Mortality among masons in Iceland

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ABSTRACT An investigation was carried out to determine the cause of death among 450 masons in Iceland who had been exposed to hexavalent chromium, a trace element in cement. The cohort was defined as all men born between 1905 and 1945 who had, according to the Register of Masons and Stone-cutters, finished vocational training as masons. For deaths occurring between 1951 and 1982 information was obtained from the Statistical Bureau of Iceland. Expected death rates were calculated, based on the national rates for men in the corresponding age groups. The total number of deaths from all causes was less than expected for the whole study period (81 v 85.86) but, with a 20 year latent period, 58 deaths were found against 50.57 expected; with a 30 year latent period, 38 deaths were found against 27.82 expected, which may, to a large extent, be accounted for by an excess of deaths from lung cancer. Nine deaths from lung cancer were found in the cohort, eight with 20 and 30 year latent periods compared with expected rates of 2.87, 2.19, and 1.28 respectively. The results seem to indicate that the increased number of deaths from lung cancer among the masons has a causal relation to occupational exposure.

Trace elements in cement can influence the health of those who work with concrete. The most important of these are nickel, cobalt, and chromium, the last exceeding all other metals in quantity.¹ The concentration of hexavalent chromium in Icelandic cement in 1983 was 5.8-9.4 mg/kg.² Hexavalent chromium in cement has skin sensitising properties and may produce contact dermatitis.^{1,3-5} Chromium compounds are also considered to have adverse effects on the respiratory system. They cause ulceration of the nasal mucosa and perforation of the nasal septum, produce attacks of respiratory distress, and may possibly cause pneumoconiosis.⁶

Among workers in the chromate producing and chromium plating industries studies have shown an excess mortality due to lung cancer.⁷⁻¹¹ In a monograph from the International Agency for Research on Cancer it is concluded that there is sufficient evidence to state that chromates cause lung cancer in those who work with their production.¹² Epidemiological studies so far reported do not allow for an evaluation of the contribution of the different chromium compounds to the risk of developing cancer,¹² nor is it known what exposure levels are safe with respect to the risk of cancer.⁶

The main objective of the present study was to examine the mortality pattern of a cohort of masons,

with a special focus on mortality from cancers and particularly lung cancer. The number of deaths observed in the cohort of masons is compared with those of the male population of Iceland.

We are not aware of any other studies of this type among masons, but a study on workers in cement production showed an excess mortality rate for stomach cancer,¹³ which was considered to be related to dust exposure.

Methods

This is a retrospective cohort study. The cohort is defined as all masons (cement finishers) on record in the Register of Masons and Stone-cutters (Múraratal og steinsmiða)¹⁴ born between 1905 and 1945 who had served their apprenticeship and were fully licensed. Stone-cutters were excluded.

The study population comprised 450 men, their vital status was traced from the year they were licensed as masons until their death or until 1 December 1982, the end of the study period.

Everyone in Iceland is identified by the date of birth, a three digit, and an eight digit number: the latter is called the personal number. Three hundred and sixty one subjects were found in the National Registry at the Statistical Bureau of Iceland on 1 December 1982. This register which, by law, must be kept at the Statistical Bureau of Iceland and consists of everyone living in Iceland is updated each year on

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1 December. Of the 89 subjects not on the National Register, 81 were found through the Register of Deceased, also kept at the Statistical Bureau of Iceland; eight had emigrated. Information on their vital status was obtained through relatives remaining in Iceland as well as Icelandic consulates or embassies. One of the emigres had died.

In this way the vital status of the study population was ascertained for all subjects. Death certificates were obtained from the Statistical Bureau of Iceland and in one case from abroad, and thereby the officially classified underlying cause of death. As different revisions of the International Classification of Diseases (ICD) have been in use under the study period, 1951–82, the certificated causes of death have been reclassified according to the 7th revision. The follow up was started at 1951, the first year for which death certificates were available. Up to that time many death certificates in Iceland were attested by clergymen.

The expected number of deaths was calculated on the basis of man-years of observation within five year age categories during respective single calendar years of the study period, multiplied by the cause and calendar year specific death rates for Icelandic men.^{15 16}

The ratio between observed and expected numbers, or the standardised mortality ratio (SMR) was calculated with 95% confidence intervals, assuming a Poisson distribution.^{15 17}

In a separate analysis the SMR was calculated with a requirement of 20 and 30 year latent period—that is, the time from which the masons were fully licensed to the beginning of the individual observation period under risk. Apprenticeship for masons in Iceland lasts four years, which may be considered as a minimum exposure time for each subject in the study population.

The working tasks of masons in Iceland remained essentially the same throughout the study period. Their functions include preparing concrete by hand or in a concrete mixer, pouring concrete into shuttering, and settling it with a vibrating machine. They also cut and bend metal rods and fix them in concrete forms to reinforce the concrete. Their main tasks, however, have been finishing and smoothing the surfaces of concrete structures and applying smooth surfacing material composed of cement and sand, and

sometimes also of lime to walls, ceilings, and floors. They did no stone cutting and little bricklaying.

Results

Among the 450 men (12 868.0 man-years at risk), there were 82 observed deaths; one had occurred before 1951. Table 1 shows the number of subjects, man-years, and deaths among the masons from 1927 to 1982, with latent periods of 20 and 30 years.

Table 2 shows the SMRs for all causes of death, all malignant neoplasms, the different types of neoplasm, and other categories of deaths from 1951 to 1982. The SMR for all malignant neoplasms was 1.45 (95% confidence limits = 0.95–2.13). An excess of observed deaths, significant at the 1% level, was recorded for malignant neoplasms of the trachea, bronchus, and lung: the SMR was 3.14 (1.43–5.95). The SMR for malignant neoplasms of the bladder and other urinary organs was 5.17, significant at the 5% level. The SMR for all other causes of death which remains when the categories of death shown in table 2 have been subtracted from the total, was 0.50 (0.24–0.92).

Table 3 shows the SMRs obtained when allowance was made for a latent period of 20 years from the date the masons were licensed. The SMR for all malignant neoplasms was 1.64 (1.02–2.51) with 21 observed deaths against 12.79 expected deaths, significant at the 5% level. The SMR for malignant neoplasms of the trachea, bronchus, and lung was 3.65 (1.58–7.20), significant at the 1% level. There was an excess mortality from malignant neoplasms of the bladder and other urinary organs and from cerebrovascular diseases with SMRs of 6.67 (1.37–19.48) and 2.37 (1.02–4.66) respectively; both were significant at the 5% level.

Table 4 shows the SMRs obtained when making allowance for a latent period of 30 years. The rise in mortality from all causes is accounted for by an excess of deaths from malignant neoplasms and, particularly, neoplasms of the trachea, bronchus, and lung. The SMR for all malignant neoplasms was 2.23 (1.30–3.57), significant at the 1% level. The SMR for malignant neoplasms of the trachea, bronchus, and lung was 6.25 (2.70–12.31), significant at the 0.1% level.

Table 1 Number of masons in study group, number of man-years, and number of deaths between 1927 and 1982 with latent periods of 20 and 30 years

Groups	No of subjects	No of man-years	No of deaths
Masons, man-years during 1927–82	450	12868.0	82
Masons, 20 year latent period, man-years during 1947–82	389	4202.0	58
Masons, 30 year latent period, man-years during 1957–82	201	1553.5	38

Table 2 Observed and expected number of deaths, SMR, and 95% confidence limits for 449 masons, 1951–82

Cause of death (ICD, 7th revision)	Observed deaths	Expected deaths	SMR	95% Confidence limits	
				Lower	Upper
All causes (001–E985)	81	85.86	0.94	0.75	1.17
Malignant neoplasms (140–205)	26	17.92	1.45	0.95	2.13
of stomach (151)	5	4.30	1.16	0.38	2.71
of large intestine (152, 153)	1	1.07	0.93	0.02	5.21
of rectum (154)	1	0.54	1.85	0.05	10.32
of trachea, bronchus, and lung (162, 163)	9	2.87	3.14	1.43	5.95**
of bladder and other urinary organs (181)	3	0.58	5.17	1.07	15.12**
other (140, 155, 161, 193, 199, 204)	7	8.56	0.82	0.33	1.68
Cerebrovascular disease (330–334)	9	4.96	1.81	0.83	3.44
Ischaemic heart disease (420)	23	25.88	0.89	0.56	1.33
Respiratory disease (470–527)	2	3.14	0.64	0.08	2.30
Accidents (E800–E985)	11	14.07	0.78	0.39	1.40
All other causes (295, 340, 434, 443, 450, 451, 541, 569, 602, 795)	10	19.89	0.50	0.24	0.92*

*SMR statistically significant at the 5% level ($p < 0.05$), two-tailed.**SMR statistically significant at the 1% level ($p < 0.01$), two-tailed.

Table 3 Observed and expected number of deaths, SMR, and 95% confidence limits for 389 masons with a latent period of 20 years after finishing vocational training

Cause of death (ICD, 7th revision)	Observed deaths	Expected deaths	SMR	95% Confidence limits	
				Lower	Upper
All causes (001–E985)	58	50.57	1.15	0.87	1.48
Malignant neoplasms (140–205)	21	12.79	1.64	1.02	2.51*
of stomach (151)	3	2.99	1.00	0.21	2.93
of large intestine (152, 153)	0	0.77			
of rectum (154)	1	0.41	2.44	0.06	13.59
of trachea, bronchus, and lung (162, 163)	8	2.19	3.65	1.58	7.20**
of bladder and other urinary organs (181)	3	0.45	6.67	1.37	19.48**
other (140, 155, 161, 193, 199, 204)	6	5.98	1.00	0.37	2.18
Cerebrovascular disease (330–334)	8	3.38	2.37	1.02	4.66*
Ischaemic heart disease (420)	15	19.55	0.77	0.43	1.27
Respiratory disease (470–527)	2	2.18	0.92	0.11	3.31
Accidents (E800–E985)	3	5.25	0.57	0.12	1.67
All other causes (295, 340, 443, 450, 451, 541, 569, 602, 795)	9	7.42	1.21	0.55	2.30

*SMR statistically significant at the 5% level ($p < 0.05$), two tailed.**SMR statistically significant at the 1% level ($p < 0.01$), two tailed.

Table 4 Observed and expected number of deaths, SMR, and 95% confidence limits for 251 masons with a latent period of 30 years after finishing vocational training

Cause of death (ICD, 7th revision)	Observed deaths	Expected deaths	SMR	95% Confidence limits	
				Lower	Upper
All causes (001–E985)	38	27.82	1.37	0.97	1.87
Malignant neoplasms (140–205)	17	7.62	2.23	1.30	3.57**
of stomach (151)	3	1.70	1.76	0.36	5.16
of large intestine (152, 153)	0	0.45			
of rectum (154)	1	0.25	4.00	0.10	22.29
of trachea, bronchus, and lung (162, 163)	8	1.28	6.25	2.70	12.31***
of bladder and other urinary organs (181)	1	0.26	3.85	0.10	21.43
other (140, 155, 161, 204)	4	3.68	1.09	0.30	2.78
Cerebrovascular disease (330–334)	2	2.09	0.96	0.12	3.46
Ischaemic heart disease (420)	11	11.61	0.95	0.47	1.70
Respiratory disease (470–527)	2	1.33	1.50	0.18	5.43
Accidents (E800–E985)	1	1.98	0.51	0.01	2.81
All other causes (295, 340, 451, 541, 569, 602)	5	3.19	1.57	0.51	3.66

SMR statistically significant at the 1% level ($p < 0.01$), two tailed.*SMR statistically significant at the 0.1% level ($p < 0.001$), two tailed.

Discussion

It is interesting to observe the increase in the SMR for all causes of death, all malignant neoplasms, and malignant neoplasms of the trachea, bronchus, and lung, which may be seen in tables 2, 3, and 4. The SMR for all causes of death increases from 0.94 for the whole study period (1951–82) to 1.15 with a 20 year latent period and to 1.37 with a 30 year latent period; the last value almost reaches statistical significance.

The SMR for all malignant neoplasms between 1951 and 1982 lacks statistical significance but becomes significant at the 5% level with a latent period of 20 years and at the 1% level with a latency of 30 years. For lung cancer, the SMR was 3.14 overall, 3.65 with a 20 year latency and 6.25 with a 30 year latency, with increasing levels of statistical significance.

The object of this study was to determine whether the risk of lung cancer is associated with the occupational exposures experienced by masons who have been fully licensed. Every member of the study population had vocational training for four years, during which period they all worked with cement and concrete as cement finishers. The training period may be looked on as a minimum exposure time, but individual exposure thereafter has differed with regard both to type and magnitude.

We are not aware of any other published mortality studies of masons. The present results cannot therefore be compared with some results, which perhaps makes them more striking since no healthy worker effect is observed but a higher than expected mortality was found with both 20 and 30 year latent periods.

Cigarette smoking is related to cancer, especially to lung cancer. It might be stated hypothetically that the presence of many heavy smokers among the masons could contribute to their excess of deaths from lung cancer. If this were so, however, an excess mortality would also be observed from other causes that have been related to cigarette smoking, such as coronary heart disease, non-malignant respiratory diseases and cancers of the larynx, pancreas, oesophagus, and bladder.^{18,19} In the present study among masons no excess mortality was found from these diseases except for cancer of the bladder. Thus it is improbable that the excess risk of dying from lung cancer found here is explained by excess cigarette smoking among the masons. The same arguments have been put forward in discussion of the results from a similar study.²⁰

In Axelson's discussion on the evaluation of confounding he has taken cigarette smoking as an example.²¹ From his hypothetical calculations it has been concluded that controlling for smoking in a study becomes relevant when the SMR is of less than 300²²; in the case of lung cancer in occupational mortality studies the share of confounding caused by smoking

is, in practice, insignificant whenever the SMR exceeds 300. In the light of these facts and the high SMR for lung cancer in the present study, it is concluded that the excess risk among the masons of dying from lung cancer is unlikely to be explained by a greater number of smokers among them than among the general population.

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