Environmental and occupational cancer in Argentina: a case-control lung cancer study

Cáncer ambiental y ocupacional en Argentina: estudio de un caso-control en cáncer de pulmón

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Abstract *The main objective of this study was to analyze the risks for lung cancer associated with occupational exposures in a developing country where lung cancer is the first cause of mortality from cancer in men. The study involved 200 men with lung cancer and 397 hospital controls. The OR for current smokers was 8.5, whereas former smokers displayed an OR of 5.3. The fraction attributable to smoking was 85%. Statistically significant high ORs were observed for employment in the alcoholic beverages industry (4.5, 95% CI:1.02-20.2), sawmills and wood mills (4.6, 95% CI:1.1-18.4), chemicals/plastics (1.8, 95% CI:1.04-3.2), and pottery, glass, or mineral manufactures (3.4, 95% CI:1.1-10.6). Other high, but not statistically significant, risks were observed for employment in leather shoe industry and repair (2.1, 95% CI:0.8-5.4), rubber industries (3.4, 95% CI:0.9-12.4), metal workers, including welders (1.9, 95% CI:0.8-4.4), motor vehicle mechanics (2.0, 95% CI:0.9-4.2), workers in cleaning services (1.9, 95% CI:0.8-4.5), and for workers in agriculture (2.4, 95% CI:0.9-6.0). Although some of the present results may be due to chance, most are consistent with those of previous investigations in other countries.*
Key words *Occupational Exposure; Lung Neoplasms; Case-Control Studies*

Resumen *El objetivo principal de este estudio fue analizar los riesgos para cáncer de pulmón asociados con exposiciones ocupacionales, en un país en vías de desarrollo donde el cáncer de pulmón es la primera causa de mortalidad por cáncer en hombres. El estudio incluyó 200 hombres con esta patología y 397 controles hospitalarios. El OR para fumadores actuales fue 8,5, mientras que los ex-fumadores mostraron un OR de 5,3. La fracción atribuible al hábito de fumar fue de 85%. Se observaron riesgos estadísticamente significativos para: empleo en la industria de bebidas alcohólicas (4,5, 95% CI:1,02-20,2), aserraderos (4,6, 95% CI:1,1-18,4), industrias químicas, plásticos (1,8, 95% CI:1,04-3,2), cerámica, loza, vidrio o productos minerales no metálicos (3,4, 95% CI:1,1-10,6). Otros riesgos elevados, pero sin significación estadística, fueron encontrados para la industria y el trabajo en la reparación del calzado de cuero (2,1, 95% CI:0,8-5,4), la industria de la goma (3,4, 95% CI:0,9-12,4), el grupo de metalúrgicos que incluye los soldadores (1,9, 95% CI:0,8-4,4), los mecánicos de automotores (2,0, 95% CI:0,9-4,2), los trabajadores en servicios de limpieza (1,9, 95% CI:0,8-4,5) y los trabajadores agrícolas (2,4, 95% CI:0,9-6,0). Si bien algunos de los presentes resultados pueden ser debidos al azar, la mayoría son consistentes con los obtenidos en investigaciones previas en otros países.*
Palabras clave *Exposición Ocupacional; Neoplasias Pulmonares; Estudios de Casos y Controles*

Introduction

In Argentina, as in many industrializing countries, vascular and neoplastic diseases are now the chief causes of premature death. Cancer is the second cause of death, and lung cancer is the first neoplastic cause of death among males, with an age-adjusted mortality rate of 39.0/100,000 for the period 1989-1992. The rate for females, 6.1/100,000 for the same period, is still low compared to the rates in developed countries (Matos et al., 1997).

Very few data are available regarding cancer incidence in the country. In La Plata, the in the Province of Buenos Aires, data from 1980 showed an annual age-standardized lung cancer incidence rate of 40.3/100,000 among males (Alvarez-Gelves & Perez-Arias, 1986). More recent figures in the country are available only from the population-based Tumor Registry of the Department of Concordia, Entre Rios. The rates were 55.8/100,000 for males and 8.3 for females, for the period 1990-1994 (Prince et al., 1997).

Environmental and occupational cancer research is still in its initial developmental stage in Argentina. Issues that have been addressed regarding environmental causes of cancer are natural exposure to groundwater with high levels of arsenic, exposure to sunlight, and tobacco smoking. Cancer in populations immigrating into Argentina, allowing the comparison of disease risk in populations of similar genetic background living in different environments, has also been analyzed.

Argentina has several areas with high natural concentrations of arsenic in groundwater. Elevated standardized mortality ratios (SMRs) for bladder cancer, associated with average concentrations of up to 533 µg/liter measured in the province of Cordoba, were reported for both sexes (Hopenhayn-Rich et al., 1996). Increasing trends for kidney and lung cancers with exposure, as indicated by SMRs, were also observed for the same province (Hopenhayn-Rich et al., 1998).

Exposure to sunlight was analyzed in a case-control study on skin melanoma. In a multivariate analysis, significantly elevated risks were observed for the occurrence of sunburn in childhood, skin sensitivity to sunlight, and sports-related exposure to sunlight (Loria, 1998).

Tobacco smoking is the main cause of lung cancer worldwide (IARC, 1986). 85% of lung cancer cases in males have been attributed to tobacco smoking (Parkin et al., 1994). A similar figure was observed in a study performed in Buenos Aires (Matos et al., 1998). Regarding bladder cancer, Iscovich et al. (1987), in a case-control study in the city of La Plata, observed a risk of 4.3 for those who had ever smoked and which was 2-3 times higher for smokers of black tobacco cigarettes.

Migrants from almost all countries have higher mortality rates from gastric cancer than born Argentines, but the risk declines in migrants, and for European migrants it is approaching that of born Argentines. Mortality from esophageal cancer is significantly lower in native Europeans than in Argentine-born individuals, and although risk increases following migration, it remains below that of Argentine-born individuals for all groups except Poles. For cancer of the colon and breast, most countries of origin show lower mortality rates than Argentine-born, the exceptions being Uruguay and Germany, and migrants demonstrate a convergence of risk towards that of Argentine-born. These results suggest that immigrants into Argentina undergo changes in some environmental exposures, in particular diet, which substantially alter their cancer risk (Matos et al., 1991; Matos et al., 1993).

The only previous epidemiological study of occupational cancer was conducted by Iscovich et al. (1987) on 117 cases of bladder cancer and two groups of controls in the city of La Plata, Province of Buenos Aires. In this study the three occupations of longest duration and the most recent one were recorded. A significant association was observed for truck drivers or railroad conductors (RR = 4.3 based on 20 exposed cases, and 4 and 5 exposed in each control group) and oil refinery workers (RR 6.2, based on 7 exposed cases and 2 exposed in each control group). After adjusting for smoking, the risk for drivers/conductors was reduced, whereas that for oil refinery workers was increased.

Several industrial processes and occupations have been associated with lung cancer. It is well documented that agents such as asbestos, polynuclear aromatic hydrocarbons (PAH), arsenic, nickel, chromium, and occupations involving exposures to these agents increase the risk of lung cancer. Additionally, several industrial sectors, like aluminum production or iron and steel founding, involving complex chemical mixtures, have been associated with increased risk of lung cancer (IARC, 1987; 1994). The vast majority of studies on occupation and industries in terms of cancer risk have been studied formally only in the developed world. However, most such risks also exist in developing countries, where exposure levels may be higher. The processes used are often more polluting and of types no longer used in industrialized nations; evidence from some epidemiological studies may in fact be related primarily to the higher levels of exposure that occurred in developed countries in the past (Vainio et al., 1994).

Occupational exposures and lung cancer were the subject of several studies in Latin American countries (De Stefani et al., 1996; Wunsch-Filho et al., 1998; Suzuki et al., 1994). A series of lung cancer cases collected in the city of Rosario, Argentina, was reported with broad information and poorly defined occupational categories, precluding valid conclusions (Mahuad et al., 1994).

The objective of this presentation is to report the results of a case-control study on lung cancer and occupation conducted in Buenos Aires.

Patients and methods

All incident male lung cancer cases, residents in the city or Province of Buenos Aires, who where admitted for treatment in four hospitals of Buenos Aires city from March 1994 to March 1996 were considered eligible for the present study. A total of 216 lung cancer cases were identified in the participating hospitals. Fifteen patients were too ill or mentally incapable of being interviewed, and one patient refused to be interviewed, leaving 200 patients, who were included as cases in the analysis, with an average age of 60 years. Fifty cases (25%) had squamous-cell carcinoma, 86 (42.5%) adenocarcinoma, 20 (10%) small-cell carcinoma, 13 (6.5%) large-cell carcinoma, and 21 (10.5%) other types or undifferentiated carcinoma. Eleven cases (5.5%) had only a clinical diagnosis. All cases reported by the pathologists as undifferentiated carcinoma were reviewed in order to confirm the diagnosis.

Two controls, residents in the same area, were matched to each case by hospital and age (± 5 years), with the exception of three cases who had one control only. A total of 397 males hospitalized for conditions unrelated to tobacco use during the same period were interviewed. The main groups of diagnoses, abstracted from medical records and coded according to ICD-9 (WHO, 1975) were: skin diseases (20%), digestive tract diseases (16%), infectious and parasitic diseases (9%), circulatory system diseases, and neoplasms unrelated to tobacco smoking (9% each), genitourinary tract diseases (7%), injuries (6%), and musculoskeletal system diseases (5.3%). Five potential controls refused to be interviewed.

All the cases and controls were interviewed in person by trained interviewers. The questionnaire included a section on demographics, complete histories on occupation, tobacco smoking, residence, heating habits, and nutrition. Level of education was used as a proxy variable for socioeconomic status.

For the analysis of smoking habits, individuals who had smoked at least one cigarette daily or equivalent amount of tobacco for one year or more at any time were classified as smokers. Those who had stopped smoking for at least one year prior to the diagnosis were classified as ex-smokers. Changes in type and brand, daily number of cigarettes, duration of habit, age at starting, age at quitting, filter use, and inhalation habit were recorded. One case and 4 controls smoked only pipes or cigars and were excluded from the analysis.

The subject's entire occupational history was recorded. For each change in occupation greater than one year throughout life, information was requested on job held, specific tasks performed in that job, and name and branch of activity of the industry.

Cases and controls were classified in branches of industrial activities according to the International Standard Industrial Classification of All Economic Activities (ISIC, 1971) and in occupational categories according the International Standard Classification of Occupations (CIUO-88, 1991). Categories including at least 10 cases or controls were retained for the analysis. For each branch of industry or category of occupation, subjects ever employed were compared to those never employed.

For data analysis, the following variables were calculated: lifetime urban residence (percentage of years spent in areas with population greater than or equal to 100,000 inhabitants), duration of consumption of tobacco, mean daily and cumulative consumption of cigarettes, age at starting smoking, number of years since quitting, main type of tobacco, and main use of filter over the total number of years. Variables including duration of employment in occupational or industrial categories over life were also calculated for each individual.

Odds ratios (OR) and 95% confidence intervals (CI) were calculated as approximations to the relative risk (Breslow & Day, 1980). Risk of lung cancer was estimated by comparing subjects ever employed in a particular branch of activity or occupational category. Thus, each subject could be counted as exposed to more than one industry or occupation. All odds ratios for occupational exposures were adjusted for the design variables, hospital of admission,

Table 1

Distribution of cases and controls according to selected characteristics.

	Cases n	Cases (%)	Controls n	Controls (%)
Total	200	(100.0)	397	(100.0)
Age group				
30-39	5	(2.5)	17	(4.2)
40-49	30	(15.0)	65	(16.4)
50-59	56	(28.0)	86	(21.7)
60-69	66	(33.0)	147	(37.0)
70-79	37	(18.5)	67	(16.9)
≥ 80	6	(3.0)	15	(3.8)
Hospital				
Tornu	48	(24.0)	96	(24.2)
British	44	(22.0)	88	(22.2)
Italian	65	(32.5)	127	(31.9)
Roffo	43	(21.5)	86	(21.7)
Education				
0-7	97	(48.5)	182	(45.9)
8-12	46	(23.0)	114	(28.7)
≥ 13	57	(28.5)	101	(25.4)
Lifetime residence*				
≥ 75% urban	103	(51.5)	199	(50.6)
≥ 75% rural	10	(5.0)	16	(4.1)
urban and rural	87	(43.5)	178	(45.3)
Smoking status				
never-smoker	11	(5.5)	110	(27.7)
current smoker	112	(56.0)	132	(33.2)
ex-smoker	76	(38.0)	151	(38.1)
pipe/cigar only	1	(0.5)	4	(1.0)
Smoking habits**				
only/mainly black	57	(30.3)	65	(23.0)
only/mainly filter	163	(86.7)	229	(80.9)
only/mainly inhalation	178	(94.7)	232	(82.0)
Type of diagnosis				
squamous-cell	50	(25.0)		
adenocarcinoma	86	(42.5)		
small-cell	20	(10.0)		
large-cell	13	(6.5)		
undifferentiated	21	(10.5)		
clinical	11	(5.5)		

*urban defined as cities with >100,000 inhabitants; 4 controls had missing values.
**percentages were calculated on ever-smokers.

group of age and pack-years of cigarettes. Occupations/industries resulting in high risk estimates were also adjusted by employment in other high-risk occupations/industries. Potential confounders were controlled for by using unconditional logistic regression modeling. All calculations were performed using SPSSPC+ and EGRET softwares.

Results

Selected characteristics of cases and controls are reported in Table 1. No differences between cases and controls were observed in educational level or lifetime residence in urban or rural areas. Eleven cases were non-smokers and all of them were histologically verified.

Table 2 shows the results for the univariate analysis of the tobacco variables by smoking status. The OR for current smokers was 8.5, whereas former smokers displayed an OR of 5.3. The ORs increased with duration of cigarettes use, number of cigarettes smoked per day, or pack-years. Men who started smoking when aged 20 or more had a lower risk than men who started before. In a multivariate analysis, the fitted final model included the number of years since quitting, the number of cigarettes smoked daily, and the duration of the habit. The addition of age at starting to the model was not statistically significant.

The mean number of jobs among cases was 4.0 and among controls 3.7. Table 3 shows the smoking-adjusted ORs for employment in branches of activities with at least 10 subjects ever employed. Estimates of risks were similar when lifelong number of cigarettes, average number of cigarettes per day, or duration of the smoking habit were used for adjusting by smoking.

Statistically significant ORs were observed for employment in the alcoholic beverages industry (4.5), sawmills and wood mills (4.6), chemicals/plastics (1.8), and pottery, glass, or minerals (3.4). Elevated (but not significant) ORs were also observed for agriculture (1.5), leather shoe manufacturing and repair (2.1), rubber (3.4), and water transportation (3.3).

When duration of employment was taken into account, the OR for working less than 10 years in agriculture (2.5, 1.2-5.3) was higher than the OR for longer duration of employment. No other statistically significant findings were observed regarding duration of employment.

Table 4 presents the smoking-adjusted results of the occupational categories examined. Only one category, salespersons (excluding street vendors), showed a statistically significant OR (1.8). The risk was higher for men working for 10 years or more (2.7, 1.1-6.8).

An elevated but not statistically significant value was observed for agricultural and livestock workers (1.5, 0.9-2.4). The risk did not increase with longer duration of employment, but changed with the age group.

When the analysis was restricted to agricultural workers only, the risk was 2.4 (0.9-6.0) reaching 4.2 (1.2-15.6) for men working for 10 or more years (6 cases and 8 controls).

Other high but not statistically significant risks were observed for metal workers including welders (1.9, 0.8-4.4), motor vehicle mechanics (2.0, 0.9-4.2), and workers in cleaning services (1.9, 0.8-4.5). The risk for butchers was 1.5, reaching 2.4 (95% CI: 0.5-11.1) for those with more than 10 years of duration of employment. The risk was higher, but not statistically significant, for those with longer duration of employment. No special features were observed regarding distribution of histological types among the different industries/occupations or categories of smokers, although the number of exposed cases was in most instances small.

Table 2

Lung cancer and cigarette smoking habits.

	ca/co	OR*	95% CI
Non-smoker (reference category)	11/110	1.0	–
Current smoker	112/132	8.5	4.3-16.7
Ex-smoker	76/151	5.3	2.6-10.7
Number of cigarettes/day			
1-14	17/88	2.0	0.9-4.5
15-24	65/90	7.5	3.7-15.0
25	106/105	10.4	5.3-20.7
trend[a]			*p<0.001*
Duration of consumption (years)			
1-24	20/84	2.2	1.0-4.9
25-39	82/110	7.2	3.6-14.5
40-70	86/89	12.7	6.1-26.1
trend[a]			*p<0.001*
Age at start			
< 15	69/90	7.8	3.9-15.7
15-19	91/120	7.8	4.0-15.5
≥ 20	28/73	3.9	1.8-8.3
trend[a]			*p = 0.022*
Pack-years			
0.25-20.0	12/97	1.3	0.5-3.0
20.25-40.0	52/68	7.7	3.7-15.8
40.25-210.0	124/118	11.1	5.6-21.9
trend[a]			*p < 0.001*
Years since quitting			
current smoker	112/132	1.0	–
1-5	28/23	1.4	0.8-2.6
6-10	21/27	0.9	0.4-1.6
≥ 11	27/101	0.3	0.2-0.6
non-smoker	11/110	0.1	0.06-0.2
trend[a]			*p<0.001*

OR* adjusted by design variables, age group and hospital.
[a] trends were calculated only for smokers.

Discussion

Our findings are consistent with studies from other countries in that tobacco smoking in Argentina is an important risk factor for lung cancer (IARC, 1986), with former consumption showing a lower effect than current consumption. Risk of lung cancer increased with duration of cigarette use, number of cigarettes smoked per day, and number of pack-years smoked.

Regarding occupational exposures, the results are discussed below in relation with previous findings.

Agriculture, an important branch of activity in Argentina, showed a high but not significant risk for all ages, achieving significantly high risks for men aged 65 or more both in agriculture as both a branch of activity and occupation. Men employed for 10 or more years in agriculture showed a statistically significant risk of 4.2, but this risk was based on small numbers (6 cases and 8 controls). In a study performed in Shanghai, a risk of 1.6 was observed for agriculture both as an industrial category and as an occupation (Levin et al., 1988). De Stefani et al. (1996) found a non-significant increased risk that was higher for cases with small-cell carcinoma. Agricultural workers also showed a high risk for lung cancer in Detroit, Michigan, United States (Burns & Swanson, 1991). These high risks are consistent with the association of lung cancer with working in agriculture, attributed to the use of arsenical and non-arsenical insecticides (IARC, 1994). Nevertheless, in other developing countries like Brazil and India, negative associations were found (Wunsch-Filho et al., 1998; Notani et al., 1993). Discrepant results have also been observed in developed countries (Ronco et al., 1992; Kristensen et al., 1996; Wiklund et al., 1988; Burns & Swanson, 1991).

The large size of the meat industry in Argentina focuses particular interest on the analysis of potential risks associated to the related industries or occupations. Previous studies in Uruguay, the United Kingdom, and Scandinavian countries have suggested an excess of lung cancer among butchers (De Stefani et al., 1996; Griffith, 1982; Fox et al., 1982; Lynge et al., 1983) and throughout the meat industry (Johnson, 1991). Exposure to live animals in the stockyard and employment in the killing/dressing areas were identified as factors associ-

Table 3

Employment in selected industries and risk of lung cancer.

Industrial branch	ISIC code*	ca/co**	OR[1a]	95% CI
Agriculture	11xx	36/66	1.5	0.9-2.6
Food	311x, 312x	38/52	1.1	0.7-2.2
Meat	3111	15/22	1.2	0.6-2.5
Bakery	3117	14/17	1.0	0.4-2.1
Alcoholic beverages	3131 to 3133	5/5	4.5	1.02-20.2
Textile	321x, 322x	30/51	1.2	0.7-2.0
Leather shoes/repair	3240, 9511	12/10	2.1	0.8-5.4
Sawmills, wood mills	3311	8/4	4.6	1.1-18.4
Furniture	3320	13/24	1.1	0.5-2.3
Paper	341x	3/7	0.7	0.1-2.8
Printing	3420	9/24	0.8	0.3-1.9
Chemicals/plastics	35xx (not 355x)	34/38	1.8	1.04-3.2
Petroleum, coal	3530, 3540	4/8	1.2	0.3-4.8
Rubber	355x	9/4	3.4	0.9-12.4
Pottery, glass, minerals	36xx	10/7	3.4	1.1-10.6
Basic metals	37xx	15/31	1.1	0.5-2.2
Metal products	381x	22/42	0.9	0.5-1.7
Machinery (not electrical)	382x	21/25	1.4	0.7-2.7
Machinery (electrical)	383x	9/15	1.0	0.4-2.5
Transport equipment (not shipbuilding)	384x	6/19	0.6	0.2-1.6
Other manufactures	3851 to 3909	9/10	1.2	0.5-3.4
Construction	5000	45/88	1.2	0.7-1.9
Trade	6100, 6200	78/137	1.1	0.8-1.7
Restaurants, hotels	63xx	17/33	0.9	0.5-1.7
Transport	71xx, 712x	36/79	0.8	0.5-1.3
Railway	7111	8/20	0.8	0.3-2.0
Urban, suburban, inter-urban	7112, 7113	15/38	0.6	0.3-1.2
Trucks	7114	10/18	1.3	0.5-3.1
Water	712x	7/5	3.3	0.9-12.6
Communications	7200	4/12	0.6	0.2-2.1
Finance/business	8xxx	30/68	0.8	0.5-1.3
Social services	91xx to 94xx	61/136	0.8	0.5-1.2
Motor vehicles, repair	9513	12/23	1.1	0.5-2.5
Laundry, cleaning	9520	6/6	1.1	0.3-3.5

* International Standard Industrial Classification of All Economic Activities (ISIC). United Nations. New York-1971.
** Number of cases and controls ever employed.
[a] For each industry, relative to a risk of 1.0 for men never employed in that industry.
OR[1] adjusted by age group, hospital, and pack-years.

ated with the greatest risk. In our study, working in the meat industry did not pose an increased risk, and the unadjusted risk of 2.4 (0.9-6.7) for butchers, based on 9 cases and 7 controls was reduced to 1.5 (0.5-4.3) when adjusted by smoking. The risk for those with longer time on the job was not significantly elevated (2.4, 0.5-11.1). These results are consistent with those reported by Coggon & Wield (1995), who did not find an occupational hazard of lung cancer in either butchers or cooks in a SMR study conducted in the UK. Consistent with these results, and not with the positive risk observed in Bombay (Notani et al., 1993), cooks did not show an increased risk in our study. The effects of coal dust and polycyclic hydrocarbons or nitrosamines in cooking fumes have been incriminated in an excess risk of lung cancer.

A high statistically significant risk (4.6) was observed for sawmills and wood mills, but not for the furniture industry. A non-significantly increased risk for employment in lumber and furniture manufacture was observed in São

Table 4

Employment in selected occupations and risk of lung cancer.

Job title	ISCO code*	ca/co**	OR[1a]	95% CI
Professionals, technicians, administrative	1xxx to 4xxx	107/224	0.8	0.5-1.1
Cooks, waiters	5122, 5123	7/17	0.9	0.3-2.5
Waiters	5123	5/13	0.9	0.3-3.0
Sales workers (not street)	52xx	35/42	1.8	1.02-3.1
Sales workers (street)	9111 to 9113	10/26	0.9	0.4-2.0
Agricultural, animal husbandry workers	6111 to 6130, 9211	36/71	1.5	0.9-2.4
Agricultural workers	6111 to 6114	11/18	2.4	0.9-6.0
Bricklayers, stonemasons	7122, 7123	23/45	1.2	0.6-2.2
Woodworkers (carpenters, cabinet makers, machine operators)	7124, 7422, 8240	10/28	0.7	0.3-1.5
Plumbers, pipe fitters	7136	4/11	0.7	0.2-2.5
Electricians	7137	3/7	0.6	0.1-2.4
Painters	714x	16/27	1.1	0.5-2.3
Painters (blowtorch)	7142	8/7	1.5	0.5-4.6
Metal workers	7211 to 7224, 8122, 8211	34/68	1.2	0.7-2.0
Metal pattern makers, welders, sheet metal workers, assemblers	721x	14/14	1.9	0.8-4.4
Welders	7212	5/5	1.5	0.4-5.7
Blacksmiths, polishers, metal pattern makers, turners, machine tool operators	722x, 8211	23/44	1.0	0.5-1.8
Motor vehicle mechanics	723x	17/23	2.0	0.9-4.2
Electricians	724x	7/8	1.6	0.5-5.1
Printers	7341, 7342	4/9	0.7	0.2-2.6
Butchers	7411	9/7	1.5	0.5-4.3
Textile workers	743x, 8261 to 8263	13/25	1.2	0.5-2.6
Leather shoe manufacture/repair	7442	8/9	1.4	0.5-4.0
Assemblers (not metal)	8281 to 8290	5/16	0.5	0.1-1.4
Drivers, motor vehicles	832x, 833x	28/64	0.7	0.4-1.2
Drivers (trucks)	8324	13/17	1.4	0.6-3.3
Service workers (cleaning)	9132	14/15	1.9	0.8-4.5
Home delivery workers	9151, 9331	49/102	0.8	0.5-1.2
Day laborers (not agriculture)	9311 to 9313	6/21	0.6	0.2-1.6

* ISCO International Standard Classification of Occupations 1988. (ILO, 1991).
** number of cases and controls ever employed.
[a] For each occupation, relative to a risk of 1.0 for men never employed in that occupation.
OR[1] adjusted by age group, hospital and pack-years.

Paulo and Bombay for cancer of the lung (Wunsch-Filho et al., 1998; Notani et al., 1993). Ronco et al. (1988) reported in Turin, Italy, no excess risk for workers engaged in carpentry or joinery but a borderline-significant increased risk for those employed in furniture and cabinet-making. Wood dust and formaldehyde have been suggested as lung carcinogens in the wood industry, but some results are not consistent with such increased risks. Kauppinen et al. (1993), did not find exposure to wood dust to be associated with lung cancer. No evidence was found for an excess risk of death due to lung cancer in a pooled re-analysis of cohort studies of wood workers (IARC, 1997a).

Wunsch-Filho et al. (1998), found an excess risk for pottery of 2.07 (0.94-4.59) that increased to 6.2 (1.07-36.01) for those exposed for more than 10 years. We found a risk of 3.4 (1.1-10.6) for the industrial branch including pottery, glass, and mineral manufacture. These industries present a lung cancer excess due to the presence of known carcinogens like crystalline silica in the form of quartz and cristobolite, and potential carcinogens like talc dust and metals containing antimony, chromium, copper, iron, and titanium (IARC, 1997b).

The statistical significance of the risk observed for the industrial group of chemicals and plastic products 1.8 (1.04-3.2) is consistent with the wide variety of industries included in this group, many of them associated (definitely or probably) with cancer of the lung (Vainio et al., 1994). A similar risk was reported in Shanghai (Levin et al., 1988). The rubber industry was analyzed separately, and a borderline statistically significant OR was observed (3.4, 0.9-12.4), with 9 cases and 4 controls exposed. Various occupations in rubber manufacturing were reported to present a lung cancer excess, but the assessment of the carcinogenic risk for this site is not definitive (Vainio et al., 1994).

The borderline significant OR of 2.1 observed for the manufacture and repair of leather shoes is consistent with the lung cancer risk associated with working as tanners and processors, but not with boot and shoe manufacture and repair (Vainio et al., 1994). An increased borderline significant risk (4.8) was observed for shoemakers but not for leather workers in Uruguay (De Stefani et al., 1996).

There is sufficient evidence that mineral oils containing various additives and impurities, and that have been used in metal machining processes are carcinogenic to humans (IARC, 1984). Wunsch-Filho et al. (1998) reported an excess risk of 1.6 (1.01-2.50) for the machinery industry in Brazil. In our study a risk of 1.4 (0.7-2.7) was observed for machinery (non-electrical), but no increased risks were found for any other of the metal industries.

Results of studies of lung cancer risk among textile workers are not consistent among different countries (IARC, 1990). Low risks among men in the cotton textile industry were observed in the Chinese study (Levin et al., 1988) and high risks in the Uruguayan study, specially for small-cell carcinoma and adenocarcinoma (De Stefani et al., 1996). In this study, the risk for textile workers, either as an industry or an occupation, was 1.2, not significant.

Construction work, entailing exposure to asbestos and polycyclic aromatic hydrocarbons, is associated with lung cancer (Vainio et al., 1994). In our study, the risk for the construction industry was 1.2, not significant, and bricklayers and stonemasons showed no increased risk. Negative, non-significant associations were observed by Lerchen et al. (1987) in New Mexico and Wunsch-Filho et al. in Brazil (1998). Other authors have reported high risks for construction workers in the United States (Shoenberg et al., 1987; Morabia et al., 1992), and Uruguay (De Stefani et al., 1996).

Two cohort studies found a small risk for lung cancer related to employment in the alcoholic beverages industries; one among Danish brewery workers (O/E: 1.16, 95% CI:1.03-1.30) (Jensen, 1980) and the other among US veterans (smoking adjusted risk: 1.2, 95% CI:0.7-1.9) (Hrubec et al., 1995). In the present study an elevated risk was observed for subjects ever employed in those industries (4.5, 95% CI:1.02-20.20).

Seven cases and 5 controls were ever employed in industries related to water transportation, in the operation of vessels for transport of freight and passengers overseas and supporting services. The smoking-adjusted risk of 3.3, of borderline significance, has no clear explanation. A broad range of occupations was described by cases and controls.

Strengths of this study are that all cases and controls were interviewed in person, with no data obtained from proxies.

Weaknesses of the study are: 1) that cases were enrolled in four hospitals, and, consequently the sample may not be representative of all cases in the city; 2) that the diagnoses were performed by the pathology unit at each hospital; and 3) that the numbers were small in many of the categories analyzed.

It is also true that computing OR by comparing subjects ever employed in one occupation with subjects never employed in that occupation can likely underestimate the true OR because the reference category includes jobs that may be at high risk of lung cancer. However, when occupations and branches of activity that resulted in high risks were adjusted for employment in other high-risk occupations/industries, estimates of risks did not change.

Although some of the present results may be due to chance as a result of multiple comparisons, most are consistent with those of previous studies in other countries. Future assessment of exposure through the application of a JEM (job exposure matrix) should allow for a more accurate classification of exposure to particular known carcinogens.

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