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Implementation of National Policies for a Total Asbestos Ban: A Global Comparison

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Summary

Background Two international Conventions from the International Labor Organization (ILO; C162 Asbestos Convention) and the UN (Basel Convention) offer governments guidelines for achieving a total asbestos ban policy, but the long-term effect of these Conventions on policy implementation, and the role of government effectiveness, remains unknown. We aimed to investigate associations between government ratification of the ILO and UN international Conventions, government effectiveness, and implementation of a national total asbestos ban.

Methods We obtained data for year of a national asbestos ban, year of ratification of one or both international Conventions, and World Bank government effectiveness scores for 108 countries that ever used asbestos. We did a survival analysis for countries with data in the follow-up period (March 22, 1989, to Feb 2, 2018) to assess whether ratification of the international Conventions and greater government effectiveness were associated with time of implementation of a national total asbestos ban.

Findings Of 108 countries with data for asbestos consumption, nine were excluded because they implemented an asbestos ban before 1989. Therefore, 99 countries were included in the survival analysis. 26 countries ratified both international Conventions and 73 ratified either one or no Convention. Countries that ratified both Conventions had a shorter time to adoption of a total asbestos ban (mean 8·9 [SD 6·4] years) than did countries that ratified one or no Conventions (16·9 [6·1] years). After controlling for government effectiveness, countries that ratified both Conventions had a significantly higher conditional probability of banning asbestos than did those ratifying one or no Convention (hazard ratio [HR] 41·8, 95% CI 4·5–383·3; p=0·0010). For every 1 point increment in government effectiveness, the percentage change in HR for persistent asbestos consumption significantly increased by 127% (95% CI 13–354; p=0·021).

Interpretation This study confirms that adoption of both the C162 Asbestos Convention and the Basel Convention facilitates countries in moving towards a total asbestos ban. The effect was reinforced by government effectiveness. Both international programmes and new agreements towards total asbestos bans and government commitments are needed.

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Introduction

Since the 1960s, scientific evidence has shown a causal relation between asbestos and carcinogenic effects in exposed individuals.[1,2] To protect people from asbestos exposure and prevent asbestos-related diseases, international Conventions and codes of practice aim to help countries regulate the use of asbestos and asbestos-containing products.[3,4] Adoption of international Conventions represents the high degree of consensus that has been reached among Member States of organisations such as the UN and WHO. Member States decide individually whether or not they can ratify a Convention. Once a country ratifies an international Convention, it should then implement corresponding laws to ensure consistency with that Convention.[5]

Two international Conventions are especially relevant to asbestos management. First is the International Labour Organization (ILO) Convention no 162 concerning Safety in the Use of Asbestos (hereafter referred to as the C162

Asbestos Convention).[3] Second is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (hereafter referred to as the Basel Convention). The C162 Asbestos Convention focuses on prevention of occupational exposure to asbestos. Among potential exposure scenarios, occupational exposure is associated with most asbestos-related diseases.[6] The principle of ensuring that workers' exposure to asbestos remains below a specific limit was stated in Article 15 of the C162 Asbestos Convention and adopted on June 24, 1986.[3] The Basel Convention, adopted on March 22, 1989, focuses on prevention of asbestos waste from being transported to other countries. Environmental exposure to asbestos caused by transboundary waste disposal is another possible exposure scenario.[6]

The C162 Asbestos Convention and the Basel Convention are helpful for prevention of asbestos exposures, but they are not comprehensive.[3] The best way to eliminate asbestos-related diseases is to

implement a total asbestos ban.[6–8] Since the late 1980s, several countries have worked gradually through the policy process to achieve a national policy for a total asbestos ban.[9] In the 1990s, global asbestos consumption decreased by half, from four million metric tons in 1990 to two million metric tons in 1999.[10] However, asbestos continues to be used in many countries, and the volume of asbestos consumption has remained relatively constant since 2000, with an average of two million metric tons per year globally.[10] Since 2006, WHO and the ILO have repeatedly urged countries to eliminate asbestos-related diseases by ceasing use of asbestos.[7,8] An ILO resolution about asbestos was adopted by the 95th session of the International Labour Conference in 2006.[8] The same year, WHO published a report aiming to help its Member States manage health risks associated with asbestos exposure.[6]

In 2016, about 80% of the global population was living in countries without a total asbestos ban.[11] Because of scant regulation or poor regulatory oversight, people are frequently exposed to hazardous substances at work. The Global Burden of Diseases, Injuries and Risk Factors Study (GBD) estimated that, in 2017, 29 909 people worldwide died from mesothelioma, including 27 447 from occupational causes and 2462 from non-occupational causes, respectively. Thus, the need remains to eliminate all forms of asbestos, manage asbestos currently in place, and advance prevention of further occupational asbestos exposures and asbestos-related diseases. To achieve these goals, national governmental authorities will need to implement national policies effectively.

Government effectiveness reflects how a government manages social and environmental conditions and responds to the needs of its citizens. The World Bank publishes Worldwide Governance Indicators, which are a measure of government effectiveness. An effective government produces high-quality public services and ensures that policies are independent from political pressures and benefit from credible governmental commitment. Previous studies have highlighted the positive relation between government effectiveness and population health.[12,13]

To narrow the gap between calls made by international organisations to take action on asbestos use and current work by countries towards total asbestos bans, it is crucial to understand whether national policies are in line with international Conventions on managing and banning asbestos. This analysis can also help identify countries lagging behind the global trend towards mitigating the risk of asbestos exposure. However, current research on this topic is sparse. Inspired by a previous report that highlighted the national asbestos situation in ten Asian countries,[14] we aimed to expand coverage to more countries across all regions to provide an overview of asbestos policies at a global level.

Iceland was the first country to enforce a national policy banning all types of asbestos, in 1983.[9] We aimed to investigate asbestos ban policies among countries with data available for asbestos consumption since 1978 (ie, 5 years before Iceland introduced its ban) to 2018 (ie, the most recent year of observation). We postulated that countries that have ratified international Conventions (ie, C162 Asbestos Convention and the Basel Convention) and have high government effectiveness scores would have governmental commitments that enable implementation of a national total asbestos ban.

For **Worldwide Governance Indicators** see http://www.govindicators.org/

For **GBD data** see http://ghdx.healthdata.org/gbd-results-tool

Methods

Selection of countries

We applied two criteria to select study countries. First, we selected countries listed as UN Member States in 2018, plus Taiwan and Hong Kong, resulting in 195 eligible countries.[15] Second, we included only countries with available data for raw asbestos consumption from Jan 1, 1978, to Dec 31, 2016, meaning people living and working in these countries were at risk of asbestos-related diseases. Data for historical asbestos consumption were obtained from the British Geological Survey website.[16]

Procedures

Asbestos is defined as a group of six naturally occurring mineral silicates: chrysotile (white asbestos), crocidolite (blue asbestos), amosite (brown asbestos), actinolite, anthophyllite, and tremolite.[6] Chrysotile, crocidolite, and amosite are the most common types of asbestos that have been used worldwide. Most national asbestos ban policies prohibit use of these three types of asbestos. Hence, we focused on national policies that ban chrysotile, crocidolite, and amosite. Data for the year that every country prohibited use of these three types of asbestos were obtained from the International Ban Asbestos Secretariat website,[9] country reports from Finland, France,[17] Hong Kong,[18] and Taiwan,[19] and WHO.[20] We classified study countries into two groups based on the status of their asbestos bans at the observation end timepoint (ie, 2018). Countries that banned either all types of asbestos or the three most common types in 2018 were classified as those with a total ban. Countries that had not achieved such a ban were classified as those with no total ban.

The ILO's C162 Asbestos Convention was adopted at the 72nd session of the International Labour Conference on June 24, 1986.[3] According to the ILO's constitution, ILO Member States should submit any adopted Conventions to a competent authority to consider ratification. Ratification of a Convention represents a country's commitment to apply that Convention in national law and practice and to report on application of that Convention regularly.[21] We obtained the list of countries that have ratified the C162 Asbestos Convention, and their dates of ratification, from the ILO website.[22] The Basel Convention was adopted by the Conference of Plenipotentiaries in Basel on March 22, 1989. We obtained the list of countries that have ratified the Basel Convention, and their dates of ratification, from the Basel Convention website.[23] The earliest year in which any country could ratify both Conventions was 1989. Because only a few countries had ratified no Convention by 2018, we classified countries into two groups—countries that had ratified both Conventions and countries that had ratified one or no Convention.

We measured the number of years that asbestos consumption persisted in a country after national adoption of both international Conventions. We used the year that a national asbestos ban policy was introduced as a proxy indicator of stopping asbestos consumption.

Indicators of government effectiveness for every country were extracted from Worldwide Governance Indicators published by the World Bank. This government effectiveness index measures common perceptions—as reported by survey respondents, non-governmental organisations, commercial businesses, and public sectors—about the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, and it is derived from variables from more than 30 data sources.[24] For cross-country and over-time comparisons, these variables were standardised into comparable units using an unobserved components model, averaged with weights based on the precision of the individual data sources, then re-scaled with a mean of 0·0 (SD 1·0) and a range approximately between −2·5 to 2·5.[24] The score reflects relative levels of government effectiveness among studied countries and does not directly quantify absolute qualities of governance.[24] Higher scores indicate a more effective government, and vice versa. A country's government effectiveness score can, therefore, be used as a proxy indicator to understand to what extent the national government has responded to the international Conventions.

The World Bank has published these data since 1996, updated every 2 years between 1996 and 2002 and updated annually since 2002. To impute missing data for government effectiveness for the years 1989–95, 1997, 1999, and 2001, we adopted a generalised linear mixed model to predict the index of government effectiveness, using a country-specific polynomial function of calendar time. We used a quadratic polynomial function in the model because it led to the smallest Akaike information criterion (AIC=196·95) after comparing different degrees of the polynomial function. The difference between original scores and imputed scores was less than 4% on average.

Statistical analysis

Data retrieved from search databases were compiled for analysis. We calculated the numbers and proportions of countries with a total ban and with no total ban. We used a χ^2 test to assess whether the proportion of countries with a total ban among those that had ratified both Conventions was different to the proportion of countries that had ratified either one or no Conventions.

We did a survival analysis to assess our hypothesis that countries ratifying both Conventions would have a shorter period to implementation of a national total asbestos ban. A Kaplan-Meier method was applied to estimate the persistence in asbestos consumption between countries with and without ratification of both Conventions. We

For the **Finnish country report** see https://www.ttl.fi/en/asbestos-hazard/asbestos-related-diseases
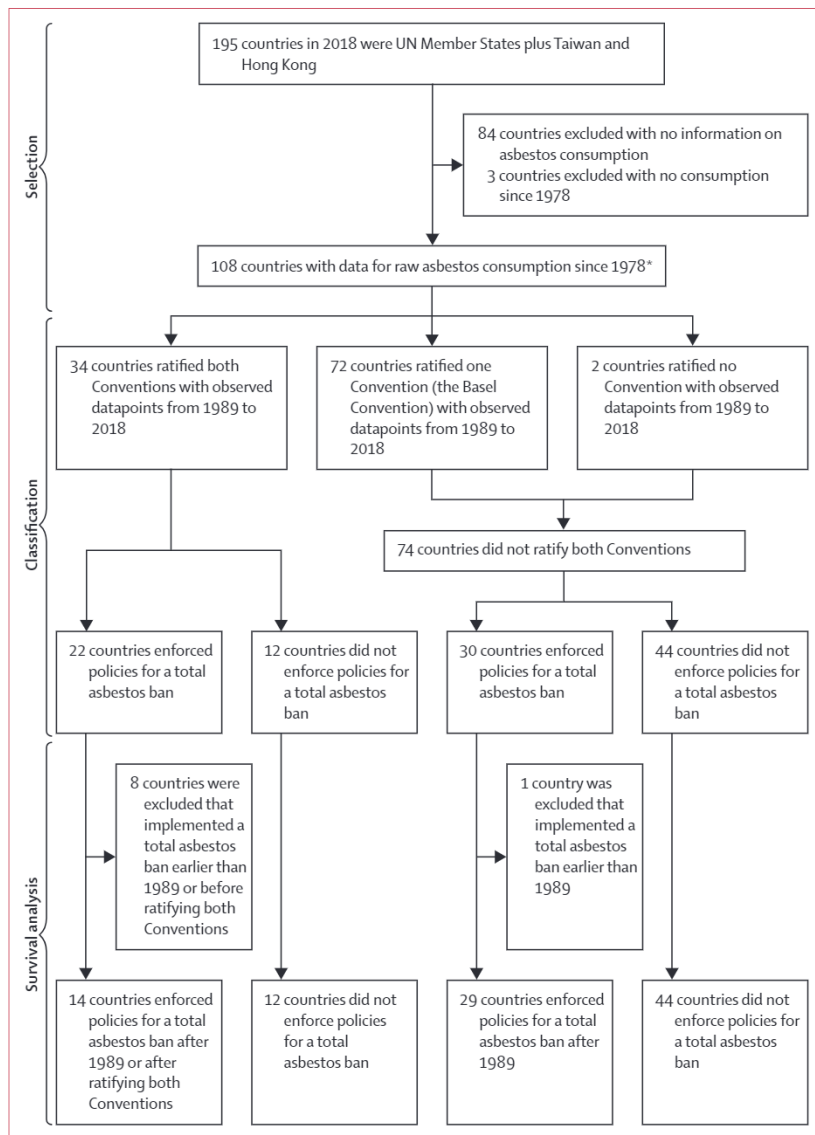
Figure 1: Selection and classification of study countries
*The most recent available data for asbestos consumption were for 2016.

defined survival time as the period between the year of ratifying both Conventions and the year of implementing a total asbestos ban. The failure event in this study was, therefore, defined as implementation of a total asbestos ban. The hazard of persistent asbestos consumption is the conditional probability of banning asbestos in a country that has or has not ratified one or both Conventions. Based on the two survival functions estimated by the Kaplan-Meier method, we used the Wilcoxon test to test whether they were significantly different. The significance level was set at 5%.

Two types of countries were excluded from the survival analysis. First, we excluded countries that implemented a total asbestos ban earlier than 1989, because this timepoint was the earliest year countries could have

ratified both Conventions. Second, we excluded countries that implemented a total asbestos ban before ratifying both Conventions.

We built the first Cox proportional hazards model (model I) to assess the hazard of asbestos in relation to Convention ratifications and government effectiveness.

Model I: $h(t) = h_0(t)\exp(\text{intercept} + \beta_1[Con] + \beta_2[GE])$

t is the time for persistence of asbestos consumption, from 1989 until a total ban. Right censoring might arise in a country that has not banned asbestos by 2018. The *Con* variable is a binary covariate for which 1 is the country ratifying both Conventions and 0 is the country not ratifying both Conventions. *Con* is time-varying, with all values 0 before the year of ratifying both Conventions and all values 1 after the year of ratifying both Conventions. The *GE* variable is also a time-varying covariate for government effectiveness from 1989 to 2018. The estimated coefficient $\hat{\beta}_1$ can be transformed into a hazard ratio (HR) by an exponential function $\exp(\hat{\beta}_1)$. The HR of the *Con* variable can account for the hazard of persistent asbestos consumption in countries that ratified the two Conventions compared with the hazard in countries that ratified one or no Conventions. We transformed the estimated coefficient $\hat{\beta}_2$ into

$$[\exp(\hat{\beta}_2) - 1] \times 100\%$$

which can account for the percentage change in HR per 1 point increment in government effectiveness score.

The second model (model II) is a modified version of model I intended to assess whether earlier ratification of the two international Conventions can affect persistence of asbestos consumption in a country.

Model II: $h(t) = h_0(t)\exp(\text{intercept} + \beta_1[Conyear] + \beta_2[GE])$

Conyear is a time-invariant variable to represent the number of years since 1989 that a country had ratified the Conventions. The other settings are identical between the two models. The estimated coefficient of the *Conyear* variable can also be transformed into the percentage change in HR when the number of years for Convention ratification increases by 1 year. Both models I and II adopted Efron's method to handle tied data.

Our compiled data for the survival analysis are provided in the appendix. Data cleaning, management, and analysis were done in SAS version 9.4 (SAS Institute, Cary, NC, USA).

Role of the funding source
The funder had no role in study design, data collection, data analysis, data interpretation, and writing of the report. The corresponding author had full access to all data in the study and had final responsibility for the decision to submit for publication.

Results

Figure 1 outlines the selection and classification of countries in the study. Of 195 countries that were Member States of the UN, plus Hong Kong and Taiwan, 108 had ever consumed asbestos since 1978. Of these, 34 (31%) countries ratified both Conventions between 1989 and 2018 (with observed datapoints), 72 (67%) ratified only one Convention (the Basel Convention), and two (2%) ratified no Convention (Taiwan and the USA). Taiwan is not a Member State of the ILO or UN and, thus, has no ratification record. The USA is a Member State of the ILO and UN and has not ratified either Convention. Hong Kong is not a Member State of the ILO or UN but, as a former territory of the UK, has been subject to the Basel Convention since 1995. Of the 34 countries that had ratified both Conventions by 2018, 22 (65%) had introduced a total asbestos ban by 2018 compared with 30 (41%) of 74 countries that ratified one or no Convention (p=0·020).

99 of 108 countries were eligible for the survival analysis, consisting of 26 countries that ratified both Conventions and 73 that ratified one or no Convention (table). The average government effectiveness score was higher in countries that ratified both Conventions (mean 0·3 [SD 0·9]) than in those ratifying one or no Convention (0·0 [0·9]). Countries that ratified both Conventions had a shorter time to adoption of a total asbestos ban (mean 8·9 [SD 6·4] years) than did countries ratifying one or no Convention (16·9 [6·1] years).

Figure 2 presents the Kaplan-Meier analysis of persistence of asbestos consumption, according to Convention ratification. The survival curve represents the probability of a country not implementing a total ban on asbestos. Asbestos consumption was estimated to persist longer among countries ratifying one or no Convention than among countries ratifying both Conventions (p=0·011). Between 1995 and 2004, countries that did not ratify both Conventions had a significantly greater probability of not implementing an asbestos ban, because the 95% CIs did not overlap between the two groups of countries. By Feb 2, 2018, the probability of persistent asbestos consumption among countries that did not ratify both Conventions was 60% (95% CI 48 to 70). For countries ratifying both Conventions, the probability of persistent asbestos consumption reduced to 46% (27 to 64).

The results of model I show that, after controlling for government effectiveness, countries that ratified both Conventions had a significantly higher conditional probability of banning asbestos than did those ratifying one Convention or none (HR 41·8, 95% CI 4·5 to 383·3; p=0·0010). For every 1 point increase in government effectiveness, the percentage change in HR for persistent asbestos consumption increased significantly by 127% (95% CI 13 to 354; p=0·021). The results of model II show that, for every additional year it took a country to ratify both Conventions, the percentage change in HR for persistent asbestos consumption significantly

	Government effectiveness scores		Time until total ban was achieved (years)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Countries that ratified both Conventions (n=26)*	0·3 (0·9)	–0·0 (–0·5 to 1·2)	..	..
Total ban (n=14)	0·9 (0·7)	1·0 (0·5 to 1·3)	8·9 (6·4)	7 (3 to 12)
No total ban (n=12)	–0·3 (0·7)	–0·5 (–0·7 to –0·1)	..	..
Countries that ratified either one or no Convention (n=73)*	0·0 (0·9)	–0·1 (–0·6 to 0·6)	..	..
Total ban (n=29)	0·6 (0·7)	0·6 (0·0 to 1·1)	16·9 (6·1)	17 (13 to 20)
No total ban (n=44)	–0·3 (0·8)	–0·4 (–0·7 to 0·0)	..	..

*Conventions were the International Labour Organization's Convention no 162 concerning Safety in the Use of Asbestos (1986) and the UN's Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989).

Table: Ratification of international Conventions, asbestos bans, and government effectiveness scores
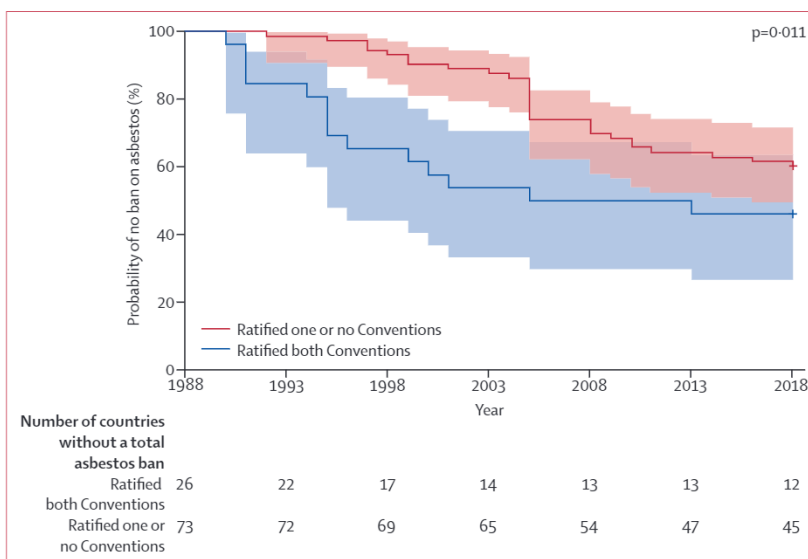
Figure 2: Survival analysis of time to a total asbestos ban
Conventions were the International Labour Organization's Convention no 162 concerning Safety in the Use of Asbestos (1986) and the UN's Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989). Shaded areas represent 95% CIs. Cross denotes when data were censored.

decreased by 3% (95% CI –6 to –1; p=0·022). Thus, asbestos is more likely to persist in countries that lagged in ratifying Conventions. Government effectiveness had a similar effect in models I and II: when the government effectiveness score increased 1 point (Model II), the percentage change in HR for persistent asbestos consumption significantly increased by 131% (95% CI 70–212; p<0·0001).

Discussion

The best way to eliminate asbestos-related diseases is to enforce a total asbestos ban. However, only 43 (40%) of 108 countries included in our study have done so since

1989. Over the past 30 years, international Conventions (in our analysis, the C162 Asbestos Convention and the Basel Convention) have provided guidelines for governments on regulating asbestos consumption in the workplace and dealing with asbestos as waste. The large number of countries and longitudinal dataset in our study provide a global perspective for understanding the effect of ratifying international Conventions related to asbestos management on adoption of a national total asbestos ban. We found that countries that ratified both international Conventions were more likely to introduce a national total asbestos ban policy than were countries that did not ratify both Conventions. This association was modified by government effectiveness score: the more effective the national government, the more likely the country was to adopt a total asbestos ban.

Our study confirms the importance of both international Conventions and government effectiveness for implementing a total asbestos ban. International Conventions are important because they are legal policies, methods, and treaties designed by representatives of stakeholders—including government officials, employees, and labour—to ensure that measures for prevention of occupational exposure to asbestos and disposal and transportation of waste are consistent across countries.[25] Rather than considering asbestos exposure a local public health issue, international bodies have challenged the global community to understand asbestos trade internationally as a cross-national issue[11] and to establish which activities should be under international control and to what extent. Once international Conventions are introduced, Member States should consider whether or not to ratify the Convention, which usually requires a period to examine and revise national regulations so that the country can comply with Conventions that they wish to ratify.[25] Therefore, ratification of a Convention means that the competent authority of that country intends to effectuate the provisions of the Convention and to report its application at regular intervals (usually every 5 years for general ILO Conventions).[21,25] Based on the C162 Asbestos Convention, ratifying countries should replace asbestos by other materials and have total or partial prohibition of asbestos; in particular, crocidolite should be prohibited (Articles 10 and 11).[3] We should expect countries that ratify international Conventions to be prepared for implementing a total ban. Countries can also decide not to ratify international Conventions but, rather, bring their national regulations in line with the Conventions.[25] Such countries can still draft their regulations based on the ideas of the international Conventions. It is also the reason why we applied survival analysis to understand whether countries that have ratified international Conventions would implement a national total asbestos ban in later years. There could be several factors affecting the decision to ratify international Conventions and to implement a total ban policy. Although we did not have direct measures of these underlying confounders during the transition, we considered that government effectiveness scores might have a role and represent the degree of a government's commitment to making sound policies. We found that Conventions and government effectiveness were significantly associated with an asbestos ban, reflecting a higher conditional probability of banning asbestos in countries that ratify both Conventions and have more effective government. Other unmeasured variables probably contribute to the effect of causal mechanism, which is beyond the scope of this study. A separate study entailing collection of potential mediators and a causal mediation analysis could help us to understand the causal pathway.

Among 108 countries that had data for asbestos consumption since 1978, we found 99 (92%) followed the pattern of first ratifying international Conventions and then adopting national ban policies. Nine pioneer countries had a different pattern. Four countries banned asbestos before both international Conventions were available for ratification (Iceland in 1983, Norway in 1984, Sweden in 1986, and Denmark in 1988) and five countries banned asbestos before ratifying both Conventions (Switzerland in 1989, Netherlands in 1991, Germany in 1993, Luxembourg in 2002, and Australia in 2003). These countries treated asbestos as a problem for law enforcement. Restrictions on asbestos consumption in Sweden began with a parliamentary motion proposed in 1972, which triggered a series of hazard reviews and appraisals authorised by the Swedish Government that eventually led to a total ban.[26] Germany banned asbestos after the Conventions were signed but before the German Government had ratified them. Factors contributing to Germany's ban include the distribution of scientific knowledge on the harm of asbestos by independent researchers and the highlighting of feasible and effective preventative measures by scientists and unions.[27] These actions forced policymakers to initiate asbestos-related regulations.[25] Previous work has also reported on the role of scientific research focusing on preventive measures in these countries.[27,28]

Data for factors related to not banning asbestos are scarce. For some countries, industrial interest seems to outweigh the public health interest. Particularly in low-income and middle-income countries, current international Conventions have been unable to ensure adequate asbestos control. The misinterpretation or misuse of Conventions by emphasising safe use of—rather than safety in the use of—asbestos has contributed to continued use of asbestos.[29] For some countries, a paucity of cost-effective alternatives and negative economic effects have been mentioned as reasons for not implementing a total ban on asbestos.[30,31] However, in a cross-country comparison of economic effects after a total asbestos ban, no relevant negative effects were noted.[31] A positive finding was that the later the peak year of asbestos consumption the shorter the time needed for a country to achieve a total asbestos ban.[31]

Our study has several limitations. First, the sources of data available for cross-country comparison were restricted to those published in English. Our information could not reflect the situation of countries not included for analysis, and our findings should be interpreted carefully outside of the studied countries. Second, the above-mentioned pioneer countries, and countries that are not Member States of the UN, ILO, or other international bodies (eg, Hong Kong and Taiwan), cannot officially ratify the international Conventions (although they can still adopt the content of the Conventions). Therefore, the effect of Convention ratification might be underestimated in this analysis. Third, we had no data for government effectiveness before 1996. We used the extrapolation method to estimate earlier government effectiveness scores, which could act as a proxy for the unmeasured years, but if government effectiveness scores had been available before 1996, we would expect a better estimation. Fourth, national economies could affect decisions by countries to introduce asbestos ban policies. A major challenge to adding economic indicators into our statistical model was collinearity with government effectiveness. Government effectiveness scores are correlated significantly with both expenditure (r=0·73, 95% CI 0·72–0·75; p=0·0003) and output (r=0·72, 0·70–0·74; p=0·047) aspects of gross domestic product.[32] Fifth, our study applied the Cox proportional hazards model with time-varying covariates, but we did not compare the semiparametric survival model with the parametric survival model (eg, the accelerated failure time model) because the ability to analyse time-varying covariates in the parametric survival model is still limited.

To eliminate asbestos-related diseases, a total asbestos ban should be enforced. International Conventions provide a legal framework for asbestos control and management that requires changes in national policies and practices. Adoption of these international Conventions facilitates countries' progress towards a total ban, and this effect is reinforced by government effectiveness. Both international programmes and new agreements towards a total asbestos ban and national government commitments are required.

References
1 Wagner JC, Sleggs CA, Marchand P. Diffuse pleural mesothelioma and asbestos exposure in the North Western Cape Province. *Br J Ind Med* 1960; 17: 260–71.

2 Selikoff IJ, Churg J, Hammond EC. Asbestos exposure and neoplasia. *JAMA* 1964; 188: 22–26.

3 International Labour Organization. C162 Asbestos Convention, 1986 (no 162): convention concerning safety in the use of asbestos (entry into force 16 June 1989). http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0:NO:P12100_ILO_CODE:C162 (accessed July 4, 2019).

4 International Labour Organization. Safety in the use of asbestos. Jan 1, 1984. https://www.ilo.org/safework/info/standards-and-instruments/codes/WCMS_107843/lang--en/index.htm (accessed July 4, 2019).

5 International Labour Standards Department. Handbook of procedures relating to international labour Conventions and Recommendations (rev 2012). Nov 5, 2012. https://www.ilo.org/global/standards/information-resources-and-publications/publications/WCMS_192621/lang--en/index.htm (accessed July 4, 2019).

6 WHO. Chrysotile asbestos. 2014. https://apps.who.int/iris/bitstream/handle/10665/143649/9789241564816_eng.pdf;jsessionid=3A2C12747C4A368346422132E4AA9DEB?sequence=1 (accessed July 4, 2019).

7 WHO. Elimination of asbestos-related diseases. September, 2006. http://apps.who.int/iris/bitstream/10665/69479/1/WHO_SDE_OEH_06.03_eng.pdf (accessed July 4, 2019).

8 International Labour Office. Resolution concerning asbestos. June 1, 2006. http://www.ilo.org/safework/info/standards-and-instruments/WCMS_108556/lang--en/index.htm (accessed July 4, 2019).

9 Kazan-Allen L. Chronology of asbestos bans and restrictions. June 14, 2019. http://www.ibasecretariat.org/chron_ban_list.php (accessed July 4, 2019).

10 Flanagan DM. 2015 minerals yearbook: asbestos (advance release). December, 2016. https://s3-us-west-2.amazonaws.com/prd-wret/assets/palladium/production/mineral-pubs/asbestos/myb1-2015-asbes.pdf (accessed July 4, 2019).

11 Marsili D, Terracini B, Santana VS, et al. Prevention of asbestos-related disease in countries currently using asbestos. *Int J Environ Res Public Health* 2016; 13: E494.

12 Mackenbach JP, McKee M. Government, politics and health policy: a quantitative analysis of 30 European countries. *Health Policy* 2015; 119: 1298–308.

13 Lin RT, Chien LC, Chen YM, Chan CC. Governance matters: an ecological association between governance and child mortality. *Int Health* 2014; 6: 249–57.

14 Takahashi K, Karjalainen A. A cross-country comparative overview of the asbestos situation in ten Asian countries. *Int J Occup Environ Health* 2003; 9: 244–48.

15 UN. Member States. http://www.un.org/en/member-states/index.html (accessed July 4, 2019).

16 BGS. World mineral statistics data. https://www.bgs.ac.uk/mineralsuk/statistics/wms.cfc?method=searchWMS (accessed July 4, 2019).

17 Dorozynski A. France bans asbestos. *BMJ* 1996; 313: 72.

18 Wong CK, Wan SH, Yu IT. History of asbestos ban in Hong Kong. *Int J Environ Res Public Health* 2017; 14: E1327.

19 Wu HY, Lin RT, Wang JD, Cheng Y. Transnational dynamics amid poor regulations: Taiwan's asbestos ban actions and experiences. *Int J Environ Res Public Health* 2017; 14: E1240.

20 Allen LP, Baez J, Stern MEC, George F. Asbestos: economic assessment of bans and declining production and consumption. 2017. http://www.euro.who.int/__data/assets/pdf_file/0009/341757/Asbestos_EN_WEB_reduced.pdf?ua=1 (accessed July 23, 2019).

21 International Labour Organization. Conventions and Recommendations. http://www.ilo.org/global/standards/introduction-to-international-labour-standards/conventions-and-recommendations/lang--en/index.htm (accessed July 4, 2019).

22 International Labour Organization. Ratifications of C162 Asbestos Convention, 1986 (no 162). June 16, 1989. http://www.ilo.org/dyn/normlex/en/f?p=1000:11300:0::NO:11300:P11300_INSTRUMENT_ID:312307 (accessed July 4, 2019).

23 Secretariat of the Basel Convention. Parties to the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal. May 5, 1992. http://www.basel.int/Countries/StatusofRatifications/PartiesSignatories/tabid/4499/Default.aspx (accessed July 4, 2019).

24 Kaufmann D, Kraay A, Mastruzzi M. The Worldwide Governance Indicators: methodology and analytical issues. *Hague J Rule Law* 2011; 3: 220–46.

25 International Labour Organization. Rules of the game: a brief introduction to International Labour Standards (revised edition 2014). Nov 6, 2014. https://www.ilo.org/global/standards/information-resources-and-publications/publications/WCMS_318141/lang--en/index.htm (accessed July 4, 2019).

26 Westerholm P, Remaeus B, Svartengren M. The tale of asbestos in Sweden 1972–1986: the pathway to a near-total ban. *Int J Environ Res Public Health* 2017; 14: E1433.

27 Baur X. Asbestos-related disorders in Germany: background, politics, incidence, diagnostics and compensation. *Int J Environ Res Public Health* 2018; 15: E143.

28 Lin RT, Soeberg MJ, Chien LC, et al. Bibliometric analysis of gaps in research on asbestos-related diseases: declining emphasis on public health over 26 years. *BMJ Open* 2018; 8: e022806.

29 Furuya S, Chimed-Ochir O, Takahashi K, David A, Takala J. Global asbestos disaster. *Int J Environ Res Public Health* 2018; 15: E1000.

30 Li JH, Dong QY, Yu KL, Liu LL. Asbestos and asbestos waste management in the Asian-Pacific region: trends, challenges and solutions. *J Clean Prod* 2014; 81: 218–26.

31 Allen LP, Baez J, Stern MEC, Takahashi K, George F. Trends and the economic effect of asbestos bans and decline in asbestos consumption and production worldwide. *Int J Environ Res Public Health* 2018; 15: E531.

32 Feenstra RC, Inklaar R, Timmer MP. The Next Generation of the Penn World Table. *Am Econ Rev* 2015; 105: 3150–82. DOI:10.15141/S50T0R.