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Increased lung cancer risk among bricklayers in an Italian population-based case-control study.

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Abstract

Background—Bricklayers may be at increased risk of lung cancer, although a firm association has not been established. We examined this association within the EAGLE (Environment And Genetics in Lung cancer Etiology) study, a population-based case–control study conducted in Italy between 2002 and 2005.

Methods—For men in selected occupations in the construction sector we calculated smoking-adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs). For bricklayers we estimated the population attributable fraction (PAF) and the attributable community risk (ACR).

Results—We found increased lung cancer risk for bricklayers (OR 1.57, 95% CI 1.12–2.21; 147 cases, 81 controls). The PAF was 3.9% (95% CI 0.7–7.0), corresponding to an ACR of 4.1 cases annually per 100,000 men (95% CI 0.7–7.3) in the whole community. Among bricklayers, there were increased risks for squamous cell (OR 2.03, 95% CI 1.32–3.13, 56 exposed cases) and small cell carcinomas (OR 2.29, 95% CI 1.29–4.07, 21 exposed cases), while no excess (OR 1.06, 95% CI 0.68–1.65, 41 exposed cases) was found for adenocarcinoma.

Conclusions—Our findings provide additional evidence of increased lung cancer risk in Italian bricklayers. The association is plausible because they are exposed to several carcinogens, notably crystalline silica.

Keywords

epidemiology; occupational health; case–control study; pulmonary neoplasms; construction industry

INTRODUCTION

More than half of 11 million workers in the construction industry of the European Union are exposed to carcinogenic agents [Kauppinen et al., 2000]. The most prevalent agent is crystalline silica in the form of quartz dust (19% of the workforce exposed), followed by diesel fumes (6%) and asbestos (5%). Less frequent exposures include cadmium (0.3%), chromium (0.2%), and nickel (0.3%) [Driscoll et al., 2005]. The impact of this industry on lung cancer burden is large [Rushton et al., 2010; Stocks et al., 2010]. Several occupations within this sector are included in lists of occupations known to increase risk for lung cancer, termed “list A” (including insulators and pipe coverers, roofers, asphalt workers, painters), or suspected to be associated, termed “list B” (including carpenters and joiners, bus and truck drivers, and operators of excavating machines) [Ahrens and Merletti, 1998; Mirabelli et al., 2001]. Conversely, although several studies found an increased risk [Minder and Beer-Porizek, 1992; Robinson et al., 1995; Andersen et al., 1999; De Stefani et al., 2005], a firm association between lung cancer and other occupations in the construction sector, including bricklayers, has not yet been established [Dong et al., 1995; Stern et al., 2001; IARC, 2011].

The Environment And Genetics in Lung cancer Etiology (EAGLE) study, performed in northern Italy in the period 2002–2005, is one of the largest population-based case–control studies on lung cancer [Landi et al., 2008]. In a recent article we analyzed the lung cancer risk associated with list A and B occupations within EAGLE [Consonni et al., 2010]. In the present study we focused on occupations in the construction sector not included in the A and B lists. In particular, we estimated the lung cancer risk for bricklayers, who in some countries (including Italy) represent a substantial proportion of the construction workforce [Brockmann et al., 2010; Vitelli et al., 2011] and are exposed to known carcinogens, notably quartz dusts [Rappaport et al., 2003; Boschman et al., 2011].

MATERIALS AND METHODS

Study Design

From April 2002 to June 2005 the EAGLE study enrolled 2,100 incident lung cancer cases and 2,120 population controls in five provincial areas in Lombardy, northern Italy [Landi et al., 2008]. Subjects were 35–79 years of age at diagnosis (cases) or at sampling/enrolment (controls). Verified lung cancer cases were recruited in 13 hospitals. Controls were randomly sampled from population databases and frequency-matched to cases by residence, gender, and age. The study was approved by institutional review boards (IRBs) of the National Cancer Institute, Bethesda, of the University of Milan, and of each participating hospital. Participants signed an informed consent.

Data Collection

Subjects enrolled in the EAGLE study underwent a computer-assisted personal interview and completed a self-administered questionnaire (both available at <http://eagle.cancer.gov/>). The interview included lifetime work history (years of start/stop, industry, job title) of jobs held 6 months. Industries and job titles were blindly coded by two of the authors (SDM, DC) following the International Standard Industrial Classification of All Economic

Activities (ISIC, 1971) and the International Standard Classification of Occupations (ISCO, 1968) [Consonni et al., 2010].

Statistical Analysis

For men ever employed in the Construction Industry (ISIC code 5000), we analyzed occupations (ISCO codes) with at least 10 cases. Since our aim was to study occupations for which an association with lung cancer is not yet established, we analyzed occupations in the construction sector not included in list A or B [Ahrens and Merletti, 1998; Mirabelli et al., 2001]. The occupations in the construction sector already classified in list A (insulators and pipe coverers, roofers, asphalt workers, painters) and B (carpenters and joiners, bus and truck drivers, operators of excavating machines) were covered in our recent paper [Consonni et al., 2010].

We calculated odds ratios (ORs) and 95% confidence intervals (95% CIs) using unconditional logistic regression, taking as reference the subjects never employed in the construction sector. The regression model included the following covariates: residential area, age, cigarette and other tobacco smoking, number of jobs held, and ever employment in list A or B occupations [Consonni et al., 2010].

For bricklayers we estimated the population attributable fraction, which measures the fraction of cases in the population due to an exposure, $PAF = P_{EC} \times (OR - 1)/OR$, where OR is the adjusted odds ratio and P_{EC} the proportion of exposed cases. We also calculated the attributable community risk (ACR) [Wacholder, 2005] a measure which expresses the risk or rate of disease due to an exposure in a population, $ACR = PAF \times I_c$, where $I_c = 104 \times 100,000$ person-years is the lung cancer incidence rate in men in Lombardy in 2005. We used multinomial logistic regression to evaluate risks for the main histologic types (adenocarcinoma, squamous, and small cell carcinoma). Analyses were performed with Stata 11 [StataCorp, 2009].

RESULTS

A total of 3,154 men (1,537 cases and 1,617 controls) were interviewed (Table I). Overall, there were 404 cases and 299 controls ever employed in the construction sector, with blue collars numbering 364 and 253, respectively (see Table I, footnote). After excluding occupations in list A or B, we estimated ORs for 328 cases and 254 controls (corresponding to 287 and 208 blue collars, respectively) (Table I). We found a small (OR 1.15) increased risk for the whole construction sector, with a 21% increased risk when restricting the analyses to blue collars. No increased risks were found for electrical wiremen and other jobs including reinforced concreters, cement finishers, and terrazzo workers, plasterers, glaziers, and construction workers not elsewhere classified. Small to modest increases were found for plumbers and pipe fitters, laborers (mostly bricklayers' assistants), and other blue-collar occupations. The elevated OR for chimney builders, firebrick layers, stonemasons, and marble setters was based on very few subjects. The only clearly elevated OR (1.57, 95% CI 1.12–2.21), based on a large number of cases (147) and controls (81) was found for bricklayers. For this latter occupation, the OR after adjusting also for education was 1.44 (95% CI 1.01–2.07). Additional adjustment for dietary factors (red/processed meat and fruit/

vegetables consumption), alcohol drinking, and environmental tobacco smoking, yielded an OR of 1.61 (95% CI 1.08–2.39).

For bricklayers, the ORs across smoking status were as follows: in never smokers: OR 1.03 (95% CI 0.12–9.08, 1 exposed case/16 controls); in former smokers: OR 1.77 (95% CI 1.17–2.68, 66/43); in current smokers: OR 2.17 (95% CI 1.32–3.59, 80/22). The likelihood ratio test of the bricklayer–smoking interaction term yielded a *P*-value of 0.50, consistent with a multiplicative pattern for the ORs.

For bricklayers we found a positive association with length of employment. The largest OR of 2.42 was found for the 20–29 year category, but the OR of 1.67 for 30 or more years of employment was based on a larger number of exposed subjects (Table II). There was an association with employment as a bricklayer for squamous cell and small cell carcinomas, and no association for adenocarcinoma (Table II). The lung cancer PAF and ACR for bricklayers were respectively 3.9% (95% CI 0.7–7.0), and $4.1 \times 100,000$ person-years (95% CI 0.7–7.3).

DISCUSSION

The present study goes beyond the analyses we recently performed on occupations known (list A) or suspected (list B) to be associated with lung cancer [Consonni et al., 2010], because we focused on occupations in the construction sector that have not yet acquired sufficient evidence to be included in those lists. We found a substantial (OR 1.57) increased lung cancer risk for bricklayers, the most represented occupation. The increased risk (OR > 2) was limited to squamous and small cell carcinomas. Our PAF and ACR estimates, if correct, would mean past employment in this occupation was responsible for 176 (95% CI 32–316) of 4,515 incident male lung cancer cases diagnosed in Lombardy in 2005. These figures contrast with the low number of lung cancer cases officially reported to and compensated by the Italian Workers' Compensation Authority (Istituto Nazionale per l'Assicurazione contro gli Infortuni sul Lavoro, INAIL). In Lombardy, in the period 1999–2004 only 399-lung cancer cases (all industrial sectors) and 133 cancers (all types) in the construction sector were reported [INAIL, 2005]. In Italy, in the years 2000–2006, the number of compensated lung cancer claims in the construction industry amounted to only 51 cases [Scarselli et al., 2009].

The EAGLE study has several strengths beyond large sample size [Landi et al., 2008; Consonni et al., 2010]. Incident cases were enrolled soon after diagnosis. Controls were drawn from the catchment area of the cases. Participation rates were high. All participants had in-person interviews by trained personnel. Reliability of self-reported job history is generally good [McGuire et al., 1998; Siemiatycki et al., 2006], and therefore we can exclude important recall biases. Blind coding of occupations eliminated the possibility of differential bias, although a certain degree of nondifferential misclassification is practically unavoidable, leading to an average bias toward the null. A structured questionnaire collected detailed information on lifetime smoking habits and work histories. Residual confounding could in theory explain part of the increased relative risk for bricklayers, especially considering the elevated ORs for squamous and small cell carcinomas (the subtypes more

strongly associated with tobacco smoking). However, it is unlikely that such a bias would have affected bricklayers and not the other occupational groups, some of which had more current smokers (electrical wiremen) or ever smokers (plumbers and pipe fitters) than did bricklayers (data not shown). Further, the positive association with length of employment lends more support to a causal association between lung cancer and working as a bricklayers rather than to a confounding bias from smoking.

Several studies on lung cancer had previously been conducted among construction workers, but few gave results specifically for bricklayers. Among studies with large sample size, a study in Switzerland analyzed all country mortality in 1979–1982 and found a standardized mortality ratio (SMR) of 2.12 and a proportionate mortality ratio (PMR) of 1.58 based on 242 lung cancer deaths among masons [Minder and Beer-Porizek, 1992]. A study in 19 US states 1984–1986 found a PMR of 1.20 (240 lung cancer deaths among brickmasons) [Robinson et al., 1995]. In four Nordic countries with nationwide cancer registration the standardized incidence ratio (SIR) in 1971–1991 was 1.19 for bricklayers (981 cases) compared to the national population [Andersen et al., 1999]. The SIRs were increased in Denmark (1.18), Finland (1.38), Norway (1.28), but not in Sweden (0.96). A hospital-based case–control study on adenocarcinoma cases in Uruguay found in the late 1990s a smoking-adjusted OR of 1.4 for masons (108 cases) compared to other occupations [De Stefani et al., 2005]. Two studies gave conflicting results depending on the measure of association used. A study in UK covering all construction workers aged 18–64 years in England, Wales, and Scotland (1975–1987) found that the mortality for bricklayers (251 deaths) was elevated by 34% using PMR but only 9% using the mortality OR (MOR) [Dong et al., 1995]. In the USA (1972–1996), among members of the Operative Plasterers' and Cement Masons' International Association (OPCM), the PMR for cement masons (852 deaths) was 1.34, but the proportionate cancer mortality ratio (PCMR) was 1.06 [Stern et al., 2001].

Several carcinogenic agents might have been responsible for the increased lung cancer risk we observed. Before Italy banned asbestos in 1992, some bricklayers were exposed to asbestos during specific tasks like insulation or building renewal. However, the estimated fraction of construction workers exposed above background levels to asbestos is low [Driscoll et al., 2005]. Even lower is the fraction of those exposed to hexavalent chromium and nickel (contained in cement in small concentrations) [Driscoll et al., 2005]. The most relevant carcinogenic exposure for construction workers and bricklayers in particular is crystalline silica [Kauppinen et al., 2000; Driscoll et al., 2005; Rushton et al., 2010]. Working practices have not changed much [van der Molen et al., 2004]. Recent US industrial hygiene assessments for bricklayers and other construction workers [Rappaport et al., 2003; Flanagan et al., 2006] reported concentrations of quartz dusts well above the recommended limit of 0.025 mg/m³ [ACGIH, 2011]. Measurements in the Italian construction sector are few and discordant: one survey found an average of 0.055 mg/m³ [Giovanazzi et al., 2011], while in another study most measurements were lower than the recommended limit [Miscetti et al., 2011]. Reduction of exposure to quartz is regarded as a priority for bricklayers [Boschman et al., 2011]. The implementation of quartz dust monitoring programs in the construction industry would be a means to assess the present relevance of silica as a cause of lung cancer in Italy. It should be noted that in our study only

8 subjects (5 cases, 3 controls) reported to have been diagnosed with silicosis, and so the association with lung cancer risk was unlikely to have been mediated by pneumoconiosis.

Our findings are not directly generalizable to all settings, because the building technology and the proportion of bricklayers in the construction industry differ between countries. Based on 2007–2009 data, bricklayers represent a sizable group in Poland (20.3%), France (17.5%), Germany (15.0%), and Belgium (10.9%); conversely, in Denmark, UK, and The Netherlands the proportion of bricklayers was <10% [Brockmann et al., 2010]. In our study base (controls), bricklayers (lifetime) were the largest occupational group, with a proportion of 27.1% (81/299) of all construction occupations and 32.0% (81/253) of blue collars. In Italy, the construction sector currently employs almost 2.0 million workers [Brockmann et al., 2010]. Wood is rarely used as construction material. A recent survey of a representative sample of 2,247 blue-collar construction workers in a province located in the same region where our study was performed reported a proportion of bricklayers of 52.5%, followed by painters (9.5%), carpenters (6.3%), and other occupations (<5%) [Vitelli et al., 2011].

In conclusion, we found a substantial increase in lung cancer risk among bricklayers. The large number of workers involved in Italy and other countries and the potential for exposure to crystalline silica suggests that a focus on the work environment of bricklayers, in particular the monitoring and control of quartz concentrations, may provide a further opportunity for lung cancer prevention.

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Table I.

Lung Cancer Risk Associated With Selected Occupations in the Construction Industry (ISIC 5000), the Environment And Genetics in Lung Cancer Etiology (EAGLE) Study, Lombardy, Italy, 2002–2005

Occupation ^a (ISCO code)	Cases, N (%)	Controls, N (%)	OR ^b	95% CI
Total interviewed	1,537 (100)	1,617 (100)	—	—
Never employed in the construction industry (reference)	1,209 (78.7)	1,363 (84.3)	1.00	—
Ever employed in the construction industry	328 (21.3)	254 (15.7)	1.15	0.92–1.43
White collar occupations (non-blue collar codes)	46 (3.0)	49 (3.0)	0.95	0.58–1.56
Blue collar occupations (55, 56, 581, 628, 631, 7–9)	287 (18.7)	208 (12.9)	1.21	0.96–1.54
Electrical wiremen (855)	27 (1.8)	35 (2.2)	0.80	0.44–1.45
Plumbers and pipe fitters (871)	24 (1.6)	21 (1.3)	1.27	0.64–2.53
Bricklayers (95120)	147 (9.6)	81 (5.0)	1.57	1.12–2.21
Chimney builders, firebrick layers, stonemasons, marble/tile setters (951, except 95120)	11 (0.7)	5 (0.3)	1.62	0.48–5.41
Reinforced concreters, cement finishers and terrazzo workers (952), plasterers (955), glaziers (957), construction workers not elsewhere classified (959)	15 (1.0)	18 (1.1)	0.58	0.26–1.29
Other blue collar occupations (not 855, 871, 95)	29 (1.9)	29 (1.8)	1.11	0.58–2.15
Laborers (99)	65 (4.2)	39 (2.4)	1.23	0.76–1.99

CI, confidence interval; ISCO, International Standard Classification of Occupations, 1968; ISIC, International Standard Industrial Classification, 1971; OR, odds ratio.

^aExcluding occupations known (list A) or suspected (list B) to be associated with lung cancer. List A includes: insulators and pipe coverers (ISCO 956), roofers (ISCO 95320–95340, 95390), asphalt workers (ISCO 95340, 97450, 97460), painters (ISCO 931). List B includes: carpenters and joiners (ISCO 81 and 954), bus and truck drivers (ISCO 98540–98560), operators of excavating machines (ISCO 97420–45, 97455, 97470, 97490). Considering also these occupations, there were 404 cases and 299 controls (blue collars: 364 and 253, respectively).

^bOR, odds ratio calculated with a logistic regression model, adjusted for area, age, smoking, number of jobs, and employment in list A or B occupations.

Table II.

Lung Cancer Risk by Length of Employment and Main Histological Subtypes for Bricklayers (ISCO code 95120), the EAGLE study, Lombardy, Italy, 2002–2005

	Cases (N)	Controls (N)	OR	95% CI
Never employed in the construction industry (reference)	1,209	1,363	1.00	
Length of employment (years)				
0.5–9	51	31	1.49	0.86–2.58
10–19	19	11	1.48	0.63–3.44
20–29	20	9	2.42	0.90–6.52
30	56	27	1.67	0.95–2.94
<i>P</i> -value for trend			0.02	
Lung cancer morphology				
Adenocarcinoma	41		1.06	0.68–1.65
Squamous cell carcinoma	56		2.03	1.32–3.13
Small cell carcinoma	21		2.29	1.29–4.07
<i>P</i> -value for homogeneity			0.006	

CI, confidence interval; ISCO, International Standard Classification of Occupations, 1968; OR, odds ratio calculated with a logistic regression model, adjusted for area, age, smoking, number of jobs, and employment in list A or B occupations.