A COMPARISON OF THE PREVALENCE OF RESPIRATORY SYMPTOMS IN WORKERS EXPOSED TO ENDOTOXIN ALONE AND THOSE EXPOSED TO A COMBINATION OF DUST AND ENDOTOXIN

Francis HC, Oldham LA, Pickering CAC, Niven RmcL,
Simpson JCG, Fletcher AM, Adisesh A, Fletcher GD
North West Lung Centre, Wythenshawe Hospital
Manchester, U.K.

Abstract

We have previously reported on respiratory symptoms dust and endotoxin exposure within workers exposed to organic dusts. These show increasing symptoms with both increased exposure to dust and airborne endotoxin exposure. However the relative effects of dust and endotoxin were difficult to separate out. In all the industries higher dust levels were associated with increased endotoxin exposure. We are currently studying sewage workers who are potentially exposed to endotoxin but not to dust to determine the respiratory effects of endotoxin exposure alone on respiratory symptom reporting.

A cohort of sewage workers employed at 4 sites across the South of England were be interviewed with a respiratory questionnaire in identical fashion to the study of workers exposed to a variety of organic dusts (wood, mushroom, pig, cotton, wool and poultry workers). Each employee performed pulmonary function on a dry bellows wedge spirometer to obtain measures of lung volume. Endotoxin exposure was be measured using personal sampling pumps worn by the workers across the working shift. As with the study of organic dust exposed workers, endotoxin will be extracted using a simple water extraction and analysed with a quantitative turbidometric LAL assay. Endotoxin is expressed as ng per m^3 of sampled air.

Prevalence rates for respiratory symptom reporting are presented and compared to those found in different groups of organic dust exposed workers. Levels of endotoxin are presented and compared to the above groups.

Introduction

Exposure to airborne endotoxin has been implicated in several respiratory situations including:- acute and chronic byssinosis and other work related respiratory symptoms in textile workers (Haglind 1984, Niven 1993), "toxic pneumonitis" (an illness characterised by cough and fever in paper recycling workers; Sigsgaard 1997) and work related respiratory symptoms in a variety of industries with exposure to organic dusts (Simpson 1995 a and b). In a cross-sectional study of a number of different organic dust exposed industries, Simpson reported a relationship across the industries between the prevalence of work related respiratory symptoms and the exposure to both dust and endotoxin (Simpson 1996a). In this study, the exposure to dust and endotoxin were quite closely correlated and it was not possible to separate the effects of dust exposure from endotoxin exposure. As a result the independent influence of endotoxin exposure in the organic dust workers could not be determined.

Since this time we have been attempting to identify industries with organic dust exposure where there is high dust and low endotoxin exposure or low (or absent dust) and high endotoxin exposure. Water treatment or sewage workers are potentially exposed to bio-aerosols which may have significant levels of endotoxin within them. However it is not known whether these aerosols are of sufficiently low particle size as to be respirable or whether they remain airborne long enough in the working environment to pose any risk in terms of significant airborne levels of endotoxin. After several unsuccessful attempts we recently identified a water company who were prepared to allow us to study their work-force with regards to respiratory health and to perform personal sampling for endotoxin.

Methods

Target Population

All workers employed by a single water company in one of 4 main activity sites comprised the target population. One of these sites was a sewage maintenance section and the other 3 were water (sewage) treatment works. A representative sample of each occupation identified on a site by site basis were targeted for personal sampling. All individuals participating the study provided written informed consent. They completed an interviewer led respiratory questionnaire, performed lung function using a bellows dry wedge spirometer and performed nasal and expired NO measurement (as part of a larger study of workers exposed to respiratory hazards). The results presented here represent the findings of the respiratory questionnaire and endotoxin sampling.

Respiratory Questionnaire

The questionnaire used is a modified version of the MRC respiratory questionnaire. This particular questionnaire has been validated by, and used for a number of years within, the department. It is identical to that used in the previous study of organic dust exposed workers (Simpson 1996a). The questionnaire is designed to collect demographic data, occupational history, upper and lower respiratory symptom (including specific questions on the work related nature of any such symptoms). Information regarding past respiratory illness and a detailed smoking history are also included. The questionnaire was administered by a single trained interviewer who also was involved in the previous study.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:224-226 (1998)
National Cotton Council, Memphis TN

Endotoxin Sampling

Personal sampling as previously described for collection of organic dusts was performed (Simpson 1996a). Whatman 25mm micro-glass fibre filters were mounted in an IOM sampling head and were worn at the level of the left clavicle by the selected operative. They were worn for a proportion of the work shift and pumps (Casella 2L/min) and were switched off for meal and smoking breaks. Control filters were also taken to each site and handled in identical fashion, to control for any contamination of original filters and during storage.

Following sampling, filters were stored at -20C until analysis. Throughout the analysis, endotoxin free glassware was used. Samples were thawed at room temperature for 1 hour prior to a simple water extraction technique. 10mls of pyrogen free water were added to the 10oz universal containers used to store the filters in. Samples were vortexed and then agitated on a spiramix for 60 minutes. They were re-vortexed prior to centrifugation. The supernatants were then collected for analysis. Serial dilutions were then made with 0.5mls of the supernatant. Samples were then analysed with a quantitative kinetic turbidometric method (LAL 5000e, series 2 machine; Associates Cape Cod). Standard curves were generated with control standard endotoxin. Water negative controls were also included in each analysis. The control filters from each site were also analysed for their endotoxin content, the results from which were then used to correct the measured values. Using the calculated volume of air sampled the results were expressed as ng/m3. A conversion factor of 10 can be used fro the control standard endotoxin to convert the result to approximate endotoxin units.

Results

11 sewer workers and 34 sewage (water) treatment workers were interviewed from a target population of 64 (70.3%) of these 7 were unavailable because of holidays, courses and sickness absence leaving an available population of 57 (response rate 79%). 44 were male, 1 female. All white caucasian. Average age was 44.2 years (standard deviation SD; 10.9yrs). Most had spent a prolonged period of time within the industry (mean 16.7 years SD 8.4 range 1-33 years). 12 (26.7%) were current smokers, 20 (44.4%) had never smoked, 13 were ex smokers (28.9%).

Symptoms were relatively rare. Only 2 (4.4%) reported chronic bronchitis, although one of these was a life long non-smoker. In total 7 (15.6%) reported at least one work related respiratory symptom. 6 of the 7 symptomatic workers were current or ex-smokers. 4 (8.9%) reported work related eye symptoms, and 4 (8.9%) reported work related nasal symptoms (7 had either eye or nasal symptoms).

7 (15.6%) of the workers reported at least 2 of the following symptoms; fever, chills, weakness, malaise and joint/muscle pains, experienced for less than 72 hours. However, none of the cases were worse on returning to work after a break and therefore not classified as ODTS. One of these workers was based underground in the sewers. The other six workers were based on the same water treatment site; 4 worked in all the areas on the site and 2 worked in the screen house.

The level of symptom reporting in comparison to that seen in the other organic dust exposed populations we have already studied are presented in figures 1 and 2.

Endotoxin levels as measured were extremely low. The lowest level was in a gravity filtration technician of water treatment and was below the level of detection. The median level of exposure throughout all areas was 5.7ng/m3. It was lower for sewer operatives (2.6 ng/m3) than in the sewage treatment areas (5.8 ng/m3). The highest level was in a general labourer for one of the treatment sites (33.0 ng/m3).

The relative exposure compared to the organic dust industries previously studied is presented in figures 3 (median levels) and figure 4 (maximum levels.

Conclusions

The study was disappointing in demonstrating only low levels of endotoxin exposure. As the sewage contains large numbers of gram negative bacteria, the low personal airborne exposure is presumably related to the absence of aerosolisation. Activities within the sewers while still requiring a degree of manual manipulation of sewage, such as in screening may not be producing particles or droplets of sufficiently small aerodynamic size to remain airborne for any length of time and therefore they are also unlikely to be respirable. As a result the study has not been able to clarify the relative importance of dust or endotoxin ion the aetiology of symptoms in endotoxin exposed workers.

The levels of exposure were comparable with those seen in weaving, mushroom and sawmills. The work related respiratory symptoms were moderately prevalent but the target population was small. Work related upper respiratory symptoms were of low prevalence and similar to those seen in wool workers.

In order to separate the relative effects of endotoxin, dust and other organic particles, further industries with differential exposures to endotoxin and dust need to be sought.

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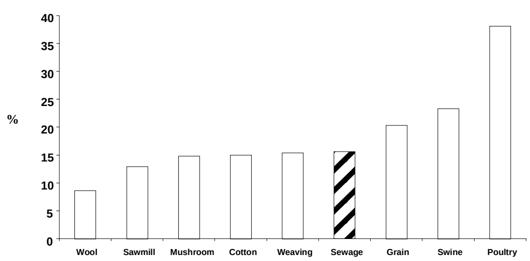

Figure 1. Prevalence of work related lower respiratory tract symptoms in sewer/sewage treatment and organic dust exposed workers.

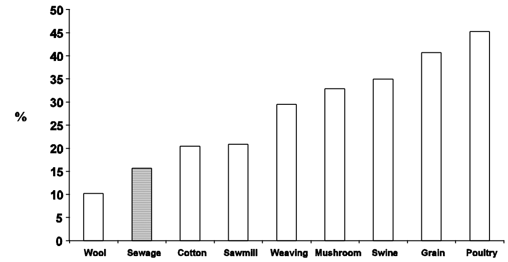

Figure 2. Prevalence of upper respiratory tract symptoms in sewer/sewage treatment and organic dust exposed workers.

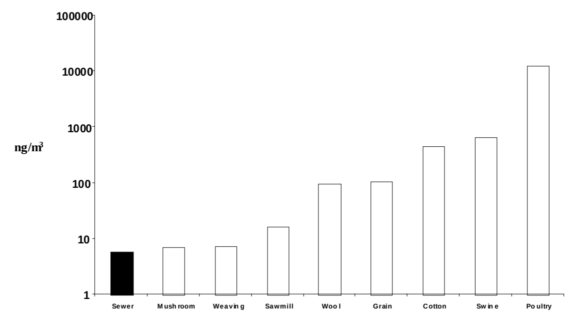

Figure 3. Median endotoxin exposure in sewer/sewage treatment and organic dust exposed workers.

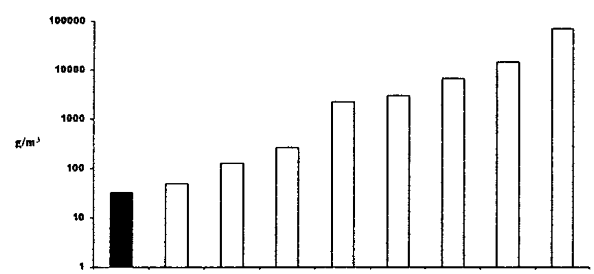

Figure 4. Maximum endotoxin exposures in sewer/sewage treatment workers and organic dust exposed workers.