Hanskov et al. Int J Respir Pulm Med 2015, 2:4
ISSN: 2378-3516

International Journal of
Respiratory and Pulmonary Medicine

Original Research: Open Access

Respiratory Symptoms and Lung Function among Danish Construction Workers. A Cross-Sectional Study

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Abstract

Objective: This study investigated whether Danish construction workers had an increased prevalence of chronic obstructive pulmonary disease (COPD) or affected lung function and if the prevalence differed between types of jobs within construction.

Methods: A cross-sectional study of 899 Danish male workers: demolition workers, insulators, carpenters and a control group of hospital porters aged 35-60 years answered a questionnaire and performed spirometry. Results were tested statistically for differences between occupational groups, and all analyses were adjusted for smoking status, age and body mass index.

Results: COPD (Global Initiative on Obstructive Lung Disease 2-4) was found in 2.4% of carpenters, 4.7% of insulators, 7.8% of demolition workers and 6.1% of hospital porters (P = 0.055). Compared to hospital porters, demolition workers had significantly increased odds of coughing more than average [odds ratio (OR) = 2.2, 95% confidence interval (CI) 1.2-3.8] and carpenters had significantly lower odds of forced expiratory volume in one second below the lower limit of normal (i.e. FEV_1 < LLN) (OR = 0.5, 95% CI 0.2-0.9). The OR of FEV_1 < LLN for demolition workers compared to carpenters was 2.7 (95% CI 1.3-5.5) and for insulators compared to carpenters was 1.8 (95% CI 0.8-3.9). Demolition workers had significantly lower odds compared to all other groups for forced vital capacity < LLN.

Keywords

COPD, Lung function, Construction workers, Dust exposure

Abbreviations

BMI: Body Mass Index, CI: Confidence Interval, COPD: Chronic Obstructive Pulmonary Disease, FEV_1: Forced Expiratory Volume in One Second, FVC: Forced Vital Capacity, GOLD: The Global Initiative on Obstructive Lung Disease, LLN: Lower Limit of Normal, OR: Odds Ratio

Introduction

Worldwide, 80 million people suffer from moderate or severe chronic obstructive pulmonary disease (COPD) and, according to the World Health Organization, COPD is expected to become the third leading cause of death by 2030 [1]. Apart from smoking, risk factors for COPD include occupational dust and chemicals including vapours, irritants and fumes [2-5].

One of the larger trades in which workers historically have been subjected to considerable dust exposure is construction, which employs about 6% of the workforce in Denmark. The number of occupational lung diseases reported to the National Board of Industrial Injuries in Denmark has remained constant at around 660 each year. In 2013, 127 of these cases (19%) were reported in construction workers as related to dust, fibres, smoke and exhaust fumes [6] but few of these were compensated as work-related.

In a cohort of 317,629 Swedish male construction workers followed in the period 1971-2011, increased mortality from COPD was found among those exposed to inorganic dust, especially among those who never smoked [7].

In a longitudinal study from the US, including 7200 male construction workers followed for 10 years, there was an increased risk of chronic lung disorders at follow-up when compared to white-collar workers, but no differences compared to other blue-collar workers [8]. Although there has been a focus on limiting occupational dust exposure in Denmark, the current exposure level in the construction industry is unknown and workers may still be subject to occupational dust exposure at levels that can cause COPD.

The purpose of this study was to investigate the prevalence of COPD among Danish construction workers. Based on historical knowledge of dust levels generated by different work tasks [9-11], the following groups of workers were chosen to participate: demolition workers, insulation workers and carpenters.

Demolition work is unskilled and consists of manual and mechanized demolition tasks including sorting of building materials for recycling. Based on previous dust measurements we expect demolition workers to have a high level of dust exposure in their daily work [9,12,13].

Older insulation workers are unskilled, while the younger are skilled. Their work tasks consist of technical insulation of, for example, pipes, air ducts and storage tanks using mainly mineral wool. We consider, based on previous dust measurements, the group as a whole to be moderately exposed to dust at work [14,15].

Carpenters are skilled workers. Their primary work tasks are installation of windows and doors, constructing or repairing walls

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Citation: Hanskov DJA, Brauer C, Breinegaard N, Kirkeskov L (2015) Respiratory Symptoms and Lung Function among Danish Construction Workers. A Cross-Sectional Study. Int J Respir Pulm Med 2:029

Received: September 07, 2015: **Accepted:** September 29, 2015: **Published:** October 02, 2015

and ceilings with gypsum boards, roof and floor work plus minor insulation work. Based on previous dust measurements, carpenters were expected to have a low level of exposure to dust [9,12,16].

Hospital porters were chosen as a control group. They are unskilled workers and their daily tasks consist of transporting patients, laundry, mail, blood samples and equipment, as well as other jobs around the hospital. The hospital porters are not exposed to any considerable level of industrial dust or chemicals.

We wanted to examine the two following research questions. (1) Do construction workers in Denmark have a higher prevalence of COPD than a control group without dusty work? (2) Is COPD prevalence related to the type of job in the construction industry, e.g. do carpenters experience a lower prevalence of COPD than other construction workers?

Methods

Study population

The study population comprised demolition workers, insulation workers and carpenters in construction companies mainly from the Copenhagen area, as well as hospital porters from hospitals on Zealand. All groups consisted of males between 35 and 60 years of age. The workers had been asked to participate in the investigation through their employer and all participants gave informed consent.

The study consisted of a questionnaire and a spirometry. The questionnaires were delivered to the firm prior to the workplace visit by the project staff and were collected on the day that the spirometries were carried out. The questionnaire included questions about work tasks, seniority, dust exposure, use of protective equipment and smoking habits. It also included questions concerning respiratory symptoms, allergy and physician-diagnosed asthma. We defined chronic bronchitis as coughing daily for at least three consecutive months for more than two consecutive years according to The British Medical Research Council (BMRC) guidelines [17].

Spirometric tests were performed at the workplace using a transportable spirometer (EasyOne Diagnostic Spirometry System, Model 2010, Zürich, Switzerland) according to the European Respiratory Society (ERS) guidelines [18]. The highest forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) measured in up to eight trials were used to calculate FEV_1/FVC. The ERS guidelines as adopted from the European Community for Steel and Coal report [19,20] were used as a reference for predicted values, and interpretation of the trials was determined by the Global Initiative on Obstructive Lung Disease (GOLD) principles [1,21,22]. Participants with $FEV_1/FVC < 0.7$ performed a reversibility test where a bronchodilator (Bricanyl 0.5 mg/dose and two doses) was administered and the measurement repeated after 15 min. COPD was defined if the post-bronchodilator FEV_1/FVC value was also < 0.7 [18]. Subjects with $FEV_1/FVC < 0.7$ and FEV_1 and FVC > 80% did not perform the post-bronchodilator test and were defined as GOLD 1 (i.e. mild COPD).

The lower limit of normal (LLN) for FEV_1 and FVC was defined as the lower fifth percentile of the predicted value [23].

Statistical analysis

Data were analysed using SAS Enterprise Guide statistical software (version 5.1). One-way ANOVA was used to test for equal means [of age, height, weight and body mass index (BMI)] across occupational groups, and a chi-square test was used to test for equal proportions (of age group and smoking status). Occupational group differences with respect to outcomes from questionnaires and spirometries were investigated in logistic regression models for categorical outcomes, and in linear regression models for continuous outcomes. All analyses were adjusted for smoking status (current, never and former smokers), age (≤ 49 and ≥ 50 years) and BMI = weight/height^2 (in kg/m^2). Two-way interactions between occupational group, age group and smoking status were included in the initial model and removed if not significant at the 5% level.

Results

Table 1 shows the distribution of the study population across occupational groups. The response rates (including corresponding questionnaires and spirometries) were 83.4% for demolition workers, 71.3% for insulators, 82.9% for carpenters and 60.7% for hospital porters.

Table 2 shows the characteristics of the participants in the

Table 1: Study population and final study sample for questionnaires and spirometries distributed according to occupational group.

	Demolition workers	Insulators	Carpenters	Hospital porters	Total
	N (%)*	N (%)*	N (%)*	N (%)*	N (%)*
Study population	169	209	357	516	1251
Questionnaire responders	151 (89.3)	204 (97.6)	321 (89.9)	360 (69.8)	1036 (82.8)
Questionnaires and spirometries	141 (83.4)	149 (71.3)	296 (82.9)	313 (60.7)	899 (71.9)

*percentage of study population for each occupational group

Table 2: Characteristics of the study population distributed on occupational groups.

	Demolition workers	Insulators	Carpenters	Hospital porters	Total	
	N = 141	N = 149	N = 296	N = 313	N = 899	*P*-value
Age, years, Mean (SD)	44.2 (7)	49.9 (7)	45.3 (7)	48.5 (7)	47.0 (7)	< 0.0001
Height, cm, Mean (SD)	180.8 (7)	179.8 (7)	181.3 (7)	181.0 (6)	180.9 (7)	0.1709
Weight, kg, Mean (SD)	87.8 (15)	86.8 (14)	86.6 (12)	89.0 (15)	87.7 (14)	0.1734
BMI*, Mean (SD)	26.9 (4)	26.8 (4)	26.3 (3)	27.1 (4)	26.8 (4)	0.0797
≤ 49 years, n (%)	108 (77)	63 (42)	203 (69)	153 (49)	527 (59)	< 0.0001
≥ 50 years, n (%)	33 (23)	87 (58)	93 (31)	160 (51)	373 (41)	< 0.0001
Current smokers, n (%)	79 (56)	56 (38)	64 (22)	100 (32)	299 (34)	0.0018
Former smokers, n (%)	37 (26)	54 (36)	92 (32)	110 (36)	293 (33)	< 0.0001
Never smokers, n (%)	24 (17)	39 (26)	135 (46)	100 (32)	298 (33)	< 0.0001
Pack-year of tobacco						
None, n (%)	24 (17)	39 (26)	135 (46)	100 (32)	298 (33)	< 0.0001
< 20, n (%)	32 (23)	44 (30)	66 (23)	93 (30)	235 (27)	
≥ 20, n (%)	81 (59)	66 (44)	91 (31)	115 (37)	353 (40)	
GOLD 1 (FEV_1 ≥ 80 % predicted), n (%)	10 (7)	14 (9)	19 (6)	21 (7)	64 (7)	0.3050
GOLD 2 (50 % ≤ FEV_1 < 80 % predicted), n (%)	9 (6)	7 (5)	6 (2)	14 (5)	36 (4)	
GOLD 3 (30 % ≤ FEV_1 < 50 % predicted), n (%)	2 (1.4)	0 (0)	1 (0.3)	3 (1.0)	6 (0.7)	
GOLD 4 (FEV_1 < 30 % predicted), n (%)	0 (0)	0 (0)	0 (0)	2 (0.6)	2 (0.2)	

*BMI is calculated as weight /height^2 (kg/m^2)

Table 3: Self-reported lung symptoms among demolition workers, insulators and carpenters compared to hospital porters. Adjusted odds ratio* (OR) and 95 % confidence interval (CI)

n = number of persons who answered 'yes' (% of answers)	Demolition workers			Insulators			Carpenters			Hospital porters		Total
	N = 141			N = 149			N = 296			N = 313		N = 899
	n (%)	OR	95 % CI	n (%)	OR	95 % CI	n (%)	OR	95 % CI	n (%)	OR	n (%)
Coughing more than average	38 (28)	2.2	1.2–3.8	22 (15)	1.2	0.7–2.2	37 (13)	1.5	0.9–2.5	35 (11)	1	132 (15)
Cough and sputum daily for three months per year for two years	22 (16)	2.0	1.0–3.9	14 (10)	1.5	0.7–3.0	22 (8)	1.7	0.9–3.3	19 (6)	1	77 (9)
Breathlessness walking fast or uphill	46 (34)	1.5	0.9–2.4	51 (34)	1.7	1.1–2.6	53 (18)	0.9	0.6–1.4	74 (24)	1	224 (25)

*OR is adjusted for smoking status, age group and BMI

Table 4: Spirometry. FEV_1, FVC and FEV_1/FVC among demolition workers, insulators, carpenters and hospital porters. Adjusted odds ratios* (OR) with 95% confidence interval (CI).

	Demolition workers		Insulators		Carpenters		Hospital porters		Total
	N = 141		N = 149		N = 296		N = 313		N = 899
	n (%)	OR [95% CI]	n (%)	OR [95% CI]	n (%)	OR [95% CI]	n (%)	OR	n (%)
FEV_1/FVC<0.7	29 (21)	1.1 [0.6-1.9]	27 (18)	0.9 [0.5-1.5]	37 (13)	0.8 [0.5-1.3]	55 (18)	1	148 (17)
FEV_1 < LLN	24 (17)	1.3 [0.7-2.3]	16 (11)	0.8 [0.4-1.6]	14 (5)	0.5 [0.2-0.9]	37 (12)	1	91 (10)
FVC < LLN	9 (6)	1.1 [0.5-2.6]	7 (5)	0.7 [0.3-1.6]	2 (1)	0.1 [0.0-0.6]	21 (7)	1	39 (4)

*OR is adjusted for smoking status, age group and BMI

respective occupational groups. The *P*-values in the last column refer to a test for overall differences between the four groups. Insulators and hospital porters were significantly older (P < 0.0001). More carpenters had never been smokers and more demolition workers were current smokers (P < 0.0001).

Self-reported lung symptoms

Table 3 shows the questionnaire items related to self-reported symptoms of potential lung disease. Participants had the option of answering 'yes' or 'no' and table 3 shows the distribution of the 'yes' answers in the different groups of construction workers compared to hospital porters.

Compared to hospital porters, all groups of construction workers were estimated to have increased odds of coughing more than average, but the odds ratio (OR) was only significant for demolition workers (OR = 2.2, 95% CI 1.2-3.8).

The ORs for self-reported lung symptoms were generally higher for demolition workers and insulators compared to hospital porters, although not significantly. The estimated interaction with age group for 'Coughing more than average' showed the odds of coughing being greater among demolition workers ≥ 50 years of age (OR = 8.3, 95% CI 2.3-30.2) and carpenters (OR = 5.3, 95% CI 1.8-15.4) compared to hospital porters, whereas there was no significant difference among younger workers. The estimated interaction with smoking status showed a tendency of increased odds of coughing among smokers for all groups of construction workers compared to hospital porters: demolition workers (OR = 11.0, 95% CI 4.2-29.0), insulators (OR = 7.6, 95% CI 2.6-21.8) and carpenters (OR = 7.5, 95% CI 2.7-20.7). There were no significant differences between construction workers compared to hospital porters when separately comparing those who never smoked and former smokers.

Spirometry

Table 4 shows results from the comparison of spirometry outcomes of groups. The number of participants and cases in all groups are reported along with ORs for each of the three groups of construction workers compared to hospital porters.

With respect to FEV_1/FVC < 0.7, no significant differences in odds were found between occupational groups. Compared to those who never smoked, odds were significantly increased for current smokers (OR = 2.7, 95% CI 1.7-4.4) and former smokers (OR = 1.5, 95% CI 0.9-2.5) and slightly decreased for workers with higher BMI. The OR for older (≥ 50 years) compared to younger workers (≤ 49 years) was borderline significant (OR = 1.5, 95% CI 1.0-2.16, P = 0.04).

A total of 148 participants (17%) showed pre-bronchodilator FEV_1/FVC<0.7; of these, 29 had both FEV_1 and FVC values > 80% and were not administered a bronchodilator – they were classified as GOLD 1. In total, 45 of the participants had normal post-bronchodilator values and were therefore diagnosed with asthma. In total, 26 carpenters (8.8%), 21 insulators (14%), 21 demolition workers (14.9%) and 40 hospital porters (12.8%) had COPD (GOLD 1–4) (P = 0.305). GOLD 2-4 was found in seven carpenters (2.4%), seven insulators (4.7%), 11 demolition workers (7.8%) and 19 hospital porters (6.1%) (P = 0.055). Two demolition workers (1.4%) and five hospital porters (1.6%) had GOLD 3-4.

An overall test for occupational group differences in FEV_1 < LLN was significant (P = 0.03). The estimated odds of FEV_1 < LLN were highest for demolition workers, and lowest for carpenters. Demolition workers and insulators had higher odds than hospital porters, but the difference was not significant. Carpenters had significantly lower odds than hospital porters (OR = 0.5, 95% CI 0.2-0.9). Within the group of construction workers, the OR for demolition workers versus carpenters was 2.7 (95% CI 1.3-5.5) and for insulators compared to carpenters it was 1.8 (95% CI 0.8-3.9). A significant association was found between smoking status and FEV_1 < LLN, with higher prevalence for current and former smokers compared to those who never smoked (OR = 5.2, 95% CI 2.5-10.7 and OR = 3.1, 95% CI 1.5-6.5, respectively). The odds of FEV_1 < LLN were significantly increased for workers with higher compared to lower BMI.

A significant overall difference in odds of FVC < LLN was found between the four occupational groups (P = 0.003), with lowest prevalence among carpenters who had significantly lower odds compared to all other groups. There were no differences between the other groups. Within the group of construction workers, the OR for demolition workers versus carpenters was 8.7 (95% CI 1.8-41.9) and for insulators compared to carpenters it was 5.1 (95% CI 1.9-25.4). The analyses showed no effect of age or smoking status, but an increased prevalence of FVC < LLN for workers with higher compared to lower BMI.

In table 5, mean values are reported for measured FEV_1, FVC, FEV_1/FVC and lung function measures defined as the ratios of measured/expected values of FEV_1 and FVC, respectively. Results are distributed according to occupational group, smoking status and age group. Within all smoking groups, demolition workers ≥ 50 years had the lowest FEV_1 and FVC values compared to all other occupations.

The difference between younger and older participants with respect to values standardized to expected values for FEV_1 and FVC was also largest in the group of demolition workers, where average FEV_1 ratios were < 90% for the older participants.

Linear regression analyses comparing the ratio of measured and

Table 5: Average values of spirometric parameters distributed on occupational group, age group and smoking status.

	≤ 49 years				≥ 50 years			
	Demolition workers N = 108	Insulators N = 63	Carpenters N= 203	Hospital porters N = 153	Demolition workers N = 33	Insulators N = 87	Carpenters N = 93	Hospital porters N = 160
Never smokers	**n = 20**	**n = 11**	**n = 96**	**n = 58**	**n = 4**	**n = 28**	**n = 39**	**n = 42**
Measured FEV_1 (litres)	4.11	4.13	4.18	3.91	3.01	3.80	3.83	3.69
Measured FVC (litres)	5.31	5.31	5.35	4.98	4.03	4.85	5.00	4.79
FEV_1/FVC	0.78	0.78	0.78	0.79	0.74	0.79	0.77	0.77
Measured FEV_1/expected FEV_1	98.93	102.33	101.81	96.41	87.32	102.24	104.03	98.55
Measured FVC/expected FVC	104.45	107.73	106.67	99.71	93.15	103.82	107.90	101.71
Former smokers	**n = 22**	**n = 20**	**n = 58**	**n = 44**	**n = 15**	**n = 34**	**n = 34**	**n = 66**
Measured FEV_1 (litres)	3.89	3.82	4.14	3.87	3.29	3.37	3.65	3.51
Measured FVC (litres)	5.06	4.93	5.37	5.13	4.40	4.47	4.90	4.70
FEV_1/FVC	0.77	0.78	0.77	0.76	0.74	0.75	0.75	0.74
Measured FEV_1/expected FEV_1	94.83	96.66	99.28	95.70	89.18	94.01	98.61	94.49
Measured FVC/expected FVC	100.90	101.48	104.83	103.32	94.94	99.25	105.18	100.80
Current smokers	**n = 65**	**n = 31**	**n = 45**	**n = 51**	**n = 14**	**n = 25**	**n = 19**	**n = 49**
Measured FEV_1 (litres)	3.81	3.81	4.04	3.76	3.11	3.29	3.17	3.35
Measured FVC (litres)	5.18	5.21	5.39	5.02	4.32	4.67	4.43	4.63
FEV_1/FVC	0.74	0.73	0.75	0.75	0.72	0.71	0.72	0.72
Measured FEV_1/expected FEV_1	92.53	94.23	97.43	91.32	85.28	91.82	88.67	91.09
Measured FVC/expected FVC	102.84	104.97	106.12	99.69	94.44	103.41	98.35	100.24

N = All in age and workgroup.

n = total in smoking sub-group.

expected lung function across occupation, adjusted for age group, smoking status and BMI found differences between the occupational groups. For FEV_1, there was a significant overall difference (P = 0.004), and carpenters had significantly higher values than demolition workers and hospital porters. Current and former smoking was associated with a significant difference in standardized FEV_1 (P < 0.0001 for smoking status), and larger values of BMI were associated with a lower value in standardized FEV_1 (P = 0.0014).

The interaction between occupation and age group was borderline significant (P = 0.08) for standardized FVC, indicating that differences between occupational groups were not the same for younger and older workers. Table 5 shows that for any smoking status, the older demolition workers have the lowest ratio of measured vs. expected FVC.

Discussion

The results in this study did not support the research hypothesis of Danish construction workers having a higher prevalence of COPD defined as GOLD 1-4 or GOLD 2-4 when compared to a group of hospital porters.

Self-reported symptoms of chronic bronchitis (cough and sputum daily for three months per year for two years) were higher for all groups of construction workers compared to hospital porters, but only significantly for demolition workers. Demolition workers also had the highest prevalence of FEV_1 < LLN and FVC < LLN, insulators had slightly lower prevalence and carpenters had the lowest prevalence among the three groups within the construction industry. While the construction workers did not seem to be worse off than the hospital porters with respect to these two measures, there were significant differences between demolition workers and carpenters, who were assumed to have a high and low dust exposure, respectively.

The results concerning symptoms of bronchitis are consistent with other studies on construction workers. Vermeulen et al. [24] found that working in construction increased the risk of developing symptoms of bronchitis and that the risk increased with prolonged employment. Rothenbacher et al. [25] found a non-significantly elevated prevalence of chronic respiratory diseases in construction workers. In a Swedish cohort study by Bergdahl and Torén, a significantly increased risk of COPD-mortality was associated with exposure to inorganic dust among construction workers [26].

Kennedy et al. [27] found an increased risk of lung disease in 1991 insulators, corresponding to the results of Clausen [28]. We did not obtain similar results; and this is in accordance with Albin et al. [29], who found no relationship between exposure to mineral wool and decreased lung function. This discrepancy could be due to changes in occupational exposure over time and associated with both cessation of asbestos use, better protection and more frequent use of protective equipment.

Another explanation for the lack of a high prevalence of COPD among construction workers in this study could be that working conditions in the Danish construction industry have improved significantly, resulting in a reduced risk of developing COPD. This explanation corresponds with the findings of the studies by Tüchsen [30] that showed a decline in standardized hospitalisation ratio during 1981-2009, which could indicate that the problems are decreasing.

Zock et al. [31] found an association between FEV_1 and high exposure to vapours, gas, dust or fumes, as predicted by the job exposure matrix in current smokers. The few positive results may be due to the young age of the participants. The association was unrelated to the level of cigarette consumption, similar to results of the present study. Rothenbacher et al. [25] found a non-significantly elevated prevalence of chronic respiratory disease in construction workers.

In this study, lung function values were higher in the age group ≤ 49 years compared to ≥ 50 years, which was expected, since lung function normally decreases with increasing age [1,32]. High BMI was associated with lower absolute values of both FEV_1 and FVC. No differences were found with regards to age and BMI between occupational groups that could explain the differences in lung function values.

As expected, those who never smoked were significantly less likely to have FEV_1 < LLN, coughing with sputum and breathlessness compared to both current and former smokers. The interaction between age and smoking status made the differences larger in the older age category, where we found significantly increased odds of coughing among current smokers in all groups of older construction workers compared to hospital porters [33].

Surprisingly, carpenters seemed to be healthier as defined by lung function tests than hospital porters, whom we expected to have jobs without dust exposure. Previous findings show a lower risk among carpenters to be hospitalized with COPD compared with other workers in the construction industry [30]. Even though there were significantly more that never smoked and fewer current smokers among carpenters compared to the other occupational groups, the carpenters' results remained significantly better after adjusting for smoking status. Therefore the difference in lung function between the groups cannot be explained by smoking habits alone. It is possible that carpenters are generally healthier than workers from other occupations in the construction industry because of the specific physical demands of the work, and thereby may be selected for carpentry (healthy-worker effect).

The strengths of our study were the high participation rate among construction workers, the relatively high number of participants and that the COPD diagnoses were based on lung function tests including post-bronchodilator values [34].

In this study, only employment was used as a proxy for dust exposure, not seniority or level of dust exposure. This may lead to a misclassification and thereby a risk of not detecting an association between COPD and occupational groups among construction workers. Another explanation for the lack of association between the occupational groups among construction workers and COPD may be too few participants with diagnosed COPD.

There were fewer responders (60.7%) among hospital porters compared to carpenters (82.9%). If hospital porters with lung problems were over-represented among the participants then the effect of working in construction on the prevalence of COPD would be underestimated. The problem would be increased if the recruiting pattern in this regard was different between hospital porters and construction workers. Among hospital porters, there was no difference in self-reported respiratory symptoms among those who participated – and did not – in the lung function test. We have no further description of non-responders to clarify this potential selection bias. Among construction workers we had quite high response rates and the majority of those not participating were due to logistic problems, caused by changing workplaces, sickness or vacation. Therefore, it is unlikely that differences in response rates caused selection bias for the construction workers but it could affect the relationship to the control group.

Conclusions

Our results showed no overall differences in the prevalence of COPD among construction workers compared to hospital porters. There was a tendency toward more self-reported symptoms of bronchitis in male Danish construction workers than comparable hospital porters and a tendency toward higher prevalence of $FEV_1 <$ LLN in demolition workers compared to insulators and carpenters.

Acknowledgements

This study was made possible by Grant no. 21-2010-09 from the Danish Working Environment Research Fund.

Ellen Molgaard participated in designing the questionnaire. Inge Lise Bjerring and Yun Ladegaard helped gathering data.

Ethical statement

The study was conducted with the approval of the National Committee on Health Research Ethics.

References

1. Pauwels RA, Buist S, Calverley PMA, Jenkins CR, Hurd SS (2001) Global strategy for the diagnosis. management, and prevention of chronic obstructive disease. NHLBI/WHO global Initiative for chronic obstructive lung disease (GOLD) workshop summary. Am J Respir Crit Care Med 163: 1256-1276.
2. Lokke A, Lange P, Scharling H, Fabricius P, Vestbo J (2006) Developing COPD: a 25 year follow up study of the general population. Thorax 61: 935-939.
3. Mastrangelo G, Tartari M, Fedeli U, Fadda E, Saia B (2003) Ascertaining the risk of chronic obstructive pulmonary disease in relation to occupation using a case-control design. Occup Med (Lond) 53: 165-172.
4. Viegi G, Scognamiglio A, Baldacci S, Pistelli F, Carrozzi L (2001) Epidemiology of chronic obstructive pulmonary disease (COPD). Respiration 68: 4-19.
5. Omland O, Würtz ET, Aasen TB, Blanc P, Brisman JB, et al. (2014) Occupational chronic obstructive pulmonary disease: a systematic literature review. Scand J Work Environ Health 40: 19-35.
6. The Danish Working Environment Authority: Occupational diseases - The Danish Working Environment Authority (2013) Annual report.
7. Torén K, Järvholm B (2014) Effect of occupational exposure to vapors, gases, dusts, and fumes on COPD mortality risk among Swedish construction workers: a longitudinal cohort study. Chest 145: 992-997.
8. Dong XS, Wang X, Daw C, Ringen K (2011) Chronic diseases and functional limitations among older construction workers in the United States: a 10-year follow-up study. J Occup Environ Med 53: 372-380.
9. Bagschik U, Böckler M, Chromy W, Dahmann D, Gabriel S, et al. (2008) Exposure to quartz at the work place (BGIA-Report 8/2006e) 1-154.
10. Norén JO (2005) Byggdamm vid ROT-arbeten. Measurement project Swedish Work Environment Authority 2004. Report 2: 1-17.
11. Björkgren L, Gustafsson CA, Hammarlin N, Hassel A, Nilsson U, et al. (1997) Environmental description of occupations in the construction industry. Report from National Institute of Work Environment Protection for Construction Industry 1-104.
12. Karlsson A, Christensson B (2008) Effektiva åtgärder mot damm på byggarbetsplatser. Etapp 1 Effective measures against dust at construction sites stage 1 IVL-Rapport. Stockholm, Svenska Miljöinstitutet 1-47.
13. Lumens ME, Spee T (2001) Determinants of exposure to respirable quartz dust in the construction industry. Ann Occup Hyg 45: 585-595.
14. Kim JH, Chang HS, Kim KY, Park WM, Lee YJ, et al. (1999) Environmental measurements of total dust and fiber concentration in manufacturer and user of man-made mineral fibers. Ind Health 37: 322-328.
15. Breysse PN, Lees PS, Rooney BC, McArthur BR, Miller ME, et al. (2001) End-user exposures to synthetic vitreous fibers: II. Fabrication and installation fabrication of commercial products. Appl Occup Environ Hyg 16: 464-470.
16. Radnoff D, Todor MS, Beach J (2014) Occupational exposure to crystalline silica at Alberta work sites. J Occup Environ Hyg 11: 557-570.
17. (1965) Definition and classification of chronic bronchitis for clinical and epidemiological purposes. A report to the Medical Research Council by their Committee on the Aetiology of Chronic Bronchitis. Lancet 1: 775-779.
18. Celli BR, MacNee W; ATS/ERS Task Force (2004) Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. Eur Respir J 23: 932-946.
19. Quanjer (1983) Standardized lung function testing. Bull Eur Physiopathol Respir 1-95.
20. Quanjer PH, Tammeling GJ, Cotes JE, Pedersen OF, Peslin R, et al. (1993) Lung volumes and forced ventilatory flows. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. Eur Respir J 16: 5-40.
21. Ndd: Easyguide - Operator's manual (2014) (https://nddmed.com/pulmonary-resources/library/download)
22. Vestbo J, Hurd SS, Agustí AG, Jones PW, Vogelmeier C, et al. (2013) Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med 187: 347-365.
23. Pellegrino R, Viegi G, Brusasco V, Crapo RO, Burgos F et al. (2005) Interpretative strategies for lung function tests. Eur Respir J 26: 948-968.
24. Vermeulen R, Heederik D, Kromhout H, Smit HA (2002) Respiratory symptoms and occupation: a cross-sectional study of the general population. Environ Health 1: 5.
25. Rothenbacher D, Arndt V, Fraisse E, Daniel U, Fliedner TM, et al. (1997) Chronic respiratory disease morbidity in construction workers: patterns and prognostic significance for permanent disability and overall mortality. Eur Respir J 10: 1093-1099.
26. Bergdahl IA, Torén K, Eriksson K, Hedlund U, Nilsson T, et al. (2004) Increased mortality in COPD among construction workers exposed to inorganic dust. Eur Respir J 23: 402-406.
27. Kennedy SM, Vedal S, Müller N, Kassam A, Chan-Yeung M (1991) Lung Function and Chest Radiograph Abnormalities Among Construction Insulators. Am J Ind Med 20: 673-684.
28. Clausen J, Netterstrom B, Wolff C (1993) Lung function in insulation workers. Br J Ind Med 50: 252-256.
29. Albin M, Engholm G, Hallin N, Hagmar L (1998) Impact of exposure to insulation wool on lung function and cough in Swedish construction workers. Occup Environ Med 55: 661-667.
30. Tüchsen F, Hannerz H, Mølgaard EF, Brauer C, Kirkeskov L (2012) Time trend in hospitalised chronic lower respiratory diseases among Danish building and construction workers, 1981-2009: a cohort study. BMJ Open 2.

31. Zock JP, Sunyer J, Kogevinas M, Kromhout H, Burney P, et al. (2001) Occupation, chronic bronchitis, and lung function in young adults. An international study. Am J Respir Crit Care Med 163: 1572-1577.

32. Hnizdo E, Sircar K, Glindmeyer HW, Petsonk EL (2006) Longitudinal limits of normal decline in lung function in an individual. J Occup Environ Med 48: 625-634.

33. Global Strategy for the Diagnosis, Management and Prevention of COPD, Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2015.

34. Cerveri I, Corsico AG, Accordini S, Niniano R, Ansaldo E, et al. (2008) Underestimation of airflow obstruction among young adults using FEV1/FVC < 70% as a fixed cut-off: a longitudinal evaluation of clinical and functional outcomes. Thorax 63: 1040-1045.