Mortality Experience in an Historical Cohort of Chrysotile Asbestos Textile Workers

Carlo Mamo[1] **, Giuseppe Costa**[2]
[1]***Epidemiology Unit, Piedmont Region, Grugliasco, Turin, Italy***
[2]***Department of Public Health, Turin University, Italy***

Abstract

Introduction and aims
The issue of whether exposure to chrysotile asbestos causes lung cancer, mesothelioma and non-malignant diseases was investigated in an historical cohort in Grugliasco, Italy, where the largest Italian asbestos textile factory had been in operation until 1986. In this urban area there are important mortality differences by social class.

Methods
The study cohort comprised 1,653 asbestos textile plant workers. Vital status was ascertained by means of postal follow-up. The cause of death was ascertained through a record linkage with the national mortality registry. Standardized Mortality Ratios (SMR) were computed using the manual workers population of Turin as a reference (in order to reduce the healthy worker effect and the bias from social class), adjusted for age and birth area. The observation period went from 1/1/1981 to 31/12/1995

Results
Overall mortality was significantly in excess, in both males (SMR=212; 119 obs.) and females (SMR=265; 84 obs.). Cancer mortality was significantly in excess (SMR=194 males; SMR=261 females). Statistically significant excesses for pleural mesothelioma (SMR=3,322 males; SMR=13,248 females) and lung cancer (SMR=302 males; SMR=523 females) were observed. Other sites of cancer in excess were: larynx, stomach, pancreas and brain. Mortality excesses for asbestosis (SMR=12,797 males; SMR=3,124 females), ischaemic heart diseases (SMR=139 males; SMR=164 females) and cerebrovascular diseases (SMR=159 males; SMR=173 females) were estimated. Analysis for length of employment and year of hire evidenced a correlation between mortality rates and length of employment and the latency period for the tumours.

Conclusions
These results confirm that occupational exposure to asbestos causes lung cancer and malignant mesothelioma. Moreover, the results suggest, in agreement with previous studies, a role of the exposure to asbestos in the etiology of non-malignant diseases (ischaemic heart diseases and cerebrovascular diseases).

Introduction

Exposure to asbestos is considered a causal factor for mesothelomias and for lung cancer (IARC, 1987). Other damaging effects on the human organism, whether cancerogenous or not, remain unclear.

Mortality studies among persons exposed in the workplace to asbestos, including amosite, crocidolite and chrysotile, have shown excesses for, in addition to mesothelomias and lung cancer, gastroenteric tumours, laryngeal tumours, and cardiovascular disease (Brown et al., 1994; Levy & Wegman, 1995).

The health risks related to exposure to chrysotile, which continues to be used on a large scale in various countries, especially in economically underdeveloped countries, remains a topic of debate (Kazan-Allen, 2003).

The Region of Piedmont (Northwest Italy), specifically the area surrounding the city of Turin, was home to one of Europe's largest asbestos mines (Balangero). In the area of Turin the main plant for the manufacturing of asbestos-based products was located in the area of the town of Grugliasco (a suburb of Turin). The plant was founded in 1865 and was greatly expanded from the 1950s to the 1970s, with the production of asbestos textiles. The textiles were mostly composed of medium and long-fibre chrysotile asbestos, generally mixed with antiacid synthetic rubber, various resins and additives, at times with metallic netting for structural reinforcement. The plant was closed in 1986, even before the extraction and use of this compound was banned by Italian law. The personnel of this plant represent a population of particular interest, from the medical-epidemiological point of view, providing the opportunity to investigate the impact on health after a long latency of work-related exposure to asbestos.

The average cumulative exposure among workers in an asbestos textile factory, estimated through dust sampling in the period 1951-1978 and revised to correspond to modern counting methods, was 200-300 fibres/ml-years.

The mortality from asbestos exposure in the manufacture of asbestos textile products was rarely investigated. In the present study, we attempted to provide additional data for evaluating the health impact of occupational exposure to asbestos in the textile industry. It was important to control for bias due socio-economic factors, in that mortality among Turin's population, especially that for cancer and cardiovascular disease, is correlated with social class.

Materials and methods

The study population consisted of 1,653 former employees of the manufacturing plant for asbestos-based products in Grugliasco, hired before 1971. Vital status was determined by performing linkage with the archives of the Tax Register and with the Population Register of Turin. For the persons without information on vital status, a postal follow-up was performed. The cause of death was determined through linkage with the National Registry of Deaths (ISTAT) and by consulting death certificates at the Piedmont Cancer Registry.

Person-years of observation were calculated from January 1, 1981 until death or the end of follow-up (December 31, 1995).

The reference population for estimating the standardised mortality ratios (SMR), with 95% confidence intervals (95% CI), consisted of Turin residents who on the 1981 national census had declared manual work (job position = “manual”; employment status = “employed” or “unemployed looking for work”). Using this reference population allowed the distortion due to the “healthy worker effect” to be reduced. It also allowed us to control for bias due to area of birth and socio-economic factors (Cardano et al., 1999; Mamo et al., 2005).

Results

During the study period, analysing the cohort in the age range of 18-74 years, 967 persons were included in the analysis: 322 men (mean age at enrolment: 54.6 years; SD: 11.7) and 645 women (mean age: 45.9 years; SD: 12.5). The cumulative number of person-years of observation was 10,711 (3,261 for men; 7,450 for women). The median duration of employment in the plant was 6 years for men (standard deviation: 6.1) and 7 for women (SD: 6.9).

For both males and females (Table 1), statistically significant excesses were observed for: overall mortality (among men, SMR = 212; among women, SMR = 265), mortality for cancers overall (SMR = 194 among men and 261 among women), pleural mesothelomias (SMR = 3,322 among men and 13,248 among women), lung cancer (SMR = 302 among men and 523 among women) and asbestosis (SMR = 12,797 among men and 3,124 among women; statistically significant). The average latency for 14 cases of mesotheliomas (period from first hire to date of death) was 29.3 years (SD 11.3; range: 16-52).

Other excesses of interest were observed for ischaemic heart disease and cerebrovascular diseases. When using duration of employment as an indicator of cumulative exposure, the SMR for neoplasms in general increased from 186 (less than 5 years of employment) to 253 (more than 10 years) among men (statistically significant risks) and from 194 to 294 among women (statistically significant). For lung cancer, the SMR was 243 among men with less than 5 years of employment and 411 among those with more than 10 years (both statistically significant). Among women, it increased from 143 to 677. For mesotheliomas, no association was observed for either men or women. For ischaemic heart disease, the SMR increased from 154 for men employed for less than 5 years to 169 for those employed for more than 10 years; among women, it increased from 160 to 365. No association was found for cerebrovascular diseases.

When considering three five-year periods of observation, the SMR for lung cancer among men increased from 159 in the first five years (1981-1985) to 704 in the last 5 years (1990-1995) (statistically significant risk). Among women it remained substantially linear (SMR from 741 to 582). The SMR for mesothelioma increased in the last 5 years of observation only in men, not in women. Among other causes, the SMR for ischaemic heart disease increased in the last 5 years of observation only in women, while the SMR for cerebrovascular diseases increased only in men.

Discussion

The high mortality from mesothelioma and lung cancer was expected. The high SMR from mesothelioma appears even more relevant considering that for many subjects the follow-up was much shorter than the average latency of this cancer. The lack of an evident association between mesothelioma and length of employment is apparently consistent with previously published data. The findings in the literature on the association between chrysotile exposure and lung cancer are contradictory. Some evaluations have stressed that exposure to pure chrysotile is an important risk factor for lung cancer (Stayner et al., 1997; Yano et al., 2001), and studies conducted among persons working with asbestos textiles have shown a positive exposure-response relationship (Brown et al., 1994; Dement et al., 1994; Rosler & Woitowitz, 1995). A case-control study on chrysotile asbestos textile workers in South Carolina found that employment in preparation and carding operations was associated with a slightly reduced, although not statistically significant, risk of lung cancer, whereas spinning and twisting were associated with a statistically significant increased risk (Dement et al., 1994). A study among former workers in a chrysotile asbestos textile plant in South Carolina supported the hypothesis that the high prevalence of asbestosis and lung cancer in these workers resulted from exposure to long fibres of chrysotile asbestos in the workplace (Green et al., 1997). In a study conducted among Italian women compensated for asbestosis, it was observed that there is a greater relationship between lung cancer and chrysotile used for textile production, compared to other types of asbestos (Germani et al., 1999).

With regard to the finding of excesses in mortality for larynx cancer, gastroenteric cancers, pancreatic cancer, based on only a few cases, they were probably casual, although they were described in previous studies. It is possible that the cases of brain cancer could have been cerebral metastases of pleural tumours (Kawai et al, 1997). Statistically significant excesses in the mortality for ischaemic heart disease in cohorts of persons working with asbestos textiles have been reported (Dement et al., 1994). In persons working with chrysotile textiles and miners of chrysotile, excesses in mortality have also been reported for cerebrovascular disease (Dement et al., 1994; McDonald et al., 1993). Nonetheless, the currently available data do not allow a causal association to be affirmed. Regarding the excess in mortality for asbestosis, this was expected (Levy & Wegman, 1995). Regarding cumulative exposure (duration of employment), although the low number of observations did not allow us to draw definitive conclusions on its relationship with specific causes of death, certain findings are worth mentioning. The results concerning lung cancer seem to support the hypothesis of a relationship with the duration of exposure. With regard to mesotheliomas, the lack of an evident association is apparently consistent with previously published data which indicate that the risk of mesotheliomas is not strictly correlated with cumulative exposure.

The study has some limitations. Firstly, the small number of observed deaths was not sufficient to enable us to detect significant associations for many specific causes of death when stratifying for duration of employment and calendar period. Given that our study's observation period only began in 1981, it was not possible to accurately evaluate the effect of latency (to do so it would be necessary to observe each individual from the time that he/she was hired). An important limit of this study may be that we did not control for cigarette smoking. Nonetheless, this potential confounding factor was in part controlled for by the use of a reference population that reflected the study population in terms of socio-economic level and type of profession. However, there remains the problem of a possible interaction between asbestos and smoking in the onset of lung cancer. Other

possible limits were that we assumed that the workers in the cohort were exposed to uniformly high levels of fibres and that the duration of employment could be considered as a good indicator of cumulative exposure.

References

Brown DP, Dement JM, Okun A. 1994. Mortality patterns among female and male chrysotile asbestos textile workers. J Occup Med 1994 Aug;36(8):882-8.

Cardano M, Costa G, Demaria M, Merler E, Biggeri A. Inequalities in mortality in the Italian longitudinal studies. Epidemiol Prev. 1999;23:141-52

Dement JM; Brown DP; Okun A. 1994. Follow-up study of chrysotile asbestos textile workers: cohort mortality and case-control analyses. Am J Ind Med 1994 Oct;26(4):431-47.

Germani D; Belli S; Bruno C; Grignoli M; Nesti M; Pirastu R; Comba P. 1999. Cohort mortality study of women compensated for asbestosis in Italy. Am J Ind Med 1999 Jul;36(1):129-34.

Green FH; Harley R; Vallyathan V; Althouse R; Fick G; Dement J; Mitha R; Pooley F. 1997. Exposure and mineralogical correlates of pulmonary fibrosis in chrysotile asbestos workers. Occup Environ Med 1997 Aug;54(8):549-559.

Kazan Allen L. 2003. The asbestos war. Int J Occ Environ Health; 9: 173-193.

Kawai A, Nagasaka Y, Muraki M, Fukuoka M, Satou T, Kimura M, Hashimoto S. Brain metastasis in malignant pleural mesothelioma. Intern Med. 1997 Aug;36(8):591-4.

Mamo C, Marinacci C, Demaria M, Mirabelli D, Costa G. Factors other than risks in the workplace as determinants of socioeconomic differences in health in Italy. Int J Occup Environ Health. 2005;11:70-76

McDonald JC, Liddell FD, Dufresne A, McDonald AD. 1993. The 1891-1920 birth cohort of Quebec chrysotile miners and millers: mortality 1976-88. Br J Ind Med 1993 Dec;50(12):1073-1081.

Rosler JA; Woitowitz HJ. 1995. Recent data on cancer due to asbestos in Germany. Med Lav 1995 Sep-Oct;86(5):440-8.

Stayner L; Smith R; Bailer J; Gilbert S; Steenland K; Dement J; Brown D; Lemen R. 1997. Exposure-response analysis of risk of respiratory disease associated with occupational exposure to chrysotile asbestos. Occup Environ Med 1997 Sep;54(9):646-52.

Yano E, Wang ZM, Wang XR, Wang MZ, Lan YJ. 2001. Cancer mortality among workers exposed to amphibole-free chrysotile asbestos. Am J Epidemiol 2001 Sep 15;154(6):538-43.

Table 1: Observed Deaths and SMRs for selected causes of death. 1981-1995.

	Males			*Females*		
Causes of death (ICD-IX)	*Obs.*	*SMR*	*95% C.I.*	*Obs.*	*SMR*	*95% C.I.*
All causes	***119***	***212***	***176-254***	***84***	***265***	***211-328***
All cancers	***44***	***194***	***141-251***	***36***	***261***	***183.362***
Cancer of lips, oral cavity, pharynx (140-149)	1	129	2-718	1	560	7-3117
Cancer of oesophagus (150)	1	239	3-1331	0	0	
Cancer of stomach (151)	2	101	10-364	2	218	25-788
Cancer of colon, rectum (153-154)	1	110	1-614	2	169	19-611
Other cancers of digestive apparatus (152,158,159)	1	234	3-1305	2	714	80-2581
Cancer of liver and biliary tract (155-156)	1	50	7-278	0	0	
Cancer of pancreas (157)	2	203	23-733	1	188	3-1048
Cancer of larynx (161)	3	444	90-1297	0	0	
Cancer of lung (162)	22	302	189-457	7	523	210-1079
Mesothelioma of pleura (163)	4	3322	894-8507	10	13248	6342-24365
Female breast cancer (174)	-	-		3	92	19-271
Uterine cancer (179-182)	-	-		0	0	
Ovarian cancer (183)	-	-		1	128	2-712
Cancer of prostate (185)	1	92	1-512	-	-	
Cancer of bladder (188)	0	0		0	0	
Cancer of kidney (189)	0	0		1	596	8-3318
Cancer of brain and nervous system (191-192)	2	297	33-1074	1	219	3-1219
Non-Hodgkin's lymphomas (200 - 202)	0	0		0	0	
Leukaemias (204-208)	0	0		1	255	3-1423
Multiple myeloma (203)	0	0		0	0	
Diabetes mellitus (250)	1	76	1-426	0	0	
All vascular apparatus diseases	***30***	***170***	***115-243***	***18***	***208***	***123-329***
Ischaemic heart diseases (410-414)	10	139	67-256	4	164	44-420
Cerebrovascular diseases (430-438)	8	159	69-314	5	173	56-404
All respiratory apparatus diseases	***18***	***687***	***407-1086***	***7***	***606***	***243-1249***
Asthma, bronchitis and emphysema (490-496)	1	57	7-318	2	345	39-1246
Asbestosis (501)	13	12797	6807-21885	5	3124	1007-7291
Silicosis (502)	1	7808	102-43445	0	0	
Cirrhosis and other chronic hepatic diseases (571)	2	86	10-310	1	86	1-476
Nephritis and other renal diseases (580-589)	0	0		0	0	

Next ⇒