

# Mortality among workers in an Italian cigarette factory

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A cohort study was conducted to evaluate the mortality pattern among female and male workers in a cigarette factory. The study followed 972 female workers and 761 male workers with at least 6 months of cumulative employment from 1 January 1962 through 1 July 1996. Among women, mortality from all causes of death [standardized mortality ratio (SMR) = 0.9; 95% confidence interval (CI) = 0.8–1.1] and mortality from all malignant neoplasms (SMR = 1.1; CI = 0.9–1.3) were consistent with reference rates. Male workers had a significantly reduced overall mortality (SMR = 0.8; CI = 0.7–0.9), while mortality from all malignant neoplasms was as expected (SMR = 0.9; CI = 0.7–1.0). Among female workers the frequencies of deaths from diseases of nervous system (SMR = 2.0; CI = 1.1–3.4) and from non-Hodgkin's lymphoma (NHL) (SMR = 2.7; CI = 1.0–5.6) were elevated at a statistically significant level. No association between duration of employment and diseases of nervous system was observed. A higher risk for NHL, based on three deaths, was reported among female workers with 15 or more years of employment (SMR = 8.1; CI = 2.2–21.0). Although based on small numbers, the excess of NHL here reported suggests that potential exposure to foliar residues of pesticides should be thoroughly considered in tobacco manufacturing.

**Key words:** Mortality; non-Hodgkin's lymphoma; pesticides; tobacco industry.

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## INTRODUCTION

Workers in the tobacco industry may experience exposure to certain environmental hazards, including tobacco leaf dusts, and pesticides remaining on tobacco as residues from field or post-harvesting applications. Furthermore, exposure to asbestos should be considered since this material could have been extensively used as insulation in the heating system for drying processes.

In a few studies mortality pattern and cancer incidence among this group of workers have been analyzed, showing inconsistent results. An early study carried out in the US among workers in cigarette factories did not show any appreciable difference between this occupational group and the general population in total and cause-specific mortality rates.<sup>1</sup> Subsequently, an increased

mortality from colon cancer was reported in two studies.<sup>2,3</sup> Increased risk from lung cancer was reported among tobacco workers in Denmark, on the basis of the National Cancer Registry. Male workers were also found to be at increased risk from acute leukaemia, while female workers showed excesses for laryngeal cancer and breast cancer.<sup>4,5</sup> In a case-control study on bladder cancer and occupation, carried out in England and Wales, excess cases were reported among tobacco workers.<sup>6</sup> Increased risk of prostate cancer was reported in association with exposure to tobacco dust in a Canadian study.<sup>7</sup>

The present cohort study was aimed at evaluating the mortality patterns among female and male workers in a cigarette factory located in Bologna, North East Italy.

## MATERIALS AND METHODS

The factory under study began production of different types of cigarette in 1962. The size of the factory

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varied from approximately 820 employees engaged in production-related jobs between the early 1970s and late 1980s, to 120 employees in 1998. Around 30,000 kg of tobacco per day had been manufactured until the late 1980s, while around 10,000 kg per day are currently processed (1998).

Tobacco is received at the factory in bales which are pre-moistened and opened in order to perform stemming and cutting operations on the leaves. Subsequently, the tobacco is subjected to several operations, including moisture adjustment, toasting, curing, addition of humectants and flavours, and blending.

Cigarette making is performed by binding machines which wrap the tobacco in paper to form a continuous cigarette which is subsequently cut at definite intervals. In the same factory cigarettes are assembled and packaged for sale. Tobacco in bales is stored at the factory at ambient temperature in a warehouse and treated with insecticides from April to September. Tetrachlorvinphos, an organophosphate, is used primarily, while  $\gamma$ -hexane is occasionally applied. Fumigation with methyl bromide is usually performed before tobacco processing.

Male workers were engaged in the primary processing of tobacco and as maintenance staff, while female workers were mainly employed in making up processes.

The cohort under study consisted of all workers (972 women and 761 men) employed at the tobacco factory for at least six months in cigarette manufacturing and related jobs between 1 January 1962 and 1 January 1990. Employees were identified from plant personnel records and for each of them the full name, date of birth, address and dates of starting and finishing work were abstracted.

Members of the cohort were traced through the Municipal Offices of residence, and their vital status, as of 1 July 1996, was determined. For deceased persons, the underlying causes of death reported on death certificates were provided by the same Offices, and were coded to the Ninth Revision of the International Classification of Diseases (ICD-9).<sup>8</sup>

At the end of the follow-up period, 715 women (73.6%) and 535 men (70.3%) were found to be alive. Of the original female participants, 247 (25.4%) were deceased and 10 (1.0%) had unknown vital status. Of the original male participants, 220 (28.9%) were deceased and six (0.8%) had unknown vital status (Table 1).

Person-years at risk were accumulated from the date of hire to 1 July 1996 or date of death, whichever occurred first. Those whose vital status was unknown were assumed to be alive.

Expected numbers of deaths were obtained by multiplying gender- and cause-specific mortality rates for the Emilia Romagna region population by the person-years at risk in the study cohort, and adjusting for age and calendar period. Standardized mortality ratios (SMR), computed by dividing the observed number of deaths by the expected number, and two-sided 95% confidence intervals (CI), based on Poisson distribution, were obtained using the PC-OCMAP package software.<sup>9</sup>

**Table 1.** Vital status and employment characteristics of female and male workers in a cigarette factory, 1962–96 (Bologna, Italy)

Variables	Women (%)	Men (%)
<b>Vital status</b>		
Alive	715 (73.6)	535 (70.3)
Dead	247 (25.4)	220 (28.9)
Unknown	10 (1.0)	6 (0.8)
Total	972 (100.0)	761 (100.0)
<b>Deaths</b>		
Obtained death certificate	236 (95.5)	212 (96.4)
Person-years	26,542.8	19,894.0
<b>Age at hire (yrs)</b>		
15–19	0 (0.0)	1 (0.1)
20–29	268 (27.6)	341 (44.8)
30–39	269 (27.7)	187 (24.6)
40–49	338 (34.8)	135 (17.7)
50+	97 (10.0)	97 (12.7)
<b>Year hired</b>		
1962–69	666 (68.5)	494 (64.9)
1970–79	249 (25.5)	221 (29.1)
1980–96	57 (6.0)	46 (6.0)
<b>Duration of employment (yrs)</b>		
<5	162 (16.7)	88 (11.6)
5–9.9	166 (17.1)	77 (10.1)
10–14.9	358 (36.8)	165 (21.7)
15+	286 (29.4)	431 (56.6)

## RESULTS

Female and male workers showed similar mortality patterns for main causes of death (Table 2).

Among the women, overall mortality was as expected from regional rates in Emilia Romagna (SMR = 0.9; CI = 0.8–1.1), as was mortality from malignant neoplasms (SMR = 1.1; CI = 0.9–1.3); diseases of the circulatory system (SMR = 0.9; CI = 0.7–1.0) and diseases of the respiratory system (SMR = 1.0; CI = 0.5–1.6). An excess of deaths from diseases of the nervous system was detected (SMR = 2.0; CI = 1.1–3.4). This category of causes of death included three cases of Alzheimer's disease, three cases of Parkinson's disease, two deaths from amyotrophic lateral sclerosis and two cases of paresis. Female workers with less than five years of employment in tobacco manufacturing showed an increased risk for diseases of the nervous system (SMR = 2.0; CI = 0.5–5.1; three deaths) similar to that reported among workers with five or more years of tobacco industry employment (SMR = 2.1; CI = 1.0–3.9; seven deaths). Deaths from injury and poisoning were fewer than expected (SMR = 0.5; CI = 0.2–1.0).

Among male workers, mortality from all causes combined was significantly reduced (SMR = 0.8; CI = 0.7–0.9), while the number of deaths observed for all malignant neoplasms (SMR = 0.9; CI = 0.7–1.0); diseases of the circulatory system (SMR = 0.9; CI = 0.8–1.1) and diseases of the respiratory system (SMR = 0.7; CI = 0.4–1.1) were comparable to those expected. Deaths from injury and poisoning were significantly reduced (SMR = 0.4; CI = 0.2–0.7).

**Table 2.** Observed (Obs) numbers of deaths in the major disease categories, standardized mortality ratios (SMRs) adjusted by age and calendar period, and 95% confidence intervals (95% CI) for female and male workers in a cigarette factory, 1962–96 (Bologna, Italy)

Cause (9th ICD) <sup>a</sup>	Women			Men		
	Obs.	SMR	95% CI	Obs.	SMR	95% CI
All causes of death (001–999)	236	0.9	0.8–1.1	212	0.8**	0.7–0.9
All malignant neoplasms (140–209)	85	1.1	0.9–1.3	73	0.9	0.7–1.0
Diseases of nervous system (320–358)	10	2.0*	1.1–3.4	1	0.3	0.0–1.2
Diseases of circulatory system (390–458)	95	0.9	0.7–1.0	95	0.9	0.7–1.1
Diseases of respiratory system (460–519)	10	1.0	0.5–1.6	11	0.7	0.4–1.1
Diseases of digestive system (520–577)	14	1.2	0.7–1.8	15	0.9	0.6–1.5
Diseases of genito-urinary system (580–629)	2	0.6	0.1–2.0	1	0.3	0.0–1.3
Ill defined (780–799)	1	0.3	0.0–1.6	3	1.2	0.3–3.2
Injury and poisoning (800–999)	5	0.5*	0.2–1.0	7	0.4**	0.2–0.7
Unknown (000)	11			8		

\*  $p < 0.05$ ; \*\*  $p < 0.01$ 

Detailed analysis for specific type of malignant neoplasms (Table 3) showed a non-statistically significant increase for breast cancer (SMR = 1.3; CI = 0.9–2.0) among the women. The number of deaths from uterine

(SMR = 1.5; CI = 0.8–2.6) and ovarian (SMR = 1.3; CI = 0.5–2.7) cancers were also slightly higher than expected. Female workers were characterized by a statistically significant excess of deaths from NHL (SMR

**Table 3.** Observed (Obs) numbers of death from malignant neoplasms, standardized mortality ratios (SMRs) adjusted by age and calendar period, and 95% confidence intervals (95% CI) for female and male workers in a cigarette factory, 1962–96 (Bologna, Italy)

Malignant neoplasm (9th ICD) <sup>a</sup>	Women			Men		
	Obs.	SMR	95% CI	Obs.	SMR	95% CI
Oesophagus (150)	0			1	0.7	0.0–3.4
Stomach (151)	11	1.0	0.6–1.7	7	0.5*	0.2–1.0
Large intestine (153)	3	0.4	0.1–1.2	6	1.2	0.5–2.3
Rectum (154)	2	0.7	0.1–2.1	2	0.7	0.1–2.1
Liver (155)	3	1.8	0.5–4.6	1	0.5	0.0–2.1
Gall bladder and bile ducts (156)	2	1.1	0.2–3.6	0		
Pancreas (157)	5	1.4	0.5–2.8	2	0.6	0.1–1.9
Peritoneum and retroperitoneum (158)	1	1.6	0.0–7.5	1	2.5	0.1–11.6
Larynx (161)	0			1	0.5	0.0–2.3
Lung (162)	7	1.2	0.6–2.2	27	1.1	0.8–1.5
Pleura (163)	1	3.4	0.2–16.2	0		
Breast (174)	19	1.3	0.9–2.0	—		
Uterus (180)	9	1.5	0.8–2.6	—		
Ovary (183)	5	1.3	0.5–2.7	—		
Prostate (185)				1	0.2*	0.0–1.0
Bladder (188)	2	1.7	0.3–5.5	4	1.2	0.4–2.7
Kidney (189)	1	0.7	0.0–3.5	4	2.0	0.7–4.7
Brain (191)	3	1.7	0.5–4.3	3	2.0	0.5–5.0
Thyroid (193)	1	1.9	0.0–8.9	0		
Ill-defined (195–198)	2	1.5	0.3–4.8	2	2.3	0.4–7.2
Unspecified (199)	0			3	1.6	0.4–4.2
Non-Hodgkin's lymphoma (200, 202)	5	2.7*	1.0–5.6	0		
Multiple myeloma (203)	1	0.9	0.0–4.3	2	2.3	0.4–7.1
Leukaemia (204–207)	2	0.8	0.1–2.4	4	1.6	0.5–3.6

\*  $p < 0.05$

= 2.7; CI = 1.0–5.6). The observed excess was further increased among women who had spent at least 15 years at the factory under study (SMR = 8.3; CI = 2.3–21.4; three deaths). One death from pleural mesothelioma was observed *vs.* 0.3 expected. Male workers did not show any statistically significant increase for specific types of cancer (Table 3).

## DISCUSSION

In the present cohort male cigarette manufacturing workers showed an overall mortality rate significantly lower than that expected from reference rates. Furthermore, no excesses of respiratory and cardiovascular diseases were observed. Similar results were also observed among women. These observations could only partially be explained by a healthy worker effect, since 68.6% of female workers and 80.0% of male workers had been employed at the factory under study for 10 or more years, and the mean duration of follow-up was 27 and 26 years for women and men, respectively.

A few statistically significant excesses were only observed among female workers, including diseases of the nervous system and NHL. Similar risks for diseases of the nervous system were observed among female workers with less than five years duration of employment and among those with five years or more, suggesting that the excess observed in the cohort should be mainly considered a chance finding.

There were five deaths due to NHL among the female workers. All of them occurred in women with at least five years duration of employment. The risk of NHL was particularly increased among women who had worked at least 15 years in tobacco manufacturing. No cases of NHL were reported among male workers as compared with the 1.7 expected, however. This type of malignant neoplasm has been associated with exposure to organochlorurate compounds,<sup>10</sup> phenoxyacid herbicides,<sup>11–13</sup> organophosphorus insecticides<sup>13–15</sup> and solvents.<sup>16</sup> Exposure to residues of pesticides may have occurred in the factory under study since stocked tobacco leaves were usually treated from April to October with insecticides and barn-fumigants before processing. Trichlorvinphos and methyl bromide were the main pesticides used and were applied by seasonal workers not included in the cohort. Male and female workers in the cohort, although involved in different tasks, tended to share similar environmental conditions, and it appears rather unlikely that female workers had experienced higher exposure to residues of pesticides than had the male workers. Nevertheless, potential for exposure to pesticides should be considered and carefully accounted for during tobacco manufacturing.

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