limited, but peaks of use were late in Japan, Korea and Kyrgyzstan. The recent per capita use for the "other" Asian countries is low but shows little sign of decreasing. This is largely due to sustained use in China and India. Hence our findings reinforce the widely held concern that the center of asbestos consumption is shifting to industrializing countries (Kazan-Allen 2005; LaDou 2004; Takahashi and Karjalainen 2003). Moreover, if the ecological relationship reported here holds true for the future, a corresponding risk should be anticipated in these countries.

Regression analyses showed the strongest relationship between recent APC in mortality for pleural mesothelioma and change in asbestos use during 1970-1985 (adjusted $R^2 = 0.67$, $p < 0.0001$). Also, significant positive relations were found between absolute-level indicators for recent mortality and asbestos use of various historical periods. Notably, the parameters for the 1960-1970 model were very close to our earlier report (Lin et al. 2007), with the slight difference arising from an expansion in the number of countries studied and from using the 2000 world standard population. This relationship diminished for earlier or recent periods of use, so the absolute level of use near this period is likely to be responsible for recent mortality (latency period 37.5 year). The positive associations found for both absolute-level and change indicators support the notion that per capita asbestos use is related to subsequent mortality level at the national level. However, the time difference (i.e., latency) for the model adopting change indicators was only 22.5 year, and thus the observed relationship may have reflected only early effects. Continuing use of asbestos results in the accumulation of asbestos in place in the society, thus creating possibilities for ongoing exposure due to maintenance, repair and demolition during the entire life span of asbestos products. Given the long latency time, the mortality data available did not allow to analyze the full consequences of such effects following the new use in longer term. Nevertheless, it should be noted that significant (albeit weaker) relationships were observed for changes in use during other close periods with longer latency, e.g., 1950-1985 (latency 32.5 year) and 1950-1990 (30 year).

This study has several strengths. We took advantage of the earliest opportunity to analyze mortality trends in a range of countries. We compensated for limited information by combining analysis of pleural and all mesothelioma, and regression analyses were performed by combining the indicators of change and absolute levels. Limitations, however, also exist. We depended on a crude indicator of exposure (i.e., use per capita), "bans" entailed varying restrictions on use which could not be measured, and no distinctions could be made between asbestos fiber types. Moreover, it is important to bear in mind that the observed relationships are ecological at the national level only, and therefore all findings should be cautiously interpreted.

As there is no safe threshold of exposure to asbestos, any degree of contact will involve some risk. On the other hand, the degree of risk is related to exposure. The experience of many countries suggests that attempts to reduce exposure without an overall

concurrent reduction in overall use are insufficient to control risk. Countries implementing bans recorded reductions in asbestos use twice as fast as those not adopting bans. Even for these countries, the study period was probably too early to observe the full long-term health benefits of retreating from dependence on asbestos, but some indications of a correlation between the change in past use and recent health-burden were found. National interventions to substantially reduce asbestos use, including the imposition of bans, successfully reduce the burden of disease.

EOF

References

Ahmad OB. Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. 2000. Age Standardization of Rates: A New WHO Standard, GPE discussion Paper Series: No.31, WHO.

[Anonymous.] 1997. Asbestos, asbestosis, and cancer: the Helsinki criteria for diagnosis and attribution. Scand J Work Environ Health 23:311-316.

Burdorf A, Jarvholm B, Englund A. 2005. Explaining differences in incidence rates of pleural mesothelioma between Sweden and the Netherlands. Int J Cancer 113:298-301.

IARC (International Agency for Research on Cancer). 1973. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 2 Some Inorganic and Organometallic Compounds.

IARC. 1977. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 14.

ILO (International Labour Organization). 1980. Schedule I to the Employment Injury Benefits Convention, 1964 (No. 121): List of occupational diseases (amended 1980).

ILO. 1986. C162 Asbestos Convention, 1986.

ILO. 2006. Resolution concerning asbestos (adopted by the 95th Session of the International Labour Conference, June 2006).

Jemal A, Devesa SS, Fears TR, Hartge P. 2000. Cancer surveillance series: changing patterns of cutaneous malignant melanoma mortality rates among whites in the United States. J Natl Cancer Inst 92:811-818.

Kazan-Allen L. 2005. Asbestos and mesothelioma: worldwide trends. Lung Cancer 49 Suppl 1:S3-8.

Kazan-Allen L. 2006. International ban asbestos Secretariat. Available: http://www.ibas.btinternet.co.uk [updated 1 November 2006, accessed 8 March 2007].

Kjaergaard J, Andersson M. 2000. Incidence rates of malignant mesothelioma in Denmark and predicted future number of cases among men. Scand J Work Environ Health 26:112-117.

LaDou J. 2004. The asbestos cancer epidemic. Environ Health Perspect 112:285-290.

Lahmeyer J. 2007. Population Statistics. Available: http://www.populstat.info [accessed 11 April 2007].

Lasithiotakis KG, Leiter U, Gorkievicz R, Eigentler T, Breuninger H, Metzler G, et al. 2006. The incidence and mortality of cutaneous melanoma in Southern Germany: trends by anatomic site and pathologic characteristics, 1976 to 2003. Cancer 107:1331-9.

Lin RT, Takahashi K, Karjalainen A, Hoshuyama T, Wilson D, Kameda T, et al. 2007. Ecological association between asbestos-related diseases and historical asbestos consumption: an international analysis. Lancet 369:844-849.

Marinaccio A, Montanaro F, Mastrantonio M, Uccelli R, Altavista P, Nesti M, et al. 2005. Predictions of mortality from pleural mesothelioma in Italy: a model based on asbestos

consumption figures supports results from age-period-cohort models. Int J Cancer 115:142-147.

Montanaro F, Bray F, Gennaro V, Merler E, Tyczynski JE, Parkin DM, et al. 2003. Pleural mesothelioma incidence in Europe: evidence of some deceleration in the increasing trends. Cancer Causes Control 14:791-803.

National Disease Registeries Office, Singapore. 2006. Singapore Cancer Registry.

Nawrot TS, Van Kersschaever G, Van Eycken E, Nemery B. 2007. Belgium: historical champion in asbestos consumption. Lancet 369:1692.

Nicholson WJ, Perkel G, Selikoff IJ. 1982. Occupational exposure to asbestos: population at risk and projected mortality--1980-2030. Am J Ind Med 3:259-311.

NIOSH (National Institute for Occupational Safety and Health). 2005. Work-Related Lung Disease (WoRLD) Surveillance System: Malignant Mesothelioma. Available: http://www2a.cdc.gov/drds/WorldReportData/SectionDetails.asp?SectionTitleID=7 [updated December 2005, accessed 25 November 2007].

Peto J, Hodgson JT, Matthews FE, Jones JR. 1995. Continuing increase in mesothelioma mortality in Britain. Lancet 345:535-539.

Peto J, Decarli A, La Vecchia C, Levi F, Negri E. 1999. The European mesothelioma epidemic. Br J Cancer 79:666-672.

Price B. 1997. Analysis of current trends in United States mesothelioma incidence. Am J Epidemiol 145:211-218.

Price B, Ware A. 2004. Mesothelioma trends in the United States: an update based on Surveillance, Epidemiology, and End Results Program data for 1973 through 2003. Am J Epidemiol 159:107-112.

Ries LAG, Kosary CL, Hankey BF, Miller BA, Harras A, Edwards BK. 1997. SEER Cancer Statistics Review, 1973-1994, National Cancer Institute.

Segura O, Burdorf A, Looman C. 2003. Update of predictions of mortality from pleural mesothelioma in the Netherlands. Occup Environ Med 60:50-55.

Selikoff IJ, Churg J, Hammond EC. 1984a. Classics in Oncology: Asbestos exposure and neoplasia. CA Cancer J Clin 34:48-56.

Selikoff IJ, Churg J, Hammond EC. 1984b. Landmark article April 6, 1964: Asbestos exposure and neoplasia. By Irving J. Selikoff, Jacob Churg, and E. Cuyler Hammond. JAMA 252:91-95.

Takahashi K, Karjalainen A. 2003. A cross-country comparative overview of the asbestos situation in ten Asian countries. Int J Occup Environ Health 9:244-248.

UN (United Nations). 2006. World Population Prospects: The 2006 Revision Population Database. Available: http://esa.un.org/unpp [accessed 27 December 2006].

USCB (U.S. Census Bureau). 2006. International Data Base: International Programas Center, Population Division. Available: http://www.census.gov/ipc/www/idb [accessed 22 December 2006].

U.S. EPA (U.S. Environmental Protection Agency). 1989. Asbestos: Manufacture, Importation, Processing, and Distribution in Commerce Prohibitions; Final Rule (40 CFR Part 763).

Virta RL. 2005. Mineral Commodity Profiles - Asbestos. Circular 1255-KK.

Virta RL. 2006. Worldwide asbestos supply and consumption trends from 1900 through 2003 Available: http://pubs.usgs.gov/circ/2006/1298/c1298.pdf.

Weill H, Hughes JM, Churg AM. 2004. Changing trends in US mesothelioma incidence. Occup Environ Med 61:438-441.

WHO (World Health Organization). 1992. International Statistical Classification of Diseases and Related Health Problems, Tenth Revision. Geneva:World Health Organization.

WHO. 2006a. Elimination of asbestos-related diseases, World Health Organization 2006. Available: http://www.who.int/occupational_health/publications/asbestosrelateddiseases.pdf.

WHO. 2006b. WHO Mortality Database: World Health Organization Statistical Information system (WHOSIS). Available: http://www.who.int/healthinfo/morttables/en/index.html [updated November 17, 2006, accessed December 10, 2006].

Tables

Table 1. Recent trend in mortality of pleural and all mesothelioma in men

Region / Country (Code)	Pleural Mesothelioma pMR[a] (n[b]) [Deaths per Million per year]	Pleural Mesothelioma APC[c] (95% CI) [Percent per year]	Pleural Mesothelioma Trend[d]	All Mesothelioma pMR[a] (n[b]) [Deaths per Million per year]	All Mesothelioma APC[c] (95% CI) [Percent per year]	All Mesothelioma Trend[d]
Africa						
South Africa (ZAF)	NA[1] (0)	NA[3] NA[3]	NA[3]	13.7 (2)	0.4 NA[3]	NA[3]
Asia						
Israel (ISR)	0.7 (3)	4.4 (-48.6 to 111.5)	→	6.1 (5)	6.7 (-10.3 to 27.0)	→
Japan (JPN)	3.6 (9)	5.0 (3.4 to 6.6)	↗**	5.3 (9)	4.0 (2.8 to 5.1)	↗**
Kyrgyzstan (KGN)	NA[1] (0)	NA[3] NA[3]	NA[3]	1.1 (4)	-4.7 (-33.6 to 36.7)	→
Republic of Korea (KOR)	0.1 (2)	NA[2] NA[2]	NA[2]	1.0 (9)	3.5 (-0.5 to 7.6)	↗*
Singapore (SGP)[e]	2.0 (6)	26.8 (-7.8 to 74.5)	→	3.9 (10)	-3.1 (-12.2 to 7.0)	→
Eastern Europe and Southern Europe						
Albania (ALB)[e]	5.1 (8)	14.5 (-3.4 to 35.7)	↗*	NA[1] (0)	NA[3] NA[3]	NA[3]
Bulgaria (BGR)[e]	2.0 (9)	9.9 (-2.8 to 24.4)	→	NA[1] (0)	NA[3] NA[3]	NA[3]
Croatia (HRV)	7.7 (9)	9.1 (-1.1 to 20.5)	↗*	9.4 (9)	9.1 (0.2 to 18.9)	↗**
Czech Republic (CZE)	2.3 (9)	8.8 (3.8 to 14.0)	↗**	3.8 (9)	4.8 (-1.4 to 11.4)	→
Greece (GRC)[e]	0.6 (9)	12.6 (0.2 to 26.6)	↗**	NA[1] (0)	NA[3] NA[3]	NA[3]
Italy (ITA)[e]	16.3 (7)	2.6 (0.3 to 4.9)	↗**	NA[1] (0)	NA[3] NA[3]	NA[3]
Poland (POL)	1.8 (6)	6.3 (-3.5 to 17.0)	→	2.4 (6)	7.2 (-1.6 to 16.7)	↗*
Portugal (PRT)[e]	1.7 (6)	7.5 (-9.8 to 28.1)	→	1.9 (2)	NA[2] NA[2]	NA[2]
Republic of Moldova (MDA)	NA[1] (0)	NA[3] NA[3]	NA[3]	1.4 (9)	1.9 (-13.7 to 20.2)	→
Romania (ROU)	1.6 (6)	-1.1 (-14.8 to 14.8)	→	2.4 (6)	-3.4 (-14.7 to 9.4)	→
Slovenia (SVN)	NA[1] (0)	NA[3] NA[3]	NA[3]	10.2 (8)	13.9 (-0.8 to 30.8)	↗*
Spain (ESP)	3.6 (6)	0.3 (-7.7 to 9.0)	→	6.7 (6)	1.2 (-4.9 to 7.6)	→
Northern Europe and Western Europe						
Austria (AUT)[e]	7.7 (6)	1.4 (-4.8 to 8.7)	→	9.0 (4)	NA[2] NA[2]	NA[2]
Belgium (BEL)[e]	15.3 (2)	NA[2] NA[2]	NA[2]	23.0 (5)	0.6 (-10.1 to 12.6)	→
Denmark (DNK)	9.3 (6)	0.2 (-16.6 to 20.4)	→	15.6 (6)	5.7 (-8.3 to 21.9)	→
Finland (FIN)	12.3 (9)	0.0 (-3.4 to 3.6)	→	14.3 (9)	0.1 (-2.9 to 3.2)	→
France (FRA)	8.8 (4)	-1.1 (-19.2 to 20.9)	→	14.2 (4)	-0.5 (-13.1 to 14.0)	→
Germany (DEU)	11.2 (7)	3.7 (-0.3 to 7.7)	↗*	12.6 (7)	3.3 (-0.7 to 7.5)	↗*
Iceland (ISL)	6.3 (5)	-9.2 (-18.2 to 0.8)	↘*	12.3 (7)	-6.2 (-26.4 to 19.7)	→
Ireland (IRL)[e]	6.5 (9)	3.7 (-3.3 to 11.2)	→	NA[1] (0)	NA[3] NA[3]	NA[3]
Latvia (LVA)	NA[1] (0)	NA[3] NA[3]	NA[3]	3.9 (9)	6.4 (-8.0 to 23.0)	→
Lithuania (LTU)	1.9 (4)	17.3 (-58.9 to 234.9)	→	3.5 (7)	-2.3 (-15.0 to 12.4)	→
Luxembourg (LUX)	4.8 (5)	7.0 (-13.1 to 31.7)	→	12.8 (7)	6.3 (-11.3 to 27.3)	→
Netherlands (NLD)	6.8 (9)	-8.2 (-14.5 to -1.5)	↘**	31.1 (9)	-0.2 (-2.0 to 1.6)	→
Norway (NOR)	11.3 (9)	-6.1 (-15.4 to 4.2)	→	13.1 (9)	-2.7 (-7.3 to 2.1)	→
Sweden (SWE)	4.1 (6)	0.2 (-9.4 to 10.7)	→	14.5 (6)	2.1 (-1.6 to 6.0)	→
United Kingdom (GBR)[f]	10.8 (8)	2.5 (1.4 to 3.6)	↗**	35.0 (4)	NA[2] NA[2]	NA[2]
Americas excluding South America						
Canada (CAN)	1.4 (4)	-14.8 (-53.8 to 57.3)	→	14.0 (4)	2.1 (-0.0 to 4.4)	↗*
Mexico (MEX)	0.5 (6)	3.6 (-16.0 to 27.7)	→	2.7 (6)	4.2 (-3.2 to 12.2)	→
Panama (PAN)	1.0 (1)	NA[2] NA[2]	NA[2]	1.0 (3)	-3.0 (-8.5 to 2.7)	↘*
United States of America (USA)	1.1 (4)	-3.4 (-17.7 to 13.4)	→	11.3 (4)	-0.5 (-3.7 to 2.9)	→
South America						
Argentina (ARG)	0.5 (7)	7.9 (-0.2 to 16.5)	↗*	2.6 (7)	10.7 (6.4 to 15.1)	↗**
Brazil (BRA)	0.2 (6)	14.1 (-8.9 to 42.9)	→	0.6 (6)	6.8 (-0.8 to 14.9)	↗*
Chile (CHL)	1.6 (7)	3.7 (-9.9 to 19.4)	→	3.7 (7)	4.6 (-6.6 to 17.2)	→
Ecuador (ECU)	0.2 (2)	NA[2] NA[2]	NA[2]	0.4 (5)	21.1 (-19.2 to 81.5)	→
Paraguay (PRY)	0.6 (1)	NA[2] NA[2]	NA[2]	0.6 (3)	-3.8 (-52.3 to 94.3)	→
Uruguay (URY)	1.7 (3)	NA[2] NA[2]	NA[2]	2.3 (5)	12.0 (-45.3 to 129.6)	→
Oceania						
Australia (AUS)	8.2 (6)	-19.1 (-39.0 to 7.4)	→	31.9 (6)	1.0 (-3.5 to 5.7)	→
New Zealand (NZL)	21.2 (4)	13.3 (-1.2 to 29.8)	↗*	25.9 (4)	11.1 (-4.9 to 29.8)	↗*

Abbreviations: pMR, period mortality rate; APC, annual percent change; CI, confidence interval; NA[1], data not available; NA[2], not applicable because of biased distribution; NA[3], not applicable for reasons other than NA[2].

[a] Age-adjusted period mortality rate from 1996-2005; age-adjusted to the world population of 2000.

[b] Number of years with available data.

[c] Annual percent change, together with its 95% CI and p-values, were calculated by the Joinpoint software.

[d] ↗ when APC > 0 (p < 0.10); ↘ when APC < 0 (p < 0.10); → when P > 0.10 for APC.

[e] For pleural mesothelioma, mortality data were for neoplasm of the pleura (163, ICD-9).

[f] Mortality data for malignant neoplasm of the pleura (163. ICD-9) from 1996-2000. Number of deaths was multiplied by 0.84 to estimate pleural mesothelioma according to Peto et al, 1999.

*Marginally significant (0.05 < p < 0.10).

**Statistically significant (p < 0.05).

Table 2. Historical trend in per capita asbestos use and status of national ban

Region / Country Code	Annual Use of Asbestos[a] (kg/capita/year) 1950	1960	1970	1975	1980	1985	1990	1995	2000	2003	Change in Use (Δ) from 1970-1985[b]	National Ban[c]
Africa												
ZAF	NA[2]	NA[2]	0.63	0.59	NA[2]	0.93	NA[2]	0.11	NA[2]	0.07	0.31	2007-2009
Others (n = 33)	0.13	0.32	0.43	0.32	0.28	0.29	0.27	0.23	0.24	0.05	-0.09	1/33
Asia												
ISR	NA[1]	3.13	2.62	0.25	0.81	0.88	0.65	0.41	0.00	NA[1]	-0.59	no ban
JPN	0.15	0.98	3.06	2.29	3.41	2.19	2.37	1.54	0.67	0.18	0.12	2004
KGN	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	2.32	3.33	4.63	NA[3]	no ban
KOR	0.03	0.03	1.15	1.74	1.22	1.52	1.77	1.97	0.64	0.50	-0.07	2009
SGP	NA[1]	NA[1]	1.52	3.83	2.57	NA[2]	0.85	0.14	0.74	0.06	-0.11	no ban
Others (n = 36)	0.01	0.09	0.19	0.19	0.28	0.21	0.23	0.38	0.29	0.35	0.05	3/36
Eastern Europe and Southern Europe												
ALB	NA[1]	NA[1]	NA[1]	NA[1]	0.90	0.51	NA[1]	0.32	NA[1]	NA[1]	NA[3]	no ban
BGR	NA[1]	0.14	0.36	3.30	0.13	1.00	0.06	0.01	0.05	0.01	0.24	no ban
HRV[d]	0.30	0.49	1.77	2.87	3.05	2.56	1.47	0.65	0.81	0.60	0.49	no ban
CZE	1.23	2.00	2.72	2.94	3.07	3.03	2.11	0.43	0.11	0.16	0.21	2005
GRC	0.03	0.01	2.03	1.47	1.47	2.22	1.11	0.68	NA[2]	NA[2]	0.10	2005
ITA	0.53	1.46	2.46	2.38	3.20	2.08	1.10	0.00	0.00	0	0.22	1992
POL	0.20	0.51	1.97	2.78	2.34	2.20	1.72	0.79	0.00	0	-0.11	1997
PRT	0.29	0.28	0.75	0.64	2.04	0.99	1.23	0.91	0.33	0.16	0.82	2005
MDA	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	0.64	0.41	0.24	NA[3]	no ban
ROU	NA[1]	NA[1]	NA[1]	1.94	0.22	0.21	0.13	1.21	0.48	0.52	-1.73	2007
SVN[d]	0.30	0.49	1.77	2.87	3.05	2.56	1.47	2.49	0.38	NA[1]	0.49	2005
ESP	0.16	0.47	2.27	2.64	1.78	0.98	1.02	0.68	0.32	0.00	-1.07	2002
Others (n = 9)	0.94	1.57	2.20	3.01	3.46	3.09	2.33	3.60	2.34	2.73	0.67	2/9
Northern Europe and Western Europe												
AUT	0.50	1.81	4.67	4.51	2.68	2.85	0.71	0	NA[2]	0.00	-1.77	1990
BEL[e]	2.38	5.67	5.40	5.80	4.56	2.44	2.54	0.99	0.00	0.01	-2.04	1998
DNK	2.34	3.80	5.81	4.80	2.67	2.03	0.16	0.07	0	NA[2]	-2.96	1986
FIN	2.40	1.91	2.61	2.00	1.05	0.51	NA[1]	0	0	0	-1.53	1992
FRA	0.93	1.83	3.00	2.59	2.33	1.14	1.12	0.82	NA[2]	NA[2]	-1.06	1996
DEU	1.37	2.30	2.90	4.81	5.62	1.48	0.19	0.00	0.00	0.00	-0.30	1993
ISL	0.22	0.21	5.04	0.03	0.02	0	0	0	0	0.01	-2.52	1983
IRL	NA[1]	NA[1]	NA[1]	2.16	2.47	1.48	1.57	1.76	0.00	0	-0.18	2000
LVA	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	0.89	0.47	0	NA[3]	2001
LTU	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	0.12	0.19	0.00	NA[3]	2005
LUX[e]	2.38	5.67	5.40	5.80	4.56	2.44	2.54	0.99	0.00	0.01	-2.04	2002
NLD	0.68	1.89	1.52	2.61	1.34	0.38	0.42	0	0.00	0.00	-1.20	1994
NOR	0.82	1.93	2.06	1.40	0.03	0	0	0	0.00	0	-1.72	1984
SWE	1.43	2.28	2.32	1.87	0.14	0.12	0.07	0.03	NA[2]	0	-1.96	1986
GBR	2.13	3.11	2.69	2.45	1.66	0.66	0.27	0.17	0.00	0.00	-1.41	1999
Others (n = 2)	0.90	1.62	2.85	2.71	3.32	0.77	0.20	NA[2]	0.02	0.00	-0.73	2/2
Americas excluding South America												
CAN	3.00	2.53	4.39	NA[2]	4.34	1.12	2.74	0.52	NA[2]	0.63	-1.66	no ban
MEX	0.20	0.35	0.78	0.99	1.14	0.71	0.47	0.21	0.37	0.20	0.04	no ban
PAN	NA[1]	NA[1]	0.10	0.05	0.15	0.10	0.15	0.32	0.43	0.35	0.05	no ban
USA	4.18	3.46	3.18	2.48	1.55	0.63	0.13	0.05	0.00	0.02	-1.73	no ban
Others (n = 12)	0.20	0.30	0.67	0.92	0.96	0.57	0.40	0.21	0.28	0.23	-0.03	0/12
South America												
ARG	NA[1]	NA[1]	0.88	0.64	0.76	0.23	0.21	0.17	0.06	0.00	-0.26	2001
BRA	0.17	0.37	0.39	0.96	1.61	1.06	1.09	1.13	0.99	0.43	0.66	2001
CHL	0.07	NA[1]	0.92	0.19	NA[1]	0.69	0.59	0.81	0.12	0	0.14	2001
ECU	NA[1]	NA[1]	NA[1]	0.43	0.90	0.55	0.11	0.07	0.37	0.11	0.29	no ban
PRY	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	0.07	NA[1]	NA[3]	no ban
URY	NA[1]	NA[1]	0.74	0.68	0.83	0.20	0.58	0.28	0.23	0	-0.20	2002
Others (n = 5)	0.13	0.30	0.58	0.60	0.68	0.50	0.30	0.38	0.23	0.15	0.00	0/5
Oceania												
AUS	2.21	4.27	5.41	5.87	4.54	0.82	0.10	0.08	0.07	0.00	-2.71	2003
NZL	2.04	2.05	3.07	4.05	1.59	0.40	NA[1]	NA[1]	NA[1]	NA[1]	-2.56	no ban
Others (n = 3)	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[1]	NA[3]	0.00	NA[3]	0/3

Abbreviations: NA[1], data not available; NA[2], not applicable because of negative consumption data; NA[3], not applicable for reasons other than NA[2]; 0.00 when the calculated data <0.005; 0 if there are no data after the year the ban was introduced.

[a]Values of annual asbestos use: □5.00+, □4.00-4.99, □3.00-3.99, □2.00-2.99, □1.00-1.99, □0 or 0.00.

[b]Change in use (Δ, kg/capita/year) during the period defined as the difference between the average of consumption during the former subperiod (1970-1975) and latter subperiod (1980-1985).

[c]Year first achieved or year planned to achieve ban. Characters in blue for early ban countries, in yellow for late ban countries, and in red for no ban countries. For other countries in the region, the numerator is the number of countries that achieved or planned bans and the denominator is the number of other countries in the region.

[d]Consumption data up to 1990 was substituted by the data of the former Yugoslavia.

[e]Consumption data of Belgium and Luxembourg are the same, because consumption data are mixed in the USGS database.

Table 3. Relation between recent pleural mesothelioma mortality and historical use of asbestos based on regression analyses[a]

Period for Use of Asbestos	Indicator for Asbestos Use and Mortality					
	Change[b]			Absolute[c]		
	No. of Countries	Adjusted R^2	*p* Value	No. of Countries	Adjusted R^2	*p* Value
1950						
-1960	26	-0.014	0.423	24	0.003	0.311
-1970	28	-0.033	0.707	24	0.101	0.072
-1975	29	-0.011	0.416	25	0.216	0.011
-1980	29	0.041	0.149	25	0.305	0.003
-1985	29	0.219	0.006	25	0.335	0.002
-1990	30	0.376	<0.001	25	0.343	0.001
1960						
-1970	27	-0.040	0.978	24	0.271	0.005
-1975	26	0.093	0.071	25	0.406	<0.001
-1980	30	0.167	0.014	25	0.461	<0.001
-1985	30	0.415	<0.001	25	0.478	<0.001
-1990	32	0.519	<0.001	25	0.458	<0.001
1970						
-1975	29	0.130	0.031	25	0.514	<0.001
-1980	29	0.298	0.001	25	0.497	<0.001
-1985	**32**	**0.668**	**<0.001**	25	0.492	<0.001
-1990	32	0.585	<0.001	25	0.429	<0.001
1975						
-1980	30	0.285	0.001	25	0.419	<0.001
-1985	30	0.483	<0.001	25	0.408	<0.001
-1990	33	0.257	0.002	25	0.323	0.002
1980						
-1985	31	0.107	0.040	25	0.223	0.010
-1990	30	0.050	0.123	25	0.122	0.049
1985						
-1990	30	-0.031	0.734	25	-0.025	0.521

[a]Countries with mortality data for mesothelioma of the pleura (C45.0, ICD-10) were analyzed for change and absolute level in mortality. Countries with mortality data for neoplasm of the pleura (163, ICD-9), i.e., ALB, BEL, AUT, BGR, GRC, IRL, ITA, PRT and SGP, were analyzed for change only. Numbers in red when adjusted $R^2 > 0.5$, in blue when > 0.4, and in green when > 0.3.

[b]Annual percent change of the age-adjusted annual mortality rates from 1996-2005 (dependent variable) versus change in use during the corresponding period (independent variable).

[c]Absolute mortality level, i.e., age-adjusted period mortality rate, from 1996-2005 (dependent variable) versus absolute level of per capita asbestos use during the corresponding period (independent variable).

Appendix Table. Method of registering death numbers in the WHO mortality database

Region / Code	Year									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Africa										
ZAF	**10A**								**10A**	
Asia										
ISR	9	9	10B[d]	10B	10B[d]	10B		10B		
JPN	10B	10B	10B	10B	10B	10B	10B	10B	10B	
KGN	9	9	9	9	10B[d]	10B[e]	10B[d]	10B[d]	10B[d]	
KOR	10B	10B	10A	10A	10A	10A	10A	10A	10A	
SGP[a]	9[c]	9	9	9[c]	9	9	9	9		
Eastern Europe and Southern Europe										
ALB	9	9	9	9	9	9	9	9		
BGR	9	9	9	9	9	9	9	9	9	
HRV	10B	10B	10B	10B	10B	10B	10B	10B	10B	
CZE	10B	10B	10B	10B	10B	10B	10B	10B	10B	
GRC	9	9	9	9	9	9	9	9	9	
ITA	9	9	9	9	9	9	9			
POL	9			10B	10B	10B	10B	10B	10B	
PRT	9	9	9	9	9	9	10B	10B		
MDA	10A	10A	10A	10A	10A	10A	10A	10A	10A	
ROU	9	9	9	10B	10B	10B	10B	10B	10B	
SVN	9	10A	10A	10A	10A	10A	10A	10A	10A	
ESP	9	9	9	10B	10B	10B	10B	10B	10B	
Northern Europe and Western Europe										
AUT	9	9	9	9	9	9	10B	10B	10B	10B
BEL[b]	9	9								
DNK	10B	10B	10B	10B	10B	10B				
FIN	10B	10B	10B	10B	10B	10B	10B	10B	10B	
FRA	9	9	9	9	10B	10B	10B	10B		
DEU	9	9	10B	10B	10B	10B	10B	10B	10B	
ISL	10B[e]	10B	10B[e]	10B	10B	10B	10B[d]	10B	10B[d]	
IRL	9	9	9	9	9	9	9	9	9	
LVA	10A	10A	10A	10A	10A	10A	10A	10A	10A	
LTU	9	9	10A	10B	10A	10B[d]	10B	10B	10B	
LUX	9	9	10B	10B	10B	10B	10B[d]	10B[d]	10B	
NLD	10B	10B	10B	10B	10B	10B	10B	10B	10B	
NOR	10B	10B	10B	10B	10B	10B	10B	10B	10B	
SWE	9	10B	10B	10B	10B	10B	10B			
GBR	9	9	9	9		10B	10B	10B	10B	
Americas excluding South America										
CAN	9	9	9	9	10B	10B	10B	10B		
MEX	9	9	10B	10B	10B	10B	10B	10B		
PAN	9	9	10B	10B[e]	10B[e]	10B[d]	10B[e]	10B[d]		
USA	9	9	9	10B	10B	10B	10B			
South America										
ARG	9	10B	10B	10B	10B	10B	10B	10B		
BRA	10B	10B	10B	10B	10B		10B			
CHL	9	10B	10B	10B	10B	10B	10B	10B		
ECU	9	10B[e]	10B[d]	10B[e]	10B[d]	10B[d]	10B[e]	10B	10B	
PRY	10B[e]	10B[d]	10B[e]	10B[d]	10B[e]	10B		10B[e]		
URY	9	10B	10B	10B	10B	10B				
Oceania										
AUS	9	9	10B	10B	10B	10B	10B	10B		
NZL	9	9	9	9	10B	10B	10B	10B		

Abbreviations: 9, registered by ICD-9 (ICD 9th revision); 10A, registered by ICD-10 under C45 only; 10B, registered by ICD-10 under C45.0, C45.1, C45.2, C45.7, C45.9; Blank, no data registered; Letters in bold for data used to calculate annual percent change (APC).

[a]For Singapore, which adhered to ICD-9, we analyzed incident data in the Singaporean cancer registry.

[b]For Belgium, we analyzed data from the Flemish region for all mesothelioma (see text).

[c]Indicates no data under 163 for men.

[d]Indicates no data under C45.0 for men.

[e]Indicates no data under any of C45.0, C45.1, C45.7, C45.9 for men.

Figure Legends

Figure 1.

Historical trend in use of asbestos from 1950-2003 grouped by status of national ban. Early-ban countries comprise countries which adopted ban until 1995 (n = 9); Late-ban comprise countries which adopted ban from 1996 to 2006 (n = 19); No-ban countries excluding USA comprise countries which didn't adopt ban until 2007 (n = 16); All countries comprise countries with data on asbestos use registered in the USGS database (n = 145). Broad lines for early and late ban countries indicate the periods for which bans were adopted by the countries of the group, i.e., 1983-1995 for early-ban countries and 1996 onwards for late-ban countries. "×" indicates weighted average of use for each country group during 1970-1975 and 1980-1985. Asbestos use (x-axis) is per capita yearly asbestos use (average weighted by the size of national populations).

Figure 2.

Trend of mortality rates for male pleural mesothelioma in relation to change of asbestos use. Bubbles were drawn with sizes proportional to the size of national male populations; bubbles were drawn with equal size when the male population was < 5,000,000. Trend of mortality rates (x-axis) was defined as annual percent change (APC) calculated by Joinpoint software. For country code with underline, mortality data of neoplasm of the pleura (163, ICD-9) were used. Bivariate relations were examined by linear regression, weighted by the size of national male populations, which produced the following models: $y = 0.026x + 2.027$, adjusted $R^2 = 0.67$, $P < 0.0001$.

Appendix Figure.

Trend in annual mortality rates (aMRs) of pleural and all mesothelioma in men by region. X-axis represents calendar year. Y-axis represents age-adjusted aMRs (deaths per million per year; adjusted to the world population of 2000). Regression lines for each country were fitted to the natural logarithm of age-adjusted aMRs using calendar year as the regression variable by Joinpoint software. For countries with data with a biased distribution, no regression line was used to connect data-points. For pleural mesothelioma, mortality data were for neoplasm of the pleura (163, ICD-9) in the following countries: ALB, AUT, BEL, BGR, GRC, IRL, ITA, PRT and SGP.

Figures

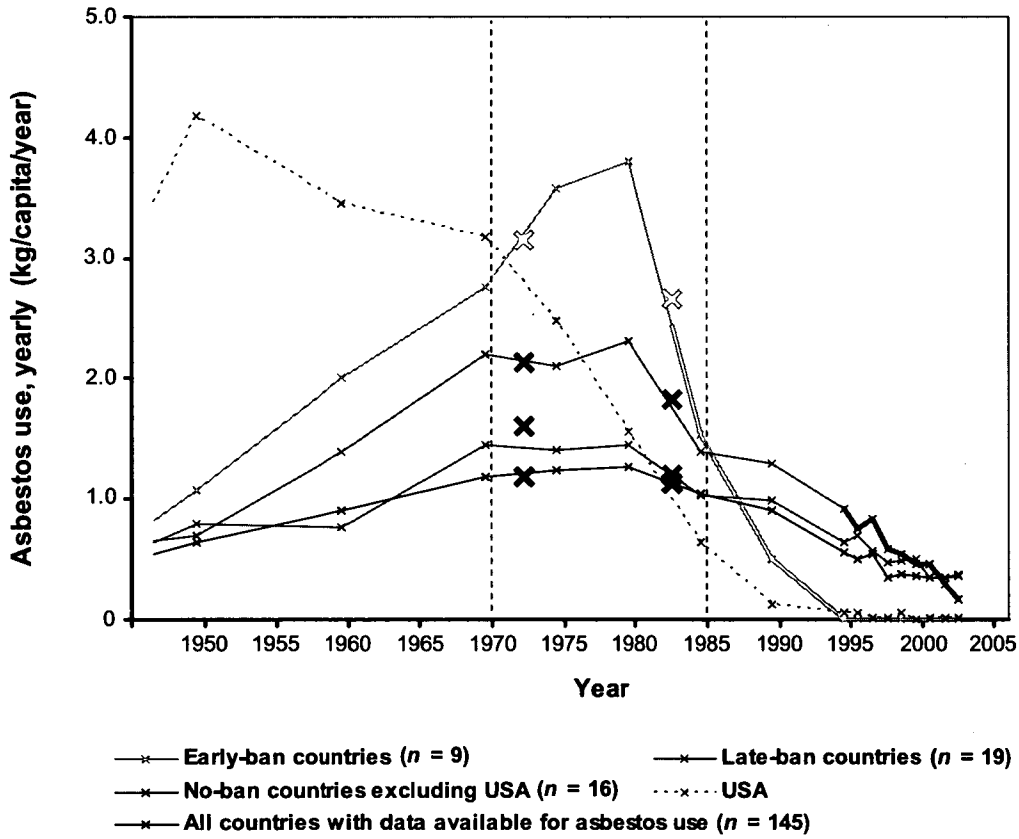


Figure 1.

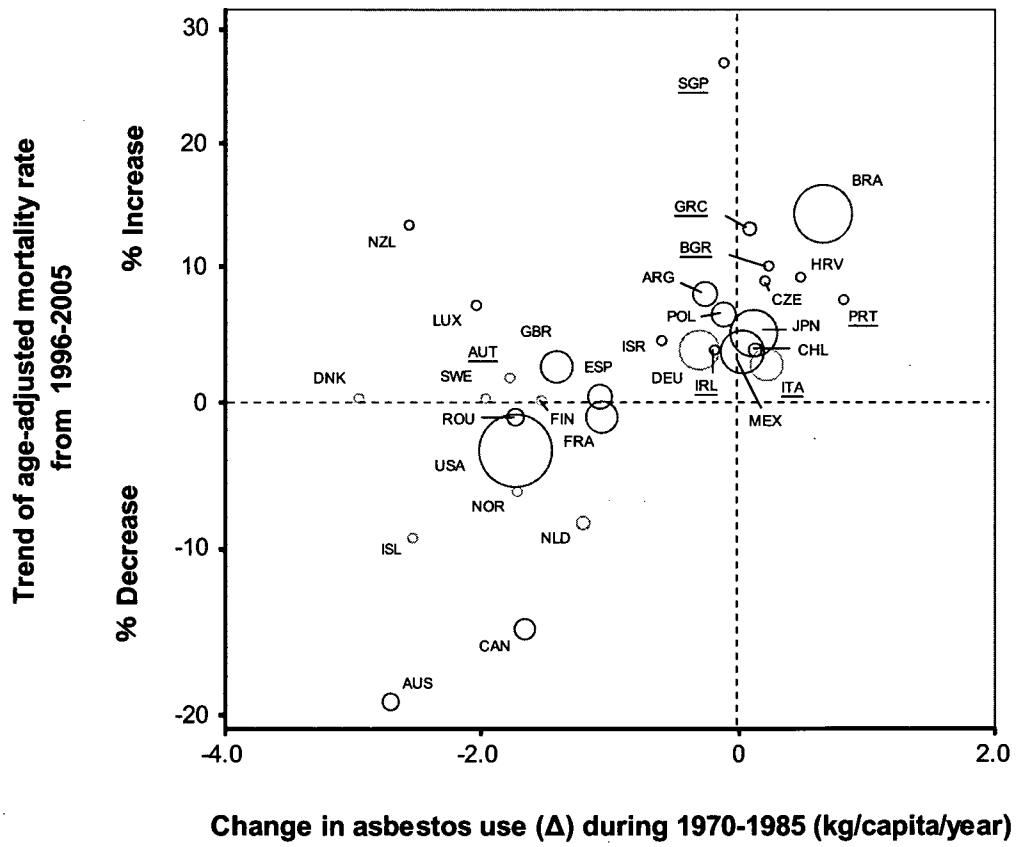
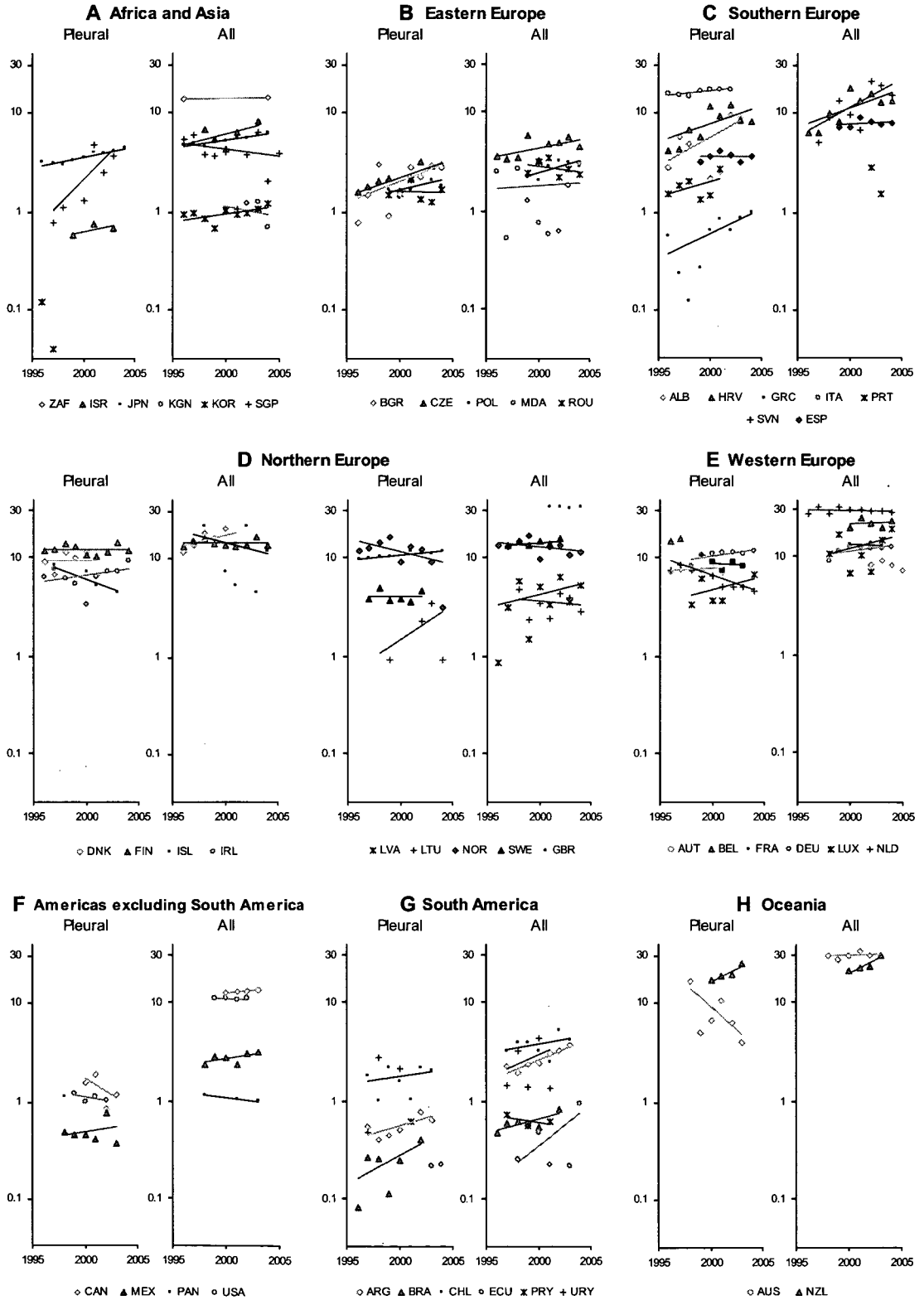

Trend of age-adjusted mortality rate from 1996-2005
% Increase
% Decrease
30
20
10
0
-10
-20
-4.0
-2.0
0
2.0
SGP
BRA
GRC
NZL
BGR
HRV
ARG
CZE
LUX
POL
JPN
PRT
GBR
ISR
CHL
AUT
DNK
SWE
ESP
DEU
IRL
ITA
ROU
FIN
MEX
FRA
USA
NOR
NLD
ISL
CAN
AUS
Change in asbestos use (Δ) during 1970-1985 (kg/capita/year)
Early-ban countries (n = 9)
Late-ban countries (n = 14)
No-ban countries (n = 9)

Figure 2.



Appendix Figure.

3. 国内実態調査研究　－全国の石綿外来での経験を中心に－

3－1. 結果の概要

平成 18(2006)年 12 月中旬に標記アンケートを 281 施設様宛に発送致したところ（第 1 次締切り平成 19(2007)年 1 月 15 日、第 2 次締切り同 2 月 15 日）、137 施設から回答を得た。なお、2 施設については、施設内容から今回のアンケートの対象に該当しない旨の連絡があったので対象外施設とした。

対象施設数:279 施設(アンケート発送:281 施設、うち無効:2 施設)
有効回答数:137 施設　うち、石綿外来設置施設数「石綿外来あり」:60 施設
未設置施設数「石綿外来なし」:77 施設
アンケート回収率:49.1%(137/279)

図 1a. 石綿外来の実施医療機関内訳

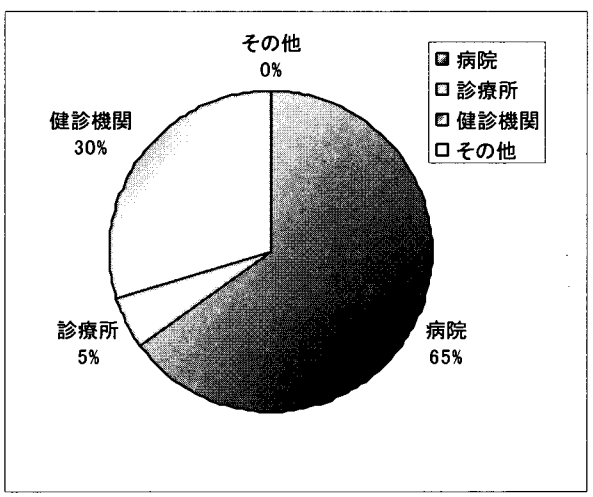
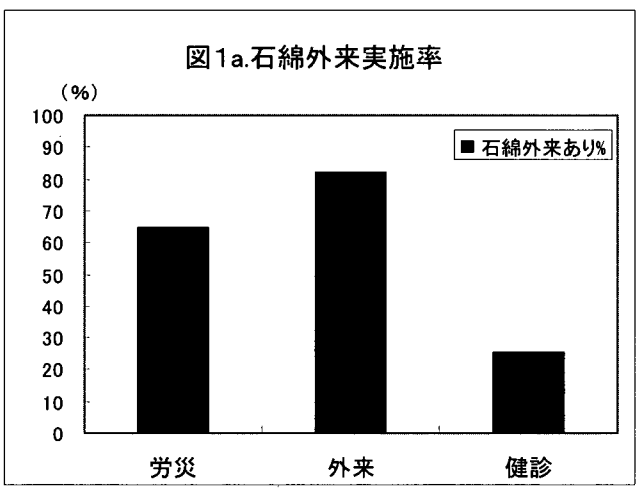


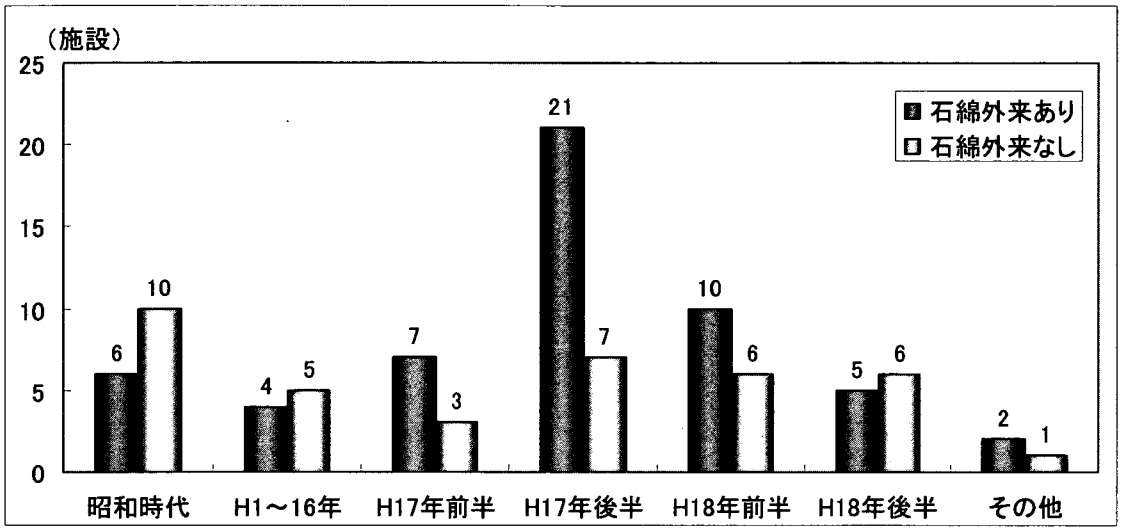
図 1b. 石綿外来の実施率（労災・外来・健診）



- 図 1 a は、「石綿外来あり」と答えた 60 施設の医療機関毎の内訳を示す。

- 図 1 b は、発送前に各施設を、①労災病院、②石綿外来、③石綿健診の 3 群に分類しており、その各群の石綿外来実施率を示している。石綿外来と分類した群でも、外来実施率は 82%であり、健診と分類した群でも 26%は外来を実施していることから、事前情報の限界およびアンケート調査の重要性がうかがえた。

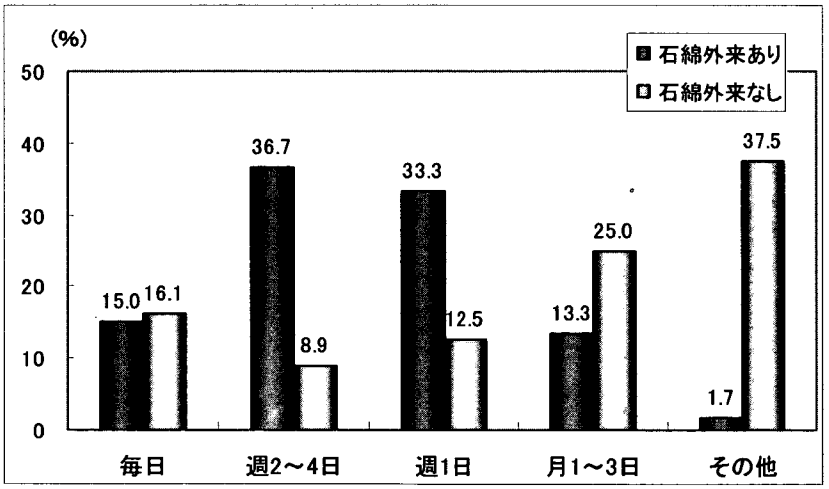
図２．石綿外来・石綿健診の開設年と施設数（前半：1～6 月、後半：7～12 月）



・ 石綿外来の開設年は H17 年後半に集中しているが、まさに同年 6 月末のクボタショックに一致しており、その影響の大きさがうかがえる。

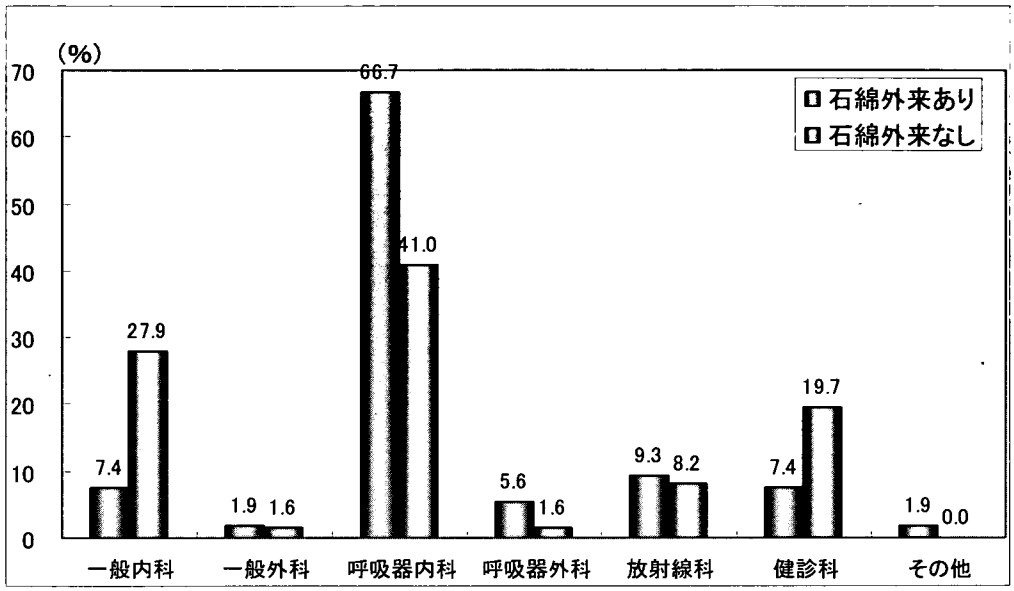
・ 昭和の開設については、昭和 50 年前後（1975 年）と昭和 63 年前後（1988 年）に集中しており、それぞれ特化則の大改正による特殊健診の実施、学校等の吹付け石綿の社会問題化に一致していた。

図３．石綿外来・石綿健診の実施頻度



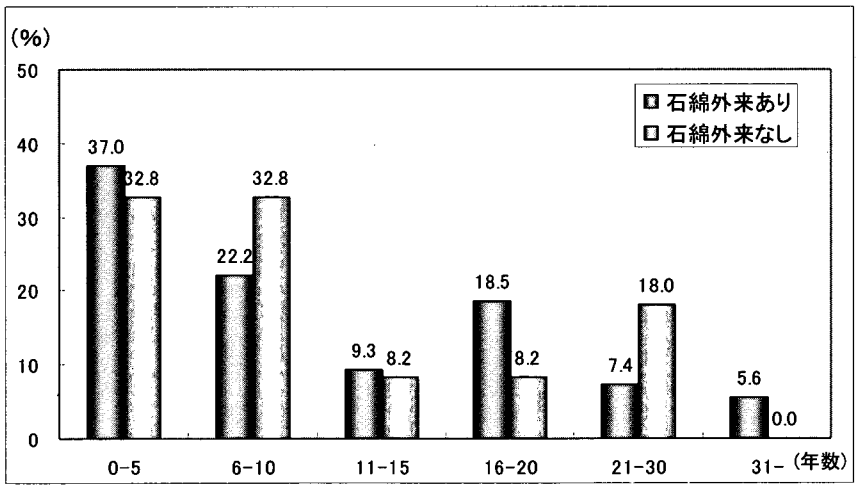
・ 週１日以上の実施は、「石綿外来あり」：84.5%、「石綿外来なし」：37.5%と明らかな開きがみられた。

図４．担当医の専門科



- 全体的に呼吸器内科の割合が最も高く、特に「石綿外来あり」ではその傾向が強い。
- 「石綿外来あり」では呼吸器外科の割合が「石綿外来なし」に比べて高く、呼吸器外科医が石綿外来を行っている３施設はすべて治療設備を有していることから（図７より）、外科手術も含めた集学的治療が実施されていると考えられた。

図５．担当医の経験年数



- 石綿外来・石綿健診における経験年数は、５年以下が３割、10 年以下が６割を占め、経験年数が少ない担当医が診療を担っていることがわかった。
- 石綿健診担当医では 30 年以上の経験年数はみられず、21 年～30 年に１つのピークがあった。これは、1975 年の特化則大改正後に石綿の特殊健診が開始された以後に健診担当医となった人が多かったと考えられた。
- 石綿外来担当医は、30 年以上の経験年数の方が一定数みられた。おそらく、特化則制定・改正以前から石綿肺の治療に係っていた人ではないかと考えられる。また、16-20 年に１つのピークがあるが、1988 年の吹付け石綿の社会問題化以後に外来担当医となった人が多かったのではないか

と考えられた。

図６a. 保険適用の実施率

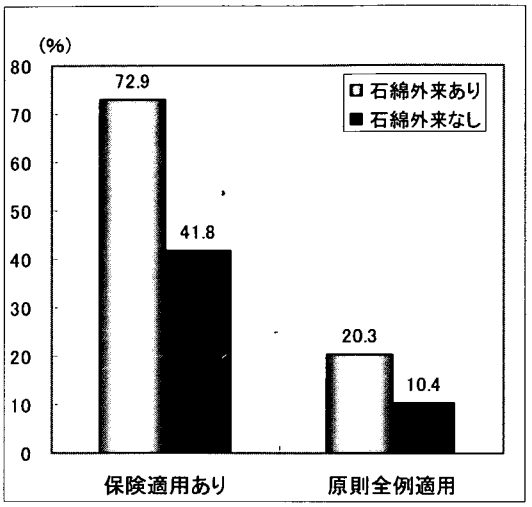
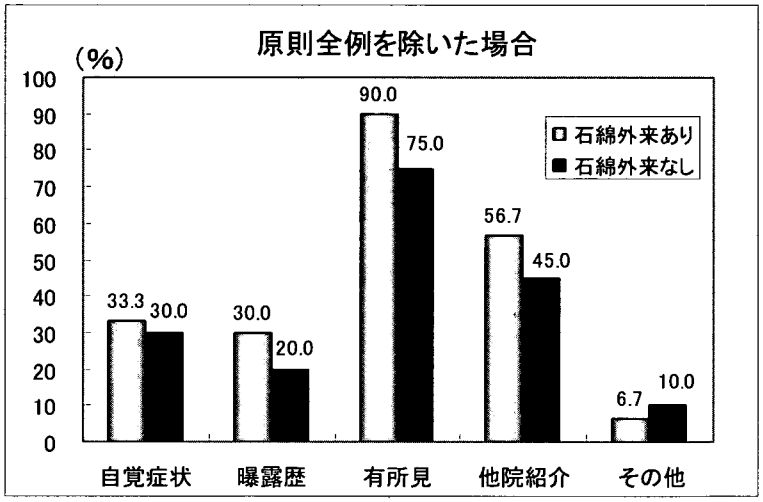


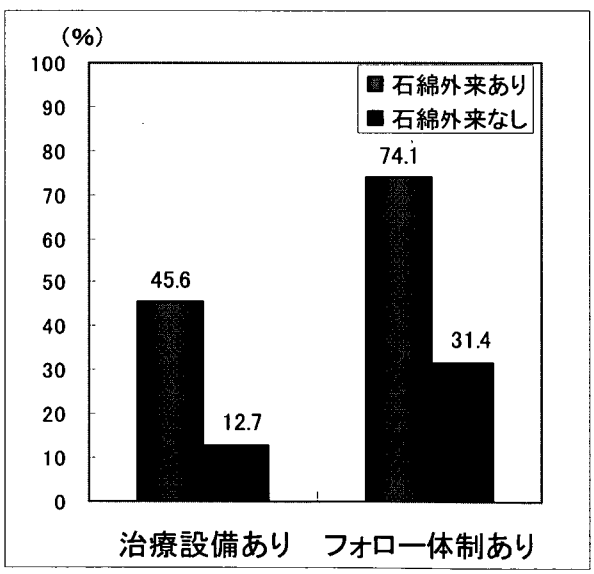
図６b. 各条件の保険適用実施率



・ 図６a より、「石綿外来あり」では、保険適用の実施率が約７割にも上り、無条件（原則全例）での適用も２割に達している。これは、石綿外来の受診者の多くが保険適用に値する健康状態にあるとも考えられる。

・ 図６b は、一定の条件を満たすことで保険適用を実施している施設（保険適用実施施設から原則全例適用施設を除く）のうち、各条件の保険適用率を示したものである。適用条件の割合については、石綿外来の有無に係らず大差なく、①健診等で所見があるか、②他院から紹介を受けるような健康状態でなければ、半数以上が保険適用外となりそうだ。

図７. 治療設備やフォローアップ体制の有無



・ 「石綿外来あり」の方が、治療設備を併設している割合が高く、フォローアップ体制も充実していることがわかる。

・ 「石綿外来なし」については、フォローアップ体制が約３割程度であることから、大半の施設が

現時点で所見のない人については、１回限りの受診になっているものと思われる。一方、石綿関連疾患の長い潜伏期間を考えると、所見等はなくとも曝露リスクの高い受診者も存在するため、曝露リスクおよび近い将来における発症リスクに基づいた定期受診等のフォローアップ体制を多くの機関で確立することが望ましい。

図８a. 問診項目の重要性

（そう思う:2、まあ思う:1、どちらでもない:0、あまり思わない:-1、思わない:-2 で算出し、各項目を相対評価）

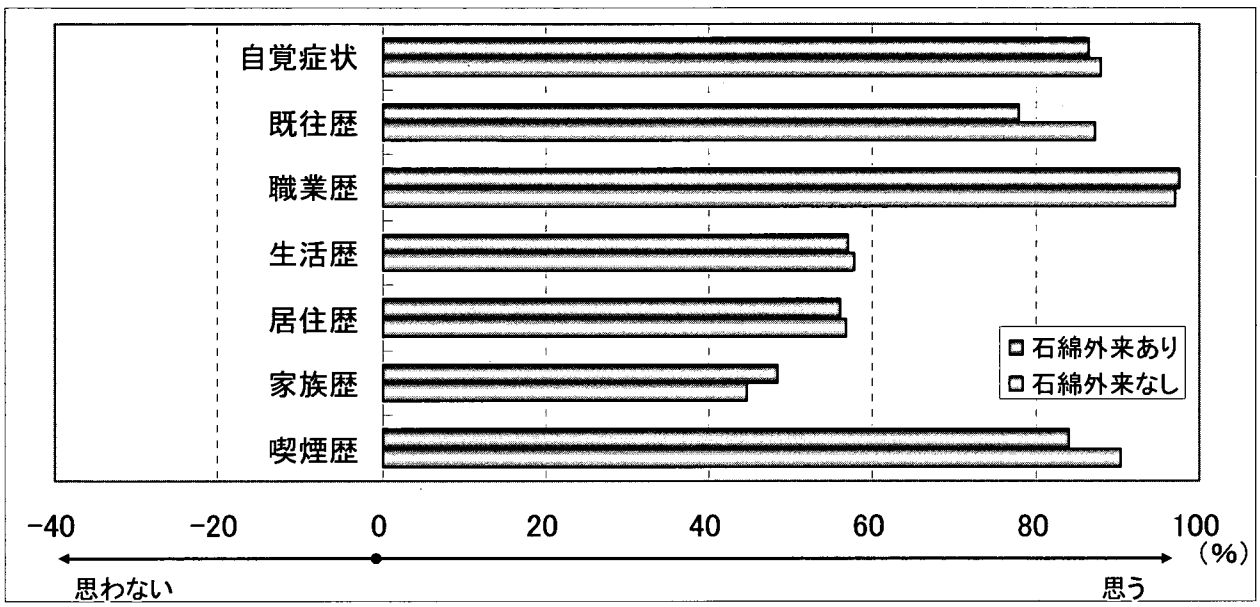
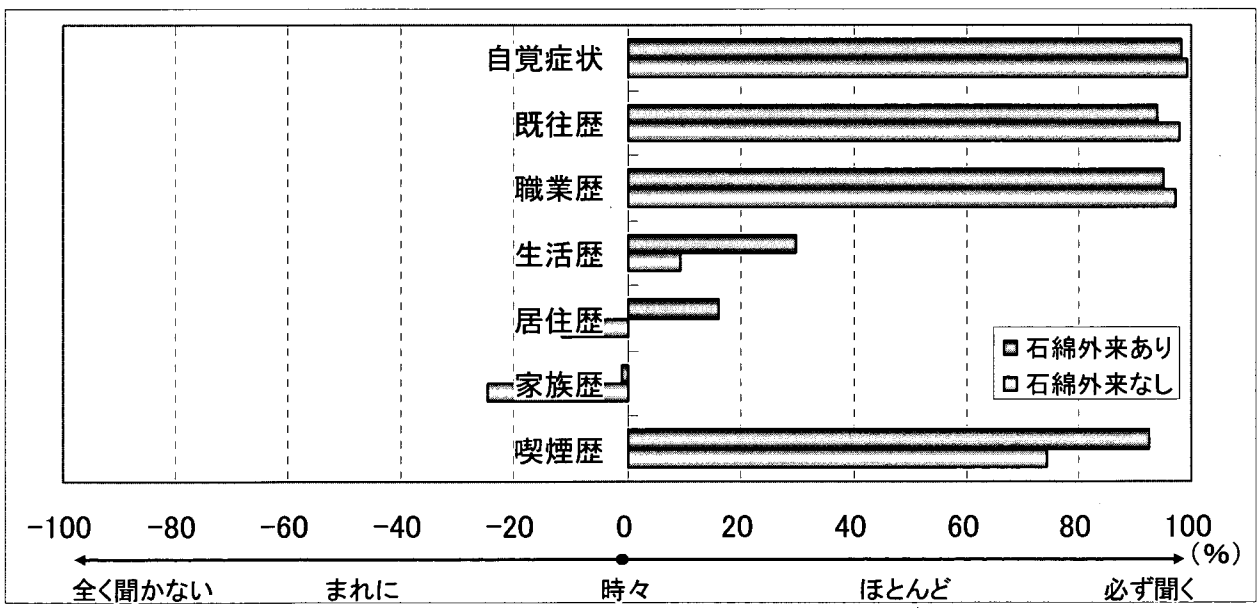


図８b. 各問診項目の実施頻度

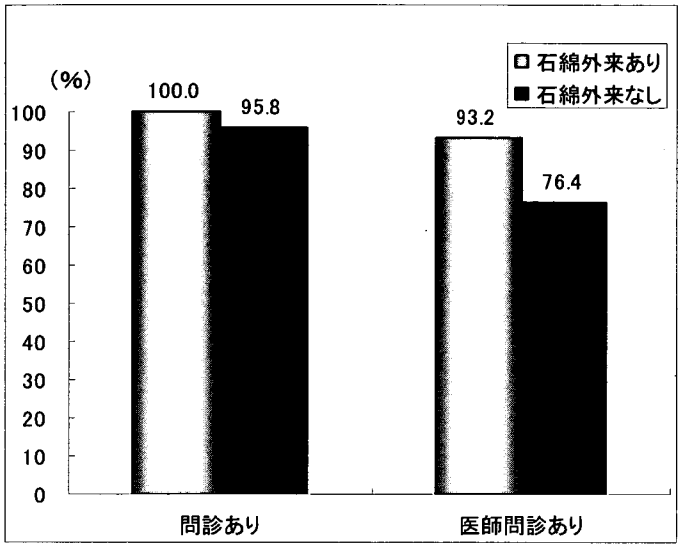
（必ず聞く:2、ほとんど:1、時々:0、まれに:-1、全く聞かない:-2 で算出し、各項目を相対評価）



・ 自覚症状・既往歴・職業歴・喫煙歴については、重要性と実施頻度はともに非常に高い傾向にあるが、生活歴・居住歴・家族歴では重要性の認識はあるものの、実施頻度との間に乖離がみられ、

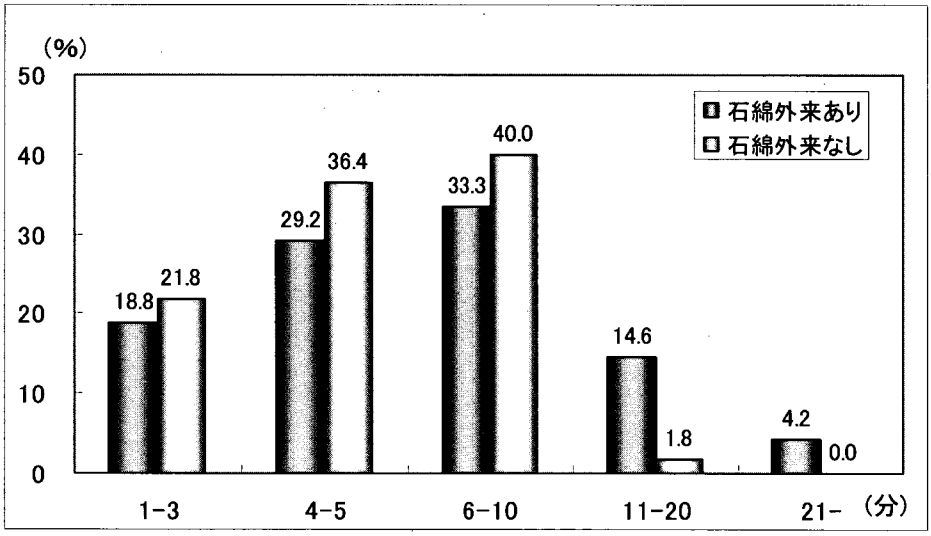
「石綿外来なし」では特にその傾向が顕著であった。

図９．問診実施率



・　「石綿外来あり」では、医師による問診がほぼ実施されているが、「石綿外来なし」では８割弱という状況であった。

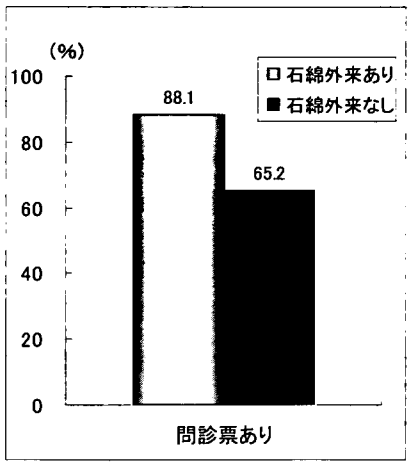
図１０．医師による石綿問診時間内訳

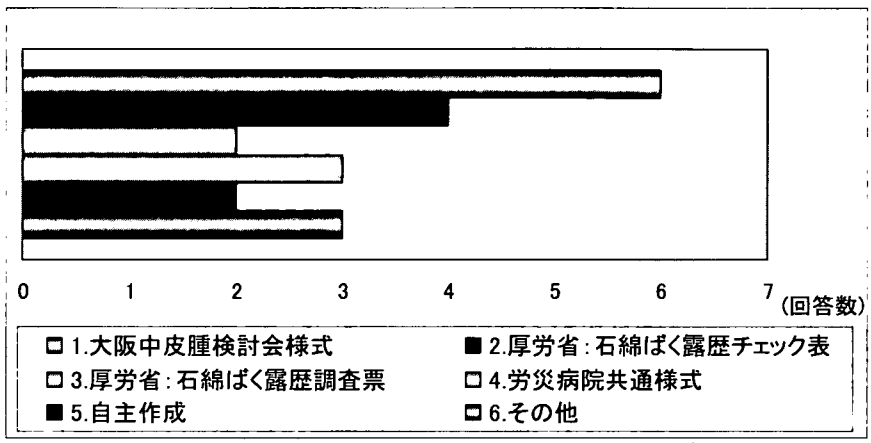


・　「石綿外来あり」の方が、より時間をかけて石綿に関する問診を行う傾向にある。

・　ただし、半数以上が５分程度であり、10 分を超える問診は外来実施機関でも２割弱である。このように短時間で有用な情報を得ていくためには、効率のよい問診を実施していく必要があると思われる。

図１１．石綿曝露歴に関する問診票の活用および種類





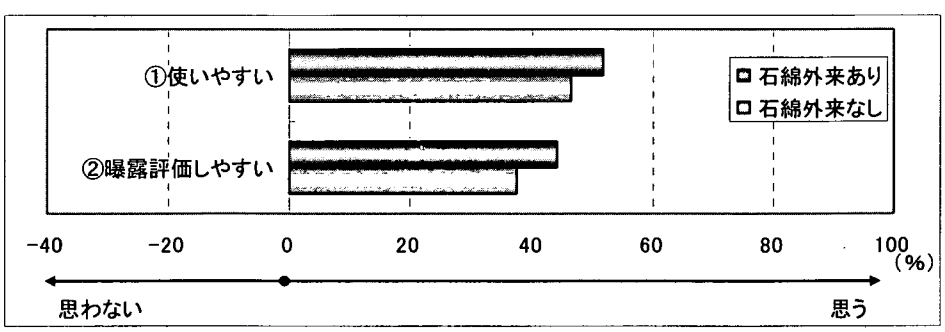
・　「石綿外来あり」の約９割が特定の問診票を活用して石綿曝露歴の問診を行っている。

・　問診票は大阪中皮腫検討会様式が多く使われており、それを簡素化した厚労省の曝露チェック表や、修正・加筆した厚労省の石綿ばく露歴調査票も使用されていることがわかった。

1. 大阪中皮腫検討会様式･･･「三信図書：職業性曝露と石綿関連疾患、産業医学振興財団：石綿関連疾患」に収録
2. 厚労省：石綿ばく露歴チェック表･･･大阪中皮腫検討会様式を簡素化
(http://www.mhlw.go.jp/new-info/kobetu/roudou/sekimen/pamph/051004-1.html)
3. 厚労省：石綿ばく露歴調査票、石綿自記式簡易調査票･･･「石綿ばく露歴把握のための手引」に収録
(http://www.jaish.gr.jp/information/mhlw/sekimen/h18_tebiki.html)
4. 労災病院共通様式（労働者健康福祉機構様式）･･･以前の石綿ばく露歴チェック表（現在より詳細なもの）を参考に、自主作成

図１２．石綿曝露歴に関する問診票の評価

（そう思う:2、まあ思う:1、どちらでもない:0、あまり思わない:-1、思わない:-2　で算出し、各項目を相対評価）



・　問診票の使いやすさや曝露評価も概ね良好だが、特に曝露評価に関しては改善の余地がありそうである。