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Original Article

Trends and Projections of Mortality Attributed to Occupational Neoplasms and Occupational Tracheal, Bronchus, and Lung Cancer in the World, G7 Countries and Turkey

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Abstract

Background: The most important and remarkable aspect of occupational neoplasms is that they are preventable. We aimed to examine the trends and projections of mortality rates attributed to occupational neoplasms (MAON) and occupational tracheal, bronchus, and lung cancer (MAOLCa) in the world, G7 countries, and Turkey from 1990 to 2040.

Methods: The study was ecological one. Data for the study were obtained from the Global Burden of Disease (GBD) Foresight Visualization. For the study, time points were set every five years. For each time point, the age-standardized MAON, MAOLCa, and their 95% confidence intervals (CIs) were recorded. Rates were analyzed by joinpoint regression analysis.

Results: Globally, MAON was projected to decrease from 3.81% in 1990 to 2.83% in 2040. According to the joinpoint regression analysis, the joint year for the world was 2020. In Germany, the US, the UK, Italy, Canada and Turkey, the trend for MAON showed a decrease, similar to the global trend. However, MAON was stable in France and increased in Japan. Globally, MAOLCa was expected to decline gradually from 19.44% to 16.82% from 1990 to 2040. In the US, France and Turkey, the trend for MAOLca decreased, similar to the global trend. However, it was stable in the UK, Italy, and Canada and increased in Germany and Japan.

Conclusion: MAON tended to decrease worldwide and in the six countries, except France and Japan. MAOLCa tends to decrease worldwide, in the US, France, and Turkey, increase in Germany and Japan, and remain stable in the UK, Italy, and Canada.

Keywords: Occupational neoplasm; Occupational lung cancer; Trend; Projection

Introduction

The relationship between occupation and disease, which was first defined by Bernardino Ramazzini in the 17th century, has been clarified by much evidence discovered in the following centuries (1-4). The asbestos-lung cancer relationship, which is a milestone in this field, was followed by the finding that workers in sectors such as mining, construction, manufacturing, agriculture and health care have higher rates of cancers such as lung, bladder, mesothelioma and skin cancer (5-7).

Today, the relationship between occupation and cancer is clearly defined with a list of the incidence/prevalence of different types of occupational cancer and the agents that cause these cancers. A study published in 2018 identified 47 occupational carcinogens, based on data from the International Agency for Research on Cancer monographs. The same study found that the most common occupational neoplasm was lung cancer, accounting for 23% of carcinogen-cancer associations (8). Several studies have highlighted the significant impact of occupational neoplasms on mortality. Cancer mortality and incidence were significantly increased for all malignant neoplasms except leukaemia due to low dose and dose rate occupational external radiation exposure (9). In a cohort study, construction workers had higher age-standardised mortality rates for all cancers than workers in other industries (10). Occupational exposure to asbestos is a major concern, with one study reporting 239,330 deaths worldwide in 2019 due to asbestos exposure, mainly from lung cancer, mesothelioma and ovarian cancer (11).

In 1999, 3.3% of cancer deaths (13.6%) for all ages worldwide were attributable to occupational risks. By 2019, the fraction of cancer deaths worldwide for all ages had increased (17.8%), but the fraction attributable to occupational risks remained similar to that of 20 years ago (3.3%) (12). The fraction of total cancer attributable to occupational risk ranges from about 2% to 8% (13). The most important and remarkable aspect of occupational cancer is that it can be prevented and protected by appropriate precautions and measures (14).

As can easily be seen from the literature, occupational neoplasms are an important and preventable cause of death. We aimed to examine the trend and projection of mortality rates attributed to occupational neoplasms and occupational tracheal, bronchus, and lung cancer in the world, G7 countries, and Turkey five-yearly during the 50-year period from 1990 to 2040.

Methods

Type and timing of the study

This ecological study was conducted and reported from March to September 2023.

Study data

Data for the study were obtained from Global Burden of Disease (GBD) Foresight Visualization and were secondary (15). GBD is the largest and most up-to-date repository of epidemiologic data, including occupational neoplasms and occupational tracheal, bronchus, and lung cancer, coordinated by the Institute for Health Metrics and Evaluation at the University of Washington (16). The strength of this dataset is based on a variety of primary sources, independent research studies, government reports, vital statistics records, verbal autopsies, disease registries, health projects, and population census data. On the basis of statistical modeling of data from these sources, GBD produces reliable projections of health metrics. Methodology of GBD Foresight Visualization for forecasting risk factors and disease mortality involves modeling three components. The first component is the calculation of relative risk, the second component accounts for variation influenced by measures of development, and the final component adjusts for changes over time not accounted for in the other two components. Details of the methodology used in the GBD study and the GBD Foresight Visualization modelling can be found elsewhere (15-19).

For the study, time points were set every five years for 50 years between 1990 and 2040. For each time point, the age-standardized mortality rates attributed to occupational neoplasms and occupational tracheal, bronchus, and lung cancer from GBD Foresight Visualization and their 95% confidence intervals (CIs) were recorded in an Excel file. In addition, the predicted values for better and worse scenarios for 2040 with CIs were recorded. Better and worse scenarios are constructed by considering the 85th and 15th percentiles of the rates of change in risk factors, per capita income, educational level, coverage of interventions, and total fertility rate under 25 years-old by country and year. These scenarios are provided as default by GBD Foresight Visualization.

Scope of the study

The scope of this study included the world, G7 countries (Germany, the United States -the US-, the United Kingdom -the UK-, France, Italy, Japan, and Canada), and Turkey. The world data was included in the study as a reference and to give an idea of the whole. The G7 countries represent the most industrialized democratic economies in the world and account for approximately 50% of the world economy. Although Turkey is not a G7 country, it is a G20 country and has a large industrialized economy. This country is also included in this study because it is where the authors live and work.

No direct human contact was involved in the study, and all data were obtained from publicly available sources and were accessible. Therefore, no ethical or institutional approval was required.

Statistical analysis

GBD Foresight Visualization, a meta-regression tool, and the Joinpoint Regression Program (version 5.0.2) were used to analyze the data (15,20). Standard error values were calculated using the upper and lower limits of the 95% CIs for age-standardized mortality rates obtained from GBD Foresight Visualization and stored in an Excel file. A total of 11 rate values from 1990 to 2040 were analyzed by joinpoint regression analysis. P<0.05 was considered statistically significant.

Results

Occupational Neoplasms

Globally, mortality attributed to occupational neoplasms (MAON) in all neoplasms mortality was projected to decrease from 3.81% in 1990 to 2.83% in 2040. The global attributable mortality for 2040 was 1.65% in the better scenario and 4.59% in the worse scenario. In 1990, the highest MAON was 10.21% in the UK and the lowest was 3.42% in Japan. Projected to 2040, the lowest MAON values were 4.29% in the US under the reference scenario, 2.50% in Japan under the better scenario, and 7.33% in Japan under the worse scenario.

The results of the joinpoint regression analysis for each five years between 1990 and 2040 without a joinpoint (Trend 0) and with the joint year detected by the programme (Trend 1 and Trend 2) are shown in Table 1, and the MAON trends, projections, and joint years are shown in Fig. 1.

Table 1: Joinpoint analyzes of mortality attributed to occupational neoplasms

Variable	***Trend 0***		***Trend 1***		***Trend 2***		***Joint year***
	Years	FPC	Years	FPC	Years	FPC	
World	1990-2040	-0.49*	1990-2020	-0.14*	2020-2040	-1.22*	2020
Germany	1990-2040	-0.08*	1990-2010	0.10*	2010-2040	-0.22*	2010
US	1990-2040	-1.03*	1990-2020	-0.61*	2020-2040	-1.96*	2020
UK	1990-2040	-0.34*	1990-2000	-0.87*	2000-2040	-0.24*	2000
France	1990-2040	-0.04	1990-2015	0.48*	2015-2040	-0.72*	2015
Italy	1990-2040	-0.46*	1990-2000	0.14	2000-2040	-0.58*	2000
Japan	1990-2040	0.91*	1990-2010	1.38*	2010-2040	0.61	2010
Canada	1990-2040	-0.27*	1990-2020	-0.12	2020-2040	-0.59*	2020
Turkey	1990-2040	-0.77*	1990-2015	-0.55*	2015-2040	-1.05*	2015

FPC: Five-yearly Percentage Change
*Indicates statistical significance (P<0.05)

When the period from 1990 to 2040 was analyzed on a five-yearly basis, MAON tended to decrease and that this decrease was statistically significant (*P*<0.05). According to the joinpoint regression analysis, the joint year for the world was 2020 and the significant decrease between 1990 and 2020 continued between 2020 and 2040. In Germany, the US, the UK, Italy, Canada and Turkey, the trend for MAON also showed a decrease, similar to the global trend. However, MAON was stable in France and increased in Japan.

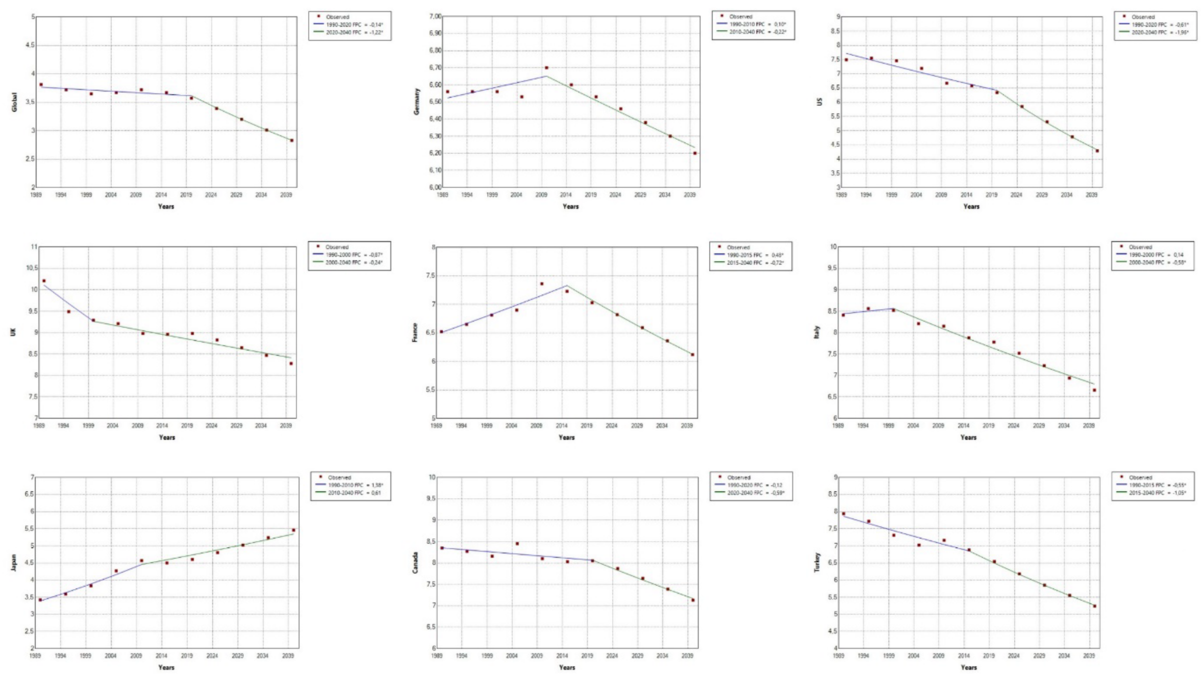

Fig. 1: Trends, projections and joint years of mortality attributed to occupational neoplasms

Occupational Tracheal, Bronchus, and Lung Cancer

Globally, mortality attributable to occupational tracheal, bronchus, and lung cancer (MAOLCa) was expected to decline gradually from 19.44% to 16.82% from 1990 to 2040. In 2040, the global MAOLCa was 12.24% in the better scenario and 20.34% in the worse scenario.

In 1990, the countries with the highest MAOLCa in all neoplasms mortality were the UK with 38.95% and Italy with 35.51%. In 1990, the country with the lowest MAOLCa was Japan (20.27%), followed by the US (24.10%), and Turkey (26.86%). In 2040, the lowest MAOLCa values were in the US according to the reference, better, and worse scenarios.

The results of the joinpoint regression analysis for each five years between 1990 and 2040 without a joint year (Trend 0) and with the joint year determined by the programme (Trend 1 and Trend 2) are shown in Table 2, and the MAOLCa trends, projections, and joint years are shown in Fig. 2.

From 1990 to 2040, there was a statistically significant downward trend in MAOLCa globally. According to the joinpoint regression analysis, the joint year for the world was 2020, and the significant decrease from 1990 to 2020 continued between 2020 and 2040. In the US, France and Turkey, the trend for MAOLCa also decreased, similar to the global trend. However, it was stable in the UK, Italy, and Canada and increased in Germany and Japan.

Table 2: Joinpoint analyzes of mortality attributed to occupational tracheal, bronchus, and lung cancer

Variable	*Trend 0*		*Trend 1*		*Trend 2*		*Joint year*
	Years	FPC	Years	FPC	Years	FPC	
World	1990-2040	-0.25*	1990-2000	-0.64*	2000-2040	-0.19*	2000
Germany	1990-2040	0.09*	1990-2015	-0.08*	2015-2040	0.27*	2015
US	1990-2040	-0.36*	1990-2020	-0.29*	2020-2040	-0.49*	2020
UK	1990-2040	0.00	1990-2010	-0.19*	2010-2040	0.12*	2010
France	1990-2040	-0.09*	1990-2005	-0.39*	2005-2040	0.00	2005
Italy	1990-2040	-0.02	1990-2005	0.23*	2005-2040	-0.10*	2005
Japan	1990-2040	0.62*	1990-2010	0.87*	2010-2040	0.48*	2010
Canada	1990-2040	0.04	1990-2000	-0.35*	2000-2040	0.09*	2000
Turkey	1990-2040	-0.33*	1990-2010	-0.61*	2010-2040	-0.18	2010

FPC: Five-yearly Percentage Change
*Indicates statistical significance (*P*<0.05)

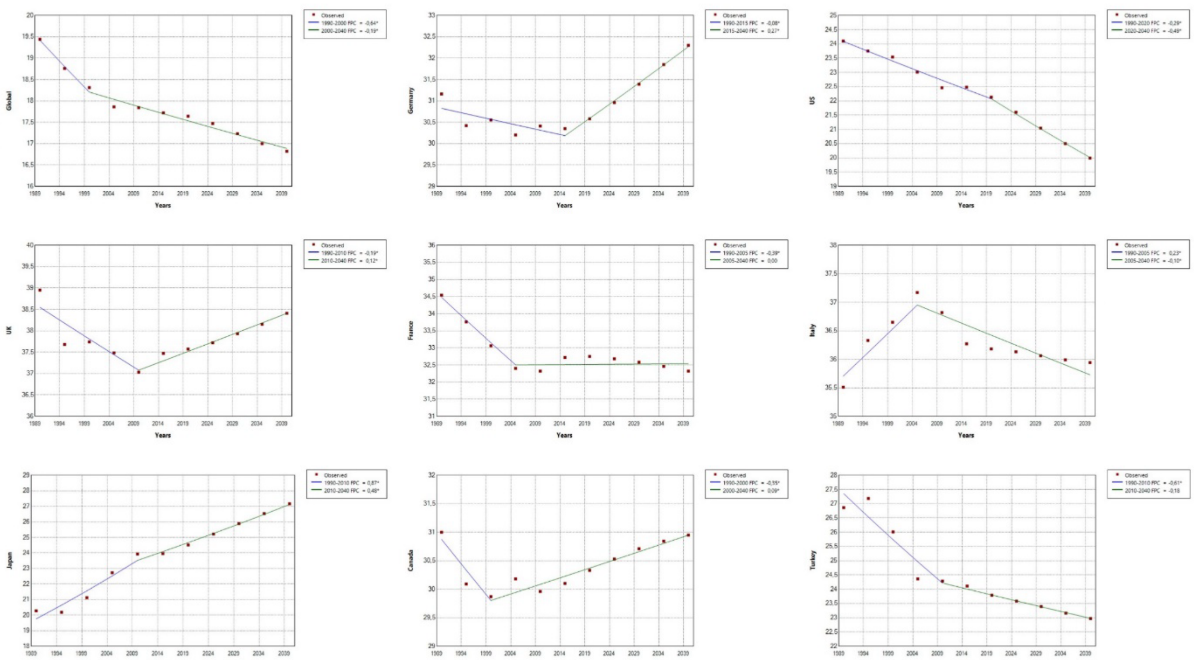

Fig. 2: Trends, projections, and joint years of mortality attributed to occupational tracheal, bronchus, and lung cancer

Discussion

Discussion of MAON

This study found that worldwide and in the six countries included in the study, with the exception of France and Japan, MAON tends to decrease over the 50 years in the reference scenario. It is stable in France and increases in Japan. Analyzing the trend graph drawn for MAON, the trend for both the worldwide and the seven countries excluding Japan is in the form of a decline after 2020. In the literature, all three trends of decrease, plateau and increase over time have been observed in several studies of occupational neoplasm deaths (21-27).

The decreases observed in this study are a positive finding and can be attributed to factors such as better working conditions, occupational health and safety measures, medical advances and increased awareness. The situation for MAON in Japan is different and interesting. In Japan, there is a significant increase between 1990 and 2040 and a plateau pattern from 2010. Possible reasons for this situation from a literature perspective could be the following: In contrast to the worldwide and the other seven countries analysed in this study, Japan has the highest life expectancy at birth (28). The ageing of the population may be one reason for the increase in MAON. The sense of commitment and responsibility to work, known as the Japanese work culture, may be driving the upward trend in MAON by leading to a tendency to work long hours. The terms Karoshi and Karojisatsu have been specifically defined to describe the health problems associated with these long working hours in Japan (29). Genetic changes related to occupational exposure may also be involved (30,31). In general, increased MAON is associated with country characteristics such as high industrial activity, ineffective occupational health and safety policies, and air pollution and environmental toxins, as well as individual characteristics such as smoking, exposure to occupational health hazards, and problems with access to health care, including lack of health-seeking behaviour (32).

Discussion of MAOLCa

In the current study, MAOLCa tends to decrease worldwide, in the US, France, and Turkey, to increase in Germany and Japan, and to remain stable in the UK, Italy, and Canada between 1990 and 2040 in the current study. Analysing the trend graph drawn for MAOLCa, the trend for the period after 2020 is increasing for Germany, the UK, Japan, and Canada, and plateauing for France. In this study, it was found that all three trends of decrease, plateau and increase over time are true for the worldwide and different countries. Similar results have been reported in the literature (33-37).

There are different reasons for the decreasing, plateauing and increasing trends observed in this study. Interventions against agents such as asbestos, arsenic, beryllium, cadmium, chromium, diesel exhaust, nickel, polycyclic aromatic hydrocarbons, silica, sulphuric acid, and tobacco smoke, whose association with occupational lung cancer has been established over the years, may have been effective in reducing MAOLCa (38,39). However, in countries where there is an increasing and a plateauing trend, there may be an illusion of an increase in occupational tracheal, bronchus, and lung cancer due to a decrease in other occupational neoplasms. In particular, the increasing and plateauing trends, followed by a decreasing trend until the joint year, suggest a relative increase phenomenon. For occupational tracheal, bronchus, and lung cancer, as for other occupational neoplasms, especially haematologic types, the dependence on genetic alterations should also be taken into account (40). In addition to all these reasons, it may be necessary to consider social determinants such as income status and inequalities, which have a strong impact on health, specifically for each country (41).

Study Highlights and Limitations

This is a pioneering study to evaluate the trend and projection of mortality attributed to occupational neoplasms and occupational tracheal, bronchus, and lung cancer. The study was modeled using a meta-regression tool linked to the GBD study. The GBD study currently provides the most comprehensive and up-to-date data for the two health outcomes studied. These were the strengths of the study.

The results may have some limitations due to poor quality and/or missing data. As with any modelling study, there may be factors influencing the health outcome being studied that the modelling used in this study does not take into account due to the nature of the modelling used. As with all population-level studies, this study is susceptible to ecological bias. These three issues were the limitations of the study.

Conclusion

This study presents the trend and projection of mortality attributed to occupational neoplasms and occupational tracheal, bronchus, and lung cancer from 1990 to 2040. In the reference scenario, MAON tended to decrease worldwide and in the six countries evaluated, except France and Japan. When the graph drawn for MAON is examined, the trend for both the worldwide and seven countries, excluding Japan, is decreasing after 2020. Over the 50-year period, MAOLCa decreased in the US, France, and Turkey, increased in Germany and Japan, and remained stable in the UK, Italy, and Canada. After 2020, the regression plot for MAOLCa shows a decrease for the US, Italy, and Turkey, an increase for Germany, the UK, Japan, and Canada, and a plateau for France.

For both occupational neoplasms and occupational tracheal, bronchus, and lung cancer, better scenarios for attributable mortality are possible with the implementation of effective and accurate protection and prevention measures. However, the opposite is also true. With action, appropriate policies, and legislation worldwide and in the eight countries included in this study, the pattern of MAON and MAOLCa can be changed and significant declines in attributable mortality rates can be observed.

Journalism Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflicts of interest

None.

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