



Incidence and risk factors of asbestosis among workers in industrial sector: literatur review

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ABSTRACT

Background: The industrial sector is a vulnerable place for diseases, especially lung diseases such as asbestosis. Continuous exposure of workers to asbestos has caused the incidence rate to increase over time.

Objective: This review aimed to explore the factors influencing the increased incidence of asbestosis in workers in the industrial sector

Methods: The investigation involved analyzing the results of 17 relevant previous studies using qualitative analysis procedures, variables, themes and factors were extracted from the studies.

Results: The analysis revealed eight main categories: age, gender, occupation, industry type, length of exposure, education, income and smoking history. Age, gender and length of exposure were found to be the most important risk factors for asbestosis in workers at an average age of 54 years in men who had been exposed for 21 years.

Conclusion: In conclusion, with the increasing incidence of asbestosis from past exposure, this study is needed as an evaluation and consideration in reducing asbestosis in workers.

Keywords: *Asbestosis, Risk Factors, Incidence, Industry, Worker*

ABSTRAK

Latar Belakang: Sektor industri merupakan tempat yang rentan terhadap penyakit, terutama penyakit paru-paru seperti asbestosis. Paparan asbes yang terus-menerus pada pekerja telah menyebabkan angka kejadiannya meningkat seiring berjalannya waktu.

Tujuan: Tinjauan ini bertujuan untuk mengeksplorasi faktor-faktor yang mempengaruhi peningkatan kejadian asbestosis pada pekerja di sektor industri.

Metode: Investigasi ini melibatkan analisis hasil dari 17 penelitian sebelumnya yang relevan dengan menggunakan prosedur analisis kualitatif, variabel, tema dan faktor diambil dari penelitian tersebut.

Hasil: Analisis mengungkapkan delapan kategori utama: usia, jenis kelamin, pekerjaan, jenis industri, lama paparan, pendidikan, pendapatan dan riwayat merokok. Usia, jenis kelamin, dan lama paparan ditemukan menjadi faktor risiko terpenting terjadinya asbestosis pada pekerja rata-rata berusia 54 tahun dan laki-laki yang telah terpapar selama 21 tahun.

Kesimpulan: Analisis mengungkapkan delapan kategori utama: usia, jenis kelamin, pekerjaan, jenis industri, lama paparan, pendidikan, pendapatan dan riwayat merokok. Usia, jenis kelamin, dan lama paparan ditemukan menjadi faktor risiko terpenting terjadinya asbestosis pada pekerja rata-rata berusia 54 tahun dan laki-laki yang telah terpapar selama 21 tahun.

Kata kunci: asbestosis, faktor risiko, kejadian, industri, pekerja

INTRODUCTION

Asbestos still poses a threat to global health, especially industrial workers¹. About 80% of the asbestos has been used by India (308,000 tonnes), China (288,000 tonnes), Russia (234,000 tonnes), Brazil (120,000 tonnes) and Indonesia (114,000 tonnes)². Asbestos exposure become a risk factor of cancer, especially in workers who are around the asbestos mining, dismantling, repairing and maintaining asbestos products³. Based on data from the World Health Organization (WHO), more than 125 million people worldwide are exposed to asbestos and contributed over half of cancer deaths, so asbestos has been classified as carcinogenic to humans⁴. Asbestosis also called as 'hidden killer' in workers related to asbestos⁵.

In 2019, there were 490 deaths reported and asbestosis contributed around 50% from 219 cases. Asbestosis also reported as the main factor of death for several years where 2-3% from the death of asbestosis acute woman^{6,7}. Around 15.7% cases of asbestosis in South Africa as the highest cases, followed by Swaziland and America⁸. Asbestos exposure affects not only asbestos workers but also their families and the resident an industrial source of asbestos⁹. The increasing proportion of asbestosis in industrial field is based on risk factors such as age, gender, type of work and type of industry^{5,10,11}.

The problem of asbestosis in workers must be handled appropriately, but previous study is still incomplete and there is still much

uncertainty about the dominant risk factors of asbestosis. Knowing the incidence and risk factors associated with asbestosis is an important step to effectively treat asbestosis problems. This research aims to analyze and summarize the incidence and risk factors of asbestosis in the industrial field so that it can complement previous research with a representative sample and global coverage.

MATERIAL AND METHOD

The research design is Literature Review. The data used in this study was obtained from the results of research that had been carried out by previous researchers who conducted searches in Mei - August 2022.

Selection Studies

We searched Google Scholar, PubMed and ScienceDirect using the following keywords: ("Asbestosis" OR "Asbestos" OR "Asbestos") AND "worker" AND "Industry". We excluded duplicate articles and those not in English. Article screening was carried out based on the title and abstract and complete articles. Articles were read to evaluate their eligibility according to inclusion and exclusion criteria. We also manually reviewed the reference lists of the included studies. All articles discuss asbestos risk factors with cohort, case control and cross-sectional study designs.

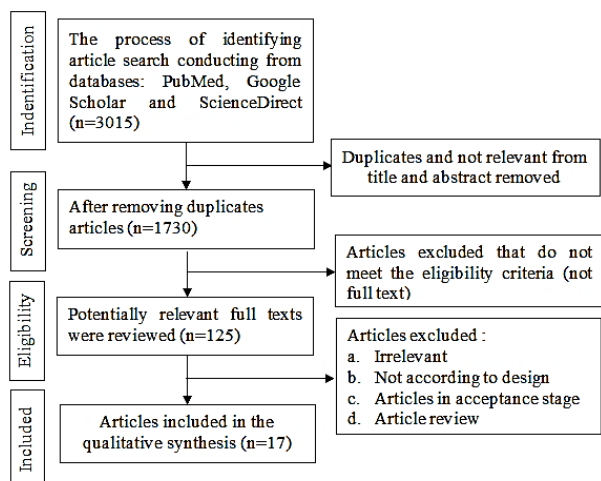


Figure 1. Flow Diagram of Selection of Studies

Characteristics of selected studies were identified from 3015 articles by searching PubMed, Google Scholar and ScienceDirect. After excluding non-English language articles, we excluded a further 1730 articles based on their title and abstract. We conducted a full-text assessment of 125 articles, resulting in the selection of 17 articles for analysis (Figure 1).

RESULTS

There are 10 journals that review gender factors and the results show that men are susceptible to asbestosis. Other findings from this review are 6 journals that review types of work related to asbestosis incidents in the industrial sector, including loaders, cable pullers, oil groups, managers), ships (cutters, installers, asbestos mines, asbestos sprayers), construction workers, tsunami debris removal workers, demolition workers, construction workers, manufacturing, assembly, machining, insulation workers,

manufacturing, mining workers and factory workers.

The length of exposure related to asbestosis with the average length of exposure occurring after 21 years and income related to asbestosis which predominantly occurs in high incomes are other factors that influence the increase in the incidence of asbestosis in workers. Of the 18 journals, there are 7 journals that review the smoking history of 1589 people with a history of smokers and former smokers. Study design cohort is the design used in this research which comes from various countries such as Brazil, China, Finland, Korea, Italy, Bangladesh, England (Table 1).

Table 1. Characteristics of included studies

No.	Study	Study Design	Sex	Number of Partisipant	Type of Industry	Country	Results
1	Fernandes, et al. (2021) ¹²	Cohort study	Men	988	cement factory	Brazil	This research highlights the damage caused by asbestos exposure and strengthens the evidence about a causal relationship between exposure and increased mortality from asbestosis (SMR, 975.7; 95% CI, 396.4–2031).
2	Wang, X., et al. (2012) ¹³	Cohort study	Both	577	textile factory	China	In this study, cancer deaths in textile workers were closely related to the level of asbestosis exposure.
3	Courtice, MN, et al. (2016) ¹⁴	Cohort study	Men	586	asbestos factory	China	Out of a total of 577 workers, 452 (78%) workers are smokers. There were 259 (45%) cases of death that occurred, 127 (22%) of them due to asbestosis and the average length of exposure was around 7.8 years
4	Nynäs, P., et al. (2017) ¹⁵	Cohort study	Both	734	workforce (asbestos industry, construction)	Finlandia	In this study there were 128 asbestosis patients, of whom 92% were men and 82% were smokers (SIR: 3.27; 95% CI: 2.52 – 4.18)
5	Kwak, K., et al. (2021) ¹⁶	Cohort study	Both	104,198 in exposed areas and 90,640 in control areas	asbestos mine	South Korea	The risk of asbestosis (adjusted hazard ratio [HR] 65.40, 95% CI = 35.02–122.12) and pleural plaque (adjusted HR 3.55, 95% CI = 1.96–6.41) increased significantly more among residents living near asbestos mines compared to general population areas far from asbestos exposure.
6	Farioli, A., et al. ¹⁷	Cohort study	Both	1823	asbestos Textiles	Italy	51 deaths due to asbestosis among 1823 workers. The HR of asbestosis deaths increased with duration of exposure (HR 2.4 for >15 years compared with <5 years
7	Girardi, P., et al. ¹⁸	Cohort study	Both	13.076	cement factory	Italy	Deaths due to asbestosis reached very high SMR values [SMR: men 508, 95% confidence interval (CI): 446–563; women 1027, 95% CI: 771–1336].
8	DeBono, NL, et al. ¹⁹	Cohort study	Both	1.764.199	diverse workforce	Canada	854 mesothelioma and 737 asbestosis cases were diagnosed during the follow-up period. Working in construction trade occupations had the largest adjusted incidence rates for mesothelioma (223 cases; HR, 2.38; 95% CI: 2.03–2.78) and asbestosis (261 cases; HR, 3.64; 95% CI : 3.11–4.25).

9	Harding, AH, et al. ²⁰	Cohort study	Both	15.557	asbestos factory	Inggris	Overall 477 asbestosis and 649 mesothelioma cases were identified. The SMR for all causes was 1.42, for asbestosis 51.3, and for mesothelioma 13.5
10	Menegozzo, S., et al. ¹⁸	Cohort study	Men	1.247	cement Factory	Italy	A significant increase in mortality was observed for respiratory diseases (81 deaths; SMR = 187; 95% CI = 149-233), especially for pneumoconiosis (42 deaths; SMR = 13 313; 95% CI = 9595-17 996) of which 41 deaths due to asbestosis (SMR = 43 385; 95% CI = 31 134-58 857)
11	Darnton, A., et al. ²¹	Cohort study	Both	39.417	asbestos workers, building construction workers, involved in large-scale tsunami debris removal work, people involved in building demolition old	Inggris	There were 33,751 (84.01%) deaths due to mesothelioma and 5,396 (15.99%) deaths due to asbestosis.
12	Miller, A., et al. ²²	Cohort study	Both	1.883	factories and mines	Montana	Asbestos-related mortality was 55% (n =112) in this series of 203 patients. Of the 203 deaths, 34 (17%) were from asbestos-related malignancies, 75 (37%) were from parenchymal asbestosis
13	Magnani, C., et al. ²³	Cohort study	Both	51.801	workers exposed to asbestos	Italy	Deaths due to asbestosis increased significantly by 366 in men (SMR: 30072; 99%CI: 27,070 – 33,317) and 51 in women (SMR: 38961; 99%CI: 29,009 – 51,227)
14	Algranti, E., et al. ²⁴	Cohort study	Both	3.057 orang	asbestosis patient in hospital	Brazil	Deaths due to asbestosis increased significantly by 366 in men (SMR: 30072; 99%CI: 27,070 – 33,317) and 51 in women (SMR: 38961; 99%CI: 29,009 – 51,227)

15	Courtice, M. N., et al. ²⁵	Cohort study	Men	104 pekerja	ship-yard workers	Bangladesh	The prevalence of asbestos-related diseases was 12 (twelve) cases (11.54%) and 6 (six) cases (5.77%) were asbestosis.
16	Visonà, S. D., et al. ²⁶	Cohort study	Both	188 subjek	asbestos cement factory	Italia	The frequency of causes of death occurred (67%) from mesothelioma, (10.7%) from asbestosis, (6.4%) from lung carcinoma and (3%) from other cancers with cardiopulmonary disease.
17	Kanecki, K., et al.	Cohort study	Both	764 pasien	all work related to abscesses	Polandia	In this study the average age was 68.1 years and the median was 69 years (CI: 67.3–68.9; SD: 11.1, min-max: 16–99 years) and often occurred at the age of 65 – 74 (267, 35%). By gender, there were 560 (73.3%) men and 204 (26.7%) women, (P<0.001). With an average number of 2.6 hospitalizations per million (95%CI: 2.3 – 3.0) per year.

Table 2. Predictor Risk Factors Related to Asbestosis

Authors	Factors Identified
Fernandes, et al.	Age, duration of exposure
Wang, X., et al.	Age, smoking, level of asbestos exposure
Courtice, MN, et al.	Age, length of exposure, smoking
Nynäs, P., et al.	Large exposure, type of industry
Kwak, K., et al.	Age, gender, family income, smoking, drinking alcohol
Farioli, A., et al.	Age, gender, length of exposure
Girardi, P., et al.	Age, length of exposure, ibreweighted Average Exposure Index
DeBono, NL, et al.	Age, type of industry (manufacturing, construction), type of work
Harding, AH, et al.	Age, duration of exposure, smoking status, gender
Menegozzo, S., et al.	Length of exposure, age
Darnton, A., et al.	Age, length of exposure
Miller, A., et al.	Gender, smoking status, type of work
Magnani, C., et al.	Age, gender, industry type
Algranti, E., et al.	Age, education
Courtice, M. N., et al.	Type of work, length of exposure
Visonà, S. D., et al.	Exposure time
Wickramatillake, B. A., et a	Exposure time
Kanecki, K., et al.	Age, gender

Source : Primary Data, 2023

DISCUSSION

This study provides a description of the factors of asbestosis among construction workers. Through a review, this study identifies existing research that investigates the factors contributing to asbestosis.

Age factor

Of the 17 journals, there are 11 journals that review age with an average age of 49.7 years. In terms of age, that asbestosis rarely appears before the age of 30 years. The standard mortality ratio (SMR) is calculated indirectly as the ratio between the observed mortality rate and the death rate occurring in men aged 30 years and over ²⁷. Mortality increases steadily with age and most asbestosis deaths are observed among

subjects aged 70 years or older ¹⁷. APC analysis reported a clear age effect with a peak in mortality at 75–80 years ²⁸.

Based on the research by *Suraya, A.*, there were patients with lung cancer, including due to exposure to asbestos, in Indonesia with an average age in the case group of 58.1 (10.23) years and 54.5 (10.23) years for controls ²⁹.

Gender Factor

Of the 17 related journals, there are 10 journals that review the gender factor and the results show that men are susceptible to asbestosis because in the industry the male sex predominates. In the multiple adjustment analysis, age and gender were significantly associated with asbestosis ³⁰.

In the general population of England and Wales from 1968 to 2008, the asbestosis mortality rate was higher in males and peaked in the last calendar period and at a later age¹⁸.

Based on Suraya, A.'s research, there were 601 of the case group and the dominant control group occurred in men in Indonesia with a P value (0.02)²⁹.

Factors Type of Work

Of the 17 related journals, there are 6 journals that review the types of workers against asbestosis in the industrial sector including loaders, cable pullers, oil groups, managers), ships (cutters, installers, asbestos mines, asbestos sprayers), construction workers, tsunami workers, workers demolition, construction workers, manufacture, assembly, machining, insulation workers, manufacturing, quarry workers, factory workers. According to estimates by *the World Health Organization* (WHO), more than 107,000 people die each year from asbestos-related lung cancer, mesothelioma, and asbestosis due to occupational exposure³¹. Occupation in the primary metal industry, especially iron and steel manufacturing and foundries is strongly associated with mesothelioma and asbestosis with predictions for both diseases. Workers in occupations related to metal manufacturing also have higher rates of both diseases, including metal processing (e.g., moulding, core making, and casting) and metal machining and forming jobs (e.g., boiler making, welding and flame cutting, and sheet metal work¹⁹.

Industry Type Factor

Of the 17 journals, there are 3 journals that review the type of industry related to asbestosis, namely the construction industry, shipbuilding, asbestos industry, manufacturing, construction, special trade contractors, primary metal industry, asbestos cement industry, railroad rolling stock and ship furniture²⁴.

Systematic measurements of asbestos fiber concentrations in air in various workplaces have been carried out in countries such as Germany and Sweden as well as in other specialized industries, allowing estimates of cumulative exposure expressed as fibers/mL-year to be made. However, no such measurements have been taken in many workplaces in different countries especially for the end use of asbestos-containing materials (e.g., building construction; shipyards, and power plants in Australia)³². Asbestos fibers have many properties for industrial and commercial use, such as high tensile strength, flexibility to weave, thermal stability, insulation, adsorption capacity, and resistance to chemical, thermal and biological degradation³³.

Based on research by Suraya, A., there are 3 (three) types of industrial subject highest in Indonesia in the manufacturing industry 94 (13.2%), the wholesale and retail trade industry in motor vehicle repair 139 (19.6%) and the transportation and warehousing industry 67 (9.4%) who have a higher chance of getting lung cancer due to exposure to asbestos²⁹.

Exposure Time

There are 10 journals that review the length of exposure related to asbestosis with an average length of exposure occurring after 21 years. The duration of asbestos exposure increases from asbestosis stage I to III and all patients with asbestosis show interstitial abnormalities (scar tissue formation or fibrosis)¹¹. The severity of asbestosis depends on the duration and intensity of exposure and having direct contact with asbestos. More intense contact over a long period of time has a poor prognosis, making it possible to perform early intervention after the first symptoms with radiological screening to prolong survival³⁴. Based on research by *Suraya A., et al*, of 696 workers interviewed in Indonesia, there were 3 (three) workers who indicated asbestosis with a duration of exposure of 10-30 years and >30 years³⁵.

Educational Factors

There is 1 journal that reviews the level of education related to asbestosis which is prone to occur at the elementary school education level, increases in education at the elementary school level occur in urban areas with a total of 167 (63%) cases and in rural areas with a total of 96 (70.1%) cases³⁶. Whereas in the study of *Algranti, E., et al*, cases of asbestosis occurred at the level of junior high school education (SMP) with a total of 83 (45.1%) cases in men and women²⁴. A study found that workers who do not get education are 2.52 times more likely to experience injuries and illnesses and a study

reports the same thing, less skills and education are a higher risk for work accidents³⁷.

Income Factor

There is 1 journal that reviews income related to asbestosis, which predominantly occurs at high incomes. Based on research by *Yang, M., et al*, asbestosis accounts for 15.7% (9400) of the total cases of pneumoconiosis worldwide, and this proportion even exceeds 80% in Denmark (87.9%) and Malta (87.7%) and over the overall period, the proportion of asbestosis increased by 31.7% , 20.0% and 16.8% respectively in high-income Australasia, North America and Western Europe³⁸. Despite the high number of cases in high-income countries, in low- and middle-income countries there is also exposure to asbestos which has a negative impact due to uncontrolled present and future exposure. There has been an increase in asbestosis due to high use in industrial construction areas, the automotive industry, insulation and piping in countries such as Brazil, China, Kazakhstan, and Russia. Based on research by *Magnani., et al*, income workers in India with a total of 245 cases were categorized as low income and 55 cases were categorized as high income where the occurrence of cases of disease related to vulnerable work also occurred at low income²³. Based on research by *Chimed-Ochir, O., et al*, there are 550 deaths from asbestos exposure per year in Indonesia and it is included in the top ten countries with high incomes³⁹.

Smoker History

There are 7 journals that review the history of smoking, 1859 people with a history of smokers and former smokers. Smoking is a factor that contributes significantly to an increased risk of death from lung cancer and asbestosis⁴⁰. Asbestos exposure and tobacco smoking interact synergistically to cause lung cancer, where tobacco smoke can interfere with the clearance of asbestos from the lungs, increasing the concentration of asbestos fibers in the airway tissue of smokers compared to non-smokers³². Exposure to asbestos does not rule out the effects of other carcinogens. Excess deaths from pulmonary MN are caused by the interaction between smoking and asbestos. Increased mortality from pleural MN and asbestosis, together with no recorded deaths from bladder MN, which were strongly associated with smoking, allowed us to conclude that factors other than smoking contribute to mortality from pulmonary MN, such as exposure to asbestos⁴⁰.

CONCLUSION

Based on the results, the factors that contribute to asbestosis were age, gender, type of work, type of industry, length of exposure, education, income, and smoking history. Mortality increases steadily with age and the majority of asbestosis deaths are observed at 54 years of age. Incidents occurring in certain occupational groups and industries can increase asbestos-related diseases, as well as showing incidents in frequency over the past 12 years. The severity

of asbestosis depends on the duration and intensity of exposure as well as having direct contact with asbestos. With the increase in the incidence of asbestosis from past exposure, this research may be needed as evaluation material in various parties such as the government, industrial areas, and in residential areas through replacing dangerous asbestos materials with safer asbestos materials.

REFERENCES

1. Visonà SD, Villani S, Manzoni F, Chen Y, Ardissino G, Russo F, et al. Dampak asbes pada kesehatan masyarakat: studi retrospektif pada serangkaian subjek dengan paparan asbes pekerjaan dan non-pekerjaan selama aktivitas pabrik Fibronit (Broni , Italia). 2018;7:122–7.
2. Chen T, Sun XM, Wu L. High Time for Complete Ban on Asbestos Use in Developing Countries. *JAMA Oncol.* 2019;5:779–80.
3. Qorri MSS, Sejdini MSS, Xhexhi PDK. Presence of Asbestos in Albania , an Approach Presence of Asbestos in Albania , an Approach. 2022;
4. WHO. Asbestos: elimination of asbestos-related diseases. World Health Organization. 2018.
5. van Zandwijk N, Reid G, Frank AL. Asbestos-related cancers: the 'Hidden Killer' remains a global threat. *Expert Rev Anticancer Ther.* 2020;20:271–8.
6. HSE. Asbestos-related disease statistic, Great Britain 2021. Vol. 31, Health and Safety Executive. Health and Safety Executive; 2021. 515–524 p.
7. Yang M, Wang D, Gan S, Fan L, Cheng M, Yu L, et al. Increasing incidence of asbestosis worldwide, 1990-2017: Results from the Global Burden of Disease study 2017. *Thorax.* 2020;75:798–800.
8. Shi P, Xing X, Xi S, Jing H, Yuan J, Fu Z, et al. Trends in global, regional and national incidence of pneumoconiosis caused by different aetiologies: An analysis from the Global Burden of Disease Study 2017. *Occup Environ Med.* 2020;77:407–14.
9. Algranti E, Ramos-Bonilla JP, Terracini B, Santana VS, Comba P, Pasetto R, et al. Prevention of asbestos exposure in Latin America within a global public health perspective. *Ann Glob Health.* 2019;85:1–15.
10. Qorri MSS, Sejdini MSS, Xhexhi PDK. Presence of Asbestos in Albania , an Approach Presence of Asbestos in Albania , an Approach. 2022;
11. Yang X, Yan Y, Xue C, Du X, Ye Q. Association between increased small airway obstruction and asbestos exposure in patients with asbestosis. *Clinical Respiratory Journal.* 2018;12:1676–84.
12. Fernandes GA, Algranti E, Wunsch-Filho V, Silva LF, Toporcov TN. Causes of death in former asbestos-cement workers in the state of São Paulo, Brazil. *Am J Ind Med.* 2021;64:952–9.
13. Wang XR, Yu ITS, Qiu H, Wang MZ, Lan YJ, Tse LY, et al. Cancer mortality among Chinese chrysotile asbestos textile workers. *Lung Cancer.* 2012;75:151–5.
14. Courtice MN, Wang X, Lin S, Yu ITS, Berman DW, Yano E. Exposure-response estimate for lung cancer and asbestosis in a predominantly chrysotile-exposed Chinese factory cohort. *Am J Ind Med.* 2016;59:369–78.
15. Nynäs P, Pukkala E, Vainio H, Oksa P. Cancer Incidence in Asbestos-Exposed Workers: An Update on Four Finnish Cohorts. *Saf Health Work.* 2017;8:169–74.
16. Kwak K, Zoh KE. Insiden Kanker dan Penyakit Terkait Asbes di Antara Penduduk yang Tinggal di Dekat Tambang Asbes Terbengkalai di Korea Selatan: Studi Kohort Retrospektif Menggunakan Database Asuransi Kesehatan Nasional. 2021;
17. Farioli A, Violante FS, La Vecchia C, Negri E, Pelucchi C, Spataro G, et al. Temporal Patterns of Exposure to Asbestos and Risk of Asbestosis. *J Occup Environ Med.* 2018;60:536–41.
18. Girardi P, Merler E, Ferrante D, Silvestri S, Chellini E, Angelini A, et al. Factors affecting asbestosis mortality among asbestos-cement workers in Italy. *Ann Work Expo Health.* 2020;64:622–35.
19. DeBono NL, Warden H, Logar-Henderson C, Shakik S, Dakouo M, MacLeod J, et al. Incidence of mesothelioma and asbestosis by occupation in a diverse workforce. *Am J Ind Med.* 2021;64:476–87.
20. Harding AH, Darnton AJ. Asbestosis and mesothelioma among British asbestos workers (1971-2005). *Am J Ind Med.* 2010;53:1070–80.
21. Darnton A, Hodgson J, Benson P, Coggon D. Mortality from asbestosis

- and mesothelioma in Britain by birth cohort. *Occup Med (Chic Ill)*. 2012;62:549–52.
22. Miller A, Black CB, Loewen G, Noonan CW, McNew T, Whitehouse AC, et al. Case-fatality study of workers and residents with radiographic asbestos disease in Libby, Montana. *Am J Ind Med*. 2022;65:196–202.
 23. Magnani C, Mensi C, Binazzi A, Marsili D, Grosso F, Ramos-Bonilla JP, et al. The Italian Experience in the Development of Mesothelioma Registries: A Pathway for Other Countries to Address the Negative Legacy of Asbestos. *Int J Environ Res Public Health*. 2023;20.
 24. Algranti E, Santana VS, Campos F, Salvi L, Saito CA, Cavalcante F, et al. Analysis of Mortality from Asbestos-Related Diseases in Brazil Using Multiple Health Information Systems, 1996–2017. *Saf Health Work*. 2022;13:302–7.
 25. Courtice MN, Demers PA, Takaro TK, Vedal S, Ahmad SKA, Davies HW, et al. Asbestos-Related Disease in Bangladeshi Ship Breakers: A Pilot Study. *Int J Occup Environ Health*. 2011;17:144–53.
 26. Visonà SD, Villani S, Manzoni F, Chen Y, Ardissino G, Russo F, et al. Impact of asbestos on public health: A retrospective study on a series of subjects with occupational and non-occupational exposure to asbestos during the activity of Fibronit plant (Broni, Italy). *J Public Health Res*. 2018;7:122–7.
 27. Jeffers D, Liao YC, Takahashi K, Lin RT. Asbestos awareness among the residents of St. Kitts and Nevis: a cross-sectional study. *Global Health*. 2022;18:1–9.
 28. Girardi P, Merler E, Ferrante D, Silvestri S, Chellini E, Angelini A, et al. Factors affecting asbestosis mortality among asbestos-cement workers in Italy. *Ann Work Expo Health*. 2020;64:622–35.
 29. Suraya A. ASBESTOS EXPOSURE IN LUNG CANCER; A HOSPITAL-BASED CASE CONTROL STUDY IN INDONESIA. *Front Neurosci*. 2021;14:1–13.
 30. Kanecki K, Kosińska I, Tyszko PZ, Nitsch-Osuch A, Goryński P, Zieliński G. Asbestosis hospitalizations in Poland (2006–2016): Results from the national hospital discharge registry. *Annals of Agricultural and Environmental Medicine*. 2020;27:284–9.
 31. Nynäs P, Pukkala E, Vainio H, Oksa P. Cancer Incidence in Asbestos-Exposed Workers: An Update on Four Finnish Cohorts. *Saf Health Work*. 2017;8:169–74.
 32. Klebe S, Leigh J, Henderson DW, Nurminen M. Asbestos, smoking and lung cancer: An update. *Int J Environ Res Public Health*. 2020;17.
 33. Jeffers D, Liao YC, Takahashi K, Lin RT. Asbestos awareness among the residents of St. Kitts and Nevis: a cross-sectional study. *Global Health*. 2022;18:1–9.
 34. Bhandari J, Thada PK, Sedhai YR. Asbestosis Asbestosis. 2020;
 35. Suraya A, Nowak D, Sulistomo AW, Icksan AG, Syahrudin E, Berger U, et al. Asbestos-related lung cancer: A hospital-based case-control study in Indonesia. *Int J Environ Res Public Health*. 2020;17:1–10.
 36. Metintas S, Ak G, Bogar F, Yilmaz S, Metintas M. Asbestos knowledge and awareness level in central part of Anatolia. *Int J Occup Environ Health*. 2017;23:243–9.
 37. Dehury P, Kumar KA. Identification of hazardous substances and occupational morbidity associated with steel and power industry workers in Odisha, India. *Clin Epidemiol Glob Health*. 2023;22:101312.
 38. Yang M, Wang D, Gan S, Fan L, Cheng M, Yu L, et al. Increasing incidence of asbestosis worldwide, 1990-2017: Results from the Global Burden of Disease study 2017. *Thorax*. 2020;75:798–800.
 39. Chimed-Ochir O, Arachi D, Driscoll T, Lin RT, Takala J, Takahashi K. Burden of mesothelioma deaths by national income category: Current status and future implications. *Int J Environ Res Public Health*. 2020;17:1–13.

40. Courtice MN, Wang X, Lin S, Yu ITS, Berman DW, Yano E. Exposure-response estimate for lung cancer and asbestosis in a predominantly chrysotile-exposed Chinese factory cohort. *Am J Ind Med.* 2016;59:369–78.