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Global, regional, and national trends in mesothelioma burden from 1990 to 2019 and the predictions for the next two decades

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ABSTRACT

Objectives: We aimed to analyze the secular trends in mesothelioma burden, the effect of age, period, and birth cohort, and project the global burden over time.

Material and methods: Based on the mesothelioma incidence, mortality, and Disability-Adjusted Life Years (DALYs) data from 1990 to 2019 in Global Burden of Diseases (GBD) database, the annual percentage change (APC) and average annual percent change (AAPC), calculated from joinpoint regression model, was used to describe the burden trends. An age-period-cohort model was utilized to disentangle age, period, and birth cohort effects on mesothelioma incidence and mortality trends. The mesothelioma burden was projected by the Bayesian age-period-cohort (BAPC) model.

Results: Globally, there were the significant declines in age-standardized incidence rate (ASIR) (AAPC = −0.4, 95%CI: −0.6,−0.3, $P < 0.001$), age-standardized mortality rate (ASMR) (AAPC = −0.3, 95%CI: −0.4,−0.2, $P < 0.001$), and age-standardized DALY rate (ASDR) (AAPC = −0.5, 95%CI: −0.6,−0.4, $P < 0.001$) of mesothelioma overall 30 years. For regions, Central Europe presented the most distinct increases and the most substantial decrease was observed in Andean Latin America on all ASRs (age-standardized rates) from 1990 to 2019. At national level, the largest annualized growth for full-range trends of incidence, mortality, and DALYs was in Georgia. Conversely, the fastest descent of all ASRs was observed in Peru. The ASIR, ASMR, and ASDR in 2039 predicted 0.33, 0.27, and 6.90 per 100,000, respectively.

Conclusions: The global burden of mesothelioma declined over the past 30 years, with variability across regions and countries/territories, and this trend will continue in the future.

1. Introduction

Mesothelioma is a generally incurable disease that affects mostly elderly individuals who have had occupational exposure to asbestos (Carbone et al., 2019). Mesothelioma accounted for 0.67 million Disability-Adjusted Life Years (DALYs) in 2019 (Vos et al., 2020). Patients with malignant mesothelioma have a poor prognosis, with a median survival of 1 year from diagnosis (Courtiol et al., 2019). Malignant pleural mesothelioma accounts for approximately 80% of reported cases of mesothelioma (Obacz et al., 2021), and it is typically diagnosed 20–50 years after asbestos exposure (Zhang et al., 2021).

To control the mesothelioma burden around the world, a systematic assessment of the global, regional and national mesothelioma burden is necessary as a reference for policy making on the global mesothelioma management. The mesothelioma burdens have high variability around the world (Abdel-Rahman, 2018). The vast disparity in spatial patterns and secular trends represents the complexity in the intervention of mesothelioma. Malignant mesothelioma is a relatively rare tumor that can mimic benign mesothelial lesions and numerous other cancers, making the identification of the disease difficult (Arif & Husain, 2015; Fels Elliott and Jones, 2020). This makes the diagnosis challenging for the pathologist. The confirmation of a mesothelioma diagnosis requires the proper use of a panel of immunohistochemical markers, and this option is often unavailable in low-income countries (Chimed-Ochir et al., 2020). Thus, the detection rates of mesothelioma may vary in countries with different medical levels. For another, although the ban on asbestos use has been implemented in some countries, some resource-limited countries still use chrysotile asbestos (Freemantle et al., 2022). In Sweden, a collective agreement between employers and labor unions prohibited the use of asbestos products in the construction

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industry and ship-building from the mid-1970s onwards, thereby eliminating the largest users of asbestos (Jarvholm & Burdorf, 2015). According to a 2016 estimate of global asbestos consumption, India, as a resource-constrained country, has the highest consumption of asbestos at 308,000 tonnes (Chen et al., 2019). Establishing targeted and effective management strategies from a global perspective is difficult.

The factors including age, period and cohort effects have the potential effect on the mesothelioma burden trend across the world. For example, a previous study indicated that the decreases in the incidence and mortality rate of cervical cancer in Korea were due to reductions in the period and cohort effects, which reflect the implementation of a cancer screening program and changes in lifestyle (Moon et al., 2017). The age-period-cohort model can enhance our understanding of incidence and mortality trends by unpacking the contributions of age, time period, and birth cohort effects (Bell, 2020), and has been used to analyze the quality and character of cancer prevalence trends (Li et al., 2022). Up to the present, there have been few investigations on the relative risk of longitudinal age, period, and cohort for mesothelioma incidence and mortality trends.

In this study, we not only described the long-term and partial time trends in mesothelioma incidence, mortality, and DALYs at the global, regional, and national levels, but we also used the age-period-cohort and Bayesian age-period-cohort (BAPC) models to analyze the contribution of different elements to the epidemiological outcome of mesothelioma and project future incidence, mortality, and DALYs to 2039. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 contains a rules-based synthesis of the available evidence on levels and trends in health outcomes, a diverse set of risk factors, and health system responses (Murray, Abbafati, et al., 2020), which provides the data to explore the long-term global, regional and national trends in mesothelioma burden and future situations.

2. Methods

2.1. Data sources

The Institute of Health Metrics and Evaluation (IHME) carried out the GBD 2019 to provide a thorough assessment of health loss across 369 diseases and injuries from January 1, 1990, to December 31, 2019 (Murray, Aravkin, et al., 2020). The sources of epidemiological data used in GBD 2019 include vital registration systems, sample registration systems, household surveys, censuses, disease surveillance, and demographic surveillance systems. GBD 2019 applied a spatiotemporal Gaussian process regression, cause of death ensemble model, and Bayesian meta-regression tool to estimate the disease burden. The GBD 2019 employed a number of interconnected measures, such as the number of deaths and mortality, the number of cases and prevalence, years of life lost (YLL) owing to premature death, years lived with disability (YLD), and DALYs, to quantify population health loss. The DALY was calculated as the sum of corresponding years of living with disability and premature death-related years of life lost caused by the disease. We extracted estimates and associated 95% uncertainty intervals (UIs) for incidence, mortality, and DALYs as measures of mesothelioma burden from 1990 to 2019 using the GBD Results Tool (https://ghdx.healthdata.org/gbd-results-tool). Mesothelioma was defined based on the International Classification of Diseases (ICD) diagnostic criteria. The ICD-10 can be utilized to identify diseases (https://icd.who.int/browse10/2019/en). The associated ICD-10 codes of mesothelioma for incidence and mortality data were as follows: C45.0 (mesothelioma of pleura), C45.1 (mesothelioma of peritoneum), C45.2 (mesothelioma of pericardium), C45.7 (mesothelioma of other sites), and C45.9 (mesothelioma, unspecified).

The socio-demographic index (SDI) for all countries/territories was also downloaded from the GHDx website. The minimum value observed during the evaluation period was set to 0 by the GBD 2015, while the greatest value was set to 1. Then the three components of lag distributed income per capita, mean education for those age 15 and older, and total fertility rate under 25 were reassigned on a scale of "0 to 1" to obtain their geometric means. Thus the SDI values were divided into quintiles and then categorized into low, low-medium, medium, high-medium, and high SDI countries according to the SDI values of each country (Vos et al., 2016). GBD 2019 provides tables with SDI values for all estimated GBD 2019 locations, as well as reference SDI quintile values (Global Burden of Disease Study 2019 (GBD 2019) Socio-Demographic Index (SDI) 1950–2019 | GHDx (healthdata.org)). Countries can be classified into low (e.g., Haiti in 2019), low-medium (e.g., Bangladesh in 2019), medium (e.g., Brazil in 2019), high-medium (e.g., Chile in 2019), and high SDI (e.g., Australia in 2019) categories by SDI values and reference SDI quintile values.

2.2. Statistical analysis

The primary indicators used to describe the burden of mesothelioma globally were age-standardized rates (ASRs) of incidences, deaths, and DALYs. The ASR (per 100,000 people) was calculated as the product of age-specific rates (ai, where I is the ith age) and the number of people (or weight wi) in the same age group of the reference standard population that was chosen, divided by the sum of the standard population weights: $ASR = \frac{\sum_{i=1}^{A} a_i * w_i}{\sum_{i=1}^{A} w_i} * 100,000$. Trends in the age-standardized mesothelioma burden were examined using joinpoint regression (National Cancer Institute, version 4.9.1.0). The joinpoint regression program's advantage is that it can indicate if changes over time are statistically significant (Kim et al., 2000). The slope of each line segment connected by joinpoint was expressed as annual percent change (APC) and average annual percent change (AAPC) with a best-fitting model (Li and Du, 2020). In this work, we evaluated the incidence, mortality, and DALYs of mesothelioma at the global, regional, and national levels, and we used the Monte Carlo permutation test to determine the APC and AAPC.

To estimate the effect of age, year period, and birth cohort, we performed the age-period-cohort model. This model illustrates the various risks associated with various age groups (age effects), the impact of environmental and historical factors (period effects), and the impacts of risk factor exposure on a population with the same birth year (cohort effects). The age-period-cohort model can be expressed as follows: $Ln(R_{ijk}) = \mu + \alpha_i + \beta_j + \gamma_k + \varepsilon$, in which μ is the constant, and R_{ijk} represents the attributable mortality rate in the *i*th age group, *j*th time period, and *k*th birth cohort. α_i, β_j, γ_k, and ε are the effects of age, period, cohort, and random error, respectively (Rosenberg and Anderson, 2011). In the age-period-cohort analysis, the relative risk (RR) is defined as the exponential value of the estimations of α_i, β_j, and γ_k. The overall log-linear trend by year period and birth cohort was then computed, and this is known as the local drift. Through the age-period-cohort Web Tool (https://analysistools.nci.nih.gov/apc/), the age-period-cohort model was estimated (Rosenberg et al., 2014). The Bayesian age-period-cohort (BAPC) model (R package "BAPC") was used to forecast the mesothelioma burden from 2020 to 2039 (Riebler & Held, 2017). To train the model, data from 1990 to 2019 were used. The United Nations Department of Economics and Social Affairs Population Division (https://population.un.org/wpp/Download/Standard/CSV/) provided the statistics on the world's population from 1990 to 2039. R software version 4.1.3 was used to create graphs showing the projection findings.

The level of significance for each statistical test was set at 0.05, and all tests were two-tailed.

3. Results

3.1. Overview of the global, regional, and national burden, 1990–2019

The global age-standardized incidence rate (ASIR) of mesothelioma was 0.49 cases per 100,000 population in 1990 and 0.43 cases per

100,000 population in 2019 (Table S1). The global age-standardized mortality rate (ASMR) and the age-standardized DALY rate (ASDR) also declined from 1990 to 2019 as shown in Table S1. At the GBD region, Australasia presented the highest ASIR, ASMR, and ASDR both in 1990 and 2019. Among 204 countries and territories, although the global changes of number in mesothelioma incidence number, deaths, and DALYs were descended from 1990 to 2019, according to the GBD 2019, there were increasing trends in some countries in East Africa and South Asia (Fig. 1).

3.2. Joinpoint regression analysis of mesothelioma burden trend

Globally, there are five trends for the ASIRs of mesothelioma, with an average decrease (AAPC = −0.4,95%CI: −0.6,−0.3, $P < 0.001$) per year from trend 1 to trend 5 (1990–2019) (Table S2). There was a significant downward trend in high-middle SDI regions ASIR from 1990 to 2019. Conversely, the results revealed a gradual upward trend in low-middle SDI regions ASIR from 1990 to 2019 (Fig. S1).

The analysis of ASMR showed a decline in the global population from 1990 to 2019, with an APC of −0.3 (95%CI: −0.4,-0.2) (Table S3). However, there was a significant upward trend in ASMR from 2007 to 2011 (APC = 0.5, 95%CI: 0.2,0.9). For the global ASMR, there was a significantly decreased trend from 1990 to 2019 (AAPC = −0.3, 95%CI: −0.4,-0.2, P < 0.001). The greatest peak of middle SDI regions growth on ASMR (2005–2011, APC = 1.5, 95%CI: 1.3,1.7) appeared later than high-middle SDI regions (1990–1994, 1.5, 95%CI: 0.9,2.1) (Fig. S2).

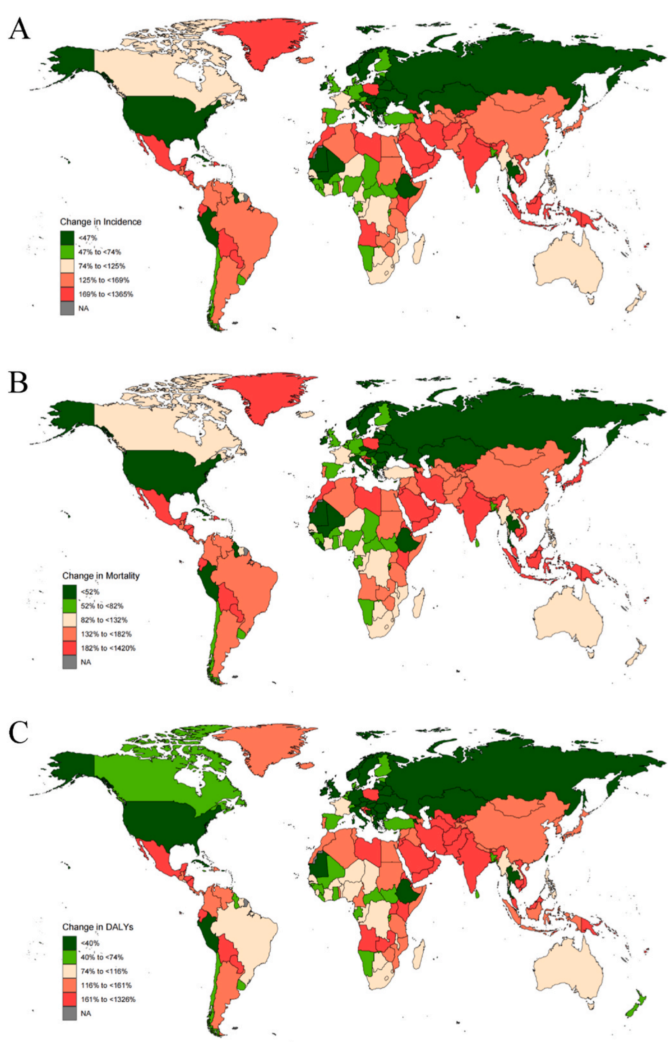

Fig. 1. The changes in incidence number(A), deaths(B), and DALY(C) of mesothelioma from 1990 to 2019. DALY: disability-adjusted life-year.

A significant decreased trend was observed in global ASDR from 1990 to 2019 (AAPC = −0.5, 95%CI: −0.6, −0.4, P < 0.001) as well (Table 1). The ASDR of high and high-middle SDI regions dropped significantly in terms of overall period, although the high-middle SDI regions ASDR exhibited a significant rising trend until 1995 (Fig. 2). The clear ASDR increase was found in low-middle SDI regions, which was contrary to the global trends. In the middle SDI regions, there were dramatic increases in ASIR, ASMR, and ASDR in 1990–1997 and 2005–2011.

For 21 regions, Central Europe presented the most distinct increases and the most substantial decrease was observed in Andean Latin America on ASIR, ASMR, and ASDR from 1990 to 2019 (Tables S4–6). However, there were significant downward trends on ASIR(APC = −2.3, 95%CI: −3, −1.6, $P < 0.001$), ASMR (APC = −2.4, 95%CI: −3.1, −1.7, P < 0.001), and ASDR (APC = −0.5, 95%CI: −0.6, −0.4, P < 0.001) in Central Europe from 2015 to 2019. At national level, the largest annualized growth for full-range trends of ASIR, ASMR, and ASDR were in Georgia. Conversely, the fastest descent rate of all ASRs were observed in Peru (Tables S7–9).

3.3. Age-period-cohort effects on mesothelioma incidence and mortality

The age-period-cohort effects on mesothelioma incidence were shown in Fig. 3. There was a rapidly increase in incidence between 50 and 80 years of age in global and all SDI regions, however, a slight decline was shown in people aged 60–64 years in middle and low-middle

Table 1
The trends in mesothelioma DALYs by Joinpoint regression.

SDI factors	Index	Year	Estimate (95%UI)	*P* value
Global	APC	1990–1995	0 (−0.2,0.2)	0.963
		1995–1998	−1 (−1.9,−0.1)	0.03
		1998–2002	−0.1 (−0.5,0.3)	0.507
		2002–2006	−0.7 (−1.1,−0.3)	0.001
		2006–2011	0.1 (−0.1,0.3)	0.321
		2011–2019	−1.1 (−1.2,−1.1)	<0.001
	AAPC	1990–2019	−0.5 (−0.6–0.4)	<0.001
High SDI	APC	1990–1998	−0.6 (−0.7,−0.5)	<0.001
		1998–2002	0.3 (−0.1,0.8)	0.100
		2002–2009	−0.8 (−0.9,−0.7)	<0.001
		2009–2012	0 (−0.7,0.7)	0.971
		2012–2015	−1.5 (−2.2,−0.8)	0.001
		2015–2019	−0.9 (−1.1,−0.6)	<0.001
	AAPC	1990–2019	−0.6 (-0.7,−0.5)	<0.001
High-middle SDI	APC	1990–1995	1.4 (0.8,2)	<0.001
		1995–1998	−2 (−4.6,0.6)	0.122
		1998–2010	−0.2 (−0.3,-0.1)	0.003
		2010–2019	−1.5 (−1.6,−1.4)	<0.001
	AAPC	1990–2019	−0.5 (−0.8,−0.2)	<0.001
Middle SDI	APC	1990–1997	1.1 (0.8,1.3)	<0.001
		1997–2005	−0.6 (−0.8,−0.4)	<0.001
		2005–2011	1.2 (1,1.5)	<0.001
		2011–2019	−1.1 (−1.2,−1)	<0.001
	AAPC	1990–2019	0 (0–0.1)	0.320
Low-middle SDI	APC	1990–1994	−0.4 (−1.3,0.5)	0.383
		1994–2001	0.8 (0.4,1.2)	0.002
		2001–2004	−0.5 (−2.7,1.8)	0.664
		2004–2010	1.7 (1.3,2.1)	<0.001
		2010–2016	1.1 (0.7,1.4)	<0.001
		2016–2019	0.1 (−0.7,0.9)	0.791
	AAPC	1990–2019	0.7 (0.4,1)	<0.001
Low SDI	APC	1990–1993	0.1 (−0.3,0.5)	0.577
		1993–1997	−0.3 (−0.7,0)	0.069
		1997–2004	−0.9 (−1.1,-0.8)	<0.001
		2004–2007	−0.4 (−1.2,0.3)	0.196
		2007–2015	0.6 (0.5,0.7)	<0.001
		2015–2019	0.3 (0,0.5)	0.019
	AAPC	1990–2019	−0.1 (−0.2,0)	0.037

Abbreviations: SDI, sociodemographic index; UI, uncertainty interval; APC, annual percentage change; AAPC, average annual percentage change.

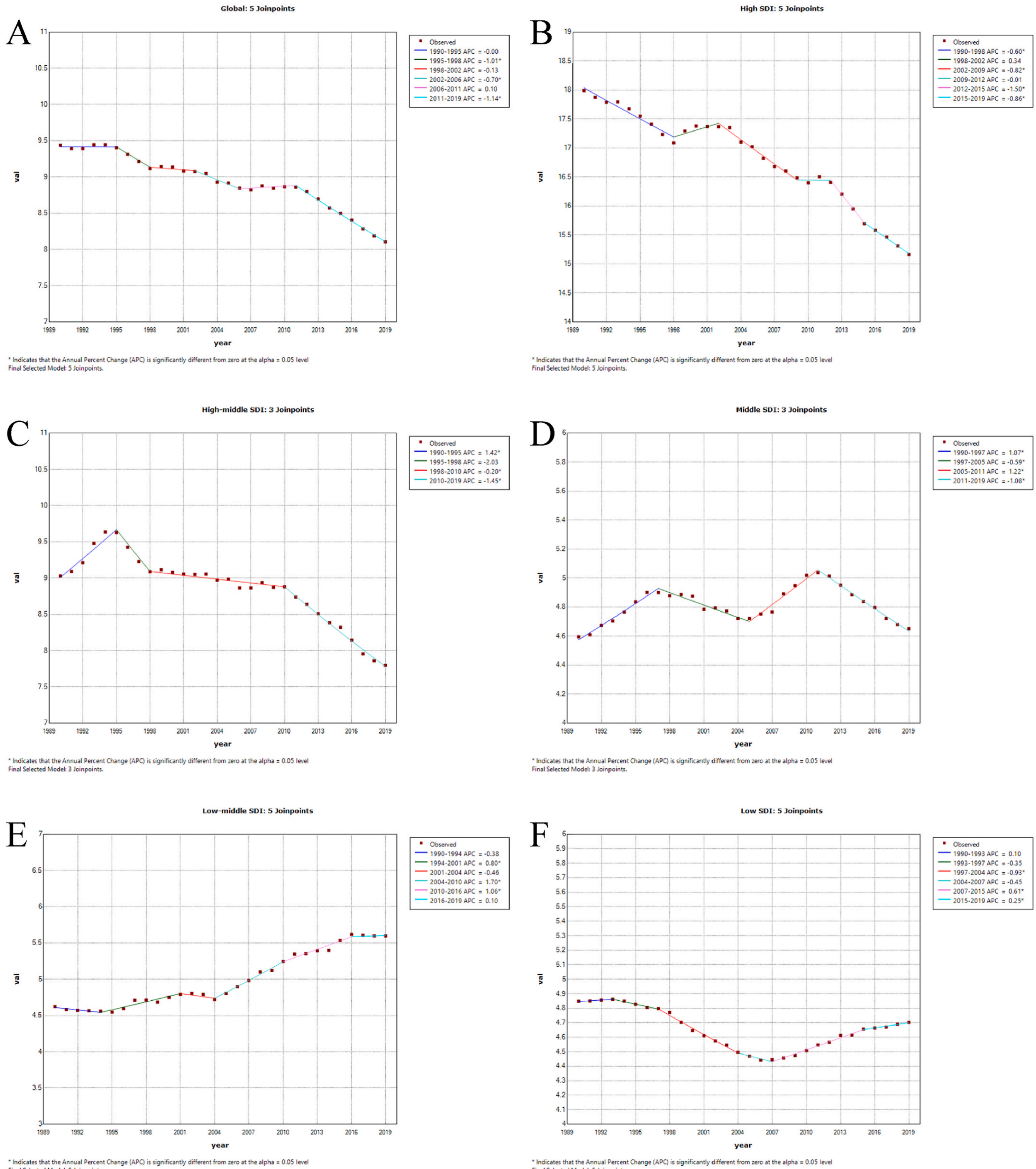

Fig. 2. Joinpoint regression analysis in age-standardized DALY rates of mesothelioma from 1990 to 2019 by SDI region. DALY: disability-adjusted life-year; SDI: sociodemographic index.

SDI regions (Fig. 3A). Except for low-middle SDI regions, global and SDI regions presented a decreased risk of period effects across the study period (Fig. 3B). Different SDI regions showed similar trends in cohort effect, with a relatively stable trend across the birth cohort (Fig. 3C). The global local drift of mesothelioma incidence in the 25–29 age groups was the lowest (−1.16, 95%CI: −1.60–0.72), and 95 plus was the highest (1.14, 95%CI: −0.41–2.71) (Fig. 3D).

The age-period-cohort effects on mesothelioma mortality were shown in Fig. 4. The longitudinal effect of age and the estimated period RRs are observed as almost similar results, except for middle SDI regions

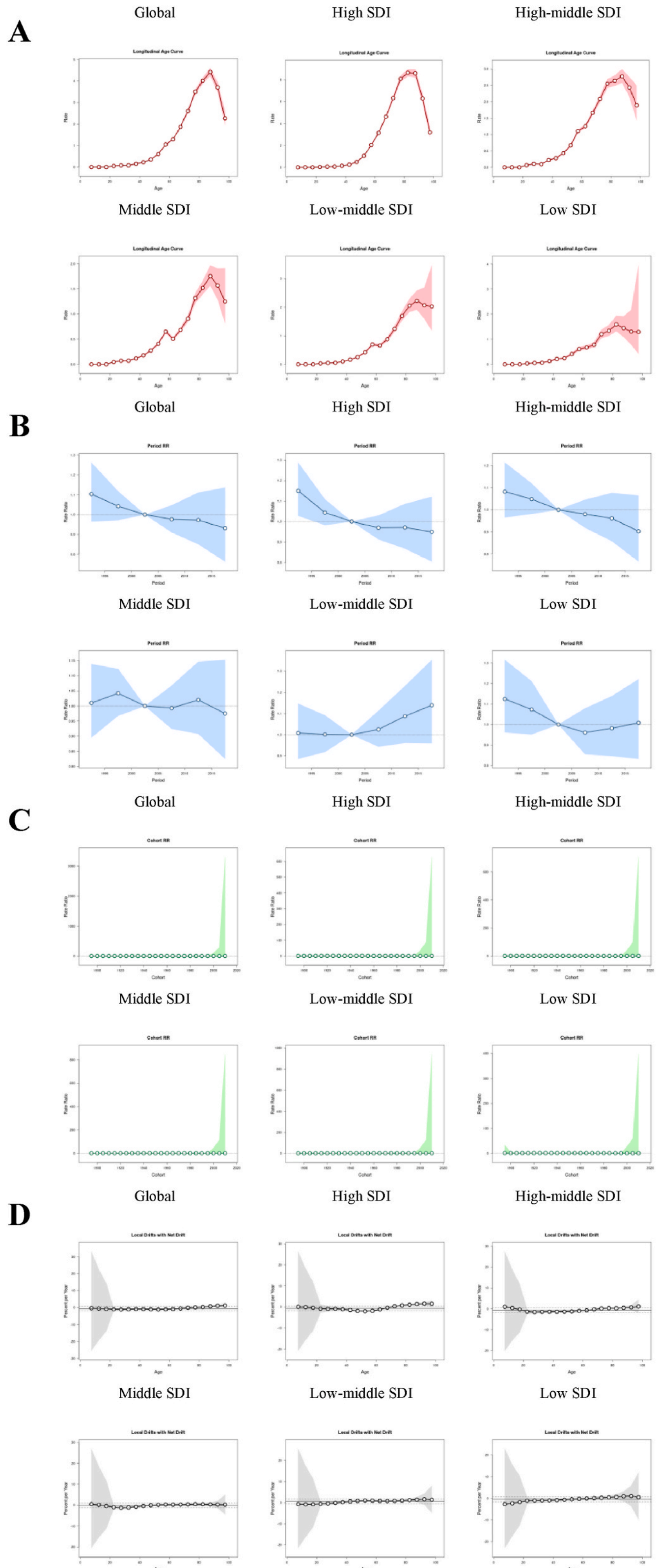

Fig. 3. Age(A), period(B), and cohort(C) effects on mesothelioma incidence and local drift(D) of mesothelioma incidence by SDI region. SDI: sociodemographic index.

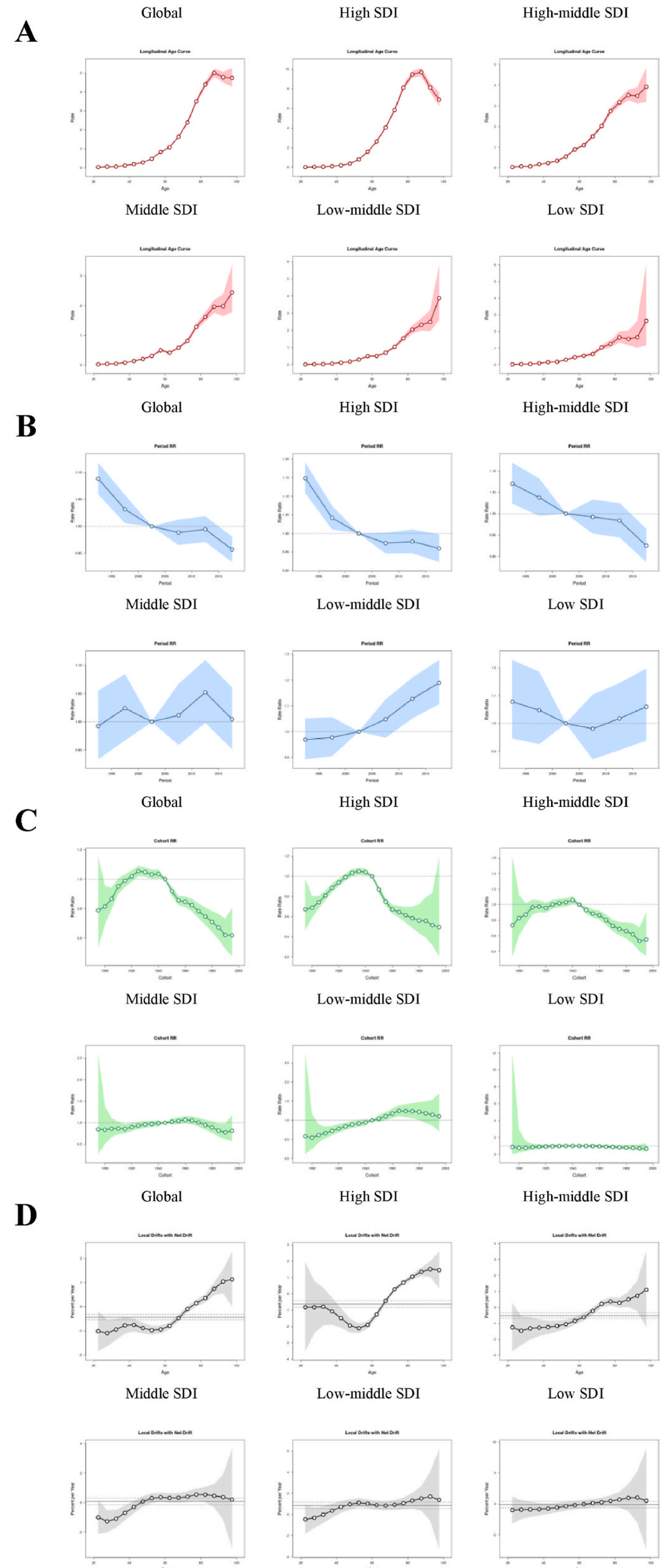

Fig. 4. Age(A), period(B), and cohort(C) effects on mesothelioma mortality and local drift(D) of mesothelioma mortality by SDI region. SDI: sociodemographic index.

revealed a slightly increased risk of period effects across the overall past 30 years (Fig. 4A and B). For cohort effects, the peak of the cohort RR appears earliest in high SDI regions, latest in low-middle SDI regions, and cohort effects in low-middle SDI regions detrimentally affected the mortality of mesothelioma in those born after 1945 (Fig. 4C). According to the overall local drifts of different SDI regions, the annual changes in mortality per year were on the uptrend as people got older (Fig. 4D). The global local drift after age 90 was more than 1, implying an increasing long-term trend in mortality.

3.4. Predictions of mesothelioma burden to 2039

The ASIR, ASMR, and ASDR were estimated the decrease trends over the next two decades in the Bayesian age-period-cohort model. The ASIR of mesothelioma will fall to 0.33/100,000, and there will be 36, 222 new cases in 2039 (Figs. 5 and 6). The ASMR will also decline over the next two decades, with the ASMR of mesothelioma likely to drop to 0.27/100,000 and deaths cases to 30,012 by 2039. There were 927,772 DALYs projected for 2039. The ASDRs in 1990, 2019, and 2039 were 9.44/100,000, 8.10/100,000, and 6.90/100,000, respectively.

4. Discussion

Our study suggested that there were downward trends of global ASIR, ASMR, and ASDR for mesothelioma over the past 30 years. The clear changes were revealed in the ASR of different SDI regions and over a certain period globally. The examinations of age, period, and cohort effects differentiate the source of morbidity and mortality trends by different age, time periods and birth cohorts for the globe and the different SDI regions. While ASIR, ASMR, and ASDR for mesothelioma were estimated to decrease globally over the next two decades, a fraction of regions and populations were experiencing significant increases in the burden of mesothelioma in recent years.

Our study found that the ASIR, ASMR, and ASDR of high and high-middle SDI regions dropped significantly in terms of overall 30 years. On the contrary, the ASRs increase was found visibly in low-middle SDI regions. Mesothelioma burden temporal trends may reflect temporal trends in asbestos use as economies developed (Furuya et al., 2018). In middle SDI regions, there are two periods (1990–1997 and 2005–2011) with dramatic increases in ASRs. In the early period, the new labor law in developed countries triggered the movement of foundational industry to other cheap-labor countries (Onozuka & Hagihara, 2007). As the economy grows in cheap-labor countries, the use of asbestos peaked in middle SDI regions at a certain level of income, then began to decrease.

Despite the global initiatives to ban asbestos, peak incidence times vary from country to country due to different effective times of asbestos ban regulations in different regions (Gudmundsson & Tomasson, 2019; Yoon et al., 2018). A previous study found that incident cases of mesothelioma and deaths associated with mesothelioma continuously increased in resource-limited regions with low SDI levels (Zhai et al., 2021), which is in agreement with our findings. The incidence, mortality, and DALYs of mesothelioma vary across the world.

There are several potential reasons that may account for the associations between ASRs and SDI levels. Mesothelioma is an asbestos-related disease. The incidence, mortality, and DALYs of mesothelioma increased as the economy developed, along with increases in industrial manufacturing and consequent exposure to asbestos (Lin et al., 2007). Mesothelioma remains challenging to diagnose, and pleural mesothelioma is frequently misdiagnosed as lung cancer. The pathological diagnosis of mesothelioma requires the properly using a panel of immunohistochemical markers. However, that is often unavailable in source-limited countries (Chimed-Ochir et al., 2020). The quality of data on mesothelioma is influenced by the quality of healthcare combined with a well-functioning registration system. In recent decades, data reporting has improved in high-income and upper-middle-income countries, but little has changed in other countries (Braithwaite et al., 2019; Numair et al., 2021). Therefore, a possible explanation is that many mesothelioma cases in high SDI regions may be attributable to the thorough reporting system.

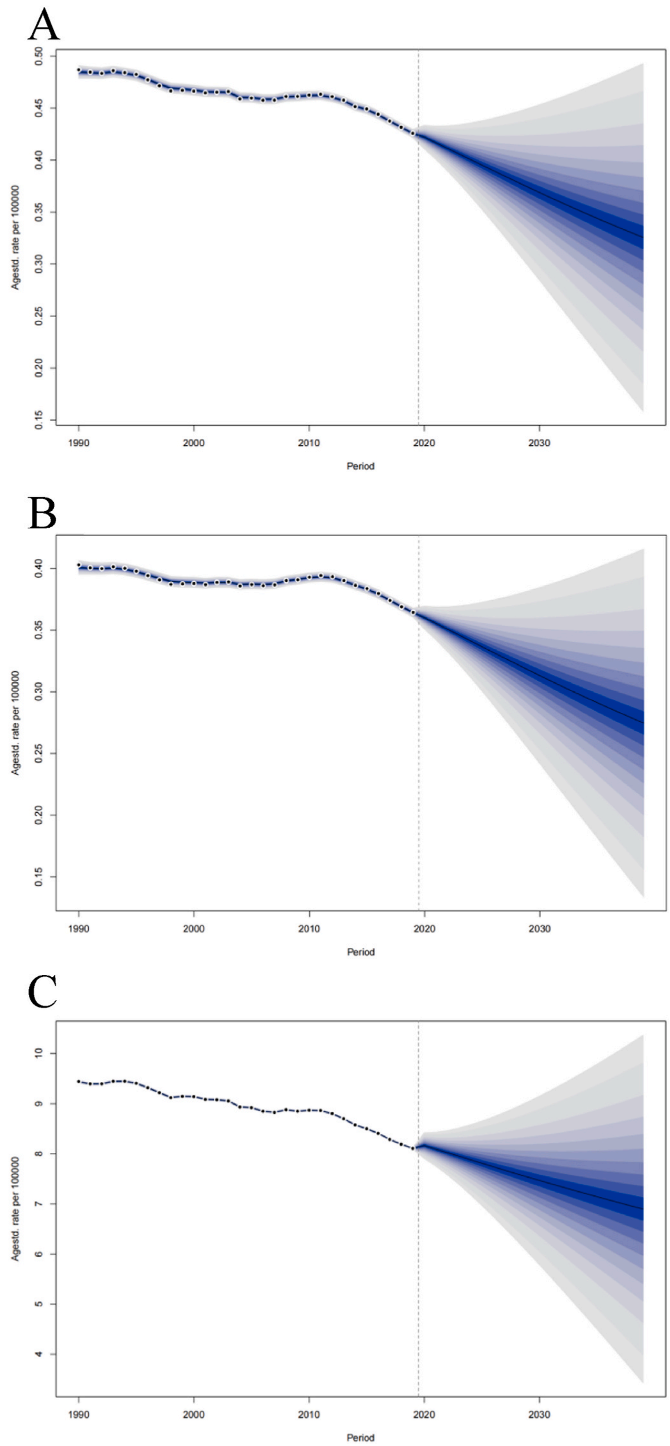

Fig. 5. The projections of the global age-standardized rate of incidence(A), mortality(B), and DALY(C) per 100,000 population of mesothelioma from the BAPC model, 1990–2039. DALY: disability-adjusted life-year; BAPC: Bayesian age-period-cohort.

Our finding demonstrated that there was a remarkably increased risk in the incidence and mortality of mesothelioma between 50 and 80 years of age in global and all SDI regions. Mesothelioma has a long latent period after initial occupational exposure (Ceresoli & Rossi, 2019). Therefore, mesothelioma is generally considered to be a disease

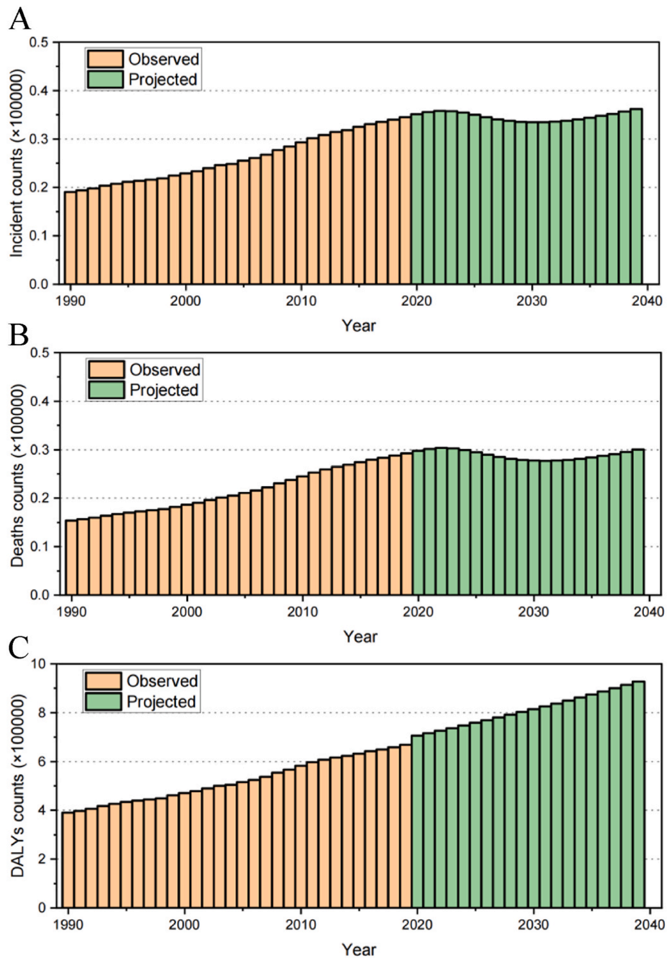

Fig. 6. The projections of global incidence number (A), deaths (B), and DALY (C) of mesothelioma in the total population from 2019 to 2039. DALY: disability-adjusted life-year.

occurring in older patients. The local drifts after age 90-year-old reveal an increasing long-term trend in mortality globally, which is likely because of asbestos exposure during their early occupations. Despite asbestos' ongoing use in some areas, the mesothelioma ASIR, ASMR, and ASDR decline over the next two decades. Stricter regulations, improved safety measures, and increased awareness about the dangers of asbestos may led to a reduction in exposure to asbestos. Advances in cancer treatments and detection methods may have contributed to improved survival rates among mesothelioma patients (McCambridge et al., 2018). Although the ASIR, ASMR, and ASDR are estimated to decline over the next two decades in the Bayesian age-period-cohort model, it is highly necessary to expand and strengthen high-risk groups for intervention and testing, and multidisciplinary collaboration for some resource-limited countries according to specific situations. For mesothelioma prevention, the use of asbestos needs to be banned or strictly regulated. According to earlier research, occupational asbestos exposure increased the proportion of Disability-Adjusted Life Years in Georgia, Kuwait, Croatia, Poland, and Bahrain, with Georgia experiencing the greatest increase—from less than 50% in 1990 to approximately 90% in 2019 (Han et al., 2022). The incidence rate of mesothelioma has decreased in Australia, the United States, and Western Europe, where the use of asbestos was banned or strictly regulated in the 1970s and 1980s, demonstrating the value of these preventive measures (Carbone et al., 2019). The fastest descent of all ASRs for mesothelioma among the countries/territories were observed in Peru. Since 2008 the importation of tons of crocidolite decreased until it was finally banned in 2014 in Peru (Torres-Roman et al., 2020). For mesothelioma treatment, with the rapid development and clinical application of new therapies, such as immunotherapy and neoadjuvant chemotherapy (Banerji et al., 2021; Janes et al., 2021; Pasello et al., 2013), the ASRs of mesothelioma have been decreasing in recent years. For mesothelioma reporting, the reporting system needs to be fully equipped. In Korea, an aid system has been in place since 2011 for those who have been exposed to asbestos or have developed asbestos-related illnesses. As a result, a huge amount of information would be gathered that could offer crucial hints regarding the epidemiologic features of mesothelioma brought on by asbestos exposure in Korea (Kwon et al., 2021).

The results reported herein should be considered in the light of some limitations. First of all, this study was conducted based on the summarized data but not on individual-level data. Thus, we cannot describe the incidence, mortality, and DALYs in the details, for example, assessing the burden trend of mesothelioma stratified by disease stage. Secondly, the predictions were based on the GDB 2019 database, meaning the quality of the original registry-based data greatly influences the accuracy and robustness of estimates in the database, especially in low-income regions, could bias the estimates. Finally, we did not project the burden trends of mesothelioma on different SDI regions for the relevant data were unavailable, and the study may focus on this issue in the future.

5. Conclusions

The global burden of mesothelioma declined over the past 30 years, with variability across SDI regions, GBD regions, and countries/territories, and this trend will continue in the future.

Credit author statement

WZ: Study design, formal analysis, data analysis, and writing the original manuscript, JL: Interpretation of data for the work, YL: Interpretation of data for the work, ZS: Revising the work critically for important intellectual content, SW: Revising the work critically for important intellectual content

Ethical approval and consent to participate

The data released from the Global Health Data Exchange query did not require informed patient consent. This is a public database study that reuses data from GBD study to evaluate disease burden. It is observational and does not require ethical approval and consent.

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Declaration of competing interest

The authors declare no conflict of interest.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. The original data were obtained through an online query tool from the website of IHME (http://ghdx.healthdata.org/), and no permissions were required to access the data.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2023.101441.

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