PREVALENCE AND PREDICTORS OF RESPIRATORY SYMPTOMS IN WORKERS EXPOSED TO ORGANIC DUSTS

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Abstract

1032 workers exposed to organic dusts in 9 different industries were surveyed using an administered questionnaire and exposure sampling. Information concerning; demographic features, occupational histories, respiratory symptoms (including temporal patterns) and smoking habits were collected. In addition total dust exposure was measured in a representative sample in each industry using personal sampling techniques. Exposure to endotoxin was then measured using a simple water extraction of collected dust and assay with an automated quantitative turbidimetric assay (LAL 5000). The highest prevalence of respiratory symptoms were found in animal handlers (swine confinement and poultry) and the lowest in wool workers. Logistic regression analysis was used to determine predictive factors of respiratory symptoms entering parameters of demographic details, smoking habits and measured exposures in a forward stepwise model (SPSS). Smoking habits, increasing dust/ endotoxin exposures and pre-existing pulmonary disease were the significant predictor variables.

Introduction

Organic dusts are a heterogeneous complex mixture of animal and vegetable matter, containing a wide range of potentially harmful agents. When considering the diversity of these dusts it is not surprising that exposures are implicated in the aetiology of respiratory disease. The occurrence of chronic bronchitis, asthma, allergic alveolitis, byssinosis and organic dust toxic syndrome have all been documented following exposures. Endotoxins derived from the cell wall of gram negative bacteria often contaminate organic dusts. In human inhalational studies endotoxins are found to provoke a variety of symptoms including fever, cough and dyspnoea (Pernis 1961). In addition physiological changes are found including bronchial obstruction, an increase in bronchial reactivity and a reduced carbon monoxide transfer factor (Rylander 1989, Michel 1992). Exposure to airborne endotoxin is implicated in the aetiology of byssinosis, organic dust toxic syndrome, humidifier fever, and more recently in the severity of asthma (Michel 1991).

A number of investigators in different countries have studied different occupational groups and ascertained symptom prevalence and exposures to dust and endotoxin. The use of this data to provide comparisons between these groups is invalidated because of different methods of data collection and analysis. The aim of this study was to document respiratory symptoms and their temporal patterns, to document exposures to dust and endotoxins and elucidate possible predictive factors for work related respiratory symptoms. This work was performed in a single centre, using the same methodology through out, studying 9 different industries spread over 36 sites. The data collected enabled risk factors for the development of symptomsin exposed workers within and across industries to be identified.

Methods

A cross sectional survey of workers exposed to organic dusts in the UK was performed. The cohort studied comprised of individuals working in the textile industry (cotton spinning, wool scouring/ combing and weaving), agriculture (grain handling, mushroom cultivation and wood) and animal handling (poultry and swine confinement workers). Individuals were invited to participate in the survey and if agreeable answered an administered questionnaire. The questionnaire used was an adapted version of the MRC respiratory questionnaire. This particular questionnaire has been validated by and used for a number of years within the department (Fletcher 1993). The questionnaire is designed to collect demographic data, an occupational history, upper and lower respiratory symptoms (including any work related relationships), information concerning previous respiratory illness and a detailed smoking history. The questionnaire was administered by 1 of 2 investigators and the information was stored using Dbase 3 software directly onto a computer.

A representative sample of the work force at each site was selected to record personal total dust exposures during a typical work shift. The IOM (institute of occupational medicine) sampling head was used to collect the dust onto Whatman 25 mm glass fibre filter papers. The head was worn by operatives at the level of the left clavicle. The filter papers were weighed pre and post collection using a Sartorius micro balance to 3 decimal places. Control filters were also taken to each site. This was necessary to correct for changes in weight of the filters due to changes in water content, and as will be appreciated later to look for cross contamination with endotoxin. Calibrated battery operated rechargeable Cassella personal sampling pumps were used to draw air across the filter. The pump flow rate was set at 2 l/min at the commencement of sampling and the flow rate checked at the end of sampling. Using this flow rate and the time of the sampling period, the volume of air sampled

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could be calculated and allowed results to be expressed as mg/m^3 .

Following gravimetric analysis the individual filters were transferred using flamed forceps to endotoxin free glass ware. The samples were then stored at < - 20 C until analysis. Throughout the analysis endotoxin free glassware, plastic and water was used. Samples were thawed at room temperature for an hour prior to a simple water extraction technique (Gould 1987). 10 mls of water was added to the 10 oz universal containers used to store the filters. Samples were vortexed for 60 seconds, prior to agitation on roller bars for 60 minutes and were finally vortexed for a further 60 seconds. This resulted in the disintegration of the filter paper. A 4 ml aliquot of this solution was then centrifuged at 3000 g for 15 minutes. Serial dilutions were then made with 0.5 mls of the supernatant. The samples were then analysed using a quantitative kinetic turbidimetric method (the LAL 5000e series 2 machine Associates Cape Cod). Standard curves were generated with control standard endotoxin (Associates Cape Cod), water negative controls were also included with each analysis. The control filters from each site were also analysed for theirendotoxin content, the results from these were then used to correct the measured collected values. Using the previously calculated volume of air sampled the results are expressed as ng/m^3. With the control standard endotoxin used a conversion factor of 10 can be used to convert the results to endotoxin units.

Exposure values were ascribed to individuals for both current endotoxin and dust exposures. Each occupational group specific to site and room has been accredited with the average value for the samples taken. Where only one sample existed this value was allocated to other individuals specific to that occupational group, work room and site.

Results

One thousand and thirty two individuals (93 % of the target population) participated in the study. These were drawn from 9 different industries and thirty six sites. The population were predominantly male (78%), Caucasians (84.4%) with a mean age of 39.1 yrs (standard deviation 13.2 yrs). For the population 45.4 % were current smokers, 35.4% ex smokers and 19.2 % lifelong non smokers.

Reported symptoms were classified as work related by their periodicity. In this paper individuals are categorised if they reported one or more lower respiratory symptom of cough, phlegm production, chest tightness, wheeze and shortness of breath. For upper respiratory tract symptoms the reported symptoms were either eye or nasal. Attempts were also made to identify symptom complexes suggestive disease chronic bronchitis byssinosis and the organic dust toxic syndrome.

One or more work related lower respiratory tract symptom was reported by 16.5 % of the population Chi squared analysis found these to be more common amongst current smokers $p < 0.001$. For 1 or more work related upper respiratory tract symptoms these were reported by 26.9 % of the population and were more common in females $p < 0.001$. The prevalence of work related symptoms and diseases specific for industries is presented in table 1. From this data it is apparent that the highest prevalence of symptoms is in the animal and grain handling industries, and also of note is the finding of an individual in the swine confinement industry who gave a symptom complex compatible with byssinosis.

In total 259 samples for personal exposures to dust and endotoxin were collected and analysed this represented sampling 25.1% of the population. The comparative exposures for both dust and endotoxin are presented in data published in this journal (Simpson 1996). The highest exposures for dust (the maximum recorded value 72.5 mg/m^3) occurred during cleaning activities (in the grain and wool industries) and in the animal handling industries. For endotoxin the greatest exposures were seen in animal handling and cotton spinning (up to 72 mcg/m^3). The correlation between measured dust and endotoxin was 0.7 (sig. < 0.001). This highly significant close correlation meant that in the multiple logistic regression analysis it was impossible to separate the independent effects of dust and endotoxin.

To fully examine the relationship between the occurrence of symptoms and disease multiple logistic regression techniques were used. The independentvariables used in the multiple logistic regression models were sex, age, ethnic group, previous occupational dust exposure, time spent in current industry and room, the wearing of respiratory protection, a history of physician diagnosed asthma or hay fever or bronchitis, smoking habits including pack years, industry and the naturally logged exposure variables for dust and endotoxin. Tables 2, 3, 4, 5 and 6 present the variables found to be predictive of an individual reporting 1 or more lower respiratory tract symptom, 1 or more upper respiratory tract symptom, chronic bronchitis, byssinosis and the organic dust toxic syndrome respectively. In addition the relative risks and their 95 % confidence intervals are quoted.

Discussion

Within the cohort of workers exposed to organic dusts animal handlers have high levels of work related respiratory symptoms with 38 .1 % of poultry workers reporting 1 or more lower respiratory tract symptom. The wool industry has the lowest reported prevalence 8.6 %. Using multiple logistic regression techniques to identify risk factors for 1 or more work related lower respiratory tract symptom not surprisingly smoking habits and previously documented respiratory illness were significantly predictive. In addition dust/endotoxin exposures and industry years were found to be independently related and associated with an increased risk of symptoms. It is possible that the low prevalence of the documented symptoms in the wool industry was due to individuals not answering the questionnaire truthfully for fear of results being communicated to the management. This group were as with all others reassured prior to the questionnaire that any information gathered was confidential in nature.

Poultry and wool workers were again found to report the highest and lowest prevalences of work related upper respiratory tract symptoms 45.2 % and 10.1 % respectively. Across the cohort multiple logistic regression techniques identified that 1 or more work related upper respiratory tract symptoms were commoner in younger females with higher dust/endotoxin exposures. This excess of symptoms in younger females is in accordance with findings previously reported by the department and other investigators (Razza 1990, Love 1986). Possibly younger females are less tolerant of the effects of dust exposures than the rest of the population. Again working within the wool industry would appear to be protective.

The highest prevalence of work related chronic bronchitis was found amongst the animal handling industries with rates of 15.5 % and 9.3 % for poultry and swine respectively. The lowest level was found in the animal feed manufacturing industry where no individual gave a history compatible with chronic bronchitis. When considering the multiple logistic regression model dust/endotoxin exposures are the most significantly related predictor variable. This is independent of present smoking and bronchitis. This is in agreement with other work reporting dusts exposures independent of smoking habits are implicated in the aetiology of workers exposed to dusts are at risk of chronic bronchitis independent of smoking (Marine 1988, Niven 1995).

The individual with a symptom complex compatible with a diagnosis of byssinosis is interesting andsuggests as others have that byssinosis may occur in individuals outside of the recognised industries (Ozesmi 1987). The finding in the multiple logistic regression that dust/endotoxin exposures were predictive of disease strengthens the case for endotoxin being an important aetiological agent.

The occurrence of the organic dust toxic syndrome was not found to be related to current personal dust/endotoxin exposures. Two possible explanations for this are firstly the questionnaire is not able to distinguish this syndrome from individuals suffering from allergic alveolitis. Support for this can be seen in the industries in which ODTS was found; saw mills, mushroom cultivation and poultry confinement. In all these situations occupationaly related allergic alveolitis is documented. Secondly that current personal exposures are not the appropriate exposure to be measuring and that peaks of exposure would be more appropriate.

Conclusion

This study highlights the need for tighter controls of organic dust exposures and active smoking cessation programmes within industries where exposures occur, if respiratory morbidity is to be reduced.

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Table 1 % Prevalence of Work Related Respiratory tract symptoms.

Industry	% LRT Symp	% URT Symp	% Chronic Bronchitis	% Byssinosis	% ODTS
Mushroom	14.8	32.8	1.6	0	2.5
Swine	23.3	34.9	9.3	2.3	0
Grain	20.3	40.6	5.8	0	4.3
Poultry	38.1	45.2	15.5	0	5.9
Saw Mill	12.9	20.8	5	0	0
Cotton	15	20.4	4.4	4	1
Wool	8.6	10.1	8.6	0	0
Animal Feed	11.8	38.2	0	0	0
Weaving	15.4	29.4	2.3	0	0
Total	16.5	26.9	4.6	1	1.3

Table 2 Predictor variables for one or more work related lower respiratory tract symptom.

Variable	Significance	Relative Risk
Present smoking	< 0.0001	1.58 - 3.36
History of asthma	< 0.0001	1.94 - 5.95
History of bronchitis	< 0.0001	1.80 - 5.47
Increasing industry years	< 0.005	1.01 - 1.05
Higher dust/endotoxin exposure	< 0.005	1.14 - 1.79
Industry	< 0.005	

Industry wool sig. < 0.005 relative risk 0.11 - 0.60

Table 3: Predictor variables for one or more work related upper respiratory tract symptom.

Variable	Significance	Relative Risk
Sex (female)	< 0.0001	2.27 - 5.25
Industry	< 0.0005	
Higher dust/endotoxin exposure	< 0.0005	1.16 - 1.67
Younger age	< 0.05	1.00 - 1.03

Industry wool sig. < 0.005 relative risk 0.14 - 0.62

Table 4: Predictor variables for chronic bronchitis.

Variable	Significance	Relative Risk
Higher dust/endotoxin exposure	0.0005	1.08 - 1.34
Present smoking	< 0.005	1.42 - 5.51
History of bronchitis	< 0.005	1.48 - 6.88
Increasing industry years	< 0.05	0.99 - 57.95

Table 5: Predictor variables for byssinosis.

Variable	Significance	Relative Risk
Increasing industry years	< 0.0005	1.05 - 1.18
Increasing endotoxin exposure	< 0.005	1.22 - 2.82
Sex male	< 0.01	1.76 - 33.81

Table 6: Predictor variables for the organic dust toxic syndrome.

Variable	Significance	Relative Risk
Industy	<0.05	
Increasing age	< 0.05	1.00 - 1.06

Industry saw mills, animal handling, mushroom cultivation and grain handling