Original Article

Asbestos Materials Management and Associated Risks: Global and Regional Perspectives with a Focus on Ethiopia

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Abstract

Background: The yearly worldwide average use of asbestos recently reached 2,000,000 tons. It is also reported that one person dies for every 20 tons of asbestos produced and consumed. With much unrecorded and unreported about asbestos, its management and poor public awareness still demand attention, especially in the developing world. The objective of the current study was to review the current global, regional, and national status of asbestos use and conduct a quantitative survey on local asbestos applications and the associated public and environmental health issues, thereby providing the latest evidence of the magnitude of asbestos-related problems, the use, and implications.

Method: A mixed cross-sectional study consisting of a survey in Ethiopia and a desk review of global and regional data was employed. This study explores asbestos use trends; asbestos-related occupational health concerns and related awareness developments, quantitative and regulatory asbestos contexts, with emphasis on Ethiopia. Data collected in an Excel sheet were analyzed and compared, presented, and discussed.

Results: Though asbestos use is banned in many countries, including four in Africa (Mozambique, South Africa, Egypt, and Gabon), it is still in use by many other nations for various civil work applications, with some 2,030,000 tons being consumed annually. Ethiopia imported around 554 tons of asbestos materials in 2015, and no strong evidence on regulatory and guiding documents exists. In addition to occupational exposure to asbestos-related morbidity and mortality, community exposure appears rather alarming, especially in developing countries like Ethiopia. In this regard, asbestos banning and the standard of practice of its removal are widely unequal between developed and developing nations. In some developing nations, the use of asbestos is still prevalent, particularly in the construction industry. Regulations and enforcement of asbestos bans may be less stringent, leading to higher exposure levels among workers and the general population.

Conclusion: There is a continued use of asbestos by many developing nations, despite limited awareness of its public and environmental health impacts and poor management, especially in Africa. [*Ethiop. J. Health Dev.* 2025; 39(2)]

Keywords: asbestos; asbestos cement materials; asbestosis; carcinogenic

Introduction

Exposure to Asbestos (AS) or AS-containing materials can occur in an industrial (including mining as occupational concerns), commercial, institutional, and residential settings. Indeed, industrial AS pollution can also be considered in industrial buildings that are constructed with AS roofing and related materials (1). It has long been proven that AS material can cause respiratory health problems and is a labeled carcinogen, whereby the linkage of such material to asbestosis, mesothelioma, and lung cancer following its inhalation (2) has been proven earlier for an industrial context. However, the ongoing usage of AS materials dates back globally for its unique properties, and its associated risks in a nonindustrial setting appeared overlooked (3, 4). Following the awareness of the environmental and public health issues with AS use, including the roofing application, has been banned. Despite that, the management of AS materials, such as those already in use, like in roofing, is concerning, especially in developing countries like Ethiopia (5). During the 1950s, AS roofing was widely applied throughout Ethiopia, especially in public institutions like boarding schools, missionary churches, universities (including those located in Addis Ababa), ware houses and water treatment plants. Unfortunately, given the less public awareness on the risk of its inhalation or ingestion, it is ubiquitous especially in large and older cities or towns where one may see children playing on the ground where AS material is broken in to pieces or residents reusing the fallen, dismantled and broken AS roofs for private kitchen enclosures as well as compound fencing.

As a unique material property, AS fibres can be isolated lengthwise into thinner fibres, which makes it so responsible for its public health issues (6, 7). In this regard, the winding and amphibole are such group of AS minerals (7-9). Chrysotile/white AS ($Mg_3Si_2O_5OH_4$) belongs to the serpentine group, and it is the most used type. Additionally, the most commonly used forms of AS in the industry include the chrysotile, crocidolite, amosite, and anthophyllite (10). Thus, there are above 3,000 different forms of commercial products containing varying concentrations of AS depending on the ultimate usage (11). The physical and chemical characteristics making AS valuable, including its industrial applications such as in thermal, electrical, auto parts, and sound insulation, as

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well as its inflammability and adsorption capacity, are considerable (8, 12, 13).

Beginning from the 1990s, asbestos-cement materials, including those forms of pipe and sheets, accounted for over 95% of the global AS use. Getting its increased application, the global usage of AS reached an estimated value of two billion tons in 2009. Despite that, AS has been banned in 55 countries worldwide recently, following the wider awareness of its public and environmental health risks. Notably, every 20 tons of AS produced and consumed is killing a person somewhere in the world (11, 14). Unfortunately, it is still being used in parts of the world even today; still, some 2,030,000 tons are being consumed annually.

Contrary to its grave public health concern, AS is still being used widely by the economic sectors such as mining, manufacturing, and construction, especially being applied in many developing countries, particularly in the African region. The wider use in the continent is largely attributed to the lack of applicable work and safety-related rules that include safety and awareness on a community level of exposure, as well as a shortage of substitute safer materials. Unlike most other African states, South Africa and Mozambique are the two examples of countries in Africa that have successfully prohibited the use, processing, and manufacturing of AS and AS-containing products. This paper summarizes the historical and related quantitative information on AS, key aspects of the past and present AS problem from global to local scale, with emphasis on Ethiopia.

Materials and Methods

A mixed cross-sectional study consisting of a survey in Ethiopia and a desk review of global and regional data was employed in this study to come up with comprehensive information on AS.

Desk review

Relevant literature reported by reputable sources, legal and regulatory documents, and other related conventions published for more than three decades were revisited to gain insights into the history of AS use, AS health problems, banning, and uneven usage conditions, as well as the challenges in banning AS. To do this, various search engines that include Google Scholar, Scopus, PubMed, and ResearchGate were used to collect peer-reviewed articles, mostly using "asbestos" as a keyword (15), however, key terms like asbestosis as well as asbestos material were applied.

Institutional repository investigation

Diverse institutions ranging from global to local levels were visited. The institutions explored both virtually and physically were those having a connection with either production and consumption or standards and regulation missions. The local institutions visited include the Ministry of Health of Ethiopia, the National Geological Survey, the Ethiopian Standards Agency, and the Ethiopian Customs and Revenue Authority.

Field surveys

Field surveys such as to Nekemte, Adama, Gondar, Assela, and Addis Ababa cities or towns were conducted in teams to gather the actual status of local AS use, especially in the construction sector, such as the type of building made with AS, its appearance, and possible mishaps. Furthermore, the surveys were complemented with photographs and the discussions of related history-telling individuals, which helped to track the history of AS use nationally. The exploration of fields was done based on the fact that there are sites in all directions of Ethiopia during the earlier developments that involved foreign aid, such as those European missionaries working on boarding school buildings. Though the quantitative expression of sites explored would be difficult, it is clear that representing locations based on technical judgments was surveyed. Accordingly, older people who have the knowledge of the areas surveyed were asked for more information.

Data analysis and presentation

The data collected in various formats were systematically organized and quantified using Microsoft Excel and other related Office software. The results were subsequently analyzed and compared with findings from existing literature.

Results

Motivated by the earlier association studies on public health and asbestos use, around 67 countries banned the use of asbestos, and related policies and guidelines have been formulated on an international and national scale, mostly regarding occupational exposures (16). The legislation by the United Kingdom extends to AS public exposure. Globally, the WHO has called for the elimination of asbestos and has set guidelines for countries to follow to protect public health. The International Labor Organization (ILO) has also developed guidelines and recommendations for the safe use of asbestos, as well as for the elimination of asbestos from the workplace (17, 18). However, only a few countries adapted such guides to their specific policies and guidelines. For instance, in the United States, the Occupational Safety and Health Administration (OSHA) has set regulations and guidelines for the handling and exposure of asbestos in the workplace (19). Similarly, in the European Union, the Asbestos-Containing Materials Regulation (EC) No. 1907/2002 sets limits on the amount of asbestos in construction products and requires labeling of products containing asbestos (20). Also, in Australia, the Safe Work Act 2010 and the Occupational Health and Safety Regulations 2017 provided regulations and guidelines for the handling and removal of asbestos (21). Likewise, in the United Kingdom, the Control of Asbestos Regulations 2012 set regulations for the safe use of asbestos and the protection of workers and the public from exposure (22).

Global history of asbestos and its epidemiology

Table 1 presents the epidemiology of AS as reported from the year 1995 by countries such as the United Kingdom (UK), France, the United States of America (USA), Japan, China, and Hungary. The studies reported between 1995 and 2018 were summarized regarding the exposure setting, related numbers of cases, and deaths for the six major categories of AS health problems.

Table 1: **Summary of the global epidemiological findings on AS-related public health issues since 1995**

Year	Country	Exposure setting	Cases			Deaths			Remark	Reference
			Mesothelioma	Lung cancer	Asbestosis	Mesothelioma	Lung cancer	Asbestosis		
1924	UK	AS spinning					1	1	AS fibrosis	(23)
1960	South Africa	Mining	33							
1964	USA	Insulation work					45	12		
1998-2003	France		646 - 800/year						AS-related cases 2086 - 4172 for 1999	(24)
2000	France			2002						
1918-1938	Finland	Mining and crushing			126				Anthophyllite AS industry	(25)
1954 - 1967					144					
1985-1994	Northern Ireland							527	pleural cancer, asbestosis, and peritoneal cancer	(26)

1971-1987		England	With direct and indirect occupational links			210	180 died in Leeds	(27)
N/a				291				(28)
1949 1986	-	China			4289			(29)
1995 1999	-	Japan	162	197		500/year		(30)
1997-1998		Hungary	157					(31)

Asbestos African perspective

Figure 1 represents the predicted 15-year AS-related mortality for several African countries, as estimated by the respective national institutes of health. Figure 1 also estimates those countries' cumulative use of AS (in tons) from 1920 to 1970.

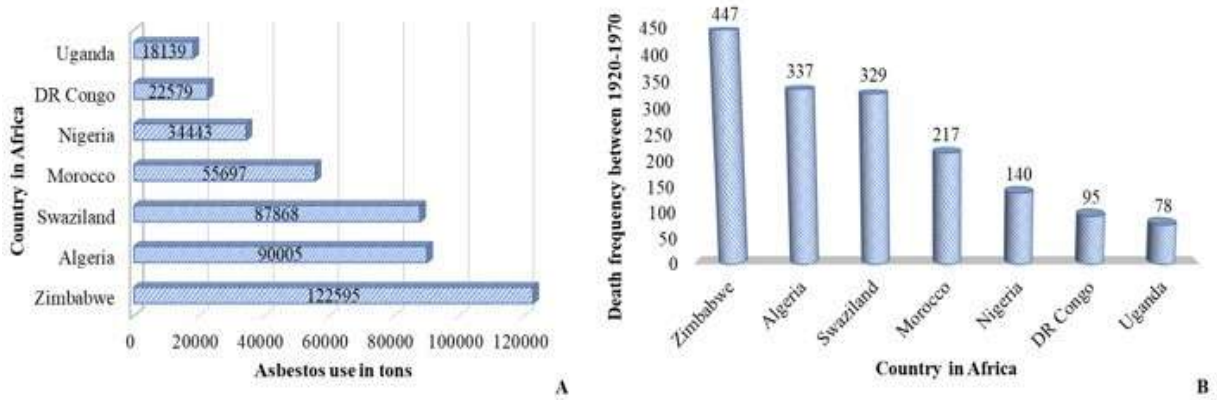

Figure 1: **Use of AS in tons (A) and AS-related deaths (B) in some African nations between the years 1920 to 1970.**

According to Figure 1, the mortality due to AS in the African countries is led by Zimbabwe, which is followed by Algeria and Swaziland. All three top nations together lost 1,113 lives to AS-related deaths. Although seven nations are presented here, it may be possible to have unreported related deaths in other countries of the continent, including Ethiopia. Figures 1 clearly show the relation between AS use and mortality, proportionally. For instance, Zimbabwe is one of the world's top producers as well as a user of AS and is the leader in the number of AS-related deaths among African countries between the years 1920 to 1970.

Current state of asbestos use and potential risks in Ethiopia

Asbestos roofings exist widely in Ethiopia

In Ethiopia, most of the old school and other institutional as well as residential buildings have used AS material for construction during the 1960's including those international offices located in the capital, Addis Ababa. Such asbestos materials are prevalent in places where missionaries came to Ethiopia and intervened in boarding schools construction as well as international or regional institutions. For instance, hazardous asbestos cement materials were used during the construction of the Addis Ababa headquarters (1961-1976) of the United Nations' (UN's Economic Commission for Africa (ECA) for acoustic insulation of ceiling panels, thermal pipes, and duct insulation and soundproofing between metal panels for wall partitions. In the same building, bulk sampling was due to begin in 2001; no further information is available to avoid any harmful effects of such materials on the health of staff members, delegates, and other persons working in and visiting the building. The UN General Assembly report on a review and assessment of the AS problem at the UN commission buildings in Addis Ababa (32) shows that, to date, no tests have been performed to determine the type of ACM at ECA. However, a program of bulk sample testing to determine the extent of the AS problem is being developed in coordination with the United Nations Headquarters for use commencing in the year 2001 and thereafter.

Figure 2: **Concrete pipe and houses constructed using AS material in different locations of Ethiopia, and the poor management and disposal.**

Houses and blocks constructed from AS material exist in the northwestern part of Ethiopia which includes Nekemete town in the Oromia region. There, AS materials have been widely used for insulation in buildings and various products such as roofing and walling as well as for water supply lines (**Fig. 3**).

Figure 3**: Evangelical Church, Mekane Yesus Central Synod offices, churches, schools, and residence buildings made of AS material in the Nekemete town of western Ethiopia.**

In the late 1960th, the Swedish missionaries built several churches, hospitals, offices, hostels, and boarding schools with AS roofing and even walling. One of the areas where the Swedish missionary was widely operating was Wallaga province which expanded to East and West Wallaga from Nekemete. Quantitative sample collection was, however, performed for Nekemete town, which is located 330 km west of Addis Ababa city, and specifically the buildings encompassed in the compound of the Evangelical Church of Mekane Yesus Central Synod. Furthermore, the hostel that was administered under the Synod was also included. The approximate areas of the buildings with AS roofing and walls evidencing the availability of AS-roofed building walls are presented in Table 2**.** In the same table, the AS building usage situation in Nekemete is presented for comparison with the context in Kotebe University of Education, where the study is based.

Table 2: **AS roofed buildings and approximate areas in Nekemete City and Kotebe University of Education in Ethiopia**

Location	Facility	Approximate area (A) covered
Evangelical Church Mekane Yesus Central Synod campus	Central Synod Head Office, roof	A = 10 m × 30 m = 300 m^2
	Nekemete Mekane Yesus Church service quarter offices wall	A = 62 m × 3 m = 186 m^2
	Nekemete Christian Education College Boys Dormitory, roof (2 Blocks)	A= (8 m × 15 m) =120 m^2 × 2 = 240 m^2
	Nekemete Christian Education College Girls' Dormitory roof (1 Block)	A = 8 m × 15 m= 120 m^2
	Residence of the Director of the College roof	A= 12 m × 15 m = 180 m^2
Evangelical Church Mekane Yesus Onesmos Nesib High School	Classrooms, roof (5 blocks)	A = (10 m × 50 m) × 5 = 2,500 m^2
	Staff Residences and offices, roof (7 blocks)	A= 12 m × 20 m) × 7 = 1,680 m^2
	School Hall, roof	A= 20 m × 80 m = 1,600 m^2
Kotebe University of Education	Administration building and students' dormitory	A = 1120 m^2
Total area		7,926 m^2

Based on Table 2, 7,926 m^2 of roof area is covered in just three institutions mentioned to showcase the extent of AS roofing material usage in the country.

Further on asbestos use, imports, and stakeholders in Ethiopia

Different stakeholders have been consulted for the current study, including the Geological Survey of Ethiopia, Ethiopian Customs and Revenue Authority, Ministry of Health Ethiopia, Ministry of Urban Development, Housing and Construction of Ethiopia, Ethiopian Standards Agency, and Ethiopian Environment, Forest and Climate Change Commission, which were visited in different times whereby discussions were made with the focal persons using a consented checklist.

Though there is no data accessed on AS material production in Ethiopia. There is evidence on recent imports of AS material into the country (**Fig. 4**). Estimates of AS consumption in Ethiopia were close to 2000 kg in 1995 and declined for the two subsequent years before reaching the highest import in 1999, reaching the lowest quantity of 300 kg until it reached 500 kg in 2004. The reason for the variation in the import quantities is not clearly understood.

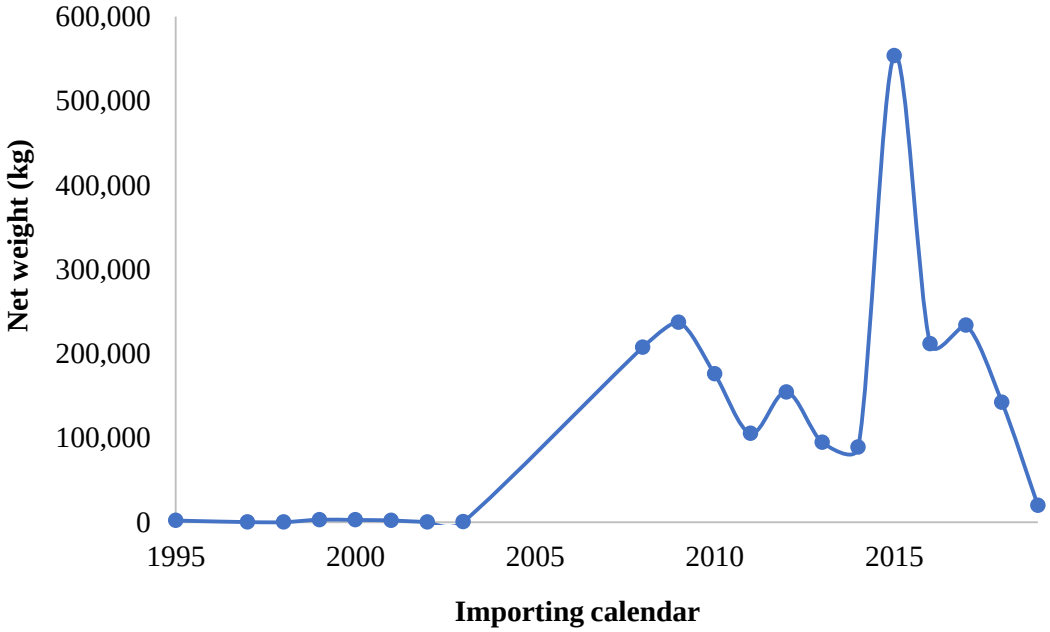

Figure 4: **AS materials imports to Ethiopia in weight from 1995-2015.**

Ethiopia imported 604 kg of AS yarn and thread in 2003 alone. This is incomparable with the 77,000 tons of AS imported by Japan in 1960 (30), but the issue is the safety precaution and the extent of its application backed by strong policy is far better in Japan than in Ethiopia. Moreover, in spite of such AS use evidence,

it is unfortunate that there is no epidemiological report so far documented regarding Ethiopia.

Discussion

Based on Table 1, most of the AS epidemiological studies were focused on occupational AS exposure and did not follow a regular or uniform protocol, and the studies hardly correlated mortality and morbidity. Mining, crushing, and spinning AS were the common exposure settings, while the reports covered mostly developed nations. The number of cases reported, especially for mesothelioma and lung cancer, was comparably high for France, which was 2086 – 4172 cases reported in a single year (23, 24). A related study done in Finland showed the standardized incidence ratio (SIR) for mesothelioma varied from about threefold to over 100 times in the different cohorts. The SIR for lung cancer was about twofold to tenfold in all except the screening cohort. AS sprayers were at the highest risk of mesothelioma and lung cancer (33).

In spite of the severe health warnings and considerable hazards reported, AS is still being used in mining, manufacturing, and construction sectors in many developing countries, such as those in Africa. This is primarily due to the lack of comprehensive occupational and community AS exposure, limiting related legislation and enforcement policies. For instance, Ethiopia included AS removal in its national cancer control strategy, but the implementation is negligible (34, 35).

Regionally, South Africa was the 3rd main exporter of AS in the world for over a century, and it is one of the countries that suffer from AS-related problems [25]. Following the ban of AS and the application of respiratory protective equipment, there is a decrease in cases and deaths due to AS-related diseases in developed countries. Conversely, the use of and problems of AS would be rising in developing countries mainly due to inadequate disease surveillance systems and the lack of official recordings of such diseases, such as mesothelioma, as well as public awareness. The problem would even be worse since clear environmental policies and guidelines may be lacking in many other African countries [26]. Until all African nations adopt and enforce a comprehensive AS ban, these rates may even continue to rise.

As of 2012, the only four countries that banned AS in Africa are Mozambique, South Africa, Egypt, and Gabon; the rest do not. Indeed, one of the four countries in the world that produced 96 percent of the world's AS in 2007 includes the African Zimbabwe. That same year, Zimbabwe mined 100,000 tons of chrysotile AS; it exported the product to the USA in the form of milled fibres. Although AS-related health and environmental problems continue to rise, even in those countries that have banned its use due to its decades of latency. Thus, the World Health Organization (WHO) made resolutions to eliminate AS in collaboration with the International Labour Organization through its outline for the development of national programs for elimination of AS-related diseases which includes the promise to support national AS profile and national AS workplan development (36).

In Ethiopia, the existing conditions of buildings containing ACM do not comply with standards applied for the minimum protection of workers and residents, as echoed by developed nations. Such standards are adopted by developed nations even before the AS ban. It has been studied and determined that an amount of AS dust particles (300-400 fibers per cubic meter) can be released from AS constructed buildings where people may inhabit them, and the release of asbestos dust increases with the condition of the building, like age and the extent of destruction (37-39). Various European studies already showed that AS environmental or community exposure risks are eminent even in the presence of serious regulations (5, 38, 40, 41). A meta-analysis report has already established the increased risk of pleural malignant mesothelioma from a non-occupational/environmental exposure to AS, including a study conducted in Italy and other cities in Romania (5, 41, 42). Thus, demolition of such structures requires careful operation by trained personnel. But the situation in countries like Ethiopia is more than that, where AS material may be run over by a car, broken and played with by children.

More importantly, there are AS-material-based constructions located in different parts of the country that can worry the susceptible labor group, including those in construction, demolition, and firefighting, as well as the inhabitants (43). Sightings of AS materials of construction, like AS roofing that has broken down and become fencing material and other small enclosures for domestic uses (including outdoor kitchens) are common. Significant numbers of institutions that include old public universities, boarding schools, high schools, warehouses, and other public offices in the country still have AS roofing.

The occupants of those buildings, especially in the school setting, can take a considerable number of years of exposure that may add up with the aging and fracture of the structure to bring about considerable risks along with the emerging minimum exposure amounts to AS in the built environment on public health effects (4). A recent study has identified up to 500 fibers/m^3 of AS and even higher to 1000 f/m^3 of AS concentrations in the air when such roof materials are damaged (38), and such damages was observed in most places as seen in figure two. Given the current situation, the potential health impact of AS is imminent in Ethiopia because of the widespread occurrence of AS materials in all of its forms in the industrial and urban environment, as well as in the waste cycle. In the current survey, only a few images of AS material used in such constructed houses were taken from accessible sites in Ethiopia that include places Addis Ababa City, Adama city, Nekemete city, and Sagure town of west Arsi in the Oromia region of Ethiopia (**Fig. 2 & 3**).

An earlier study has quantified the possible indoor air pollution with AS within AS-based buildings (39). Further, a recent study has indicated the considerable pollution of soil and water from AS roofings, thereby

showing the public and environmental health risks (44). For instance, separating AS from soil for quantification has been performed by a recent study. The study has revealed that AS lasts long in the soil, and the reuse of soil can emit AS back to the air. More importantly, rainwater can wash the AS from the roofing to the ground, whereby the pollution potential can be comparable to that of industrial production pollution (44). Worse is the unawareness of the users of the risk of AS dust inhalation and the unavailability of aware and special construction workers for either maintenance or demolition and reconstruction of such buildings.

Thus, the occupational and community exposure risks to AS demand precautionary measures to be put in place as soon as possible. Among other things, raising awareness on the hazardous effects of AS for inhabitants, construction workers, and policy makers as well as regulators is urgently needed. More importantly, detailed and extrapolative studies are required, as have been performed by Marsili et al., and related others, especially regarding building occupants (38, 40, 45). Such studies can stimulate awareness of the magnitude of the problem among the general public and the relevant stakeholders. Furthermore, the detailed studies can provide important information on the circumstances of exposure, as well as local asbestos-related health impacts. Thus, the issue can be addressed by investigating the extent of ACM use in the general community and its environmental distribution for an effective policy and enforcement to be in place.

Although WHO is aiming to eliminate AS-related diseases through several important steps that include the improvement of early diagnosis, treatment, and rehabilitation services, the Ministry of Health of Ethiopia has not documented anything on asbestos-related morbidity and mortality, except mentioning it in work plans such as on the plan for the control of chronic diseases. The same ministry has laid a strategy to control environmental and occupational hazards through its disease prevention and control responsible directorate, as written in the country's national cancer control plan, which is already ended by 2020, and it targets to promote stopping the use of all forms of asbestos. Apart from that, there is no clear intervention plan of action, nor is there a progress report on work plans so far (46). Despite that strategy, there is even an import of AS material, which is evident from the website of the Ethiopian Revenues and Customs Authority. In this regard, an alternative approach to auditing is to account for particular production, imports, and exports. national law permits mining and milling, processing, and use of ACM.

Conclusions

On a global scale, AS materials are in use and are in real demand by the developing nations, and their continuing use raises the risk of AS exposure and AS-related diseases. However, there is no regulation or there is a limited regulation on AS usage, and the assessment of the health impact of these activities remains obscure. Further, epidemiological studies are needed to establish the health effects of AS reliably in developing countries. The current work has identified the fact that AS-related diseases are far from being an occupational risk, especially in developing nations, and the less awareness of the public on AS exposure brings a wider community health concern. In the Ethiopian context, more work needs to be done to raise awareness in the general public about the existing structures with AS materials in the community and the risks associated with them. The need for applying programs and policies, such as those for the elimination of all kinds of AS use, that is, banning of new AS use and tight control and management of existing structures containing AS, is demanding. Furthermore, collaboration among stockholders is very useful to bring a meaningful impact to the entire country. There is also a need to undertake risk assessment research that goes further into the potential of AS transport through environmental media such as water and air.

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Not applicable.

Abbreviations

ACM: Asbestos Cement Materials
AS: Asbestos
ECA: Economic Commission for Africa
SIR: Standardized Incidence Ratio
UK: United Kingdom
USA: United States of America
UN: United Nations
WHO: World Health Organization

Authors' contributions

GDG and DBN contributed to the study conception and design. Material preparation, data collection, and analysis were performed by GDG, GYJ, BT and MW. The first draft of the manuscript was written by GDG and BT, and DBN commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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