Industrial Health 2001, **39**, 309–315

Review Article

Present Status of Asbestos Mining and Related Health Problems in India —A Survey

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Received December 4, 2000 and accepted May 31, 2001

Abstract: At present in India more than thirty mines are in operation. It produces 2800 tones of asbestos per month (mainly chrysotile and tremolite) and in recent years substantial quantity (-70%) is imported from Canada. The quality of asbestos produced in India is very poor. The mining and milling and other related processes expose the people to cancer and related diseases. Women are more affected by their exposure in processing unit compared to male who are generally working in mines. Direct and indirect employment in asbestos related industry and mine is around 100,000 workers. Latency period (length of the time between exposure and the onset of diseases) in India is estimated to be 20–37 yr. The causes for lung and breathing problem are mainly due to obsolete technology and direct contact with the asbestos products without proper precaution, because in India asbestos are sold without statutory warning. This paper reviews health effects (such as fibrosis, sequelae, bronchogenic cancer, and malignant mesothelioma) on the Indian mine workers caused due to asbestos mining related activities with respect to their present day condition.

Key words: Asbestos industry, Latency period, Obsolete technology, Health effects, Mineworkers, Asbestos products

Introduction

Asbestos means indistortable in Greek, it has got more than three thousand uses. Asbestos mineral has been a boon and bane for the mankind. Asbestos fibers can be molded or worn into fabrics, non-flammable and a good heat insulator. Asbestos is strong and resistant to heated chemicals. They are used in India as fireproof products such as safety clothing for fire fighters and insulation such as hot water piping. In India asbestos is widely used as floor tiles, ceiling tiles, roof materials. The asbestos industry in India is spread over in numerous states; out of this nearly 60% are in operation at present.

At present, chrysotile account for over 90% of the World production[1]. Asbestos is obtainable by underground and open cast mining in India, out of which the most common method is open-pit mining. Only about 6% of the mined ore contain usable fibers[2, 3]. The fibers are separated from the ore by crushing, air suction, and vibrating screen, and in simplified manual processes are sorted into different length or grades.

Properties

The physical properties of asbestos are its capability to be readily separated into fine filaments of high tensile strength and enough flexibility along with high degree of incombustibility. In India, the coarser and brittle fiber variety has a very limited use for the manufacture of asbestos sheet and asbestos cement. The long fiber grades are of fine silky chrysotile variety of high tensile strength. Asbestos of medium grade variety, i.e. short fibroid materials are

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compounded with various synthetic resins for the manufacture of molded articles. Asbestos of low-grade short variety are used for millboards, paper, boiler coverings and mattress fillings[1].

The length of the fiber as well as the chemical composition of the ore determines the kind of product that can be made from the asbestos. The longest fibers have been used in fabrics, commonly with cotton or rayon and the shortest ones (called as milled asbestos) for molded goods, such as pipes of gaskets. Asbestos are also used in the construction material, textiles, missile, jet parts, asphalt paints and in friction products such as brake linings.

The chemical composition of Asbestos in India varies as follows: SiO_2 40.09%, Al_2O_3 1.27%, Fe_2O_3 + FeO 2.53%, MgO 41.41%, and H_2O 14.06%[4].

Occurrence in India

In India, asbestos occurs in the states of Andra Pradesh, Rajastan, Bihar, Karnataka, Tamilnadu and Manipur (Fig. 1). Most of the Indian asbestos deposits belong to the tremolite-actinolite variety. It occurs in tremolite-actinolite schists, amphibolites and metamorphosed basic and ultra basic rocks. Bihar and Rajastan were mainly enriched with tremolite followed by small amount of chrysotile. In Andrapradesh and Tamilnadu the amphibole variety is more abundant than the chrysotile variety. In Bihar, chrysotile asbestos occurs in Singhbhum districts associated with serpentinised dunites and peridodites and is usually between 3.1 to 6.2 mm long. Chrysotile asbestos fibers are short between 9.4 to 15.75 mm in length. Lakshmana mines in Cuddapah district in Andrapradesh chrysotile fibers are between 0.076 to 0.152 mm in length[2, 4–7].

Asbestos Utility and Health Effects

The asbestos demand has decreased in the industrialized world, where it is growing in the developing countries. The amount of asbestos used by the Asian countries was almost doubled between 1970 and 1995[8]. Canada is marketing their deadly asbestos largely to countries like Thailand, Korea and India, where the powerful heat resistance and binding properties of asbestos are valued in the production of low cost building materials, as well as automobile brake linings and textiles. So the epidemic of illness and death that has plagued the West in the past will more likely to be repeating in Asia soon. Asbestos causes cancer of the lung, lung lining and abdomen and can take 20 yrs or so to manifest (latent period)[9, 10]. The detailed study in Australia[1] shows that the lung cancer and mesothelioma in asbestos mine workers are revealed after 37 years during the observation period from 1945–2000. It is expected that the affected people number will go to a maximum during 2010 in Australia.

Various malignant diseases of the lungs, pleural and gastrointestinal system are linked to the asbestos exposure as per the latest edition of Harrison principles of internal medicine[11]. Which incidentally does not mention any difference among the various types regarding potential harmful effects of asbestos namely chrysotile, crocidolite, amosite, etc.,[12]. For example Britain has allowed maximum concentration of chrysotile as 0.5 fibers/ml (f/ml) and for crocidolite and amosite as 0.2 f/ml[13]. India prescribe <2 f/ml for all asbestos[5]. Release of asbestos fiber by corroded and weathered asbestos-cement products is already a concern - this may expose millions in our country to unexpected and unknown hazards. It is proved beyond any serious doubt that asbestos cannot be used safely in any developing countries.

All forms of asbestos cause asbestosis, a progressive fiberotic disease of the lungs. All can cause lung cancer and malignant mesothelioma. EPA has proved asbestos to human carcinogens on cancer of WHO standard. Canadian asbestos is free from amphibole but still associated with mesotheliomas[14]. The strict occupational exposure risk limits of the world for chrysotile asbestos (0.1 f/ml) are estimated to be associated with lifetime risk of 5/1000 for lung cancer and 2/1000 for asbestosis[13]. Still the developed countries can technically achieve this limit but the residual risks still are too high to be acceptable. In new developing industrial nations like India the exposure are much higher and the potential for epidemics of asbestos diseases is greatly increased.

Scenario in India

The Asbestos mines in different parts of India are shown in Fig. 1. The average production per month and yearly average for one decade is shown in Figs. 2 and 3. Figure 2 shows that the production has reached a maximum of about 2800 tones per month in 1990–1995 and it reduces to 1800 tones per month, due the large-scale import from Canada. But if you see the short-term variation from Jan 96 to Jan.99 the fluctuation is too much. In general the decreasing trend of production is evident[3]. Figure 3 shows the reduction in the yearly production of asbestos in India[2].

In India, asbestos production at present is about 2000 tones per month from their own mines in Andrapradesh, Rajastan and Bihar. Several states in India have many asbestos

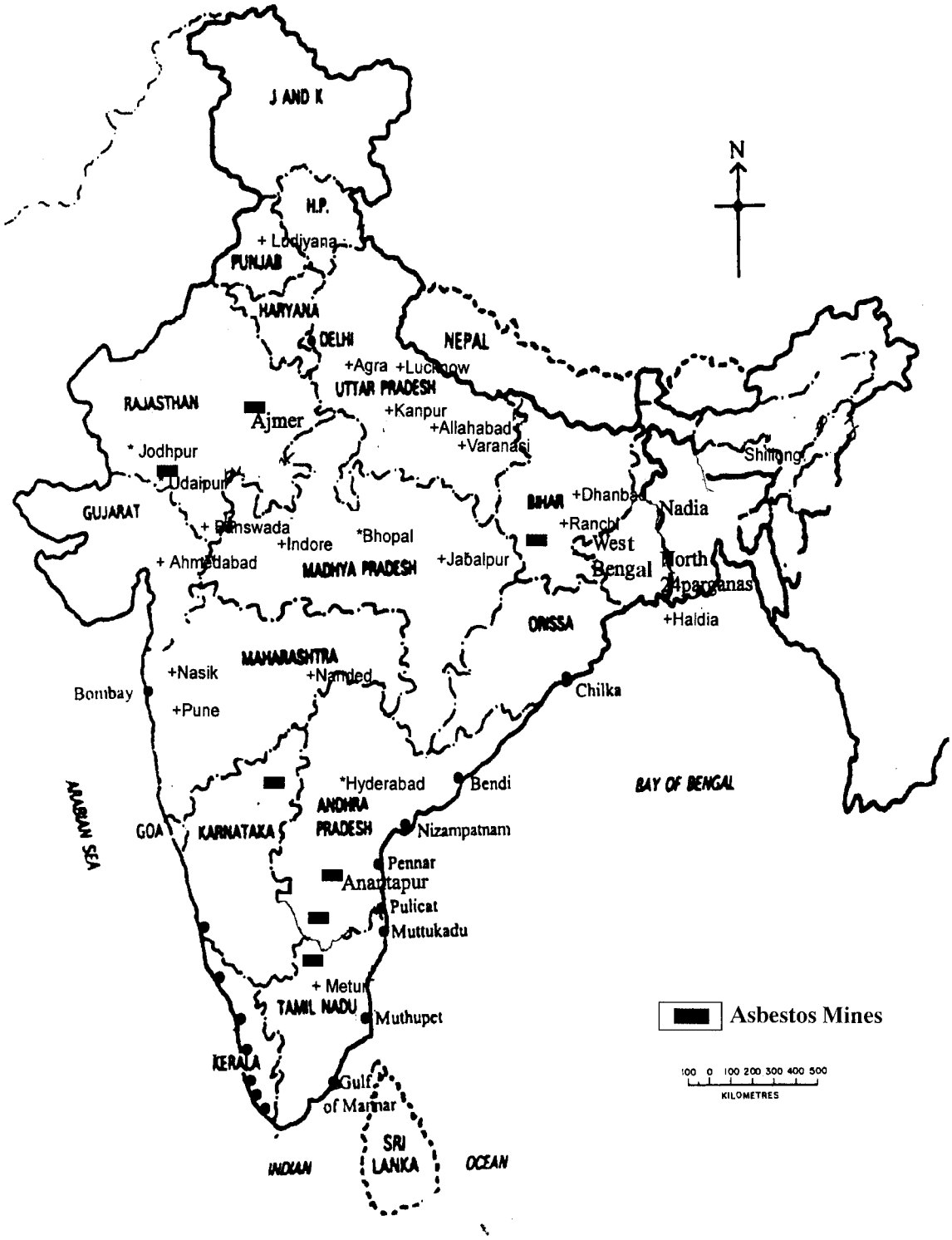

Fig. 1. Map showing major asbestos mines in India.

industries. Out of which 60% are in operation now. India imports asbestos worth Rs 40–50 crores annually, without mentioning it as a hazardous product[2, 3]. In India raw material asbestos is received from Canada without any warning and India sends back the finished product to them along with the warning *hazardous product*.

In India workers slice open the bags of Canadian asbestos with knives, then shaking the bags into troughs and mixing

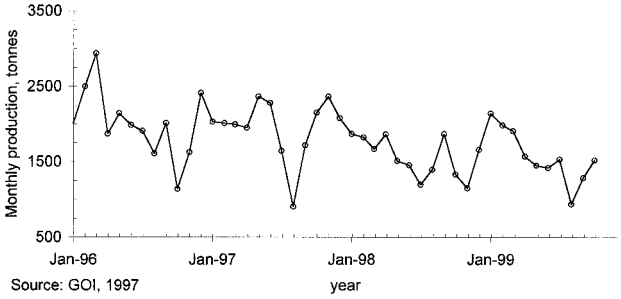

Fig. 2. Monthly production of asbestos in India.

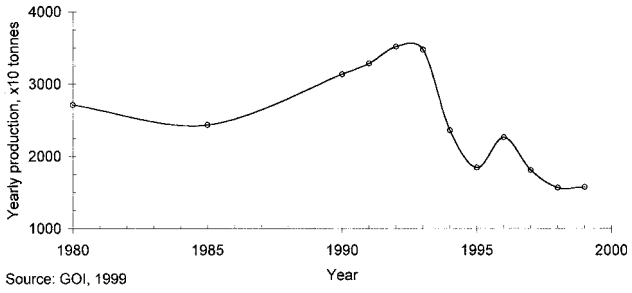

Fig. 3. Yearly asbestos production in India.

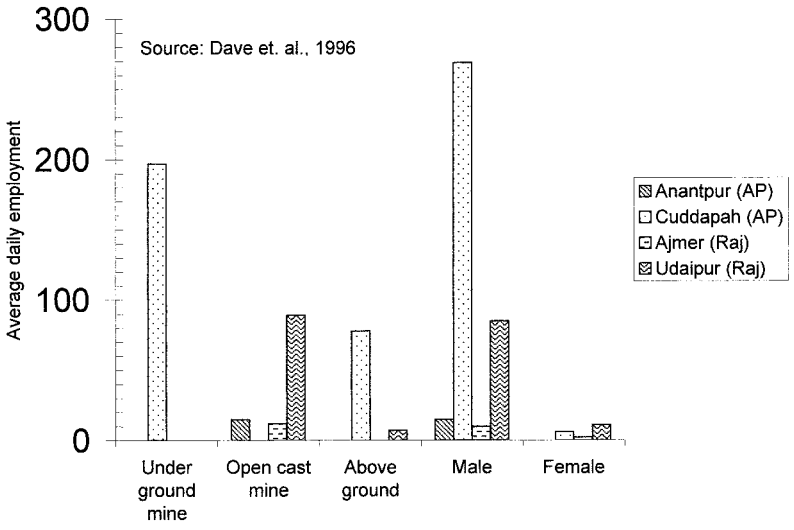

Fig. 4. Statistics of workers employed in asbestos mines in India.

it with cement to make piping[8]. Here the unprotected workers are completely covered in asbestos dust, where precautions are absolutely not in place.

Workers Occupation

At present in India more than 30 mines are in operation in AP and Rajastan. Mainly serpentine (chrysotile 42%) variety is mined in AP and amphibole (tremolite 58%) variety in Rajastan. The amphibole variety is technically of poor grade here. The main causes of environmental degradation in asbestos mining here is due to the change in the rise in the asbestos fiber level (<2 f/ml, by government of India in model rule 123-A under section 112 of the factories act as amended in 1987) in and around the mining area and milling units and their impact to health status of the workers. So lot of studies were carried out here to infer the effects of working environment on respiratory system in the workers and to find out the interdependency of various health parameters[5, 9, 15–19]. Thus this study tries syntheses the data available from these working environments and correlates them to have an understanding of the impact of asbestos mining and related activities to human health in India.

Figure 4 shows that more workers (mainly males) are engaged in underground mining and open cast mining regions of India. Females are hardly one percent working in mines; they are all working in the milling and processing units. Hence females are expected more to inhalation of fibers compared to males. For example in the Pullivendala asbestos and the associated mine milling units in Andrapradesh the levels of fibers varied over time and in different processing stages and methods (Table 1). The fiber concentrations (mean concentration) in two types of mills (both automatic and semi automatic) are shown in Table 1. The mean asbestos fiber concentrations at various locations of the semi-mechanic mill were higher than the semi automatic mills. However the fiber levels in both were several times higher than TLV (threshold limit value) (<2 f/ml) at all location. In the

Table 1. Mean asbestos fiber concentration in two types of mills in AP[5, 7)]

Semi-mechanic		Semi-automatic	
Operation	f/ml	Operation	f/ml
Jaw Crusher	24.14 (6.69–40.79)	Fiberision	21.43 (3.32–41.92)
Decorticator	52.27 (12.49–141.9)	Primary Screening	33.27 (8.4–60.97)
Loader	45.92 (30.0–63.9)	Fiber collection	75.28 (19.07–54.77)
Fiber room	148.96 (91.05–220.79)	Tailing plant (Feeding)	144.42 (2.05–261.76)
Vibrator	224.33 (96.77–488.05)	Tailing plant (Collection)	3.98 (1.36–6.60)
Hand Screening	101.30 (51.54–214.71)		– –

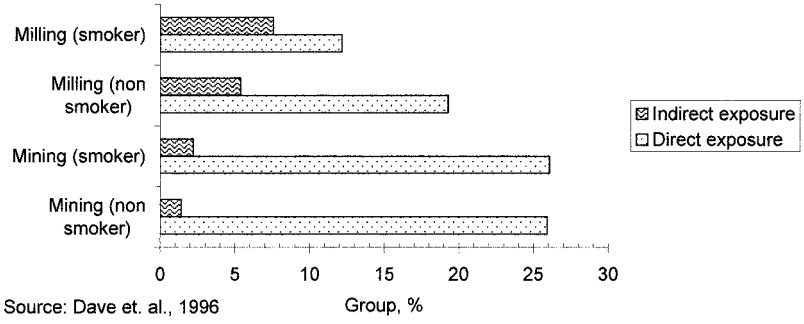

Fig. 5. Distribution of workers according to nature of exposure and smoking habits.

automatic mill, highest level was observed near the vibrator (224.23 f/ml). In semi automatic mill, the highest level was observed near the tailing plant (feeding 144.42 f/ml).

Smoking Habit

Figure 5 shows that the distributors of workers according to the nature and duration of exposure and smoking habit in both sexes. The direct exposed group included workers working either in mining and /or milling, while those working as supervisor, mechanic, electricians, helpers, divers etc have been included in indirect exposure group. Out of the total of 633 workers, 341 (53.8%) had less than 10 yrs exposure, 186 (29.3%) with 11 to 15 yrs and 106 (16.7%) with more than 15 yrs. Out of the total work force, 329 workers(52% all males) were employed in mining, 199 (31.4%) in milling, 23 (3.6%) in mining and milling and 82 (12.9%) in indirect exposures processes. Out of a total of 513 male workers, 282 (54.9%) were smokers while 22 (18.3%) of the 120 females were also smokers.

Health Effects

Impairing of lung functions in workers in both directly and indirectly exposed groups of both the sexes is shown in Fig. 6. It was observed that the restrictive pattern was more common (70%) as compared to the obstructive pattern (18%) while a mixed pattern is around 12%. Here as compared to the miners the prevalence of lung function impairment was more common in millers and in workers in the indirect exposure group. In female workers of the indirect exposure group and milling units, the prevalence of restrictive impairment was nearly two to two-and -half times more common than their male counterparts (Fig. 4). Similarly radiological changes were more common in workers in the milling units than mining units (Fig. 5). Amongst radiological changes in direct as well as indirect exposure, parenchymal changes were more common than pleural one. Pulmonary tuberculosis were detected in six workers all of them were male workers (Fig. 7). In milling units and in the indirect exposure group the prevalence of parenchymal changes was more common in females.

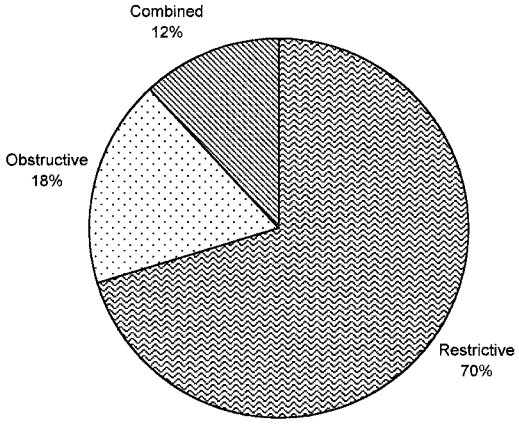

Fig. 6. Pie diagram showing the pulmonary function impairment in different operation groups (Source: Dave *et al.*, 1996).

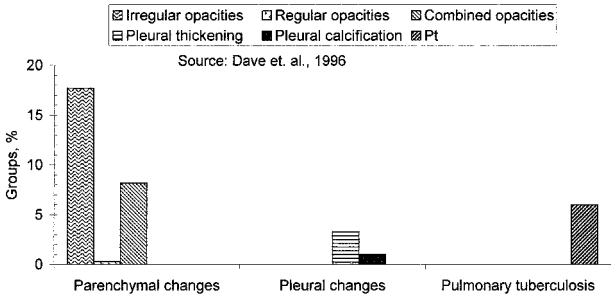

Fig. 7. Radiological changes in different operation groups.

Table 2. Correlation of chest and radiographs and pulmonary functions in asbestos miners and millers[5)]

Coronary Test results	Chest Radiographs			
	Male (513)		Female (120)	
	Normal	Abnormal	Normal	Abnormal
Normal	317 (61.7%)	94 (18.4%)	29 (24.1%)	35 (29.2%)
Abnormal	71 (13.8%)	3111 (6.3%)	21 (17.5%)	35 (29.2%)

Table 2 shows the relation of chest radiographs and pulmonary function tests in asbestos miners and millers of both the sexes. Out of the total male workers (513) 61.3% were having both the parameters normal while 6.3% had both the parameters abnormal. Of the total female (120) 24% had both the parameters normal while 29.2% had both parameters abnormal. It is observed that the males are employed mainly in the underground mines due to prohibition of employment of females. The female was largely employed in milling units (95 % female) and indirect exposure processing units. So the males are exposed to very low levels and females are exposed to higher levels than the TLV accepted by the government of India in model rule 123-a under section 112 of the factories act 1948 as amended in 1987, which is also applicable to chrysotile mine and milling environment[5, 11)].

The levels of fibers are very high due to use of obsolete technology, inadequacy complaisance to mines and safety act and low content of asbestos fiber in parent rock. May be the low yield gives a poor economic returns to mine owners and hence the less investment in environmental control aspects here. The higher significant difference in fiber levels between mining and milling units kept male work force healthier than their female counterpart in India. Primary pleural Mesotheliomas is also reported from 25 yrs of observation in some patients of this area who are not exposed at any time to asbestos[9)], but have this problem due to pollution and other sources.

Asbestos Hazards in India

The following points highlights certain asbestos hazards of concern in India:

- In India asbestos are sold without statutory warning symbol in the market and are not pelletized and in majority cases the workers do not wear the protection gear[20)]. Hence, annual turn over of the industry is around Rs 800 crores[2)].
- Direct and indirect employment in asbestos mine is around 100,000 workers. Hence the people affected by asbestosis will shoot up to a double fold soon[20)].
- Latency period in India is estimated to be 20–37 yrs[1)].
- Between 1945–2000, Asbestos production on an average is estimated to be 1800 metric tones per month[2, 3)].
- Occupation hazards in India occur due to Repair/ maintenance, shop building, asbestos by product, cement use, railway, mining, insulating materials, obsolete technology, inadequacy complaisance to mines and safety act and low content of asbestos fiber in parent rock[8, 20)].
- In India the clinical effects observed are fibrosis, sequelae, Bronchogenic cancer, malignant mesothelima (by blue asbestos) and other cancer risk[5)]. Acute mesothelioma is associated with exposure to asbestos[1, 5)].

In the third world countries use of asbestos has been increasing at an annual rate of about 7%[2)]. The grave health hazards of asbestos are entirely preventable. Now suitable safer substitutes are available. Asbestos can be substituted by Fibrous glass, animal skins etc.,[20)]. Finished products of Asbestos do not pose any health risk. When it is damaged or broken during processing the asbestos fibers became air

borne and can be inhaled. It also releases fibers when it crumbles and struck in lungs. After exposure to 20 yrs or so of latent period (length of the time between exposure and the onset of diseases) the cancer started to show up[1, 20].

Though lower fiber level has been found in all the mine sites, the health degradation among people is more due their exposure to processing units. So a further suitable strict control measure has to be adapted for importing asbestos and processing them in the milling units. Enormous studies shows the extensive epidemiological and toxicological studies which have confirmed the respiratory morbidity due to asbestos exposure which is related to dose and duration of exposure, the processes of work and type of Fiber[5, 21–23]. So it is the right time for the developing countries to keep this menace under control before it boomerang.

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