort of comparative risk assessment (CRA) of the Global Burden of Disease Study 2000 (GBD 2000). According to the results of this study, attributable fractions of the disease burden due to occupational exposure at the global level were 37% of low back pain, 16% of hearing loss, 13% of chronic obstructive pulmonary disease (COPD), 11% of asthma, 9% of tracheal, bronchus, and lung cancer, 8% of unintentional injuries, and 2% of leukaemia. Moreover, attributable disability-adjusted life years (DALYs) and deaths of the related outcomes were determined to be 10,496,000 and 310,000 for unintentional injuries, 4,150,000 and zero for hearing loss, 3,733,000 and 318,000 for COPD, 1,621,000 and 38,000 for asthma, 969,000 and 102,000 for tracheal, bronchus, and lung cancer, 818,000 and zero for low back pain, and 101,000 and 7000 for leukaemia, respectively. The contribution of occupational risks in total DALYs and deaths of the population were also reported to be 1.5% and 1.4%, respectively (Ezzati et al., 2004; Fingerhut et al., 2005). The included occupational risks as well as related risk-outcome pairs during the four repetitions of the GBD CRA have been changed based on the latest epidemiological evidence. From the first GBD CRA (GBD 2000) in 2004 to the fourth one (GBD 2015) in 2016, the number of individual occupational risks have risen from 16 to 19. According to the GBD 2015, (GBD 2015 Risk Factors Collaborators, 2016), occupational risks were responsible for about 45.5 million DALYs and 0.8 million deaths in 1990 and about 63.6 million DALYs (40% increase) and 1.1 million deaths (44% increase) in 2015. This study also indicated that the share of occupational risks in total DALYs and deaths of the world population also increased from 1.8% and 1.6% in 1990 to 2.6 % and 1.9% in 2015, respectively. The increasing trend of occupational mortality and morbidity elevates the importance of occupational risks in public health studies.

For the first time, the GBD 2015 provided subnational assessments for Brazil, China, India, Japan, Kenya, Saudi Arabia, South Africa, Sweden, and the USA along with common assessments at global, regional, and national levels. The study of disease burden in more

detailed subnational levels can provide a deep understanding of drivers of health losses and their spatiotemporal trends for national and local decision making on the basis of more detailed and accurate results (Abtahi et al., 2017; Amini et al., 2014; Forouzanfar et al., 2015). The GBD study group also highly recommends subnational burden of disease studies (Forouzanfar et al., 2015; GBD 2015 Risk Factors Collaborators, 2016; Lim et al., 2012).

The objective of this research was to determine and analyze national and subnational mortality, years of life lost due to premature mortality (YLLs), years lived with disability (YLDs), and DALYs attributable to 17 individual occupational risks apportioned by sex, age group, cause, risk factor, and year in Iran during 1990–2015 based on the GBD 2015. National and subnational databases were used to assess exposure to occupational risks. Temporal trend of disease burden attributable to occupational risks was analyzed and the changes in the attributable DALYs were decomposed into the contribution of population growth, population structure, risk-deleted DALY rate, and risk exposure. Geographic inequality of the attributable burden of disease was assessed and the most effective interventions for preventing occupational health losses were also determined.

2. Materials and methods

2.1. Study area

This study was conducted in Iran, a country located in the southwest of Asia, at national and provincial levels separated into urban and rural areas. Iran is the world's eighteenth largest country covered an area of 1,648,195 km². The population of Iran in 2017 is about 80,000,000 comprising over one percent of the world's total population. About 73.8% of Iranians (over 59,000,000) live in urban communities. According to the World Bank database, nominal gross domestic product (GDP) per capita based on purchasing power parity of Iran was 18,077 USD in 2016 that put the country in the upper middle rank of 69 between 189 countries (The World Bank, 2017).

2.2. Estimation of exposure

Exposure to occupational risks was estimated according to the methods provided by the GBD 2015 based on national and subnational databases (Statistical Centre of Iran, 1987, 1997, 2007, 2012, 2017). Among the occupational risks in the GBD 2015, occupational injuries and occupational exposure to trichloroethylene were excluded because of the lack of reliable data about them at the national and subnational levels. Therefore, this study included 17 occupational risk factors and 21 risk-outcome pairs (Table 1). Exposure to occupational risks excluding occupational asthmagens and ergonomic factors was determined using the following equation (Ezzati et al., 2004; GBD 2015 Risk Factors Collaborators, 2016):

$$E_{r,l,s,a,p,y} = OT \times \sum_{EA} (P_{EA,s,a,p,y} \times EAP_{s,a,p,y} \times ER_{r,l,EA}) \quad (1)$$

where $E_{r,l,s,a,p,y}$ is the population occupationally exposed to risk factor r at level l (upper than background level) in sex s , age group a , province p , and year y , OT is occupational turnover, defined as the rate of worker replacement due to departures from the workplace during a typical working lifetime, to account for workers exposed in the past, $P_{EA,s,a,p,y}$ is proportion of economically active population in economic activity EA , sex s , age group a , province p , and year y , $EAP_{s,a,p,y}$ is economically active population in sex s , age group a , province p , and year y , $ER_{r,l,EA}$ is the rate of exposure to risk factor r at level l in economic activity EA . The rate of exposure to occupational risks excluding asthmagens and ergonomic factors are estimated based on the economic activity. The economic activities are defined as follows: (1) agriculture, hunting, forestry and fishing, (2) mining and quarrying, (3) wholesale and retail trade, restaurants, and hotels, (4) manufacturing, (5) electricity, gas,

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