

The Trend in Airborne Asbestos Concentrations at Plants Manufacturing Asbestos-Containing Products in Japan

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Abstract: In Japan, chrysotile is still permitted to use under the Ordinance on Prevention of Hazards due to Specified Chemical Substances. In recent years many countries have introduced a policy of prohibiting the use of asbestos, based on clinical and epidemiological studies. In light of this, it is important to evaluate the airborne asbestos concentrations in workplaces and also estimate the number of related disease cases in order to discuss the ban of asbestos use. The survey covered 528 workplaces in 145 plants and included 2795 asbestos handling workers from 1985 to 1998. These plants were belonging to the Japan Asbestos Association (JAA) as member companies. In Japan, nearly all of the asbestos using manufacturing companies are members of JAA. In our study, all of the workplaces were divided under each separate manufacturing process and classified into 3 categories of Control Classes. Of the 454/528 (86.0%) workplaces classified as Control Class 1 are improved to 376/378 (99.5%). Though in the cases of small enterprises, other factors such as a shift in product lines, and the economic recession, as well as efforts, contributed to improvements in working conditions. JAA recommended self-administered concentrations of 1.0 f/ml (compatible to <0.3 f/ml in personal exposure level) in 1991 to promote further improvements of the work environment. From this point of view, exposure limits can almost be technically achieved in Japan, and it is expected that asbestos related disease could be expected to decrease in 20 to 30 years later. This survey will become basic material for verifications whether we could control asbestos related diseases enough in such well-controlled work environment.

Key words: Asbestos, Environmental measurement, Control class, Asbestos-containing products, Occupational exposure

Introduction

Asbestos is a useful material, but on the other hand, it is well known to be carcinogenic and responsible for a variety of malignant diseases such as lung cancer, malignant mesothelioma.

In recent years, the operation and maintenance of asbestos use have varied considerably between nations. The EU ban of the use of asbestos was a defining event. Clinical and

epidemiological studies have established beyond all reasonable doubt that chrysotile asbestos causes cancer of the lung, malignant mesothelioma of the pleura and peritoneum¹; however, the effects of asbestos on the human body need further reconsideration^{2,3}. Since asbestos has useful chemical and physical properties, its use as a material to construction, brake linings, and industrial material has been widespread. In Japan, it is a controlled substance under the 1975 Ordinance on Prevention of Hazards due to Specified Chemical Substances, and it may only be used in carefully regulated and specially monitored situations.

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Table 1. Number of asbestos handling plants and workers in Japan

	Year													
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. of asbestos handling plants	145	126	117	117	112	98	114	99	100	99	91	89	84	82
Products and number of workers														
Asbestos cement products	715	706	436	787	768	765	887	912	871	853	760	845	902	728
Textile	191	119	199	184	192	43	86	91	69	44	42	60	37	57
Joint Sheet	618	658	613	621	447	501	448	233	229	275	285	197	172	172
Asbestos paper and plate	102	85	108	90	87	107	73	62	63	83	82	14		
Friction material	1036	569	758	576	1346	1001	1043	1180	1083	1016	928	1010	666	618
The others	133	133	120	105	146	100	120	204	185	181	154	205	213	193
Total	2795	2270	2234	2363	2986	2517	2657	2682	2500	2452	2251	2331	1990	1768

Airborne asbestos concentrations must be measured in every workplace where it is used and are determined as geometric mean concentration over the entire plant rather than by individual employee exposure. The concept behind this practice is to decrease the dust concentration in the entire workplace and reduce everyone's exposure to the dust, not just that of workers directly involved in the contaminated areas. Measurements are taken twice a year under the ordinance, and the results have been categorized into Control Classes. Our data cover the annual change in the work environment of the Japanese Asbestos Association (JAA), who obtained them from asbestos-utilizing manufacturing plants with raw asbestos. These data show how well controlled the workplaces are and supply fundamental information about workers in these plants.

Subjects and Methods

This survey covered plants of member companies of JAA that handle asbestos directly and plants where utilize it in production; a detail worth noting is that nearly all such plants have been followed up by JAA. As of 1985, 2795 employees in 145 plants were handling asbestos. As part of their efforts to reduce airborne asbestos concentrations, plants have had to submit their environmental assessments records to the JAA annually since 1985. The results are classified into one of three classes on the basis of the combined measurement of two types of measuring methods, and further steps are recommended when results are unsatisfactory. Fiber concentrations are measured by using membrane filter method and counting WHO fibers (over 5 μm in length, over 3:1 in aspect ratio and less than 3 μm in diameter)⁴.

Two different sampling and assessing techniques, designated "A" (means "Area"-sampling) and "B" (possibly "Breathing"), were used for classification of work

environment level^{5,6}. Results were collected and evaluated at each manufacturing process, and each plant is classified into one of three Control Classes (Control Classes 1 to 3) by combining the results of the A- and B-samplings. Class 1 means the good condition that the airborne asbestos condition in work environment exceed 2 f/ml (Administration Control Level) in less than 5% in probability and the concentration at generating site is less than 2 f/ml. In Class 3, the arithmetic average concentration can be over 2 f/ml is the probability of 50% at any work area.

Results

Two thousand seven hundred ninety five employees at 145 plants handled asbestos in 1985 with these numbers were decreased to 1768 and 82 in 1998, respectively (Table 1). We analyzed the environments at each of the manufacturing processes dividing them into 3 categories of Control Class. The environment in the storehouses was taken into consideration as well. Finally, the relationship between certain types of products as sources of asbestos dust was also examined.

Opening of fibres and mixing process

In 1985, Unbinding and mixing processes had 27 working places (14.8%) categorized into Control Class 2 and 19 (10.4%) placed into Control Class 3. The development of environmental countermeasure has caused the number of workplaces where classified into Control Class 2 and 3 to decrease year by year, and by 1998 only a single working place (0.9%) was categorized as Class 2 (Table 2).

Grinding, shaping and cutting processes

In grinding, shaping and cutting processes, 13 working places (7.6%) were categorized into Control Class 2, and 2

Table 2. Control classifications at each process in asbestos handling plants in Japan

Processes	Control classification	Year													
		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Unbinding, Mixing	1	137	126	127	143	144	145	150	139	147	141	125	123	116	114
	2	27	20	12	10	12	2	7	1	1	1	1	0	1	1
	3	19	17	15	14	7	1	2	3	1	1	1	1	1	0
Grinding, shaping, cutting	1	157	145	117	159	173	169	159	160	175	176	168	184	177	170
	2	13	15	11	4	5	1	1	1	0	0	0	0	0	0
	3	2	1	0	4	1	0	1	1	0	0	0	0	0	0
The other processes	1	150	116	118	122	127	145	137	124	126	126	113	113	92	86
	2	11	11	6	4	5	4	3	3	1	0	1	1	1	1
	3	2	1	6	3	1	0	0	0	0	0	0	0	0	0
Store house	1	10	6	8	9	14	13	10	11	8	8	5	5	6	6
	2	0	2	4	2	1	1	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	454	393	370	433	458	472	456	434	456	451	411	425	391	376
	2	51	48	33	20	23	8	11	5	2	1	2	1	2	2
	3	23	19	21	21	9	1	3	4	1	1	1	1	1	0

workplaces (1.1%) were categorized into Class 3 in 1985. The environment of airborne asbestos has been improving annually, and since 1993, no plant has been rated outside of Control Class 1.

The other processes

Resting and product inspection processes are included in this category. In 1985, 13 workplaces (8.0%) were in Classes 2 and 3, requiring some improvement in air quality. Similar to the above process, only one plant has been rated Class 2 since 1993.

Store houses

The storage areas of raw asbestos materials and products were environmentally evaluated by the same methods. Almost all of storage areas of the plants monitored were kept in good condition.

Types of products

It is suggested that close relationships between types of products and environmental asbestos concentrations⁷. While the production of asbestos textile, paper, plate and joint sheet has decreased, the rates of asbestos cement and friction material have increased in relative terms (Fig. 1).

Discussion

The rate of work environments in each process rated Control Class 1 has been on the increase. The frequency of

Class 1 ratings is influenced by a number of factors. One is the number of bad workplaces declined, the plants operating with poor environments went ceased operation or simply stopped using asbestos. Another is that overall consciousness of the environmental effects is increasing. Unfortunately, we couldn't confirm the exact amount of asbestos handled at each plant. Since nearly all of these plants handled imported asbestos, a measure of their market share may be obtained by determining what annual percentage of the national asbestos totally came from foreign sources. Though the total amount of imported asbestos decreased from 261, 684 t in 1985 to 120, 813 t in 1998 (Fig. 2), the average amount of imported asbestos handled per plant did not show as marked decrease, changing from 1804.7 t to 1473.3 t over the same time period. Therefore asbestos consumption alone is not sufficient to explain the improvement. The shift in production of asbestos-containing products, such asbestos textile, paper, plate and joint sheet production has decreased, on the other hand, the rate for asbestos cement and friction material has increased in relative terms, is also considered to be a factor. We could not verify the differences of airborne concentrations for each type of product during the period, however, in a past study the airborne concentrations in textile producing plants were higher than the other types of producing plants⁶.

Another possible reason for the relatively increasing number of plants in Control Class 1 is that small enterprises no longer handled asbestos due to the high cost of purchasing and maintaining the necessary equipment to improve work

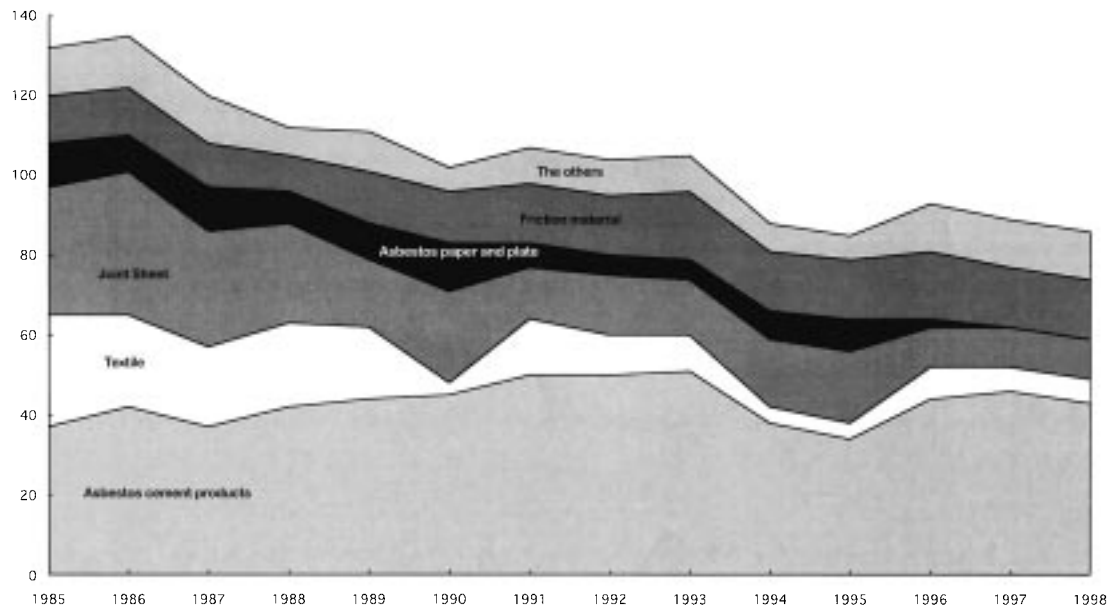


Fig. 1. Number of plants and type of asbestos products in Japan

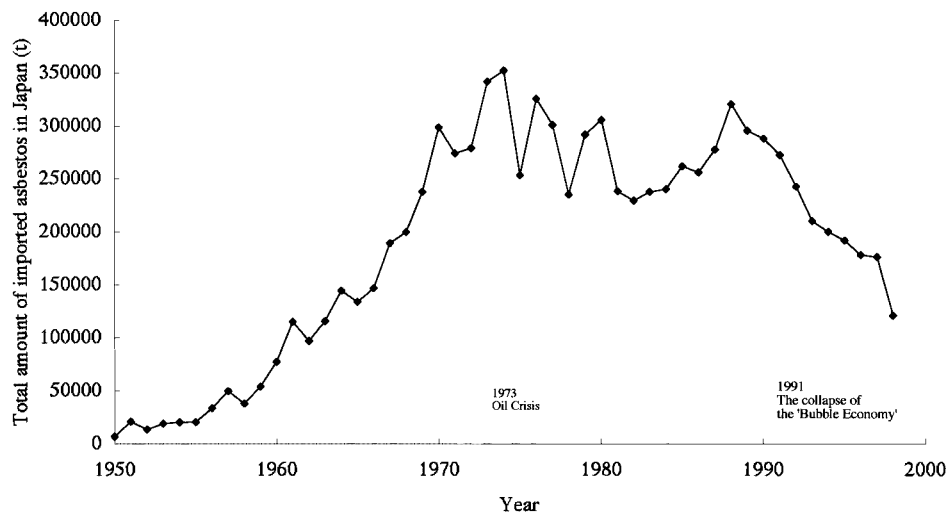


Fig. 2. Annual amount of imported asbestos in Japan

environment. Especially these situations were seen after the economic difficulties brought on by the 1973 “Oil Crisis” and the later collapse of the “Bubble Economy” in 1991.

In this study, we saw fluctuations of control class in some workplaces. Some plants currently rated class 2 or 3 have, in the past, been rated Class 1, and even with the help of costly local exhaust systems, these plants have slipped back into lower classifications. This slippage shows that merely installing these systems is not sufficient, and maintenance and proper use are of paramount importance to the improvement of air quality.

B-sampling indicates the highest airborne asbestos concentration in the workplace where worker’s exposure is considered and is used partially compatible to personal air samplings. Since the Japanese view is to adjust the entire working environment, personal air samplers are not routinely utilized and A-sampling is usually found to be more reliable than B-sampling. Individual exposures of workers in Control Classes 1 are estimated to under 0.6 f/ml respectively per worker⁸⁾. Asbestos handling workers wear respirators while working, actual asbestos inhalation is typically less than the estimated airborne concentration. This study could not

evaluate either individual exposure time or respirator effectiveness. Since exposure is an important factor in occupationally contracted diseases, it will be addressed in future surveys.

Area control system, by using Measurement A and B, is unique one of Japanese. It considers all employees in the plant, not only those working with hazardous materials, with the goal of reducing the currently unknown risks of contracting asbestos-related diseases by eliminating the risk entirely. By using simple classifications, employers and employees may grasp their working conditions more easily and act on their own to make improvements. In this study, it was confirmed that considerable improvement was made based upon not only employers' but also employees' efforts in many plants. Recommended self-administered concentrations of 1.0 f/ml for the environment and 0.5 f/ml for occupational exposure were introduced in 1982 to promote the further improvement of the work environment in JAA. In 1991, while the recommend self-administered concentrations of 1.0 f/ml remained the same, the minimum occupational exposure level was strengthened to under 0.3 f/ml. We analyzed and evaluated each plant in the same way but found the results to be almost identical with over 95% classified into Control Class 1 for each process. The strictest occupational exposure limits in the world for chrysotile asbestos (0.1f/ml) are estimated to be associated with lifetime risks of 2.3/1,000 for lung cancer and 0.8/1,000 for asbestosis⁹⁾. From this point of view, exposure limits can almost be technically achieved in Japan and asbestos related disease can be expected to decrease. We cannot say there is sufficient reason to support the use of chrysotile compared to the health risk it poses.

Conclusion

This study analyzed the annual changes in Control Class in order to determine annual changes in asbestos concentration at Japanese asbestos-utilizing manufacturing plants. In each workplace and storehouse, airborne asbestos has decreased and working conditions were much improved. From our results, it is expected that the decrease in workplace asbestos concentration should lead to a decline in the number of asbestos related illnesses in these plants. Based upon this assumption, further observation is necessary to confirm

the relationship between the plants and diseases commonly associated with this occupation, to consider the validity of banning asbestos and to exam the perceptions of 'controlled use'.

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