CANCER MORTALITY AMONG SILICOTIC CASES

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INTRODUCTION

This study takes into consideration the mortality related to all site cancer, to lung and laryngeal cancer, to silicosis and silico-tuberculosis, and to chronic non-malignant respiratory diseases among workers professionally exposed to silica.

The aim of the investigation is to ascertain whether a cancer mortality excess, particularly from lung cancer, exists, and to identify from which factors is affected.

The role of different working exposures and smoking habits in inducing lung cancer has been investigated.

METHODS

The Archives of Turin office of the National Institute of Insurance (I.N.A.I.L.) were examined and the clinical documentation was collected for each male worker who received compensation for silicosis and died between 1970 and 1983; 746 subjects were included in the study.

The following data were obtained: date of birth, type of occupation in industry, year of starting and ceasing exposure, compensation year and percentage, year and cause of death through death certificate; smoking habits were also investigated.

Mortality analysis has been carried out using the Standardized Proportional Mortality Ratio (SPMR).[1,2]

RESULTS

In Table I overall mortality data, and observed and expected deaths related to specific causes as well as Standardized Proportional Mortality Ratios (SPMR) are shown.

A lung cancer mortality excess (81 observed cases versus 59.50 expected—PMR 136; 95% C.L. 111—162) was found, together with a high mortality rate (27.8%) related to silica dust exposure.

In Tables II, III, and IV, observed and expected deaths related to specific causes are arranged according to exposure in the different working activities.

The 746 cases were divided in three groups: the first one covering mine, quarry and tunnel workers, the second one

Table I
Mortality: Overall and by Causes

	OBSERVED (%)	EXPECTED	PMR
ALL CAUSES	746 (100)	-	-
ALL CANCERS	158 (21.2)	198	80
LUNG CANCER	81 (10.8)	59.5	136 *
LARYNX CANCER	6 (0.8)	7.86	76
CHRONIC NMRD	45 (6)	46.97	95
SILICOSIS	176** (23.6)	-	-
SILICO-TB	31** (4.2)	-	-

* $p < 0.05$
** 27.8 % as mentioned in the text

Table II

Mortality: Overall and by Causes According to Job
Underground Workers and Stonecutters

	OBSERVED (%)	EXPECTED	PMR
ALL CAUSES	239 (100)	-	-
ALL CANCERS	37 (15.5)	65.41	57.6
LUNG CANCER	21 (8.8)	19.88	106
LARYNX CANCER	2 (0.8)	2.66	75
CHRONIC NMRD	4 (1.7)	14.55	27
SILICOSIS	96 (40.2)	-	-
SILICO-TB	31 (7.1)	-	-

Table III

Mortality: Overall and by Causes According to Job
Foundry Workers

	OBSERVED (%)	EXPECTED	PMR
ALL CAUSES	457 (100)	-	-
ALL CANCERS	111 (24.3)	119.65	93
LUNG CANCER	56 (12.3)	35.22	159 *
LARYNX CANCER	4 (0.9)	4.79	84
CHRONIC NMRD	36 (7.9)	29.60	122
SILICOSIS	67 (14.7)	-	-
SILICO-TB	8 (1.7)	-	-

* p < 0.05

covering foundry workers and the third one assembling all other remaining works in which a silicogenic risk is attributable: pottery, tile, glass, refractory material industries, etc.

According to this analysis a mortality excess from lung cancer is present only in the category of foundry workers (56 observed cases versus 35.2 expected—PMR 159; 95% C.L. 126—192); in the first group (miners, quarrymen, stonecutters) an increased mortality from silicosis and silico-tuberculosis is observed close to a markedly reduced mortality from chronic non-malignant respiratory diseases (NMRD) (4 observed cases versus 14.55 expected).

This result led to focus a few parameters, among those better documented, which could affect the lung cancer excess confined to foundry workers. We meant particularly to stress out the possible role in inducing pulmonary neoplasm of the type of industry, and related different intensity of silica exposure, and of the smoking habits.

Information concerning smoking habits has been collected for more than 2/3 of the group under examination. Table V shows a significant mortality increase from lung cancer in smoking foundry workers: 38 observed cases versus 21.82 expected—PMR 174; 95% C.L. 132.13–215.94.

The group of non-smoking silicotic foundry workers is numerically too small to provide statistical significance to apparent mortality increase from lung cancer observed also in this group (10 observed cases versus 6.31 expected—PMR 158). Nevertheless by means of a procedure formerly used by

Saracci[3] to assess expected values in cohorts of smokers and non-smokers, is possible to assume that mortality rates from lung cancer in the general population (which in Italy includes1/2–1/3 of smokers) are at least four times greater than those of the non-smokers. Therefore lung cancer mortality risk in non-smoking foundrymen seems to be underestimated. Table VI shows the results adjusted for smoking habit, that is 10 observed cases versus 1.57 expected; this data achieves the conventional limits of statistical significance.

In Table VII lung cancer mortality has been related to exposure length. This sorting criteria shows a lung cancer mortality excess, both in the group whose exposure duration is covered between 11 and 20 years (21 observed cases versus 12.15 expected—PMR 173; 95% C.L. 116.5–229.1), and in that whose exposure duration is more than 20 years (29 observed cases versus 18.26 expected—PMR 159; 95% C.L. 113.05–204.8).

In Table VIII foundry workers have been divided in two

Table IV
Mortality: Overall and by Causes According to Job
Other Activities

	OBSERVED (%)	EXPECTED	PMR
ALL CAUSES	50 (100)	-	-
ALL CANCERS	10 (20)	13.96	71
LUNG CANCER	4 (8)	4.23	94
LARYNX CANCER	0	-	-
CHRONIC NMRD	5 (10)	3.06	160
SILICOSIS	13 (26)	-	-
SILICO-TB	6 (12)	-	-

Table V
Lung Cancer—Observed and Expected Deaths and PMR
According to Smoking Habit—Foundry Workers

	OBSERVED	EXPECTED	PMR
NON SMOKERS	10	6.31	158
SMOKERS	38	21.82	174 *

* p < 0.05

Table VI
Lung Cancer—O/E Deaths and PMR According to Smoking Habit
—Expected Values Adjusted for Smoking

	OBSERVED	EXPECTED	PMR
NON SMOKERS	10	1.57	636 *
SMOKERS	38	27.27	139 *

* p < 0.05

groups in accordance with the average exposure characteristic of job title:[4] (1) lower risk of silica exposure (melting, furnace worker, pouring, coremaking, cut-off saw, molding, crane driving, gathering motormen, mechanical and electrical maintenance staff). (2) higher risk of silica exposure (earths and sands system, muller, grinder, chipper, sandblaster, shot blaster, tumbler, relining and repair).

In the first group the excess risk for lung cancer is statistically significant (36 observed cases versus 21.93 expected—PMR 164; 95% C.L. 122.3–206), whereas in the second group such an excess is still present but doesn't attain the conventional limits for statistical significance. Thus no relationship between lung cancer prevalence and silicotic exposure estimate seems to be present in foundry workers group.

DISCUSSION

The assumption that silica has a causal role in inducing pulmonary neoplasm is still under debate.

In a recent literature review Goldsmith[5] agreed with this hypothesis and acknowledged that silica exposure allows an enhanced risk of developing lung cancer. In historical cohort studies[6,7] and in a recent Italian case-referent study[8] an overall excess risk for lung cancer was found in workers compensated for silicosis in different industrial activities.

On the other hand the same assumption has been strictly criticized by Heppleston[9] who considered these inferences not sufficiently demonstrated, chiefly as regards the confounding effect of smoking habits. Further on, Swaen[10] argues that it is unlikely that the confounding effect of smoking can explain the high relative risk for lung cancer in workers with silicosis.

This study considers silica exposure as predominant in three categories of workers, namely miners, foundry workers and employees in other industrial fields like glass manufacturing, potting and brick works, etc. For this third group it is impossible to draw valid appraisals.

Table VII

Lung Cancer—Observed and Expected Deaths and PMR
According to Exposure Duration—Foundry Workers

	1 - 10 years			11 -20 years			> 20 years		
	OBS.	EXP.	PMR	OBS.	EXP.	PMR	OBS.	EXP.	PMR
ALL CAUSES	50			146			253		
LUNG CANCER	6	4.95	121	21	12.2	173 *	29	18.3	159 *

* p < 0.05

Table VIII

Lung Cancer—Observed and Expected Deaths and PMR
According to Exposure Level—Foundry Workers

	high risk of silica exposure			low risk of silica exposure		
	OBSERV.	EXPECT.	PMR	OBSERV.	EXPECT.	PMR
ALL CAUSES	175			282		
LUNG CANCER	20	13.39	149	36	21.93	164 *

* p < 0.05

In the first group, which is mainly formed of underground workers and stonecutters, almost exclusively exposed to silica, the collected data don't point out a mortality excess from lung cancer. This result, as far as concerns talc miners, confirms our data on miners of Piedmont (Italy Region).[11,12] Previous researches by Goldman,[13] Ashley,[14] Enterline,[15] Liddel[16] and Howard,[17] did not underline an increased mortality for lung cancer in coal miners. So that it may be assumed that no relationship exists between lung cancer and mine and quarry working activities, when specific carcinogenic agents (ionizing radiations, asbestos, etc.) are absent. This conclusion has been debated by Finkelstein[18] who reported an increased mortality for lung cancer in an Ontario miners population compensated for silicosis; no final estimate was drawn about the possible causal role of silica dust in inducing neoplasm. No definite statements are any more expressed in the report by Thomas[19] in which the role of silica itself as a cofactor in inducing lung cancer in pottery workers exposed to silica and non-fibrous talc cannot be ruled out.

On the contrary, through the analysis of data concerning silicosis cases in foundry workers, an increased mortality risk for lung cancer emerges.

This special risk does not seem solely related to smoking habit, since also in the group of non-smoking workers a significant mortality excess from lung cancer is present.

A similar result has been reported by Blot[20] in an investigation on a group of steel plant workers in which the mortality excess from lung cancer still persists after cigarette smoking adjustment.

Other reports confirm as well the presence of an increased lung cancer mortality in foundry workers.[21,22,23,24,25]

In our study the enhanced mortality risk for pulmonary neoplasm does not seem related to silicotic risk: an increased risk is not present in the group of underground workers (exposed to high silica level) and a significant excess of lung cancer is present in the group of foundry workers rated at low silica exposure. This remark agrees with a Tola's[26] observation in which the relationship between lung cancer mortality and specific occupation is evaluated.

In conclusion we can hypothesize that in foundry workplaces other risk factors (Polycyclic Aromatic Hydrocarbons?) than silica are present and they can play a role at least concomitant in inducing pulmonary cancer.

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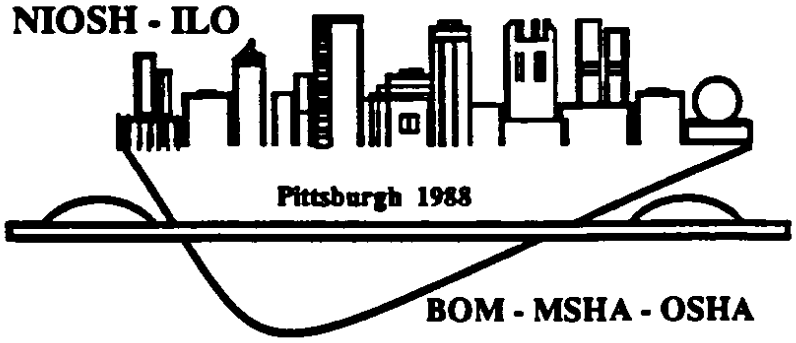
II



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