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Asbestos problem in India

V. Subramanian*, **N. Madhavan**

School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110 067, India

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Summary Primary exposure to asbestos in India can be encountered in the form of asbestos mining, asbestos cement industries, asbestos processing unit and during renovation and demolition of old asbestos cemented roof or other structures as well as modern electrical as well as mechanical appliances in which asbestos is still found. Ultimately construction workers, electricians, vehicle mechanics and other workers in the building trades who are exposed to asbestos inhale hundreds and thousands of amphiboles, which causes lung damage. It is being mined in India at places such as Andhra Pradesh (Pulivendla), Jharkand (Roro), Rajasthan (Ajmer, Bhilwara, Udaipur, Rajsamand) and the common problem faced by the locals are asbestosis through air and fluorosis through drinking water. The problem continues to be in India as well as other developing countries. Also, India import and re-export asbestos to other countries and workers at shipyard, transport of the hazardous material on road and roadside residents all are vulnerable to this uncommon disease. The signs and symptoms generally found with the workers are shortness of breath, persistent and productive cough due to pulmonary fibrosis can show up many years after the asbestos exposure.

Because of its durability and tensile strength, asbestos is used in over 3000 products. A number of substitutes to asbestos are used in developed countries, including cellulose polyacrylonitrile, glass fibre and unplasticised polyvinyl chloride (PVC). Although a substitute for asbestos is expensive, they work out to be cheaper in the long run because of their long life. These alternate products are not in common use in India. If Government of India is concerned about the health of its citizens, it must approve alternatives to asbestos, especially for roofing. Chrysotile asbestos is a convicted mass killer [1]. Its use should not be perpetuated. Although India banned the import of asbestos waste in 1998, 74,398 kg were imported (see Article Code for asbestos waste under 25240091) from Russia between April 2003 and February 2004. To add farther to the problem, import customs duties by the Federal Government on refractory raw minerals and mineral products like graphite, asbestos, mica and gypsum have been reduced by 15% in 2004 annual Government budget, and it is sad that still India facilitate asbestos industry without serious consideration of health aspects of the user population.

Different types of man-made fibres are being used as substitutes for asbestos. The concern for these materials having similar physiochemical properties to asbestos exists because some fibres can cause pulmonary fibrosis [2,3]. Pneumoconiosis,

* Corresponding author.
E-mail addresses: subra@mail.jnu.ac.in, subrama42@hotmail.com (V. Subramanian), nmadhavan@icqmail.com (N. Madhavan).

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which pursues a chronic course, can be considered the result of a series of events comprising repeated inflammation and repair due to the continued presence of dust in the lungs, eventually leading to fibrosis [4]. Particle Size is an important property related to the asbestos problem. Asbestos mineral is composed of fibrils (about 0.03 μm diameter) that are packed together. When the mineral is broken apart mechanically, the material separates primarily between fibrils and the resulting fibres are usually bundles of fibrils. The ends of the fibres can be broken apart, with smaller bundles or individual fibrils spread apart, yet still part of the fibre [2]. In addition, multiple fibres and compact particles can be held together as complex structures. The complexity of fibre shapes affects all of the measurement and separation techniques and frequently makes it difficult to compare one method to another. In addition to asbestos fibres, there is a wide range of fibrous materials being produced for commercial purposes. These include fibrous glass, mineral wool, refractory ceramic fibres, wood and other plant fibres and synthetic organic fibres. Most of these fibres tend to have larger diameters than asbestos fibres. Carbon nano tubes (<5 nm diameter) have recently been produced in small-scale commercial quantities, which are considered a serious occupational health hazard in chronic inhalation exposures [5]. Measurement techniques must be tailored to the size distribution and physicochemical properties of the fibres. The capability for measurement of fibre size distributions is available through microscopy and to a much lesser extent, through direct-reading instrumentation. The traditional methods of microscopy are relatively inaccurate when compared to many chemical analysis methods because of the many sources of error in the sampling and analysis procedure. Further work is needed in automating fibre counting through improved image analysis of microscope images and through improved direct-reading instrumentation [2]. Thus, the main problems of asbestos are two-fold: size and physiological responds to nano-particle inhalation.

Chrysotile has been shown to increase the risk of lung cancer and to produce mesothelioma in exposed workers [6]. A general feature of current asbestos use is a lesser concern for exposures to chrysotile than the amphiboles. This is a serious mistake. Available data indicate a similar lung cancer risk per fibre exposure for chrysotile, amosite and crocidolite [1,6]. There is no question concerning the greater carcinogenicity of crocidolite for mesothelioma, but very strong data from an analysis of the time course of mesothelioma risk among insulators indicate similar, substantial risks for exposures to amosite and chrysotile [6]. It is widely accepted that exposure to chrysotile asbestos increases the risk of developing lung cancer in proportion to the cumulative exposure to asbestos up to a time, 10 years prior to evaluation [1]. In India, too, studies have found lung impairment and radiological abnormalities in all varieties of asbestos milling workers (54.8%) and miners (19.5%), $n = 633$ [7].

There are no detailed data available to analyse the total number of deaths in India only due to asbestos, since the records do not categories different sources of breathing problem. A general plot shown in Fig. 1 was made for the last 20 years for all reporting death considered against asbestos production, asbestos import, re-export and causes of death due to the respiratory disease system in rural India as well as acute respiratory infection (both rural and urban). A trend was observed similar to asbestos production, import and re-export of asbestos accelerating cause of death over years due to respiratory system and respiratory infection in India. In Jharkhand state, on the eastern part of India, abandoned chrysotile asbestos mine is a health scourge for villagers and former mine workers. A massive pile of asbestos waste mixed with chromite has lain atop the hilltops of Roro village in this part of the country for 2 decades, gradually seeping into the land, water, homes and bodies of the tribal communities living at the foothills of Roro [8]. The preliminary health survey of 14 villages around the Roro hills, with 45% of the respondents ($n = 252$) being former workers of the Roro asbestos mines, indicates a highly probable link between the asbestos exposures and difficulty of breathing (Fig. 2). About

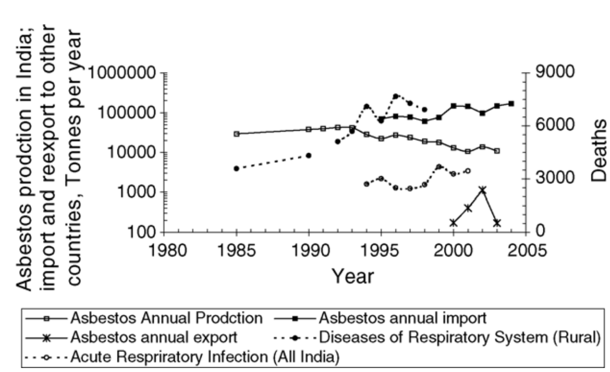

Fig. 1 Asbestos production imports and re-export in India and incidence of deaths. Data from: Government of India (2004), Health information of India 2000–2001, Ministry of Health and family welfare; Government of India (2004), Monthly statistics of foreign trade in India, Volumes I and II, Ministry of Commerce and Industry; Government of India (2003), Monthly abstract of statistics, Ministry of Planning and Programme implementation.

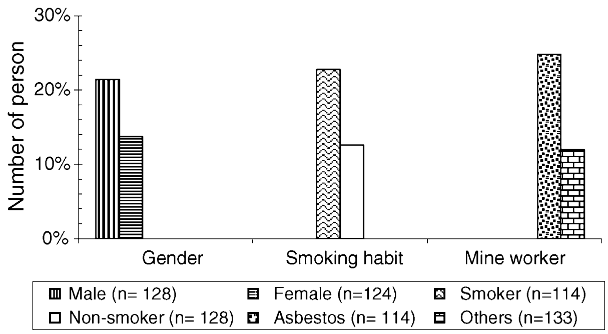

Fig. 2 Prevalence of breathing difficulty in abandoned chrysotile asbestos mine, Roro, Jharkand. Data from [8].

one in six respondents complained of difficulty of breathing (17.5%). During monsoon, the asbestos waste from the dumpsites gradually runs off into the fields, streams and ponds located at foothill. In the summer, warm winds carry fine waste material from the dumpsites across the whole area, and particular concern is the exposure to children and the elderly. Therefore, it is necessary to carry out a proper health and environmental study of the area and draw a scientific plan for cleanup and disposal of the waste [8]. In one of the cities in Northern India, soil samples collected at different sites with increasing distance around an asbestos cement factory showed contamination with asbestos fibers. Soil samples collected from the close vicinity of the factory revealed higher number of fibers in comparison to increasing distance. Further size wise pattern of fiber (<10 μm) was found higher with distance moving away from the factory and the size of asbestos fibres may cause more to human and if the exposure continues (Fig. 3). Also, analyses of pond (contaminated lake) water showed presence of suspended chrysotile fibres with the size <30 μm and sediments mostly containing coarse chrysotile fibres of size >50 μm.

There are also differences at the international level in individual national responses to the health

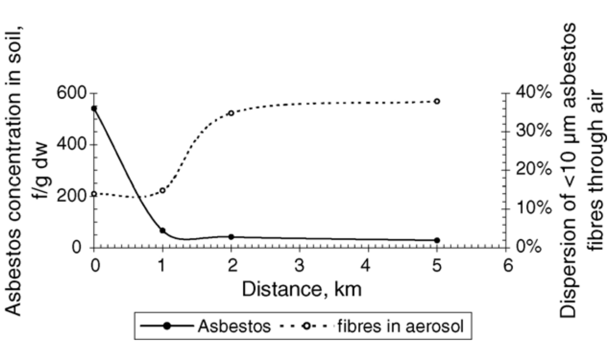

Fig. 3 Asbestos residues in and around asbestos cement factory.

hazards of asbestos. Some Scandinavian and other Western European nations have prohibited all new uses of asbestos [9]. In the United States, the permissible exposure level is 0.1 f/ml and asbestos use has been dramatically curtailed [10]. In contrast, Japan currently has a 2 f/ml for chrysotile but a recommendation has been made to lower the permissible exposure level to 0.15 f/ml by the Japan Society for Occupational Health. The uses of amosite and crocidolite are prohibited in Japan. South Korea has a 2 f/ml standard for chrysotile but lower standards apply for amosite (0.5 f/ml) and crocidolite (0.2 f/ml). Generally, developing countries, such as India does not have any ban on other asbestos variety and have permissible exposure levels greater than 1 f/ml.

With the use of asbestos being predominantly in cement products in India, a good opportunity for control of workplace and environmental exposures exists. In installation of pipes and boards exposures during sawing or other abrasive actions can be well controlled with the use of appropriate dust collectors or wetting techniques. However in India, these precautions may not always be taken and workplace monitoring by regulatory agencies is important. Uncontrolled sawing produces concentrations in the tens of f/ml. During normal use of such asbestos cement products, there is limited release of fibres because of the strong binding of the cement. Again, however, abrasion of the cement will lead to fibre release. One feature of current occupational exposures in India is that there may be a substantial use of asbestos in thermal insulation. Such products are particularly dangerous because asbestos is readily released. Such release during installation, repair or removal not only exposes the insulator, but also many workers in shipyards through import and re-export and construction sites. In the United States it has been estimated that approximately 70% of current asbestos-related cancers can be attributed to fibres released from thermal insulation materials [6].

Since this naturally occurring silicate fibre often occurs in high fluoride host rock, such as amphibolite in the state of Andhra Pradesh (Cuddapah district), state of Jharkand (Singhbhum district), and in the state of Rajasthan (Ajmer district) and the problem faced in India may hence be two-fold; apart from asbestos related diseases, the nearby population also faces fluorosis through enrichment of fluoride in the groundwater that is the only source of water for the local population.

For India, thus, future studies should be related to occupational health exposure to asbestos and an alternative substance should be found against asbestos in all fields. They can be summed up as:

1. The physical disorders of workers and family members at asbestos industry minimised by reducing the air borne asbestos at their working site and monitoring their health periodically.
2. The causes of death due to respiratory disease on asbestos should be directed in all India and studies on environmental (occupational) exposure to asbestos to be conducted in all abandoned and operational mining sites.
3. There should be a statuary warning on a cement bag, if it contains asbestos and its full composition.
4. The government should monitor all airborne asbestos and non-asbestos fiber concentrations by precision analytical method in urban and rural places (industrial, business and residential area) and the report should be made available online.
5. To compare airborne asbestos and non-asbestos fiber concentrations by the distance from highways and obtaining data that would contribute to establish background asbestos and non-asbestos fiber exposure level to refer the occupational exposure from all mining and industry, it should be monitored and the citizen health must be improved.
6. A replacement material for asbestos cement roof and drain water pipe should be made available in the construction field. Finding an alternative substance and transferring the knowledge to the asbestos cement manufacturers will rescue the workers as well as avoid people contact to asbestos. Also, domestic water supply pipe should be free from asbestos.
7. All previous asbestos waste must be buried and minimum environmental damage should be taken care.
8. Epidemiological studies to categories all respiratory diseases into asbestos, silica and other separately so that the relationship between asbestos and death counts are exact.
9. Relationship between asbestos and other problems, such as fluoride in common regions, where the source materials for both such problems may be related.

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References

[1] Lemen RA. Chrysotile asbestos as a cause of mesothelioma: application of the hill causation model. Int J Occup Environ Health 2004;10:233—9.
[2] Baron PA. Measurement of airborne fibers: a review. Ind Health 2001;39:39—50.
[3] Warheit DB, Reed KL, Webb TR. Man-made respirable-sized organic fibers: what do we know about their toxicological profiles? Ind Health 2001;39:119—25.
[4] Morimoto Y, Tanaka I. In vivo studies of man-made mineral fibers: fibrosis-related factors. Ind Health 2001;39: 106—13.
[5] Lam CW, James JT, McCluskey R, Hunter RL. Pulmonary toxicity of single-wall carbon nanotubes in mice 7 and 90 days after intratracheal instillation. Toxicol Sci 2004;77(1):126—34.
[6] Nicholson WJ. The carcinogenicity of chrysotile asbestos—a review. Ind Health 2001;39:57—64.
[7] Joshi TK, Gupta RK. Asbestos-related morbidity in India. Int J Occup Environ Health 2003;9:249—53.
[8] Dutta M, Sreedhar R, Basu A. The blighted hills of Roro, Jharkhand, India: a tale of corporate greed and abandonment. Int J Occup Environ Health 2003;9: 254—9.
[9] Hillerdal G. The Swedish experience with asbestos: history of use, diseases, legislation, and compensation. Int J Occup Environ Health 2004;10:154—8.
[10] LaDou J. The asbestos cancer epidemic. Environ Health Perspect 2004;112(3):285—90.