Asbestos Problems of Korea

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<Centens>

Ⅰ. Introduction

Asbestos mining had started in Korea, mainly under the Japanese occupation. Almost all the asbestos mined at that time was exported for the Japanese naval ship building. At the end of World War II, the mining had stopped completely. Its activity had resumed only in the 1960s with the growth of the asbestos cement industry. In the mid-1980s, asbestos mining had stopped again because the domestic products could not compete with the cheap but higher quality imports. Asbestos textile and brake lining industries had started in the 1970s, and the importation of raw asbestos had peaked in 1992 over 90 thousand tons. Since that time, the activities of these industries had dwindled down because of the economic situation of Korea. After the economic crisis in 1997, the importation of raw asbestos fell to less than a third of the previous peak level. The asbestos industry had moved or died out continuously as it could not com-

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pete with the cheap imports from other Asian countries. From 2009, all the use and manufacturing of asbestos products are finally banned.

The first case of asbestos-related disease was reported in 1993, when a former asbestos textile worker was found to have a malignant mesothelioma at the age of 46. She had worked at the same asbestos textile company for 19 years, and had to leave her job because of her thoracic pain. She was initially treated under the impression of tuberculosis. Her condition did not improve, however, and malignant mesothelioma was soon after diagnosed. With her simple job history, the recognition of causal relationship with asbestos exposure was rather straightforward. Following this index case, cases of asbestosis and lung cancer had also been recognized and compensated. Most of the compensated cases, however, were exposed mainly during the installation and use, not the manufacturing, of asbestos products.

The first systematic national survey of asbestos-related diseases among asbestos manufacturing workers was organized in 1993 by the author[1]. By that time, we had become aware of the potential of asbestos exposures during the manufacturing of asbestos products. In Korea, before the 2001 revision of asbestos abatement procedures in the Industrial Safety and Health Act, only the asbestos manufacturing sectors have been the target of occupational health and safety programs such as medical screening and work environment monitoring.

Ⅱ. Asbestos victims

Asbestos mining and manufacturing had taken place in Korea for more than 30 years before the first case of asbestos-related disease was identified. Before 1945, conscripts for military duty were sent to mines of

strategic value by the Japanese regime. Health and safety concerns could not be raised during the Japanese occupation. After 1945, all the asbestos mining industry disappeared for economic reasons. We have no record of the numbers or whereabouts of miners from the early asbestos mining period. The Korean government had paid no attention to the conditions in the asbestos mines, and health and safety problems among asbestos until quite recently.

■ Exposed Workers and Others

Only since the start of the asbestos cement industry in the 1960s we have been able to identify the numbers of workplaces and employees possibly exposed to asbestos. During the 1960s there was only one asbestos cement factory, with about 200 employees. By 1993, there were 118 workplaces with 1,476 workers in the asbestos manufacturing industry.[2] Mean tenure of asbestos cement and friction material workers was 6.7 years, and it was 4.8 years for textile workers. Based on the mean tenures and years of operation, the total number of workers exposed in these workplaces was estimated to be more than 7,000, with about 8% of them having been exposed for more than 20 years. These numbers were limited to those who had worked in asbestos manufacturing industries. Since 1993, those who have been exposed in asbestos manufacturing plants for more than 3 years have been able to register for a follow-up medical screening program and maintain a health record (Table 1). Recently, the minimum employment period to be eligible for the issuance of medical follow-up record has been reduced from 3 years to 3 months.

Table 1. The number of registered asbestos exposed workers since 1993

Year	93	94	95	96	97	98	99	00	01	02	03	Total
The number registered	4	16	7	9	98	13	21	162	77	38	4	449

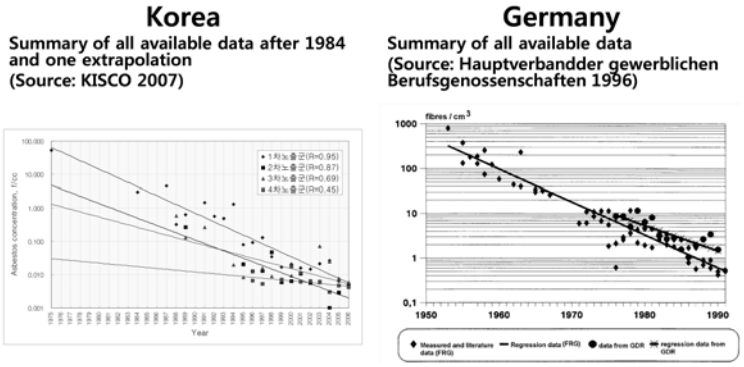
There was no measurement of asbestos exposures before 1984 in Korea. The exposure levels for asbestos cement, friction materials, and textile industries were less than 0.5, 1-2, and more than 5 fibers/cc, respectively, during mid-1980's.[2] The exposure levels soon came down thereafter, but previous exposures had undoubtedly been much higher for all industries (Table 2).

Table 2. Airborne asbestos fiber concentrations by year and type of industry

	Geometric Mean (fibers/cc)								
	1984	1987	1988	1989	1991	1992	1993	1994	1996
Construction	0.40	0.27	0.23	0.53~ 0.15	0.52	0.08	0.17	-	0.14
Friction Product	1.70	-	-	0.42	0.68	0.19	0.10	0.67	0.55
Textile	6.70	4.4~ 5.9	2.57	0.49~ 2.0	3.93	2.09	1.22	1.21	1.87
Asbestos board	-	-	-	1.04	-	-	-	-	-
Auto Repair	-	-	1.60	0.85	-	-	-	-	-
Gasket	-	-	-	0.05	-	-	-	-	-
Ship Repair	-	-	2.45	-	-	-	-	-	-
Shipbuilding	-	-	-	-	-	-	-	0.02	-
Brakepads	-	-	0.35	-	-	-	-	-	-
Rectification	-	-	-	-	-	0.10	-	-	-

As there were no measurement data before 1984, the past exposures up to 20 years prior to 1995 was extrapolated based on the changes in method and condition of manufacturing environments as assessed in 1995. The extrapolated levels from 1975 to 95 showed a quite similar trend with that of German historical data of 1960's and 70's.

Past Asbestos Dust Concentration



We have no data on how many Korean citizens used asbestos products or worked and lived near asbestos mines and manufacturing facilities.[3] Neither do we know about the exposure levels of these people. One way to guess the exposure levels is to calculate the use of raw asbestos per capita per annum. Asbestos usage peaked at 2.2 kg/person/year in 1992 in Korea. It had come down to 0.5 kg/person/year by 2001.

■ Diseased and Compensated Workers

The first cases of asbestosis were found in 1993 with the first national survey of asbestos manufacturing facilities.[1] Among those examined, about 3% had chest x-ray findings compatible with asbestosis, and half of them also had restrictive lung function changes. There was a clear dose-response

relationship when the groups were divided according to their tenures. No worker with less than 10 years of tenure had abnormal chest findings, while 8% of those with 20 or more years of work had abnormal findings (Table 3).

Table 3. Prevalence of asbestosis by tenure among asbestos workers

Tenure	Asbestosis Cases[1]	Probable Asbestosis[2]	Possible Asbestosis[3]
0 - 9	0% (0/82)	0% (0/82)	0% (0/82)
10 - 14	0% (0/15)	7% (1/15)	7% (1/15)
15 - 19	6% (1/16)	6% (1/15)	13% (2/16)
20 -	4% (1/26)	8% (2/26)	23% (6/26)
Total	1.4% (2/139)	2.9% (4/139)	6.5% (9/139)

[1]Asbestosis: over 1/0 profusion according to ILO classification with compatible lung function tests
[2]Probable Asbestosis: over 1/0 profusion according to ILO classification without compatible lung function tests
[3]Possible Asbestosis: 0/1 profusion according to ILO classification or other compatible pleural findings

Lung cancer is the fastest growing cancer in Korea. Over the last 15 years, mortality from lung cancer has increased more than threefold (Table 4). It is now the second most common cancer among Koreans, slightly behind stomach cancer.[4]

Table 4. Lung cancer mortality in Korea by sex

Year	Total		Male		Female	
	Lung Cancer Death (No)	Mortality (/100,000)	Lung Cancer Death (No)	Mortality (/100,000)	Lung Cancer Death (No)	Mortality (/100,000)
1983	2140	5.8	1517	8.2	623	3.4
1984	2329	6.0	1720	8.9	609	3.2

Year	Total		Male		Female	
	Lung Cancer Death (No)	Mortality (/100,000)	Lung Cancer Death (No)	Mortality (/100,000)	Lung Cancer Death (No)	Mortality (/100,000)
1985	2888	8.3	2147	12.0	741	4.4
1986	3259	9.6	2416	13.8	843	5.2
1987	3561	10.4	2684	15.3	877	5.3
1988	4098	11.8	3054	17.1	1044	6.2
1989	4590	13.2	3470	19.3	1120	6.7
1990	5028	14.4	3761	20.8	1267	7.7
1991	5532	15.2	4225	22.0	1307	7.7
1992	6671	16.9	4980	24.4	1691	9.0
1993	7325	17.4	5456	25.4	1869	9.1
1994	8196	18.8	6137	28.0	2059	9.5
1995	8546	18.9	6377	28.1	2169	9.6
1996	8890	19.4	6613	28.7	2277	10.0
1997	9566	20.8	7070	30.5	2496	10.9

To date, among all these lung cancer cases, less than 50 have been recognized as occupational in origin and compensated accordingly. Work histories of affected workers included exposures as underground facility keeper, foundry worker, plumbers, auto mechanic, maintenance workers, welder, and boilermaker. Only two of these cases occurred in workers who had worked with raw asbestos. The number of compensated lung cancer cases is very small in Korea, considering the emergence of mesothelioma cases among asbestos-exposed workers.

When the occupations of men who died of lung cancer were analyzed, professionals, service and sales workers, plant and machine operators, and laborers were the groups with increasing numbers, while senior officials, technicians, craft and related trade workers, and house workers showed little or no increase (Table 5). As for the women, service and sales workers

showed an increase (Table 6). These findings suggest that some occupations are linked with increases in lung cancer, particularly for men, and that asbestos exposures among plant and machine operators and laborers deserves immediate further investigation in Korea.

Table 5. Lung cancer cases among males by occupation

1983-1997 (Year)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Male Total	1049	1126	1430	1556	1697	1875	2055	2169	2409	2711	2815	3076	2985	3102	3147
1 Senior Officials	29	42	30	30	36	42	33	53	45	64	17	21	11	10	25
2 Professionals	0	0	0	5	4	3	8	9	14	13	55	67	56	67	88
3 Technicians	81	97	109	126	141	153	158	165	205	192	66	34	58	25	88
4 Clerk	131	113	149	156	196	184	196	210	206	245	144	167	219	252	231
5 Service and Sales	7	7	10	12	21	24	34	35	40	79	311	343	344	403	366
6 Agriculture/Fishery	351	372	490	504	490	588	640	652	760	842	905	1011	959	925	950
7 Craft/ Related Trade	107	110	143	154	178	216	231	255	293	426	289	343	268	281	258
8 Plant/Machine Op	0	0	0	0	0	0	0	0	0	0	86	89	187	101	95
9 Laborers	0	0	0	0	0	0	0	0	0	0	126	168	199	187	174
10 House Workers	340	391	496	561	594	658	747	781	811	820	773	820	726	815	855
11. Soldiers	3	4	3	6	4	4	3	5	6	5	11	8	14	1	6
12. Unknown	0	0	0	1	33	3	5	4	29	25	32	9	44	35	11

Table 6. Lung cancer cases among females by occupation

1983-1997 (Year)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Female Total	398	391	452	496	508	571	591	654	633	803	795	867	811	828	933
1 Senior Officials	1	1	3	2	2	5	4	2	7	4	0	0	0	0	0
2 Professionals	0	0	0	0	0	0	0	0	0	1	6	9	9	7	9
3 Technicians	5	4	3	6	8	3	16	6	7	11	4	2	1	2	9
4 Clerk	8	9	13	14	10	15	9	28	17	26	5	6	6	10	12
5 Service and Sales	0	1	1	4	2	0	4	7	3	8	45	40	27	40	50
6Agriculture/Fishery	70	77	72	73	73	94	84	104	88	131	140	134	159	141	133
7 Craft/ Related Trade	3	6	1	8	3	9	7	8	6	12	7	11	6	13	9
8 Plant/Machine Op	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0
9 Laborers	0	0	0	0	0	0	0	0	0	0	4	6	9	5	13
10 House Workers	311	293	358	389	393	442	464	497	499	607	576	656	576	594	692
11. Soldiers	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
12. Unknown	0	0	0	0	17	3	3	2	6	3	7	3	17	15	6

In Korea, about 40 to 50 mesothelioma cases are reported annually through the Cancer Registry[5] (Table 7). In view of the fact that not all cancer cases are diagnosed by the participating hospitals, the annual incidence of mesothelioma among the general population in Korea is estimated to be around 1-2 cases per million. The sex distribution of reported cases is almost even.

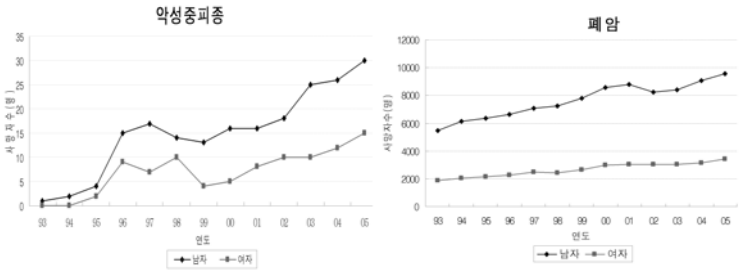
Table 7. Mesothelioma cases among Cancer Registry by year

Year	A	B	B/A(%)	Year	A	B	B/A(%)
1983	23771	12	0.05	1993	59150	57	0.10
1984	21381	18	0.08	1994	60911	37	0.06
1985	28679	18	0.06	1995	64761	40	0.06
1986	36175	28	0.08	1996	72323	44	0.06
1987	32449	27	0.08	1997	78797	58	0.07
1988	42135	36	0.09	1998	76868	48	0.06
1990	50078	44	0.09	1999	82320	39	0.05
1991	51730	23	0.04	2000	83846	45	0.05

A: Total number of cancer cases registered, B: Mesothelioma Cases

Deaths due to mesothelioma have been counted since 1993, and the number is increasing over the last 15 years. Based on the number of deaths due to mesothelioma, the sex ratio between male and female is about 2:1. Compared to the sex ratio of mesothelioma deaths of industrialized western European countries, the ratio is still quite low, but is definitely increasing with steeper increase in numbers among males.

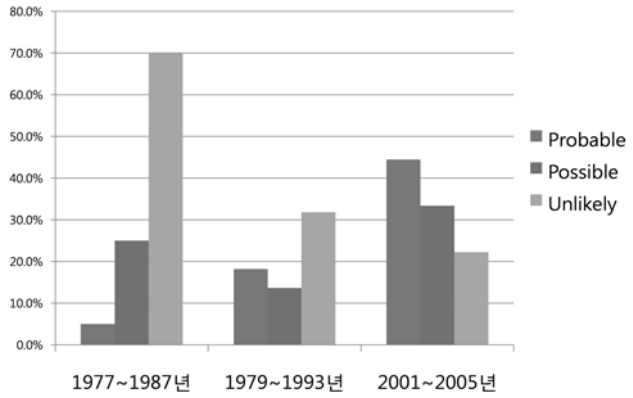
성별 분포(악성중피종, 폐암)



남 : 여 = 68 : 32	남 : 여 = 74 : 26	* 전체, 남 : 여 = 55 : 44

Increasing trend of asbestos related mesothelioma deaths is more obvious when the proportion of asbestos exposure histories among mesothelioma cases was compared among three papers of mesothelioma case series over the period of about 20 years. The proportion of cases with probable asbestos exposure history was less than 5% in 70's and 80's, but it has increased up to over 40% in 2000's.

학술지에 보고된 중피종 사례 연구의 시대별 석면노출률 비교



세부 지역별 중피종 암등록비율

When the proportions of mesothelioma cancer registry or deaths were examined over different regions, the distribution was not even, and it showed potential hot spots that could have originated from past asbestos industries of the corresponding regions. Asbestos cement industry had been operating in Daejon up to 1996, and Daejon has the highest mesothelioma cancer registry and death notification proportions. Other potential hot spots including areas of old asbestos mines and manufacturing plants should be investigated for its relation with asbestos exposures.

Up to now, less than 30 mesothelioma cases have been referred to the government for workers' compensation. Their exposures to asbestos included work at shipbuilding, as a boiler operator and a mechanic, at the serpentine rock mines, and at the construction site. Only small number of them had worked in asbestos manufacture. In fact, when the occupations of mesothelioma registry were examined, the laborers instead of plant or machine operators had the highest proportion of mesothelioma, and the results showed the importance of asbestos exposures in construction industries.

직종별 중피종 암등록비율

■ Victims' organization

In Korea, Ban Asbestos Network of Korea (BANKO) had formed in 2008. BANKO is the coalition of professionals, activists, and victims. Previous the BANKO formation, only the pneumoconiosis victims' organization has been active, but it is mainly for coal miners. The Pneumoconiosis Act in Korea covers only miners, omitting those workers from the manufacturing sector. Because of the small number, geographic locations, and lack of legal representation, the voice of asbestosis victims is still weak.

Ⅲ. National schemes of compensation, treatment, and prevention

■ Compensation criteria

The compensation criteria for asbestos-related diseases are stipulated by the Workmen's Accident Compensation Insurance Law in Korea. Asbestosis, lung cancer, and mesothelioma are compensable diseases, and evidence of 10 or more years of significant exposures at work is required for work-

relatedness. The presence of asbestosis is not required for the compensation of victims of lung cancer or mesothelioma. Instead, the presence of hyaline plaques or calcified pleural plaques on chest x-ray, asbestos bodies in sputum, or significant numbers of asbestos fibers in biopsy tissues can be used as evidence of significant exposures. Because of the low level of awareness of asbestos-related problems among workers and their physicians, few of them raise the question of work relatedness. Moreover, because the work records are not available to support claims, the exposure history is often hard to substantiate for already deceased workers with fatal diseases such as mesothelioma or lung cancer. This is particularly true for those who have only used but not manufactured asbestos products. Accordingly, we are in the process of accumulating a knowledge base for acceptable exposure criteria among end-user groups of asbestos products for the purposes of obtaining workers' compensation for victims.

■ Access to treatment

Even though Korea has pneumoconiosis hospitals, it has not provided much in the way of medical treatment for asbestos victims. The reason behind a great deal of the hospitalization is to obtain wage replacement during the hospital stay. Most hospitalization is directed at acute terminal care. Rehabilitation and active secondary prevention of complications have been largely neglected. Moreover, except for providing scholarships for the education of children of victims, family support programs have had low priority.

■ National asbestos regulations

The Industrial Health and Safety Law Raw requires employers to obtain

permission for the use of raw asbestos in manufacturing processes.[6] Crocidolite and amosite were banned in Korea in 1997, and manufacturing and use of asbestos products even made of chrysotile were banned from 2009. The occupational exposure limit to chrysotile was established in 1986 at 2 fibers/mL, and it was lowered in 2001 to 0.1 fiber/mL, which came to be effective from 2003. Those who have worked at an asbestos manufacturing site for more than 3 months can maintain a health record and become eligible for follow-up medical screenings even after leaving the site. However, one of the failings of the regulation is that only current employees are covered by the health and safety programs. Once they leave the workplace, it is extremely difficult to maintain the health record. Neither employers nor employees are interested in providing or receiving health and safety benefits because of complicating economic and privacy issues.

Ⅳ. Lessons learned

Asbestos became a social concern in Korea as a part of the social democratization following the massive people's demonstrations in 1987. As in other countries, health and safety measures were recognized when joined with human rights issues in general.

The asbestos industries have been in decline since the early 1990s in Korea, mainly as a result of a worsening economic environment, but also partly due to the stricter regulations to prevent health problems. In the early 1990s, automobile manufacturers were required to use non-asbestos friction materials when exporting cars to developed countries. At the same time, asbestos textiles imported from other developing countries such as China and Indonesia had become much cheaper. This resulted in trans-

ferring asbestos textile plants to those developing countries. As a result, since the mid-1990s in Korea, imports of asbestos friction materials and textiles increased far more than exports.[7]

In addition to the economic pressures, the efforts of unions, NGOs, and lawyers have contributed to raising public awareness and to demands for attention to asbestos-related problems. Even though it was easily recognized that asbestos victims have economic problems as well as medical problems, a neglected fact was that they have social problems too. For some of them, it was not easy to bring up the problem voluntarily because of the stigma attached to "troublemakers" or "dissidents". Because of this we feel that one of the missing links in the problem-solving process is the social worker. For many of those victims who still have to support their families and want to have an active role in society, compensation cannot be the sole solution.

The other problem in the process is the inflexibility of the workers' compensation system. In Korea, the compensation and monitoring scheme is geared mainly to coal workers' pneumoconiosis, and no specifically tailored program exists for asbestos victims. The differences in lung function test results and X-ray findings between asbestosis and coalworkers' pneumoconiosis are often ignored in the screening and compensation process with negative effect on their prognoses.

■ Future Tasks

The asbestos problem in Korea is yet to arise. The incidence of mesothelioma in Korea is still low, around the pre-epidemic level of other countries. However, the major use of asbestos occurred only after the 1960s, and we are now beginning to observe asbestos-related health problems. We do not know the past occupational exposure patterns and

environmental burdens, but most of asbestos-related health problems to date have been found among workers exposed to asbestos products. For almost all of these workers, we do not know the levels of past exposures. Even though we do not know the exact size of the asbestos problems, it is estimated that the problems will reach to the peak only after 2045 based on historical unfolding of consumption of and exposure to asbestos products in Korea.

Prediction of Peak

	Supurt of asbestos industry	peak of asbestos industry	Spurt of meso industry	Ban of asbestos use	Peak of meso incidence
Nethe rlands	1950's	1965'	1990'	1991'	2017
Japan	1960's	1975'	2000'	2005	2030
Korea	1970's	1990'	2010'	2009	2045(?)

In 2001, workers who are involved in removing asbestos products and in asbestos abatement have been protected by regulation. From 2009, all the use and manufacturing of asbestos products has been banned. Even though the regulation is there to be implemented, it is not always practical to expect it will happen. We need much heightened safety and health cultures in Korea.

To raise social awareness and to target the potential problem areas, we need to have systematic and effective surveillance programs, not just medical screening and workplace exposure measurements. One useful approach would be a mesothelioma registry.

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국문초록

한국의 석면관련질환의 제문제

백 도 명

한국에서 석면광산은 1920년대부터 채굴되었으며, 1970년대부터는 석면이 건축자재, 마찰재 및 단열재와 배관 가스켓 제품 등으로 제조되어 광범위하게 사용되기 시작하였다. 그러나 이로 인한 석면노출 및 석면관련질환발생에 대한 조사와 규제는 1984년 이후에야 한국에서 수행되었으며, 2009년에 이르러서야 전면적인 석면제품의 제조 및 사용이 금지되게 되었다. 이와 같은 석면산업의 실태에 대한 자료는 매우 부족하지만, 제한된 자료에 근거하여 볼 때 지난 70-80년대의 한국 석면산업의 규모 그리고 노출수준은 지난 60-70년대 선진국에서 진행되었던 석면산업의 모습과 흡사하였던 것으로 판단되고 있다.

한편 지난 1993년 석면방직 작업자에게서 발생한 중피종이 첫 석면관련질환으로 인한 산업재해로 인정되고 난 이후, 석면관련질환이 지속적으로 보고되고 있으며, 특히 21세기에 들어와 석면관련질환이 꾸준히 증가하는 양상을 보여주고 있다. 그렇지만 아직 석면관련질환의 인정이나 보상의 기준과 절차가 제대로 마련되어 있지 못하여, 석면작업자들에게서의 문제제기가 계속되고 있으며, 특히 환경성 석면노출로 인한 질환의 인정과 보상 기준마련이 시급히 요구되고 있다.

주제어 : 석면, 중피종, 노동자재해보상

Key words : asbestos, Korea, mesothelioma, workers' compensation