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Respiratory symptoms in wool textile workers. An epidemiological study of respiratory health in West Yorkshire wool textile mills

Love RG, Smith T, Jones CO, Gurr D, Soutar CA, Seaton A



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RESPIRATORY SYMPTOMS
IN WOOL TEXTILE
WORKERS

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**An epidemiological study of respiratory health in West Yorkshire wool
textile mills.**

by

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SUMMARY

This epidemiological study was intended to investigate exposures to inspirable wool dust in selected wool textile mills, the patterns of respiratory symptoms reported by workers in the industry, and the relationships of symptoms to exposure to dust. Fifteen mills in West Yorkshire representing all stages of the woollen and worsted process, and production of carpet yarns, were included in the study, their size ranging from four to nearly four hundred employees.

Occupational hygiene surveys of airborne dust levels were carried out at each mill by means of the IOM personal inspirable dust sampler, which was worn during 629 shifts. Inspirable dust samplers were used because we wished to examine the effects of dust inhalation throughout the respiratory tract. A further 216 samples were collected in order to compare its performance with other samplers, to study the influence of a mesh guard on the samplers to keep out flocks of dust, or to estimate the presence of endotoxin in the dust.

Two thousand one hundred and fifty three current employees from these mills were interviewed, in order to obtain detailed information about respiratory and related symptoms, smoking habits and past and present occupations. A general purpose respiratory symptoms questionnaire was designed to elicit all the common respiratory symptoms, including cough, phlegm, wheeze, chest tightness, shortness of breath, rhinitis and nosebleeds. Questions on level and variability of breathlessness (intended to help identify asthma), itchy red eyes (conjunctivitis) and chills (intended to identify humidifier fever) were also included. The symptoms of cough, wheeze, rhinitis, itchy red eyes and chills were supplemented, if present, by questions intended to determine whether these symptoms were better or worse at certain times of the day, days of the week, seasons (rhinitis) and in particular situations. An occupational history questionnaire was also designed to identify all previous and current jobs, current working hours and usual shift patterns.

The total working population of 2793 at these mills included over six hundred workers of Asian origins. The questionnaires were therefore translated into Urdu, and locally based Urdu-speaking clerks were trained to administer the questionnaires during the surveys at mills where Asians were employed.

The dust sampling surveys indicated that dust levels ranged from zero to over 2000mg/m³. Average inspirable dust levels greater than 10mg/m³, the currently accepted nuisance dust standard, were experienced by about 9% of the workforce. Microscopic examination of wool samples and chemical and physical analysis revealed no obvious association of composition with the stage of processing. Measurement of the endotoxin levels of airborne samples revealed occasional very high concentrations.

Eighty five per cent of the currently employed workforce were interviewed and on average they reported symptoms with the following relative frequencies or prevalences: persistent cough and phlegm (chronic bronchitis), 9%; wheeze, 31%; breathlessness grade 3 or worse, 10%; variable breathlessness 3%; persistent rhinitis, 18%; persistent conjunctivitis, 10%; persistent chills, 2% and more than 10 nosebleeds in the past year, 2%. These symptoms were in general commoner in women, Europeans and smokers and they mostly showed no change or a decreased frequency with age. Cough and wheeze tended to be worse on average early in the morning, early afternoon and late evening, and better at weekends, whereas rhinitis and itchy red eyes were most often worse during working hours, week days and Spring and Summer months. A majority also reported these symptoms being worse at specific places of work.

Symptoms tended to occur together in the same individual: for instance persistent conjunctivitis, persistent rhinitis, chronic bronchitis and breathlessness each tended to be associated with the others, though not invariably so.

Prevalences of each of these, and other, symptoms were related to the inspirable dust concentrations in current job (76% of the workers had done only one or two jobs in the industry). After allowing for the effects of age, sex, ethnic background, language and smoking habit, positive associations between inspirable dust concentrations and prevalences of symptoms were confirmed. This was shown clearly for persistent conjunctivitis, persistent rhinitis, chronic bronchitis, wheeze and breathlessness. Variable breathlessness was more frequent in non-process than process workers, suggesting some selection of asthmatics out of dusty jobs. Within process workers, the relative frequency of variable breathlessness was positively associated with dust concentrations. Time off work because of chest illness was reported more frequently by process

than by non-process workers, but within the group of process workers such absences were not obviously related to dust concentration.

The magnitude of the effect of dust for chronic bronchitis, for example, was estimated as a prevalence of 4.0% for 40 year old, male, European, non-smoking non-process workers, but 7.8% for non-smokers exposed to $25\text{mg}/\text{m}^3$ of inspirable dust. For those who smoked 20 cigarettes a day, the estimated prevalences were 14.5% and 25.5% respectively.

Backwinding, blending and work with wool waste tended to be particularly dusty, and were associated with even greater frequencies of respiratory symptoms than could be accounted for by the inspirable dust concentrations in these jobs. Prevalence of symptoms was related to length of time worked in these jobs.

The exposure/response relationships found in this study indicate that even at the "nuisance dust" level of $10\text{mg}/\text{m}^3$, the relative risks of dust related symptoms range from 1.3 to 1.6 times the risk for unexposed workers.

This study confirms reports of respiratory illness related to dust in wool textile mills, and indicates that wool dust causes symptoms of inflammation or irritation throughout the respiratory tract. While some of these symptoms may be unpleasant but not serious, others such as chronic bronchitis and complaints of breathlessness are likely to be associated with functional impairment of the lungs. Studies of selected workers would be advisable to estimate the functional effects of exposure to dust in wool textile mills.

CHAPTER 1
PLAN OF STUDY

1.1 Aims

This epidemiological study is intended to establish what patterns of respiratory symptoms occur among workers in the wool textile industry and to investigate the extent to which these symptoms are related to exposure to factory dusts.

The research seeks answers to the following specific questions.

1. What are the levels and variations of exposures to inspirable wool dust between different mills, processes and jobs in the industry?
2. What are the main physico-chemical characteristics of dusts in the mills and how do these characteristics vary between mills and different processes?
3. What patterns of respiratory symptoms occur among workers employed in the wool textile industry?
4. Is there any relationship between syndromes of chest illness among workers in the industry and exposures to wool dust? What relative risks are associated with different jobs and exposures?

1.2 Study plan

In order to achieve these objectives in the present study it was intended to investigate over 2000 employees from wool textile mills, which include a range of different processes, jobs and environmental conditions in the industry. Occupational hygiene surveys of airborne dust levels in each mill were to be carried out and occupational histories collected from each employee.

A detailed respiratory symptoms questionnaire would then be administered to all employees at selected mills and information about smoking habits collected. Patterns of respiratory symptoms would be studied in order to identify syndromes of chest illnesses among those surveyed, and associations of symptoms with exposure to dust would be examined.

CHAPTER 2
PROCESSES WITHIN THE WOOL TEXTILE INDUSTRY*

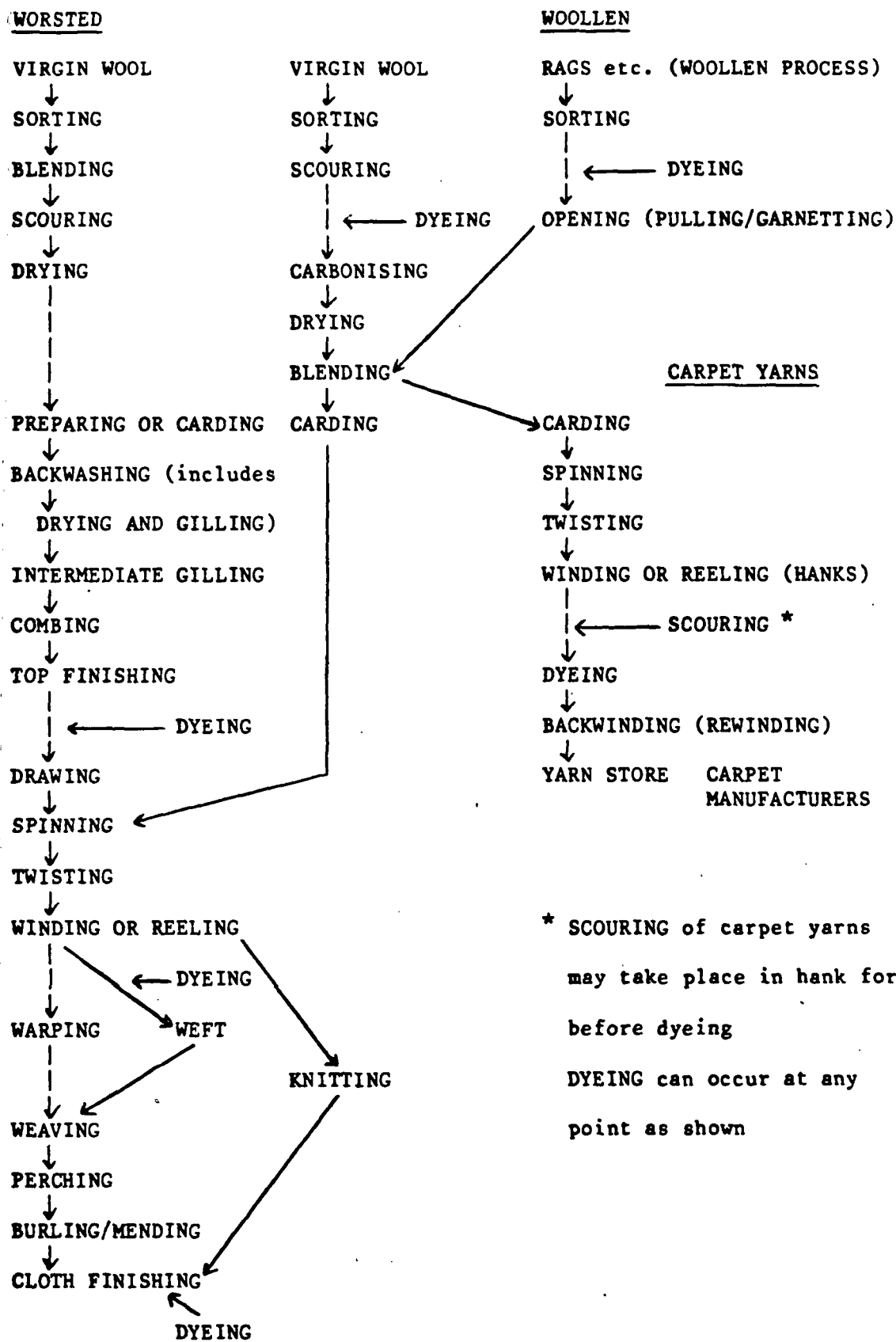
The wool textile industry is divided into two main sections; woollen and worsted. Carpet yarn production is mainly an extension of the woollen process but some semi-worsted yarns (i.e. uncombed wools) are also used in carpet manufacture as they contribute to the characteristic 'lift' of the finished product.

The basic processes are much the same for the two types of material, the main differences being that there are several intermediate processes between carding and spinning in the worsted process and there are usually more opening and finishing processes in manufacture of woollen cloth.

The typical sequence of events is shown in Figure 1 and the terms used in describing these processes are given in the following sections.

- 2.1 Processes in producing worsted and woollen fabrics and carpet yarns
- 2.1.1 Worsted
- Sorting : usually hand sorting of fleeces into baskets by skilled sorters according to quality.
- Blending : raw wool passed mechanically (pneumatic conveyors) into layers in blending bins; may be raked out manually.
- Scouring : Washing in hot liquor (heated water with soap and soda ash or other detergents) to remove wool fat, sweat and other soluble impurities. By-product is lanolin.
-

* Much of the information in this chapter is taken from accounts of the woollen and worsted industries by BREARLEY and IREDALE (1977, 1980).



* SCOURING of carpet yarns may take place in hank form before dyeing
 DYEING can occur at any point as shown

Figure 1 Typical sequence of processes in the worsted, woollen and carpet yarn industry

- Drying** : Removal of excess water by mangling and oven drying, following scouring.
- Carding** : Passage of wool over successive teathed rollers to open up and mix fibres, remove vegetable matter and to deliver material in a twistless rope-like form called card-sliver.
- Preparing** : Similar function to carding for longer wools resulting in prepared sliver (not very common now).
- Backwashing: (including drying and gilling):** treatment in aqueous detergent solution to remove any impurities picked up in carding; lubricant is added towards end of process.
- Gilling, combing, pin drafting:** straightens fibres, separates long and short fibres. Short fibres rejected as 'noil', long fibres continue to make a 'top'.
- Top-finishing** : Continues blending and straightening of fibres, adds moisture. Delivers a sliver of uniform dimensions according to requirements, forming it into a ball of top of standard size and weight.
- Drawing** : Operations which involve drawing out or 'drafting' the slivers and 'doubling' (assembling a number of slivers together). This regularises and gradually reduces the thickness of the material to a 'roving' of suitable thickness for spinning the required yarn.
- Spinning** : Forms a yarn of required thickness and number of twists per unit length - usually on a ring-spinning machine.
- Twisting** : Combination of two or more spun threads with the addition of twist for further strength, regularity, special effects or colour combinations.

Yarn preparation:

- Reeling** : Forming yarns into hanks of predetermined length for dyeing or hand knitting.
- Winding** : Transferring single or twisted yarns on to cones, cheeses or pirns for weaving or knitting.
- Warping** : Single or twisted threads placed in pre-determined order side by side on a beam for subsequent weaving.

- Weaving** : Mechanical process (shuttle or rapier looms) whereby warp and weft threads are interlaced to form a cloth.
- Perching** : Inspection of cloth and marking of any faults.
- Burling/
mending** : Manual removal of minor defects.
- Finishing** : Treatment by wet or dry processes to produce the required quality of finish to the cloth.
- Dyeing** : Can be done after top-finishing, reeling or during finishing of the cloth.

2.1.2 Woollen

The processes involved in production of woollen textiles are basically the same as for worsteds but there are no processes between carding and spinning. However, there are a variety of opening processes and many more finishing processes.

- Opening** : Preliminary opening of rags and other material to a fibrous state by means of steel-teethed machines. Rough wool will also be opened in this way and sand, grit, coarse vegetable matter, etc., are removed (garnetting, willeying, shake willeying, teasing and fearnought machines can be used).
- Carbonising:** If necessary, removal of cellulose-based impurities (vegetable matter) by acid treatment, followed by neutralisation by alkali. Can be of fleece, rags or cloth.
- Carding** : A twistless slubbing is collected on a condenser unit at the end of this process. (Includes scribbling, carding and condensing). Spinning through to cloth finishing are similar to the worsted processes.
- Dyeing** : In addition to the stages at which dyeing can occur in the worsted process, it can also be performed before rag pulling (rag dyeing) or after scouring of virgin wool.

2.1.3 Carpet yarn

The processes are as described for worsted or woollen yarns depending on the requirements of the carpet manufacturer. After spinning and twisting the yarn is then wound on a hank (reeling), which is usually then dyed and transferred to a suitable bobbin

(backwinding), which is passed on to the carpet manufacturer for weaving into a finished carpet.

2.2

The nature of the processes

There are clear distinctions between woollen yarn processing and worsted yarn processing. The basic fibre for both materials is wool, but in worsted yarns, the fibres have been laid parallel to each other, which gives the finished material a smooth, neat appearance. In woollen processing, the fibres cross each other in many directions and give the fabric a rougher, whiskery appearance.

Worsted cloth is manufactured from virgin wool, which is first scoured and dried. The wool is then usually combed into a top (a ball of combed sliver or continuous, twistless strand) to remove the shorter fibres and to straighten the longer ones. It is then passed through several drawing operations using up to twenty machines in sequence, each attempting to lay the fibres parallel to one another. The worsted cloth, once woven, is virtually in its finished state.

For some worsted yarns used in carpet manufacture the combing process may be omitted for reasons of economy and also to give the finished product its characteristic lift. Yarns used in hand knitting may also be produced by this method, which is called semi-worsted.

Woollen spinners, on the other hand, may not use any new wool at all but may draw on material from previously made fabrics (shoddy or mungo), semi-waste from worsted processing (noils), other wastes or man-made fibres. The various components are blended together in blending machinery, and the blend is carded and processed into a slubbing on the end of a carding machine. The slubbings are then spun on a woollen mule or spinning frame. Production of woollen yarns is a much more rapid process than that of worsted yarns; only three or four machines in sequence being required compared to about twenty for worsteds. The yarn is consequently produced in a matter of hours rather than weeks. After the yarn has been woven, however, a woollen cloth may require a whole range of finishing processes, in order to improve

the appearance of the final article from a bare thready state into a fibrous, soft-feeling fabric.

CHAPTER 3

PREVIOUS STUDIES OF THE WOOL TEXTILE INDUSTRY

3.1 Previous studies of respiratory effects of wool dust

Detailed reports of the incidence and prevalence of respiratory disease in workers in wool textile mills have only been available during the past 15 years, most of these being of a non-specific nature. More recent studies have indicated that an immunological mechanism may be responsible for an allergic type of lung reaction.

Jordeczka et al (1970) observed a prevalence of chronic non-specific lung disease of 18% in 800 men in the Polish wool industry, 6% in men less than 40 and 45% in those over 40 years old. More importantly, as well as there being the expected smoker/non smoker differences, there were significant differences in such symptoms between men employed for more than 15 years and those working for less than 5 years. Another prevalence study in Poland (Brysiewicz et al 1970) reported results on 1047 men (94% of the workforce) who had occupational histories, chest X-rays and physical examinations taken. Where the dust concentration was greater than 10 mg/m^3 symptoms of chronic bronchitis ranged from 16.6-30% but where it was below this level prevalence was only 5.4 - 6.6%. The authors concluded that dust concentration and work duration were factors responsible for causing chronic bronchitis. Forty five per cent of the 97 with chronic bronchitis (including 27 with advanced emphysema) were found to have an obstructive syndrome on spirometry. Bacteriological and mycological examinations of sputum were made in 50 men with and 50 without symptoms but no results were available.

A study of 175 Indian wool workers reported that the incidence of chronic bronchitis was related to length of employment and was up to 50% in those working over 16 years in the industry (Mathur and Misra 1972).

More detailed effects of wool dust on respiratory function were published in 1976 by Zuskin et al, who examined maximum expiratory flow volume curves on the first working day of the week pre- and post shift. They found that workers with more than

10 years' exposure had a greater prevalence of chronic respiratory symptoms. V_{max50} (maximum expiratory flow at 50% of the vital capacity) fell significantly during the shift and was more sensitive in this respect than FEV_1 . Those with more than 10 years exposure also had a significantly lower than expected pre-shift V_{max50} . Zuskin et al noted that, compared to cotton dust, wool dust had a similar effect on lung function in the first 40 minutes but a lesser effect during the next hour. They reported mean total airborne dust levels of 1.44 and 1.48 mg/m^3 and mean respirable dust levels of 0.46 and 0.12 mg/m^3 at each of two mills in Yugoslavia.

Zuskin et al also showed that non-smoking female wool workers, who had been exposed to wool dust for more than ten years had a significantly higher prevalence of chronic cough and grade 3 or 4 dyspnoea than non-smoking unexposed workers. Only chronic cough was reported significantly more frequently by the equivalent male non-smoking wool workers compared to unexposed controls. Comparison of smoking males, who had been exposed to wool dust for less than 10 years, with controls showed significant differences in prevalence of chronic cough, chronic phlegm and chronic bronchitis. Large but not statistically significant differences in prevalence of these symptoms were also found between workers exposed to wool dust for more and less than 10 years.

Pimentel et al (1975) reported the presence of various broncho-pulmonary diseases, such as asthma, extrinsic allergic alveolitis, chronic bronchitis with bronchiectasis, spontaneous pneumothorax and chronic pneumonia, in textile workers, some of whom were exposed to mixtures of wool and synthetic textile fibres. In all cases the histological changes were thought to be due to the presence of synthetic material, and the authors postulated that the underlying cause might be a common, immunological mechanism. Results from an animal study (Baizakova 1979) showed that guinea pigs exposed to wool dust containing a high concentration of micro organisms (mostly mould fungus and bacteria) became sensitised. Baizakova thought that respiratory symptoms in textile workers might have an allergic causation.

The possible role of humidification systems in causing lung disease in the textile industry was recently emphasised by a study of Flaherty et al (1984), who isolated endotoxin from a biomass growing on a chilled-water spray air humidifier system in a textile producing plant. Tests showed that subjects with biopsy-proven lung disease and most suspected cases had antibodies directed towards the purified endotoxin (*Cytophaga* spp.).

There are therefore only a few studies which indicate that respiratory symptoms are associated with working in the wool textile industry and most of these studies refer to the non-specific symptoms of chronic bronchitis and a possible allergic basis for some of the symptoms. Possible causes of respiratory disease in wool workers are discussed in Appendix 3.

3.2 Previous investigations of dust levels in wool textile mills

Although measurements of general dust levels (e.g. greater or less than 10 mg/m^3) have been made and reported in some of the studies of respiratory symptoms in wool textile workers described in a previous section, there are few published data available for comprehensive surveys of dust levels at the different processes in wool textile factories.

Recently, however, WIRA Technology Group Ltd. carried out a survey of dust levels in the wool sector of the textile industry in West Yorkshire and reported that total dust levels exceeded 10 mg/m^3 (the recognised hygiene limit for nuisance dusts) in four processes, namely, winding carpet yarns, willeying, worsted carding, woollen opening and blending. (Textile Research Council 1980). Much of this dust was found to be foreign matter (vegetable matter, sweat, faeces, bacteria). Carpet yarn backwinding, particularly where hanks of dyed wool are wound on to cones, was consistently found to be a dusty process, over half the measured concentrations exceeding 10 mg/m^3 . The dust appeared microscopically to consist mostly of fibre chips and sometimes insoluble soaps. Concentrations between 50 and 100 mg/m^3 were found in carding, willeying and backwinding on occasions.

A subsequent study of backwinders (Allardice et al 1983) provided supportive evidence for the dustiness of backwinding departments in the WIRA study. The levels of total dust, although wide ranging, were of the same order as in the previous study, and varied from mill to mill, depending also on the type of dye and level of dryness of the wool being wound. The respirable dust concentrations, however, were all less than 1 mg/m^3 in the five mills studied.

Some of the mills in these reported studies have also been included in the present study and some of the operatives (particularly in the backwinding departments) who had previously worn personal samplers were interviewed in 1985; some may have worn personal samplers during our dust surveys. These data may provide useful comparisons of conditions during these particular years.

CHAPTER 4

METHODS

4.1 Selection of population for study

With a view to selecting the study population, agreement was obtained from the Confederation of British Wool Textile Manufacturers to obtain information on the type of process, raw material used, number of employees (male and female) in each job, and numbers requiring use of questionnaires in a language other than English at each factory.

Information was received from 46 factories, which varied in size from 20 to 700 employees. After discussion with HSE it was decided to limit the study to mills whose principal raw material was wool, in or near three towns: Bradford, Dewsbury and Huddersfield. Nine mills covering the main processes and job categories in woollen, worsted and carpet yarn production were selected, giving a potential population of over 2300 employees.

It was subsequently discovered that one of the selected mills used a lower than had been assumed proportion of wool in its processes and that the initial plan, to include only larger mills in the study, might bias estimates of levels of dust that may occur in the industry. Therefore this one mill was replaced by five other mills: one similar mill of smaller size, another mill producing carpet yarns, thought to be dusty, and employing just over 100 workers and three much smaller factories, carrying out only one or a few processes employing less than 25 persons each. In total, fifteen distinct manufacturing units were included in the study. Fourteen of them were geographically separated. One small factory was adjacent to a larger factory owned by the same company.

4.2 Preliminary visits to mills

Each of the mills selected for the study was visited by a member of Her Majesty's Factory Inspectorate or the Employment Medical Advisory Service to explain the background to the study. Visits to each mill were then arranged, at which Dr M. Hartley of

HMFI and one or more IOM representatives were shown the various processes undertaken at the mill.

Details relating to dust sampling and questionnaire surveys were given at this stage to one or more representatives of the mill management (usually personnel or safety officers, production managers or directors), and in most cases representatives of the workforce. Inquiries were made to establish what facilities would be available to accommodate staff and equipment during environmental and questionnaire surveys and also to assess labour turnover, sickness absence rates and availability of employee work histories.

4.3 Identification of the current workforce

Several months before the questionnaire surveys a request was sent to each mill for information on each current employee, to be entered on a computerised form if possible (see Appendix 1.1).

This information provided the basis for the mill population to be seen at the time of the survey and any changes and new starters could be easily updated on the original list at this time.

4.4 Letters of invitation

Invitations to attend these surveys were issued to each named employee and extra letters were distributed as appropriate through the personnel officers of the mills concerned. Initially a full page letter describing the purpose and requirements of the study, the information required of them and stressing confidentiality (see Appendix 1.2) was sent to the first eight mills and usually distributed internally through the personnel officer. Included with the letter was a reply slip which enabled the individual to state whether or not he or she was willing to take part. On some occasions, where attendance rates were low and if senior mill personnel agreed, a second approach was made to those who had not attended (Appendix 1.3) and a further visit was arranged at these mills. This resulted in sixty nine additional attendances.

Principally because of a high 'refusal' rate this method was abandoned and replaced by a much shorter letter and no reply slip (Appendix 1.4) in order to streamline the process and avoid "refusals" by default on the part of employees slow in returning the slips.

4.5 Airborne dust surveys

4.5.1 Dust sampling plan

During preliminary visits to the mills visual assessments of the dustiness of each process were made, which were used in conjunction with data provided by HSE to plan the programme of dust measurements. A hygienist obtained information on the jobs being undertaken, the numbers employed in each job and the shifts and hours worked. The workforce was then classified into provisional occupational groups, which were based on the type of job, the place of work and probable dust levels.

A sampling plan was devised which specified, by occupational group, the workers who were to be sampled on each day of the survey. The plan was devised with the intention of obtaining estimates of concentration with comparable degrees of precision for each individual and standard errors of the estimates as low as possible.

Samples were allocated to occupational groups broadly in accord with the criteria of Ashford (1958). In practice this sampling plan was difficult to apply, since relevant dust concentration data were not always available. Rigid adherence to the procedure would have meant that the least dusty occupations (as judged a priori) would have barely been sampled: additional samples were therefore allocated to these jobs. Maintenance jobs, on the other hand, were under-sampled, since the samplers could not be worn by workers carrying out many maintenance tasks. Adherence to the original plans was not perfect, since the exact number of workers in an occupational group on any particular day was unpredictable.

4.5.2 Selection of dust samplers

Health effects associated with exposure to dust from wool textile operations may occur not only in the alveolar region of the respiratory tract but also in the bronchial airways and the nasopharyngeal region. Therefore, it was considered appropriate to measure not only fine but also coarse particles. The measurement of 'total' dust in occupational hygiene investigations has reflected previous recognition of this general problem in many workplaces. The 7-hole personal sampler currently recommended by the HSE (1983) for the measurement of 'total' dust is consistent with this rationale. More recently, however, more representative guidelines have emerged, based on the measurement of a fraction of the airborne dust which enters through the nose and/or mouth during breathing; that is, the inspirable fraction. Based on work carried out at the Institute of Occupational Medicine and elsewhere in Europe, a quantitative definition for the inspirable fraction has been proposed (VINCENT and ARMBRUSTER 1981). This in turn has been adopted by the American Conference of Governmental Industrial Hygienists (ACGIH 1985) as the formal definition for inspirable particulate mass (and it is now known as the ACGIH-IPM curve). The IOM personal inspirable dust sampler has since been developed, having performance characteristics consistent with this ACGIH-IPM curve (MARK and VINCENT 1986).

4.5.3 Dust sampling trials

Dust sampling trials, the results of which are reported in Appendix 2 along with details of the samplers, were carried out with the following objectives.

- (a) Comparison of the sampling performance of three different sampling heads.

Comparisons were made in order to decide whether the IOM inspirable dust sampler (Mark & Vincent, 1986), the HSE 7 hole 'total' dust sampler (Health and Safety Executive, 1983), or the Gelman 'total' dust, open-filter sampler

(Marshall and Stevens, 1980) should be used as the principal sampling instrument in this study and, parenthetically, in other studies within the textile industry.

- (b) To obtain estimates of the dust levels associated with different jobs.

This was necessary to help establish the length of time required for sampling in different processes. Jobs involving very dusty conditions can only be sampled for a relatively short time before the sampling head becomes clogged with dust, whereas less dusty jobs may require nearly a whole shift to allow accumulation of sufficient dust for accurate weighing. The estimates of dust levels and of variability within occupations were also used in the design of the main sampling plans.

- (c) Assessment of the contribution of 'fly dust' to inspirable dust samples.

Fly dust consists of waste fibres longer than 1.8mm thrown into the atmosphere during some stages of processing. There are large amounts of visible 'fly dust' in the atmosphere near certain processes. This was liable to overwhelm the filter of some types of sampling heads in certain circumstances. It was therefore decided to compare the sampling performance of the IOM and HSE samplers with and without a 2mm mesh gauze over the sampling inlet.

4.5.4 Collection and weighing of dust samples

People encountered by the sampling team working in the groups described in 4.5.1 on the appropriate days were asked in situ to participate in the sampling exercise, and allocated samplers accordingly. Persons chosen for sampling were fitted with a waist belt to which was attached a sampling pump (Casella AFC 123). This provided an airflow rate of 2 litres per minute via a length of PVC tubing to an IOM sampling head or alternative

(see Appendix 2 and section 4.5.3 [a]), fitted with a glass fibre filter. The sampling head was clipped to the coat or shirt lapel. Great care was taken to ensure that the equipment was fitted neatly, and that it did not interfere with the individual's ability to carry out his or her tasks.

At the start of each shift the sampling flow rate of each instrument was adjusted to 2 l/min. Each subject wore a personal sampler for some five to six hours, a period that was recorded to the nearest minute, and during this time the instruments were examined at least twice to check that they had not been switched off, that the sampling head was correctly located on the lapel and that the person concerned was not being impeded at his or her work. At the end of the sampling period the instrument flow rates were measured again and recorded. (This verified that for all instruments the final flow rate was within 5% of the initial value, and this is the stability of flow rate claimed by the manufacturers of the instrument).

Sampling cassettes and/or filters were weighed both before and after sampling, having allowed the sample filters and corresponding control filters to reach equilibrium with the laboratory atmosphere. Mean changes in the weights of control filters were used to correct the derived sample weights for changes in filter weight due to humidity variation. The precision of this procedure is about 0.1mg.

The corrected sample weights and volumes of air sampled were used to calculate the airborne dust concentrations. For samples where the initial and final flow rates differed, the larger value was used.

4.5.5 Assessment of physical and chemical characteristics of wool

Nominal fibre size and oil, ash and quartz contents of bulk samples of wool collected at various points in the production line of a woollen mill and two carpet yarn mills were estimated, using the following methods.

1. Nominal fibre size

The nominal fibre sizes of the wool samples were determined by phase contrast optical microscopy (X600 magnification). Small sub-samples of fibres were dispersed in water filtered onto cellulose ester membrane filters, which were mounted on microscope slides. These samples were scanned in a series of parallel traverses. The lengths and diameters of 25 fibres in each sample crossing the centre point of the field of view were measured.

2. Oil content

Known weights of wool were placed in a weighed paper thimble and extracted in N-hexane for about six hours in a soxhlet apparatus. The oil content of the extract was determined by UV spectrophotometry at 290 nm. An arbitrary standard oil was used owing to the lack of an ideal standard. This may have produced systematic errors but there is no reason to believe that the relative proportions of oil are incorrect.

3. Ash and quartz contents

Wool samples were ashed at 380°C to a constant weight and the proportion of quartz in ash was determined by X-ray diffraction on an aliquot of ash deposited on a 25mm Gelman VMI filter. Snowit X6403 quartz was used as the standard. The full Xray diffraction patterns of the samples were used to give qualitative mineral analyses.

4.5.6 Endotoxin levels

Endotoxins are heat-stable lipopolysaccharide-protein complexes released when the outer cell walls of Gram-negative bacteria are disrupted. Intravenous administration of endotoxin results in a wide range of potent pharmacological and immunological reactions both in animals and in man. (Also see Appendix 3).

4.5.6.1 Measurement of endotoxin

This was performed, under the direction of Dr M. Topping of the Occupational Medicine & Hygiene Laboratory, HSE, using the Limulus Amebocyte Lysate test (LAL), which employs the properties of the blood of the Horseshoe Crab Limulus polyphemus, which coagulates in the presence of endotoxin. The 'gel clot' test was used, a method which involves incubating for a fixed time an amebocyte lysate preparation with an equal volume of the test solution. When coagulation occurs the clear solution changes to an opaque gel. To estimate the concentration of endotoxin, serial dilutions of test and standard solutions are incubated until an end point is reached. However, at best this procedure is semiquantitative because of inhibition of enzymic activity of the lysate by a wide range of substances and changes in temperature and pH.

4.5.6.2 Materials and sampling methods

Six mills were selected for sampling (mills 4, 10, 12-15). Four of these prepared wool from the raw state through to yarn for weaving into carpets (12-15) and one each produced worsted fibre (4) and woollen cloth (10). At each mill the concentration of airborne endotoxin was determined for each stage of the production process.

Sampling was carried out for 2-5 hours using L25F air-sampling pumps (Rotheroe and Mitchell Ltd) at a flow rate of approximately 2 l/min. Samples were collected on sterile 0.45 um MF Millipore filters fitted into sterile plastic filter holders (Millipore Microbial Analysis Monitors 37mm).

To determine the dry weight of dust collected the whole filter unit was desiccated and weighed before and after sampling. Endotoxin was extracted by tumbling the filter in its holder overnight at room temperature with 2ml of pyrogen-free water (Travenol) and then for 2 hours with a further 1ml of water. 50mg of each bulked sample was placed in a sterile universal container (Sterilin) and similarly extracted. Both washings from each filter (or bulk sample) were combined and centrifuged for 15 minutes at 2500g to remove particulate material.

The concentration of endotoxin in the extract was assayed using the LAL test according to the manufacturer's instructions (Sigma - E TOXATE No 210). Test solutions were serially diluted and compared with a standard dilution series constructed using a Shigella flexneri LPS preparation over a concentration range of 0.1 - 1.0 mg/ml. The lower test dilution giving a stable clot was considered equivalent in endotoxin concentration to the lowest standard concentration producing a similar solid gel. The total amount of endotoxin in the original solution was calculated and expressed in terms of both the volume of air sampled (m³) and the weight of dust collected.

4.6 Questionnaire surveys

All data concerned with the individual employee's personal health and occupational history were obtained from questionnaire responses. Two questionnaires were designed:

1. Respiratory symptoms questionnaire - including smoking habits.
2. Occupational history questionnaire - including shift patterns and usual working hours.

4.6.1 Respiratory Symptoms Questionnaire

Based on the results of a previous study of respiratory symptoms in carpet backwinders (Allardice et al 1983), and our a priori assumptions about the type of symptoms to be expected in workers exposed to a range of organic and inorganic airborne

particles, we designed a questionnaire with the following aims:

1. Identification of all the common respiratory symptoms, enabling descriptions of their frequency and comparisons with possible causative factors to be made.
2. Establishment of the relationship of these symptoms to time and place, so that unbiased comparisons could be made between symptoms and work.

More specifically the syndromes we aimed to identify were as follows:-

1. Chronic cough and phlegm
2. Cough insufficiently persistent to qualify as chronic (less than 3 months in the year)
3. Episodes of breathlessness and/or wheeze
4. Episodes of rhinitis or itchy red eyes or sneezing
5. Chest tightness or breathlessness (byssinotic type symptoms if worst on Mondays)
6. Humidifier fever symptoms (fever, shivering, chills).

In addition questions about nosebleeds and past and present chest illnesses were included. A control question about a symptom thought unlikely to be related to occupation was also included. In this study, dizziness was chosen as being unlikely a priori to be associated with work in the wool textile industry.

The persistence, frequency and variability of the symptoms were ascertained where appropriate and further questions about symptoms of cough, wheezing and shortness of breath, rhinitis and chills were intended to establish their relationship with place, and time of day or week, and in some cases, with possible causative factors.

The questionnaire is reproduced in Appendix 4. This shows the structure adopted, the logical sequence, interviewer instructions, the coding used and notes on the questionnaire, definition of respiratory symptoms and translation into Urdu. It will be clear that use was made of formulations from existing

questionnaires where possible. Some questions were taken from the Medical Research Council questionnaire on respiratory symptoms (MRC, 1976), the questionnaire on respiratory symptoms for research on pneumoconiosis in the British Coal Industry (Rae et al 1971), an allergy questionnaire (Fletcher et al 1976) and an asthma questionnaire designed in collaboration with Dr. E. T. Peel. (unpublished).

4.6.1.1 Testing of the questionnaire

Once the layout and instructions to users had been agreed the questionnaire as originally designed was tested for comprehensibility, logic and ease of use by two chest physicians (AS, CAS) on colleagues, family members and a range of chest clinic patients. Following minor amendments the revised version was then administered by a clerk experienced in the use of respiratory symptoms questionnaires to a group of volunteers attending a chest clinic and to 37 subjects employed at a wool textile mill not participating in the main study. Some further minor modifications were made, although no major problems were encountered.

4.6.2 Smoking history

A questionnaire on current and past smoking habits, which was included with the respiratory symptoms questionnaire, was designed to allow some quantification of amounts smoked since smoking first began. The questionnaire was based partly on one used in recent studies by us (unpublished) but derived more limited information on variation in amounts smoked (cigarettes only). The use of other less common smoking materials (cheroots, bidi [biri]) by Asian immigrants was also established.

4.6.3 Occupational history questionnaire

The aim of this questionnaire was to obtain a complete chronological history of all employment and breaks in employment for the years since leaving school. Information relating to employer, type of job, place of work and start/finish dates were

recorded for every occupation held. Since it was intended to try to relate symptoms to times of the day or week, additional questions were included to establish the hours normally worked and, if night shifts were worked, which hours were spent in bed.

In order to simplify this part of the questionnaire it was decided to ask about the hours worked in the week of interview and whether these were the regular hours. If they were, data could be used to relate these times to any time-dependent symptoms, if appropriate.

The full questionnaire with instructions is given in Appendix 5.

4.6.4 Pilot studies

In order that the field survey methods for acquisition of questionnaire data could be tested for reliability before the surveys proper began, a trial was arranged at a mill in another town in West Yorkshire as described in Appendix 6, which also describes the procedures for recruiting and training Urdu-speaking clerks.

4.6.5 Procedure for interviews at mills

Each mill was visited by the survey team between the end of March and October 1985. Subjects were interviewed during their normal working hours usually in two separate, relatively quiet areas, so that confidentiality could be maintained. Interviews usually took 15-20 minutes in total and as far as possible disruption to normal production in the mill was minimised by liaison with the relevant personnel officer or equivalent member of staff. Urdu interviews were conducted in a separate area in a similar manner.

4.7 Data analysis

Extensive tabulations and graphical analyses of the data were carried out using programs from the BMDP Statistical Software (Dixon et al, 1981). Following data description by means of successive tabulations relating respiratory symptoms and

other response variables to the principal population characteristics, (age, sex, ethnic group, etc.). Logistic regression analysis (Cox, 1970) was carried out on ten of these responses. The aim was to investigate the relative contribution of the potential explanatory variables to the frequency or prevalence of each response. (See Table 10 for a list of responses analysed). They included non-occupational and occupationally related factors, described in section 5.4.1.

CHAPTER 5

RESULTS

5.1 Dust sampling

Seven hundred and seventy nine measurements of dust concentration were made during the dust sampling surveys at fifteen mills. Seven of these samples had to be discarded because of unreliable weighing data. Six hundred and twenty nine of the remaining samples were taken with the IOM inspirable sampling head without gauze (standard instrument). These data were used for assigning dust concentration levels to various occupational groups.

5.1.1 Occupational groups and dust concentrations

As it was impractical to measure the dust exposure of every individual in a mill and to deal with the data on an individual basis, workers were assigned to occupational groups and allocated the mean dust exposure of the group. Within each occupational group were workers who performed the same job and others who were considered to be exposed to dust that was similar in concentration and composition, even though they performed different jobs. Sixteen occupational groups were formulated, into which were allocated the workforce of the 15 mills investigated. There were between two and eleven coded jobs within each occupational group (Table 1). Further descriptions and details of the groups and associated jobs are given in Appendix 7.

Table 2 shows the mean inspirable dust concentrations by occupational group and mill. There are 19 groups (if the same group in another mill is treated as a separate group) with average inspirable dust levels greater than 10mg/m^3 (Table 3).

TABLE 1

ALLOCATION OF JOBS INTO OCCUPATIONAL GROUPS (OGs)

The groups are in an order approximating to that of the manufacturing process

<u>OG No</u>	<u>Description</u>	<u>Other jobs included in group</u>
1	Sorting/blending	Balers, teasers, willeyers, bale breakers
2	Opening/blending	Wool pullers, baggers, dryers, blending bins
3	Blending/waste workers	Machine opening/blending, shakers, shoddy operatives
4	Dyeing/scouring	
5	Carding/fettling	Card minders and fettlers/grinders
6	Combing/gilling/drawing	Rovers, press minders, gillers & pressers
7	Winding	
8	Backwinding	Pickers-up
9	Spinning/twisting/reeling	
10	Weaving/warping	Loom tuners, healders
11	Dry finishing (1)	Burlers, menders, perchers, knotters, weighers, packers
12	Dry finishing (2)	Blowers, cutters, beaters, riggers.
13	Wet finishing	Autoclavers, moserers, raisers & millers, teaslers, etc
14	Maintenance/general work	Service tradesmen, mechanics, cleaners etc.
15	Technicians/engineers	Yarn inspectors
16	Foremen/managers/ non-process work	Quality control, colour matchers

TABLE 2

MEAN MEASURED CONCENTRATIONS OF INSPIRABLE DUST (mg/m³) USING ION SAMPLER BY OCCUPATIONAL GROUP AND MILL

Mill	Occupational group															All Groups	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		16
1	0.8 (1)	10.5 (2)	14.5 (6)		0.8 (27)		0.9 (6)	3.8 (3)	0.4 (2)	0.3 (9)		0.1 (2)	1.2 (5)				2.5 (63)
2						0.6 (4)	0.9 (8)		0.9 (15)		0.6 (2)			0.6 (4)			0.8 (33)
3	2.2 (10)																2.2 (10)
4	3.7 (1)	6.3 (4)	676.1 (5)	4.4 (1)	39.1 (17)	11.8 (26)					1.4 (12)			10.3 (3)	18.2 (1)		63.6 (70)
5				0.9 (3)			1.4 (4)		0.6 (5)	1.6 (12)	0.5 (11)	1.3 (2)		1.7 (6)			1.1 (43)
6							* (2)				0.2 (8)						0.2 (10)
7	22.8 (2)	5.4 (1)			1.4 (2)				1.5 (7)								5.4 (12)
8			180.5 (3)														180.5 (3)
9	1.4 (3)			1.4 (1)	0.8 (13)		0.7 (17)		0.3 (16)		0.6 (3)			1.1 (5)	0.5 (1)	0.8 (2)	0.7 (61)
10	6.8 (4)				0.5 (6)		0.7 (6)		0.4 (8)	0.4 (16)	0.2 (6)	2.8 (2)	1.5 (1)	0.7 (5)			1.1 (54)
11					2.8 (11)			46.7 (24)	2.7 (9)		0.9 (1)			13.9 (2)	18.6 (1)	0.7 (4)	23.6 (52)
12	8.2 (14)	14.8 (10)	4.9 (1)		3.6 (15)	1.7 (1)	5.8 (4)	1.3 (6)	1.0 (11)		7.1 (2)			2.9 (4)		2.1 (2)	5.7 (70)
13	3.5 (6)	2.4 (2)	8.4 (1)	3.2 (4)	1.6 (9)			26.5 (17)	1.0 (13)				1.0 (1)	1.4 (3)			9.5 (56)
14	1.5 (1)		3.8 (2)		1.0 (21)		23.9 (1)	11.4 (28)	0.8 (17)					0.8 (2)	29.4 (1)		5.7 (73)
15	15.9 (2)		29.5 (3)		0.7 (7)				1.2 (7)								7.0 (19)
Group Mean	6.2 (44)	10.7 (19)	196.1 (21)	2.4 (9)	6.5 (128)	10.0 (31)	1.7 (48)	24.5 (78)	1.0 (110)	0.7 (45)	1.1 (37)	1.4 (6)	1.2 (7)	2.9 (34)	16.7 (4)	1.1 (8)	13.0 (629)

Figures in brackets are number of samples
 * = too low to be measured reliably

TABLE 3

OCCUPATIONAL GROUP MEAN INSPIRABLE DUST LEVELS GREATER THAN 10mg/m³

Mean inspirable dust concentration (mg/m ³)	No. of samples in group	Occupational Group name & (No.)	Mill No
676.1	5	Blending/waste (3)	4
180.5	3	" (3)	8
46.7	9	Backwinding (8)	11
39.1	17	Carding worsted (5)	4
29.5	3	Blending/waste (3)	15
29.4	1	Technicians (15)	14
26.5	17	Backwinding (8)	13
23.9	1	Winding (7)	14
22.8	2	Sorting/blending (1)	7
18.6	1	Technicians (15)	11
18.2	1	" (15)	4
15.9	2	Sorting/blending (1)	15
14.8	10	Opening/blending (2)	12
14.5	6	Blending/waste (3)	1
13.9	2	Maintenance (14)	11
11.8	26	Combing (6)	4
11.4	28	Backwinding (8)	14
10.5	2	Opening/blending (2)	1
10.3	3	Maintenance (14)	4

5.1.2

Dusty jobs

Nine mills had one or more groups with mean concentrations above 10 mg/m^3 and three mills had at least three high dust level groups (mills 4, 11 and 14). Mill 4 had five of these 19 groups with levels greater than 10 mg/m^3 . The highest dust concentration was over 2000 mg/m^3 measured on a worker handling 'shoddy'.

The occupational groups with arithmetic mean inspirable dust levels higher than 10 mg/m^3 were:-

1. Opening and blending in any type of mill (woollen, worsted and carpet yarns).
2. Backwinding of carpet yarns, particularly in mills with large backwinding departments.
3. Worsteds carding (one department in a large mill, Mill 4):
4. Combing (Mill 4).
5. Some maintenance workers and technicians in Mill 4 and some carpet yarn mills (small numbers).

One hundred and thirty nine samples were collected from these various dusty jobs with the majority from backwinding (55), opening/blending (33), combing (26) and worsteds carding (17). One hundred and twenty of these showed inspirable dust concentrations greater than 10 mg/m^3 .

The remaining six mills had uniformly low dust levels at all stages of wool processing i.e. about $1-2 \text{ mg/m}^3$ or less. Only one process (sorting and blending) at one of these mills (mill 10) gave rise to inspirable dust concentrations greater than 5 mg/m^3 on average. (Table 2).

The mills have been ranked in two ways. Firstly, the arithmetic mean of the estimates of shift average dust concentration was derived by assigning each member of the workforce the dust concentration for his or her group and then calculating the mean concentration for the mill. Secondly, the concentrations assigned to each worker have been multiplied by

the numbers of hours he/she worked per week to give a mean weekly exposure. The ranking of the mills with respect to both these variables is shown in Table 4.

These two methods of ranking give rise to a very similar order, all 15 mills having the same or adjacent rank.

5.1.3 Physical and chemical characteristics of samples of wool

The samples of bulk material were collected from the production lines at three mills for analysis. Nominal fibre sizes, oil, ash and quartz contents and mineral analyses are shown in Table 5.

The fibres were as much as several millimetres long in some cases and others were ribbon-like in appearance. The widths of these ribbons were used as an indicator of diameter. Such fibres would have a different aerodynamic behaviour from fibres with a circular cross-section and the same measured diameter.

Although samples were ashed to constant weight, several sample residues appeared to contain carbonaceous material. This may have caused over-estimates of the ash contents but it will not have affected estimates of the quartz contents.

The wool samples from Mill No. 9 were finer (mostly merino and fine crossbred wools) than those from the carpet yarn mills (Nos 14 and 15), where the wool was mostly from medium to low crossbred sheep. There were low levels of ash, quartz and oil in all the samples examined. Anhydrite, calcite and plagioclase feldspar were detected in some samples in very small quantities.

There appeared to be no clear association between any of these measurements and the production process from which the samples were collected.

TABLE 4

RANKING OF MILLS BY DUST CONCENTRATIONS† AND WEEKLY EXPOSURES

Mill	No. of employees	Mean shift av. conc ⁿ (mg/m ³)	Rank of* av.concs	Mean weekly exposure (mg.h./m ³)	Rank of weekly exposures*
1	127	0.56	14	26.55	13
2	69	0.58	13	23.47	14
3	12	1.62	9	70.95	9
4	257	12.45	3	783.72	2
5	169	0.99	10	42.56	10
6	15	0.23	15	8.01	15
7	22	5.77	4	237.40	4
8	4	114.31	1	5915.42	1
9	324	0.68	11	34.73	11
10	144	0.66	12	34.59	12
11	102	15.37	2	554.54	3
12	267	2.58	8	105.24	8
13	292	5.17	5	222.06	5
14	228	3.29	6	140.07	7
15	111	3.03	7	158.95	6

* 1 = Most dusty 15 = Least dusty

† Since occasional concentrations were much higher (or lower) than the mean for the occupational groups, it was thought appropriate to use the geometric mean of the concentration measurements for the occupational group as an index of current exposure. Outlying measurements have much less influence on the geometric means than on the arithmetic means, because the data are first logarithmically transformed. In most cases, the geometric means are very close to the arithmetic means.

5.1.4 Endotoxin levels

Sixty six samples were collected from the six mills sampled. Since some of the operations had few employees, and personal inspirable dust sampling was being performed at the same time, only three personal samples for endotoxin estimation were obtained. The (63) other results were from samplers run as static instruments at places most representative of workers' exposure.

The results obtained from the analysis of the samples collected from the six mills are shown in Tables 6 and 7, as endotoxin ng/m³ sampled air and endotoxin ng/mg dust, respectively.

Table 6 demonstrates the wide variation of airborne endotoxin concentrations observed between mills, between different locations within the same mill and within a single work process. The range of concentrations may be due, in part, to the inherent variability and imprecision of the assay available for LPS measurement. However, blank filters extracted and assayed in an identical manner to the test filters had negligible amounts of endotoxin by the LAL assay. Therefore the test filters contained real amounts of endotoxin, although the actual concentration values should be interpreted with caution. The values should at best be regarded as high, medium or low concentrations.

Wide variations in endotoxin concentration were noted when the amount of endotoxin was expressed in terms of the amount of dust sampled (Table 7) indicating that differences in airborne levels did not simply reflect different concentrations of dust but also variations in the degree of endotoxin contamination of the dust. (The filters from Mill 13 were not desiccated before weighing after sampling, so the amount of endotoxin in terms of mg dust collected has been omitted). The results suggest that in some areas i.e. blending, carding, twisting and backwinding, airborne endotoxin concentrations are generally higher than in other regions of these particular mills. However, since only a small number of samples was obtained from each process it is not possible to establish with any confidence whether the apparent variations in observed mean results from different processes represent real differences between processes

TABLE 5

PHYSICAL AND CHEMICAL ANALYSES OF SAMPLES OF DUST FROM WOOL TEXTILE MILLS

Mill No.	Mill Type	Sample	Nominal Fibre diameter (μm)	Mineral Analyses					
				% Oil	% Ash	% Quartz	Qualitative		
							Anhydrite	Calcite	Plagioclase feldspar
15	Carpet	After opening	33	0.1	2.8	0.02	✓	✓	n.d.
14	"	Opening + blending	35	0.1	4.2	0.3	✓	✓	✓
"	"	Carding	28	n.m.	1.3	0.06	n.d.	n.d.	n.d.
"	"	Spinning room fly	35	n.m.	2.7	0.1	✓	✓	✓
9	Woollen	Blending + teasing	21	0.2	1.4	0.01	✓	n.d.	✓
"	"	Carding	32	0.4	6.2	0.03	✓	n.d.	✓
"	"	Spinning	23	0.3	1.6	n.d.	n.d.	n.d.	n.d.
"	"	Winding	28	n.m.	0.7	0.02	n.d.	n.d.	n.d.
"	"	Twisting	29	n.m.	1.4	0.004	✓	✓	n.d.

n.m. = not measured

n.d. = not detected

✓ = some detected

TABLE 6

ENDOTOXIN CONCENTRATIONS (ng/m³) IN DIFFERENT PROCESSES AT SIX WOOLLEN MILLS

Process	Mill No							
	4	10	12	13	14/15			
Blending	1	31	540	390	274	6		
		37		120	147	5000*		
		43		13		6000		
Scouring	30		988					
Willeying			48					
			6000					
Shaking						48		
Carding	182*	30000	24	1000	69	1	0.4	46
	7000	374		1000	306	3	0.6	
	3000				6	18	0.7	
Combing	557							
Cott box	<0.4							
Gilling	419*							
Spinning			273					4
Twisting					270			0.7
					152			4
					346			
					27			
Winding			2	5				47
				28				
Reeling								5
Backwinding				0.4	60	5	1000	
				5	17	628	5000	
					13			
Warping			25					
Weaving			29					
Shuttle weaving			3					

* denotes personal sampling

TABLE 7

ENDOTOXIN CONCENTRATIONS (ng/mg dust) IN DIFFERENT PROCESSES
AT FIVE WOOLLEN MILLS

Process	Mill No			
	10	12	13	14/15
Blending	1	10		325
				0.2
				145
Scouring		47		
Willeying		0.9		
		15		
Shaking				2
Carding	1	11	4 96	0.1 2
		16	183 656	0.1
			11	0.2
Combing			10	
Cott box			<0.02	
Gilling			18	
Spinning	9			0.2
Twisting				0.1
				0.1
Winding	0.1	0.6		2
		0.1		
Reeling				0.2
Backwinding		0.01		254
		0.1		15
Warping	1			
Weaving	1			
	1			
Shuttle weaving	0.1			

5.2 Questionnaire surveys

5.2.1 Attendance rates

Lists of current employees of the fifteen selected mills were compiled by mill personnel at their convenience from December 1984 onwards. These lists were updated at the time of survey several months later to ensure that all current employees were invited to attend.

Table 8 shows the response rate of those available to attend the survey based on 2793 people invited, including new starters. Two hundred and forty nine people had left the mills prior to the survey in varying proportions dependent mainly on the interval between the employee lists being compiled and the questionnaire survey being carried out. On average this represents an 8.9% loss from the originally listed workforce.

Table 8 shows that the mills visited earlier in the survey (Nos 1-8) tended to have a poorer response rate than those visited later. (These mill code numbers do not represent the exact chronological sequence in which the mills were surveyed but mills 1-8 were all visited before mills 9-15).

A possible contributory factor to the relatively low response rates at mills 2 and 5 was reduced interest among the workers because of announcements, just prior to or during the surveys, of imminent closure or redundancies at these mills.

The revised (shorter) letter of invitation (see Section 4.4 and Appendix 1.4) may also have contributed to the improved response at later surveys. Refusal rate fell to insignificant proportions: only 26 refused out of a total of 1559 available for survey. Allowing for those who were either off sick or unable to attend because of work, 94.4% of the available workforce attended at the last seven mills compared with 69.1% at the first eight. The overall response rate was 84.6%.

TABLE 8

ATTENDANCE RATES AT QUESTIONNAIRE SURVEYS

Mill	1 Invited	2 Left prior to survey	3 Refused	4 Off sick	5 Unable to attend	6 Attended	7 Response rate(%)
1	196	14	53	2	0	127(48)*	69.8
2	175	16	78	7	0	74	46.5
3	26	4	10	0	0	12	54.5
4	346	23	52	12	2	257(4)	79.6
5	265	10	73	12	0	170(14)	66.7
6	18	1	2	0	0	15	88.2
7	28	5	1	0	0	22	95.7
8	4	0	0	0	0	4	100.0
9	372	33	3	7	4	325	95.9
10	167	9	5	2	7	144	91.1
11	125	12	5	5	0	103	91.2
12	319	34	10	4	4	267(3)	93.7
13	367	56	0	15	4	292	93.9
14	266	27	2	6	1	230	96.2
15	119	5	1	2	0	111	97.4
All	2793	249	295	74	22	2153(69)	84.6

Response rate (7) is derived as follows from the numbered columns:
 $7 = 6 / (1-2)$

*() denotes (inclusive) no. of total who attended surveys only after a second approach was made.

5.2.2 Description of population studied.

Two thousand one hundred and fifty three persons attended the questionnaire surveys and all but two completed respiratory symptoms and smoking questionnaires*. The remaining 2151 constitute the study population for respiratory symptoms. Six of these subjects did not provide occupational histories, so their symptoms cannot be assessed in relation to their jobs or hours of work.

The characteristics of the study population of 2151 persons are shown in Table 9. The male/female ratio is about 3:1; 69% are Europeans, nearly 28% are of Asian origin (almost exclusively male) and 3.3% are of West Indian/African origin. Sixty five per cent of the Asian group opted to be interviewed in Urdu.

The mean age and range is also shown in Table 9 and it was found that the overall age distribution demonstrated a fairly even spread between ages 20 - 60. There were smaller numbers in the under 20 and over 60 age groups but five individuals were over 70 years old.

5.3 Prevalences of reported symptoms

Each symptom or symptom complex (as described in 'Definition of respiratory symptoms' in Appendix 4) was reported with the prevalences shown in Table 10.

* There were several occasions when questionnaires were incorrectly completed, although most of the mistakes were easily rectified later. Some mistakes (0.26% of the total questions asked) were not recoverable and unreliable or missing data codes were assigned to the relevant sections.

TABLE 9

CHARACTERISTICS OF STUDY POPULATION OF 2151 WOOL TEXTILE WORKERS

Characteristic	Mill N ^o															All Mills
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
N ^o examined	127	74	12	257	170	15	22	4	324	144	103	267	292	229	111	2151
Males %	64.6	78.4	100	93.8	67.6	26.7	63.6	100	81.5	77.1	63.1	77.9	76.7	65.9	91.9	76.9
Females %	35.4	21.6	0	6.2	32.4	73.3	26.4	0	18.5	22.9	26.9	22.1	23.3	34.1	8.1	23.1
Age (yr) Mean	43.7	41.5	49.8	41.7	45.3	49.2	36.9	50.2	38.5	43.1	36.9	42.7	40.7	38.0	40.8	42.3
Range	17-78	19-68	26-60	16-73	17-68	24-62	20-57	42-58	17-64	16-64	16-73	17-74	17-72	18-63	24-61	16-74
% European	90.6	54.1	100	69.3	97.1	100	100	100	42.3	80.1	66.0	96.3	54.1	69.9	51.4	69.3
% W.Indian	1.6	0	0	1.6	0	0	0	0	9.3	8.3	12.6	0.4	1.4	1.3	0.9	3.3
% Asian	7.9	45.9	0	29.2	2.9	0	0	0	48.5	21.5	21.4	3.4	44.5	28.8	47.7	27.5
% interviewed in Urdu	1.6	20.3	0	17.1	1.2	0	0	0	31.2	16.7	10.7	0	34.2	18.8	38.7	17.9
Smokers %	43.3	52.7	41.6	52.9	38.8	53.3	59.0	25.0	44.8	43.8	49.5	65.5	51.3	44.1	50.4	48.2
Non-smokers %	36.2	37.8	25.0	31.9	37.1	33.3	22.7	50.0	43.2	34.7	34.0	25.8	36.0	35.8	32.4	34.9
Ex-smokers %	20.5	9.5	33.3	15.2	24.1	13.3	18.2	25.0	12.0	21.5	16.5	17.6	13.7	20.1	17.1	16.9
Mill type*	1	2	2	2	2	1	3	4	1	1	3	3	3	3	3	

* Woollen = 1
 Worsted = 2
 Carpet = 3
 Blending only = 4

TABLE 10

PREVALENCE OF REPORTED SYMPTOMS

Symptom	Grade	N ^o	%
Cough and phlegm	None	1463	68.1
	Occasional	497	23.1
	Persistent	189	8.8
Wheeze	Absent	1482	68.9
	Present	669	31.1
Grade of breathlessness at best	1	1200	56.2
	2	729	34.1
	3	160	7.5
	4	41	1.9
	5	6	0.3
Variability of breathlessness	None	1736	81.8
	1 step	274	12.9
	2 steps or more	66	3.1
Rhinitis	None	1362	63.4
	Occasional	393	18.3
	Persistent	393	18.3
Itchy red eyes	None	1644	76.9
	Occasional	277	13.0
	Persistent	216	10.1
Chills	None	1981	92.1
	Occasional	122	5.7
	Persistent	48	2.2
Nosebleeds in past year	None	1881	87.4
	1 - 9	233	10.4
	10 or more	45	2.1
Dizziness in past year	None	1731	80.5
	1 - 9 episodes	321	14.9
	10 or more episodes	82	3.8
No. of chest illnesses in past 3 years	0	1712	80.5
	1	200	9.4
	2	102	4.8
	3 +	114	5.3

Figures for some symptoms may not add up to 100% because of missing or incomplete data.

Six hundred and eighty six individuals (32%) reported having some cough and/or phlegm of whom 189 (8.8%) had cough and phlegm frequently enough to qualify as having chronic bronchitis. Six hundred and sixty nine (31.1%) reported having either a wheezing/whistling sound in their chest or feeling tightness in the chest or shortness of breath at some time. On separate questioning about the degree of breathlessness experienced, 207 (9.6%) said they became short of breath at their best when walking with other people of their own age on level ground (Grade 3).

Three hundred and forty (16.0%) reported some degree of variability of their breathlessness and 66 of these (3.1%) had a two step degree of variability, which may be considered to suggest an asthmatic condition. Forty seven (2.2%) had grade 4 or 5 breathlessness at best and were not included in the assessment of variability, because their breathlessness could not deteriorate much further.

The most commonly reported symptom was an itchy nose with sneezing and stuffiness (rhinitis), which occurred in 786 (36.6%) of the population. Exactly half of these (18.3%) had this symptom for at least three months in the year. Four hundred and ninety three (22.9%) reported itchy red eyes and in 216 (10.0%) of these the symptoms were persistent.

Less frequently reported were symptoms of feverishness or shivering (chills). One hundred and seventy (7.9%) reported the symptoms of chills, including 48 (2.2%) with persistent chills.

Two hundred and sixty eight (12.5%) had had at least one nosebleed during the last year and 45 (2.1%) of these had experienced ten or more nosebleeds in the same period.

Dizziness was reported to have been experienced at least once in 403 (18.7%) of the population. Eighty two (3.8%) of these reported over ten episodes in the last year.

Four hundred and sixteen employees (19.5%) had had time off work because of a chest illness in the last three years; of these 114 (5.3%) had been off work three or more times.

5.3.1 Associations between symptoms

Associations between the following symptoms were examined:-

Chronic bronchitis (MRC criteria)
 Breathlessness (Yes to Q32 or worse - i.e. grade 3 +)
 Wheeze or chest tightness
 Persistent rhinitis
 Persistent itchy red eyes
 Persistent chills
 More than 9 nosebleeds in the last year
 More than 9 episodes of dizziness in the last year

Complete data for 2121 respondents were available and the frequency with which each pair of positive responses occurred together was investigated by means of a two-way table. The following combinations were expected (on the basis of our clinical prejudice).

Chronic bronchitis with wheeze or breathlessness
 Rhinitis with itchy red eyes or nosebleeds
 Chills with breathlessness or wheeze
 Wheeze with breathlessness

An eight way contingency table was then constructed and log-linear models incorporating first order interaction terms between symptom pairs were fitted. This allowed identification of combinations occurring more frequently than expected. An approximate relative risk can be derived for each combination from these models, and these can be interpreted as measures of higher order association between symptoms, after adjustment for other possible two-way associations between symptoms. The results are shown in Table 11, in which combinations of pairs of symptoms are ranked according to these approximate relative risks (odds ratio in Table 11).

TABLE 11

ASSOCIATION BETWEEN SYMPTOMS: ODDS RATIOS DERIVED FROM LOG LINEAR MODEL (See footnote)

	Estimated log odds	Odds ratio	s.e. of log odds	t
* itchy red eyes and rhinitis	1.947	7.0	0.164	11.86
* wheeze and bronchitis	1.820	6.2	0.185	9.86
* nosebleeds and rhinitis	1.488	4.4	0.350	4.25
* breathlessness and wheeze	1.442	4.3	0.171	8.42
chills and dizziness	1.280	3.6	0.421	3.04
chills and itchy red eyes	1.162	3.2	0.372	3.13
* chills and breathlessness	1.125	3.1	0.350	3.21
wheeze and dizziness	1.071	2.9	0.267	4.01
rhinitis and dizziness	0.775	2.2	0.277	2.80
rhinitis and wheeze	0.747	2.1	0.135	5.51
* chills and wheeze	0.745	2.1	0.369	2.02
chills and nosebleeds	0.708	2.0	0.609	1.16
rhinitis and chronic bronchitis	0.697	2.0	0.190	3.67
itchy red eyes and wheeze	0.660	1.9	0.174	3.80
nosebleeds and dizziness	0.523	1.7	0.532	0.98
breathlessness and dizziness	0.507	1.7	0.304	1.67
itchy red eyes and chronic br.	0.422	1.5	0.222	1.90
chills and rhinitis	0.375	1.5	0.374	1.00
* breathlessness and chronic br.	0.327	1.4	0.218	1.50
nosebleeds and itchy red eyes	0.317	1.4	0.400	0.79
itchy red eyes and dizziness	0.279	1.3	0.320	0.87
chills and chronic bronchitis	0.271	1.3	0.398	0.68
rhinitis and breathlessness	0.265	1.3	0.195	1.35
nosebleeds and breathlessness	0.240	1.3	0.440	0.54
itchy red eyes and breathlessness	0.155	1.2	0.233	0.67
nosebleeds and wheeze	0.123	1.1	0.357	0.35
nosebleeds and chronic bronchitis	0.006	1.0	0.458	0.01
chronic bronchitis and dizziness	-0.273	0.8	0.354	-0.77

(asterisks indicate symptoms expected to be associated a priori)

The associations found correspond quite closely with those expected a priori. None of them is strong enough to render superfluous analysis of each symptom in relation to risk factors separately, nor were they thought to be strong enough to allow categorisation of any combinations into symptom complexes which could then be analysed separately as a response.

However, the combinations of rhinitis with wheeze, rhinitis with chronic bronchitis and itchy red eyes with wheeze are commoner than expected, occurring 62, 11 and 23 times respectively. The corresponding ratios of log-odds to estimates of their standard errors (t-statistics) were all greater than 3.6. This suggests that these three symptom patterns are really associated in this population, and possibly also among wool textile workers generally. This could be due either to associations between risk factors or to related pathology.

5.3.2 Effect of age and sex on frequency of reporting symptoms

Most symptoms showed very little consistent change in frequency with age. Wheezing or shortness of breath was slightly commoner in the older age groups as was variability of breathlessness. On the other hand rhinitis, persistent itchy red eyes and nosebleeds were reported less frequently in older subjects (Table 12a).

Women generally reported more symptoms than men (Table 12b) notably for wheeze (38.9 vs 28.8%), rhinitis (51.1 vs 32.2%), itchy red eyes (33.0 vs 20.0%) and chills (12.7 vs 6.5%). Frequent nosebleeds (i.e. more than 10 per annum) were also commoner (4.0 vs 1.5%), dizziness was almost twice as often reported by women (28.5 vs 15.8%) and more women (19.1%) than men (12.7%) had 1-2 spells off work because of chest illnesses in the past three years.

TABLE 12(a)

PREVALENCE OF SYMPTOMS (%) BY AGE GROUP

Symptom	Grade	Age group							
		< 19	20-29	30-39	40-49	50-59	60-69	70-79	All
	No	81	414	538	500	468	144	5	2150
Cough and phlegm	Occasional	32.1	26.1	21.0	22.0	21.0	27.8	40.0	23.1
	Persistent	12.3	8.2	9.3	7.2	8.6	12.5	20.0	8.8
Wheeze	Present	28.4	29.5	28.8	30.2	33.1	41.0	60.0	31.1
Breathlessness	Grade 3+	3.7	8.4	9.1	11.2	10.6	11.2	0	9.7
Variability of breathlessness	1 step	23.5	9.8	11.9	11.1	14.6	21.0	0	12.9
	2 steps	2.5	2.9	2.1	3.2	3.9	4.2	25.0	3.1
Rhinitis	Occasional	29.6	22.1	17.1	16.8	15.6	20.1	0	18.3
	Persistent	25.9	23.5	19.7	16.6	12.6	17.4	40.0	18.3
Itchy red eyes	Occasional	12.3	11.6	13.7	12.9	13.9	12.0	0	13.0
	Persistent	8.6	13.8	11.7	8.6	7.5	7.7	20.0	10.1
Chills	Occasional	7.4	5.3	7.1	6.6	3.4	4.9	0	5.7
	Persistent	1.2	1.9	1.7	3.6	2.6	0	0	2.2
Nosebleeds	1-9 per year	14.8	14.0	9.9	9.4	8.5	9.0	0	10.4
	> 10 per yr	7.4	2.7	2.0	2.0	1.3	1.4	0	2.1
Dizziness	1-9 per yr	12.3	13.0	15.8	13.6	18.2	12.5	20.0	14.9
	> 10 per yr	4.9	2.7	3.0	5.8	3.6	2.8	20.0	3.8
Chest illnesses in past 3 years	1 - 2 spells	9.9	13.7	11.8	15.7	16.0	13.2	0	14.2
	3+ spells	7.4	6.6	6.6	4.2	4.0	4.9	0	5.3

TABLE 12(b)

PREVALENCE OF SYMPTOMS IN MEN AND WOMEN

Symptom	Grade	Men		Women		All	
		N ^o	%	N ^o	%	N ^o	%
Cough and phlegm	Occasional	373	22.6	124	25.0	497	23.1
	Persistent	142	8.6	47	9.5	189	8.8
Wheeze	Present	476	28.8	193	38.9	669	31.1
Breathlessness	Grade 3+	156	9.5	51	10.3	207	9.7
Variability of breathlessness	Possible	215	13.2	59	12.0	274	12.9
	Likely	52	3.2	14	2.8	66	3.1
Rhinitis	Occasional	274	16.6	119	23.9	393	18.3
	Persistent	258	15.6	135	27.2	393	18.3
Itchy red eyes	Occasional	183	11.1	94	19.0	277	13.0
	Persistent	147	8.9	69	14.0	216	10.1
Chills	Occasional	81	4.9	41	8.3	122	5.7
	Persistent	26	1.6	22	4.4	48	2.2
Nosebleeds	1-9 per yr	164	9.9	59	11.9	223	10.4
	> 10 per yr	25	1.5	20	4.0	45	2.1
Dizziness	1-9 per yr	214	12.9	107	21.6	321	14.9
	> 10 per yr	48	2.9	34	6.9	82	3.8
Chest illnesses in past 3 years	1-2 spells	208	12.7	94	19.1	302	14.2
	3+ spells	87	5.3	27	5.4	114	5.3

TABLE 13(a)

PREVALENCE OF SYMPTOMS BY ETHNIC GROUP AND LANGUAGE (%)

Symptom/grade		Ethnic group			Language	
		European (1489)	W.Indian (70)	Asian (592)	English (1766)	Urdu (385)
Cough and phlegm	Occasional	25.7	30.0	15.9	24.5	16.9
	Persistent	10.6	8.6	4.2	10.0	3.4
Wheeze	Present	37.4	38.6	14.4	34.7	14.5
Breathlessness	Grade 3+	7.4	8.6	15.6	7.5	19.5
Variability of breathlessness	Possible	14.2	7.1	10.4	14.1	7.2
	Likely	2.8	1.4	4.1	2.6	5.6
Rhinitis	Occasional	23.6	18.6	4.8	22.0	1.3
	Persistent	21.2	28.6	9.8	20.6	7.6
Itchy red eyes	Occasional	15.2	20.0	6.5	14.8	4.5
	Persistent	9.2	15.7	11.9	10.4	8.8
Chills	Occasional	6.8	1.4	3.4	6.2	3.4
	Persistent	2.0	4.3	2.5	1.9	3.9
Nosebleeds	1-9 per yr	11.6	15.7	6.4	11.3	6.2
	> 10 per yr	2.4	2.9	1.3	2.1	1.8
Dizziness	1-9 per yr	14.9	27.2	13.5	14.8	15.3
	> 10 per yr	4.3	2.8	2.7	3.8	3.9
Chest illnesses in past 3 years	1-2 spells	16.7	14.7	7.6	15.8	6.9
	3+ spells	5.5	1.5	5.7	5.3	5.3

TABLE 13(b)

PREVALENCE OF SYMPTOMS (%) IN ASIANS SUBDIVIDED BY LANGUAGE

Symptom	English (207)	Urdu (385)
Persistent cough/phlegm	5.8	3.4
Wheeze	14.1	14.6
Breathlessness Grade 3+	8.2	19.5
Persistent rhinitis	14.0	7.6
Persistent itchy red eyes	17.4	8.9
Persistent chills	0	3.9
Nosebleeds > 10 per yr	0.5	1.8
Dizziness > 10 per yr	0.5	3.9

5.3.3 Effect of ethnic group and language

The reporting of respiratory symptoms may differ between different ethnic groups because of differences in attitudes as well as understanding, because the questions were asked in a different language and also possibly because of real ethnic differences in symptoms. Table 13a shows the frequency of symptoms according to the three defined ethnic groups and two languages used. The Asian group's responses have also been further subdivided into whether the questions were in English or Urdu. (Table 13b)

There are some large differences in the frequency with which symptoms are reported in the different groups although these are inconsistent in the direction of the difference. Chronic bronchitis and wheeze are about twice as common in Europeans as in Asians and there is also a language difference even within the Asian group. Persistent rhinitis is commonest in those of West Indian origin, less common in Europeans and least reported among Asians. However, twice as many Asians reported symptoms of rhinitis amongst those interviewed in English (14.0%) compared to Urdu (7.6%). A similar language effect was observed for itchy red eyes, although in this case these symptoms were more than twice as common in the Asians interviewed in English (17.4%) compared with the Europeans (9.2%).

Whereas no Asians interviewed in English reported symptoms of chills, twice as many Asians interviewed in Urdu reported chills (3.9%) compared to Europeans (2.0%). Other symptoms demonstrated further differences between the groups and this emphasises the need to take account of ethnic/language effects in assessment of occupation on respiratory symptoms. (But see section 5.3.12).

5.3.4 Smoking habits

The smoking habits of the whole study population are summarised in Tables 9 and 14. Analyses in relation to gender showed that tobacco smoking was about as common in men as in

women (48%) although 4% of men smoked tobacco in a form other than cigarettes. Because more men than women had given up smoking only 33% of men had never smoked compared with 40.5% of women. Part of this difference is attributable to different ethnic smoking habits. Twice as many persons of West Indian origin were non-smokers (60%) compared to Europeans (29.1%) with Asians being intermediate (46.6%). The corresponding figures for current smokers were 30%, 51.1% and 43.1% respectively, the remainder (10.0, 19.8 and 10.3%) being ex-smokers.

As expected there were also clear differences between smoking habits in the different age groups. None of the over 70 year olds were lifelong non-smokers and 48.1% of under 19 year olds had never smoked. There was a much less clear-cut gradation among the smokers, 45.5% to 52.8% of each ten-year age group up to 70 were current smokers.

More than twice as many current cigarette smokers reported some symptoms of cough and phlegm compared to the non-smokers and four times as many had persistent cough and phlegm (chronic bronchitis) (Table 14). Other and ex-smokers had frequencies intermediate to these groups. Similar differences were observed for wheezing and shortness of breath but breathlessness (grades 2 and 3) was only slightly more common in smokers. Smokers had also been off work more often because of chest illnesses in the previous three years.

5.3.5 Temporal variation in respiratory symptoms

Because the symptoms of cough, wheeze/shortness of breath, rhinitis/itchy red eyes and chills were supplemented by additional questions on their temporal relationships, it should be possible to establish more clearly any relationship of these symptoms to work. The frequencies of occurrence of each of the above symptoms were plotted against the time of day, day of the week or season of the year (rhinitis only) when the symptom was reported to be worse or better than normal.

TABLE 14

PREVALENCE OF SYMPTOMS (%) ACCORDING TO SMOKING HABITS

Symptom/grade		Smoking category			
		Non-smoker (751)	Cigarette smoker (966)	Other smoker (71)	Ex-smoker (363)
Cough and phlegm	Occasional	13.8	32.2	21.1	18.5
	Persistent	3.7	14.7	5.6	4.1
Wheeze		18.5	41.8	26.8	29.5
Breathlessness	Grade 3+	8.0	10.7	0	12.2
Variability of breathlessness	Possible	10.5	14.0	8.7	15.8
	Likely	2.6	3.7	1.4	3.1
Rhinitis	Occasional	14.9	19.9	12.7	22.1
	Persistent	15.7	19.9	15.5	19.9
Itchy red eyes	Occasional	11.4	13.5	11.3	15.2
	Persistent	9.0	11.6	7.0	9.1
Chills	Occasional	3.7	7.0	4.2	6.3
	Persistent	2.3	2.6	0	1.7
Nosebleeds	1-9 per yr	9.9	10.5	2.8	12.7
	> 10 per yr	2.4	1.8	0	2.6
Dizziness	1-9 per yr	12.8	15.5	19.7	16.8
	> 10 per yr	3.9	4.0	2.8	3.1
Chest illnesses in past 3 years	1-2 spells	12.9	15.2	21.4	12.6
	3+ spells	4.6	7.1	0	3.4

Results were as follows:

(a) Cough

Figure 2a shows that among the individuals reporting cough at any time (YES to q1, 2 or 4) 245 who thought that it was worse at certain times of the day on (average) said that it was more often worse early in the morning (between 5 and 8 a.m.) and, to a lesser extent, at about 2 p.m. and between 10 p.m. and midnight.

On average there did not appear to be any particular day on which cough was worse (Figure 2b) but a significantly greater number reported it as being better on Saturday and Sunday.

(b) Wheeze and shortness of breath

The pattern of these symptoms being worse than normal was very similar to that for cough and therefore is not illustrated graphically here. However, there was a more pronounced peak late in the evening and a smaller peak first thing in the morning. A large number of respondents reported that wheeze and shortness of breath were better at week-ends, as for cough.

(c) Rhinitis and itchy red eyes

The additional questions on temporal variability in this section applied to either or both of these symptoms and they were stated as being worse between 7 and 11 a.m. and between 1 and 4 p.m. in most people. There was also a small increase in numbers reporting symptoms being worse late in the evening. (Fig 3a).

In contrast to the responses about cough and wheeze, many more people complained that their rhinitis or itchy red eyes were worse between Monday and Friday, as compared with Saturday and Sunday, when large numbers reported that their symptoms were better. (Fig 3b)

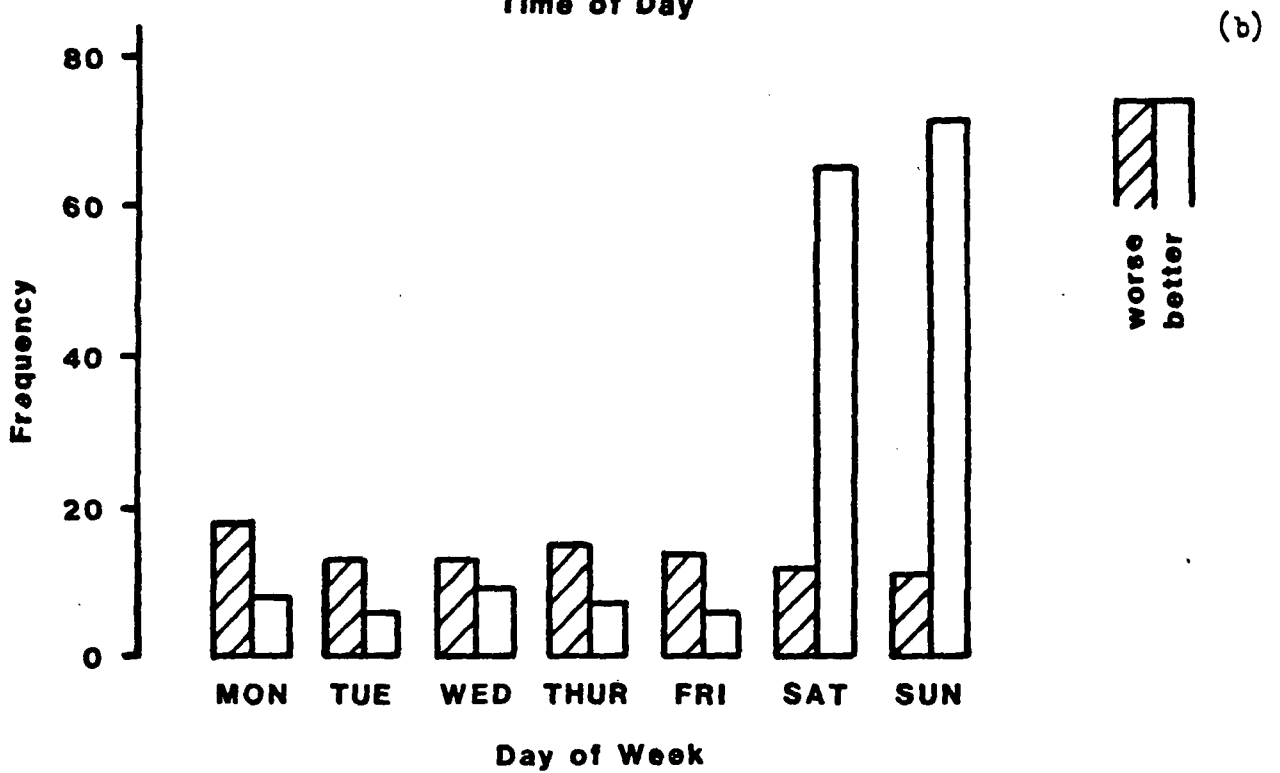
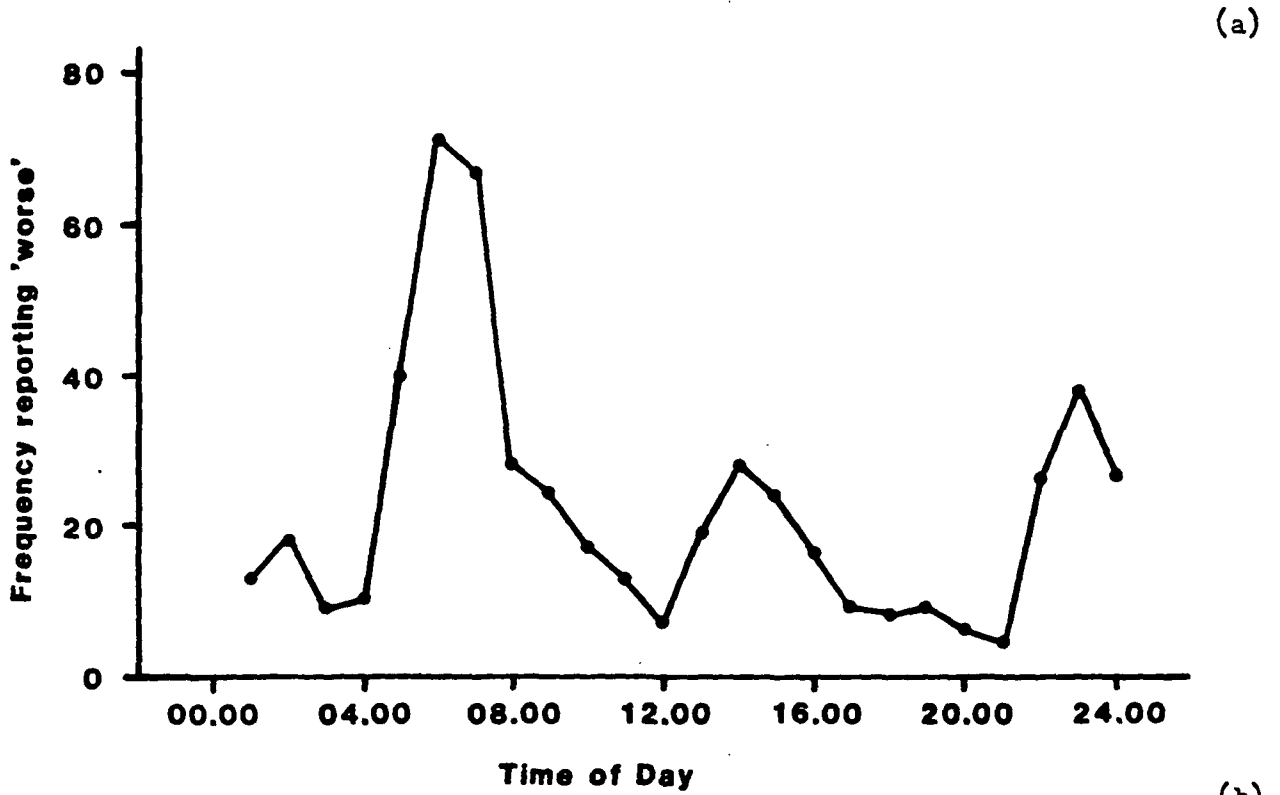


Figure 2

Frequencies of respondents, indicating cough (a) 'worse' at different times of day (b) 'better' or 'worse' on different days of the week.

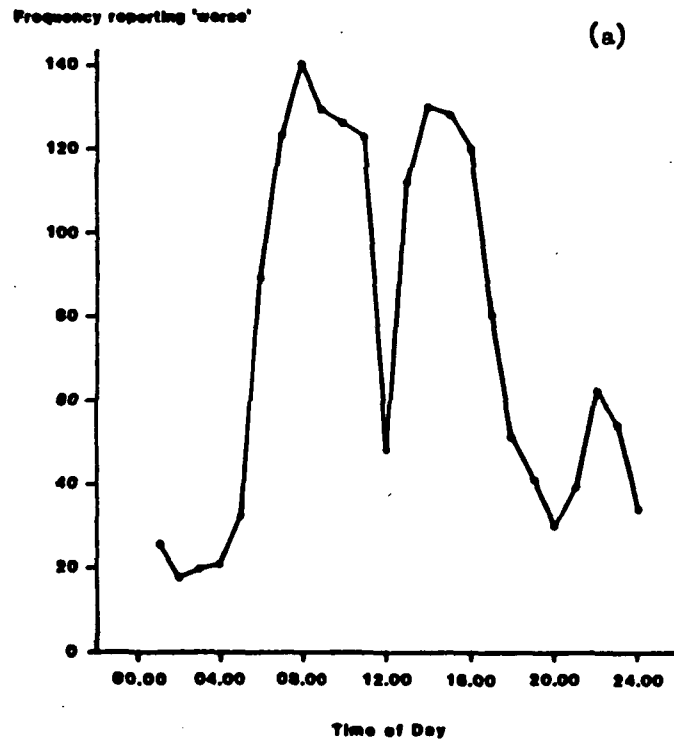
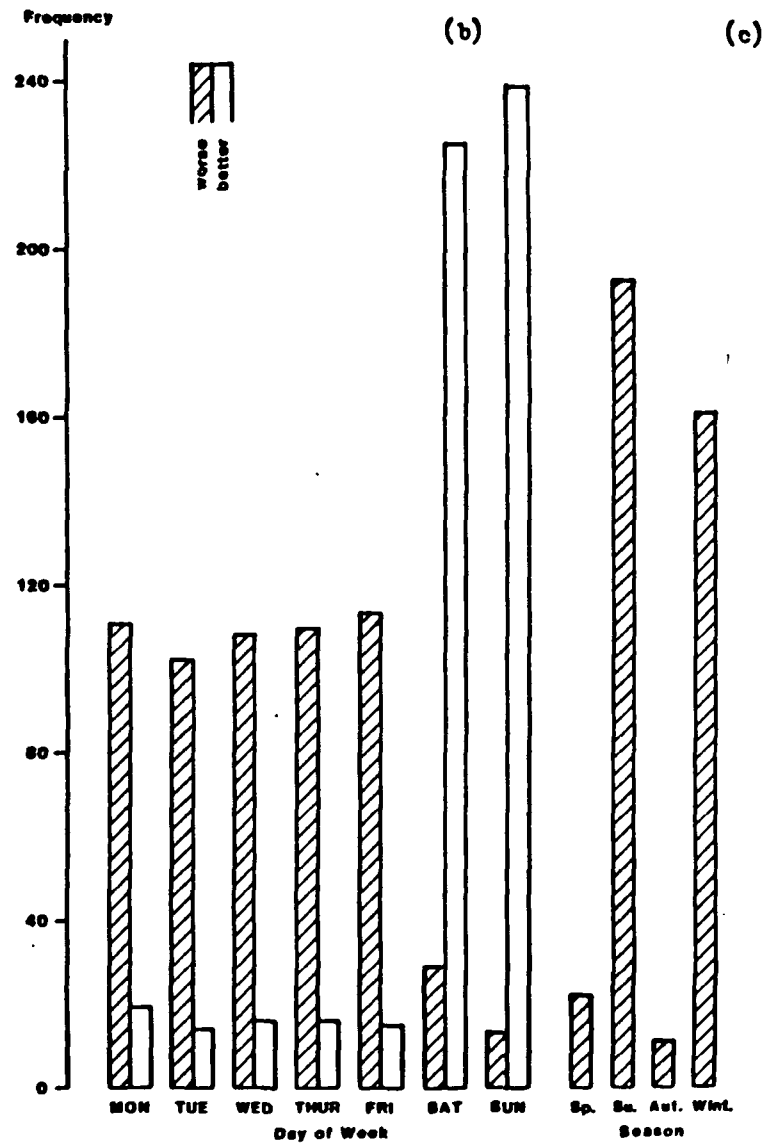


Figure 3

Frequencies of respondents indicating rhinitis and/or itchy red eyes (a) 'worse' at different times of day (b) 'better' or 'worse' on different days of the week (c) 'worse' during different seasons of the year.



In addition, the question intended to establish seasonal variation of these symptoms was found to identify two groups: those with symptoms worse during the summer months and slightly fewer whose symptoms were worse during the winter. (Fig 3c) The former may relate more to hay fever sufferers and the latter to those who are prone to winter colds. However, these sub-groups may represent different individuals from those who reported worse symptoms during the week.

(d) Chills

These showed no strong diurnal variation and only a slight tendency to be better at weekends.

5.3.6 Relationship between symptoms and place

Anyone who reported the presence of a symptom was subsequently asked whether that symptom was worse than normal in a particular place. Of those who said it was, the majority stated that it was worse in a place at work. Between 69 and 84% reported that the symptoms were worse at work for the four symptoms where this question was asked. A few others reported the symptoms being worse at work as well as at other places. Fifty five per cent of 906 persons, who said that something in particular made them sneeze, nominated a substance, process or place at work as the cause.

In addition, persons who reported symptoms were asked if the symptoms altered when they were on holiday for a week or more. Between 52.4 and 71.6% of these people said that the symptoms improved but, of those who said that they were not better than normal, the vast majority, 95%, said that they were not worse than normal when they were on holiday. These reports imply that most respondents with symptoms felt either that they improved or that they did not change during extended periods away from work.

5.3.7 Relationships between symptom prevalences and dust exposure

There was a very wide range of dust concentrations to which this population was exposed and the frequency with which many of the symptoms were reported is clearly associated with these dust concentrations. Table 15 demonstrates the dust concentration-symptom relationships for different ranges of dust exposure: cough and phlegm, wheeze, breathlessness, rhinitis, itchy red eyes and nosebleeds were all reported with greater frequency in groups working in higher dust concentrations. There were only small numbers exposed to very low or very high concentrations, consequently this trend is not always apparent at the ends of the range of dust concentrations.

5.3.8 Association between symptoms and mill

In the previous section symptoms were reported in relation to the individual's stated association between those symptoms and a place at work or elsewhere. If there is any association between the presence of respiratory symptoms and the workplace, specifically airborne dust in the working environment, there should be a relationship between the prevalence of symptoms and dustiness of individual mills or particular processes at these mills.

Each mill was ranked according to the mean of the estimated dust concentrations, with the dustiest mill having rank 1 and the least dusty rank 15. (Table 4) The prevalence of rhinitis is plotted against this ranking in Fig 4a. There is evidence of a downward trend with increasing rank, i.e. greater prevalence with increasing dustiness. The greatest deviations from this trend are at mills ranked 3,5,7,11 and 13 which correspond to mills 4,13,15,9 and 2 respectively where there was a large number of Asians. As noted previously this group reported considerably lower prevalence of these symptoms than average.

Symptoms of cough and phlegm also exhibited this downward trend, though not quite so strongly. (Fig 4b) There was some evidence for an increasing sickness absence rate due to chest illnesses with increasing dustiness at the eight most dusty mills, but overall there was no significant trend. (Fig 4c)

TABLE 15

SYMPTOM PREVALENCES IN GROUPS EXPOSED TO DIFFERENT DUST CONCENTRATIONS

Symptom/	Grade	Dust concentration(mg/m ³)				
		<0.1 (4)*	0.1-1 (1206)	1-10 (740)	10-100 (187)	>100 (6)
Cough/phlegm	Occasional	25	19.6	25.2	37.4	50
	Persistent	0	5.8	10.8	19.8	33.3
Wheeze	Present	50	24.6	35.3	55.1	66.7
Breathlessness	2 and 3	25	39.3	40.8	60.4	50
	4 and 5	0	1.8	3.0	1.6	0
Rhinitis	Occasional	25	15.7	19.7	29.4	0
	Persistent	0	14.9	19.3	36.9	16.7
Itchy red eyes	Occasional	25	11.3	12.6	23.0	33.3
	Persistent	0	8.0	10.0	23.0	50
Nosebleeds in past year	1 - 9	0	9.3	10.8	15.5	33.3
	> 10	0	1.7	1.6	6.4	0
Dizziness in past year	1-9 episodes	0	14.8	12.8	24.1	33.3
	> 10 "	0	3.9	3.2	5.9	0

* Number of individuals in group

5.3.9 Relationship between symptoms and occupational group

The study population was divided into 16 occupational groups, as described in Table 1 and more fully in Appendix 7. Each subject was assigned to a current occupational group (O.G.) according to his or her job at the time of interview and the

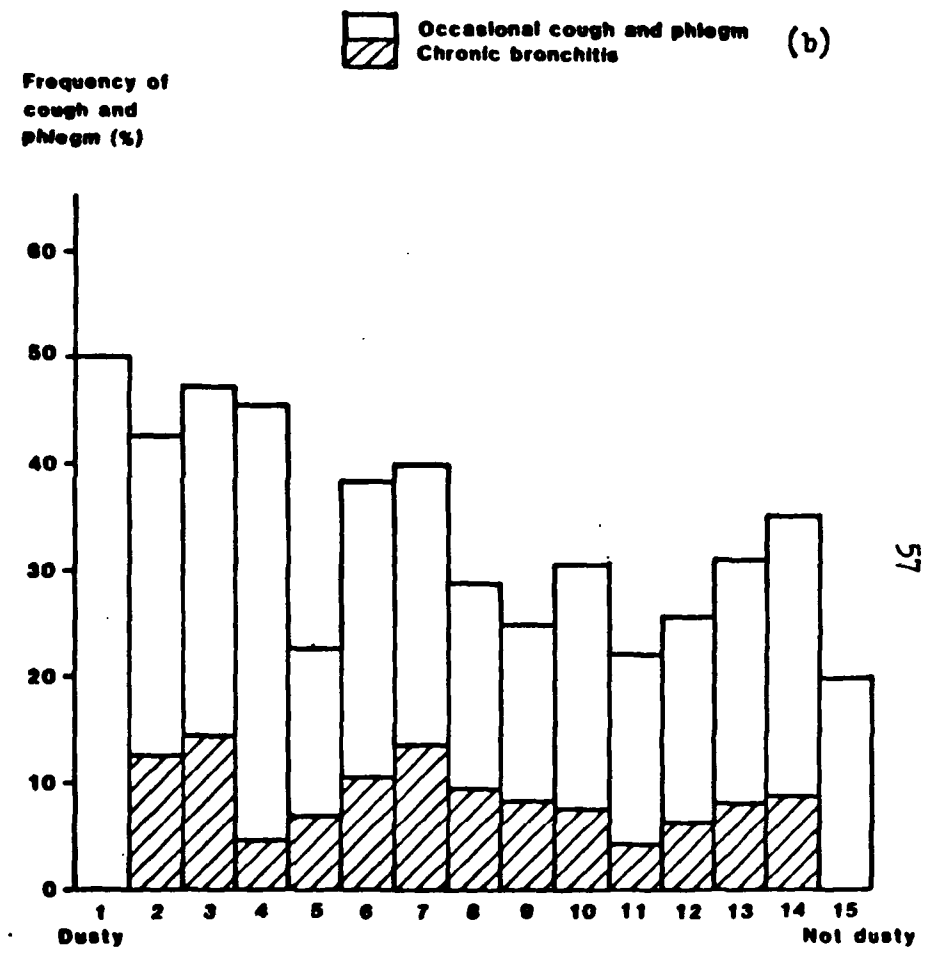
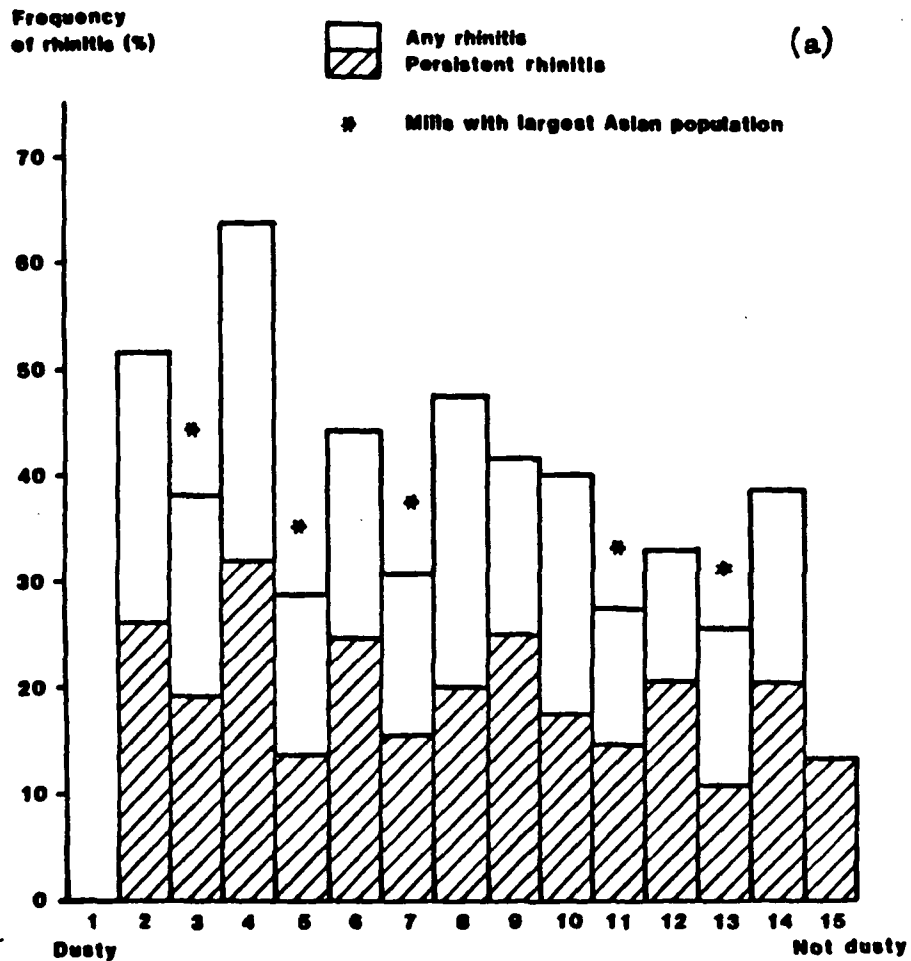


Figure 4

Frequency of (a) rhinitis and (b) cough and phlegm at each mill by rank order of dust concentrations.

(c)

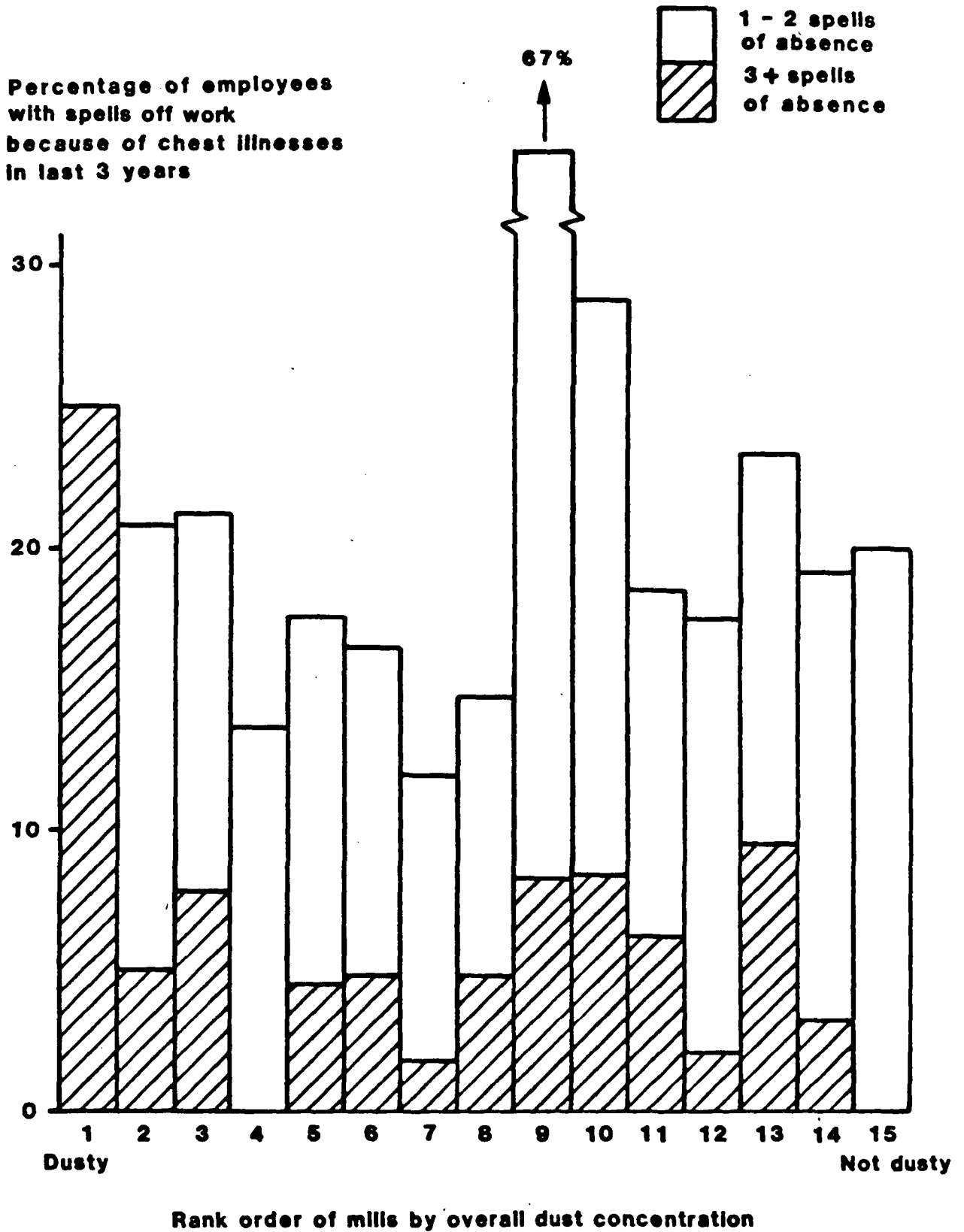


Figure 4.cont^d

(c) Percentages of employees with spells off work because of chest illnesses in the last 3 years at each mill by rank order of dust concentrations.

frequency of symptoms reported by each O.G. for all 15 mills has been calculated. Similar relationships were investigated for the O.G. in which most of their working lives has been spent. However, 76.1% of the workforce had worked in no more than two occupational groups during their working lives, so for the majority the current OG represented the one in which they had worked most. In the majority of cases OGs 3 and 8, (blenders/waste workers and backwinders respectively) were the two groups reporting the most symptoms, whether occasional or persistent. These groups were also those with the highest measured dust levels. OG3 consists of 100% men and OG8 is 93% women and very few of either group were other than Europeans.

When symptom frequency was plotted against time spent in each OG, only OGs 3 and 8 showed any evidence of an exposure-response relationship (Figs 5 and 6). Other groups either showed no trend with time in OG or had insufficient numbers in some sub-groups to allow any possible trend to be apparent.

Cough and phlegm, wheeze, rhinitis and itchy red eyes all tended to increase in frequency with years spent in these two OGs (3 and 8). Backwinders experienced increasing frequency of occasional chills with years worked in that department, except for those working more than 15 years in backwinding. Other symptoms showed a less exposure-related effect. (Fig 6).

5.3.10 Further relationships within occupational groups 3 and 8

Although 130 men in OG3 and 148 women and 11 men in OG8 had worked in these groups at one time, only 36 and 135 (including 9 men) respectively were currently employed in these occupations. Where possible they have been further subdivided into groups by mill according to whether these occupations were performed at a particular mill. Some of the numbers in certain mill subgroups are very small (1-3 individuals) and it is not possible to give reliable symptom prevalences for these groups nor for any of the mill subgroups of OG3. However for OG8 four mills had sufficient numbers to justify calculation of symptom frequency by mill.

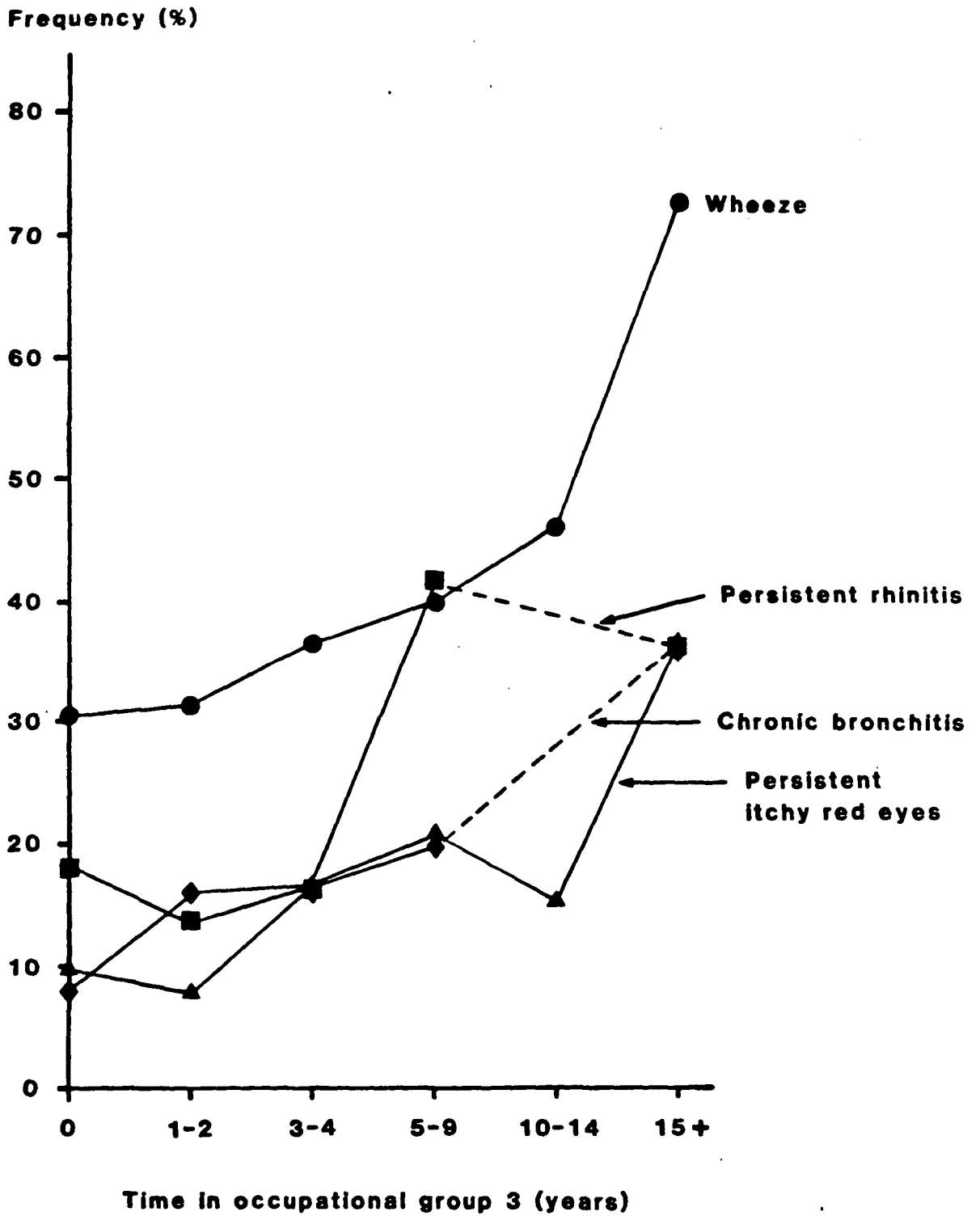


Figure 5

Frequency of reporting symptoms in OG3 (blenders/waste workers) by time worked in OG.

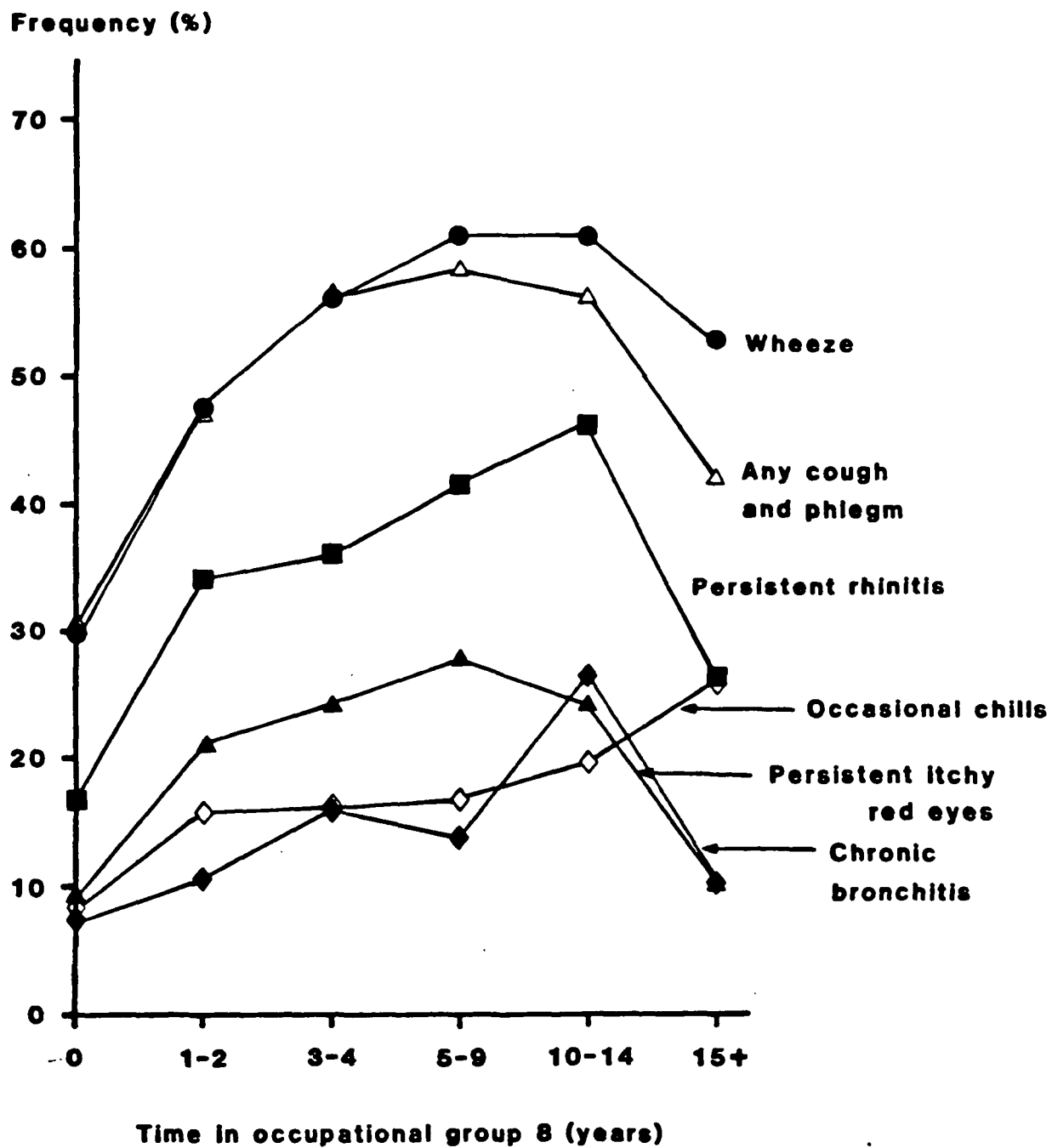


Figure 6

Frequency of reporting symptoms in OGS (backwinders) by time worked in OG.

Table 16 shows these frequencies for some symptoms in order of average measured dust concentrations of the backwinding groups at each mill. There were considerable differences in dust levels between these mills, ranging from 1.3 to 46.7 mg/m³.

TABLE 16

SYMPTOM PREVALENCES (%) IN BACKWINDERS (OG8) AT 4 MILLS

	Mill No				Total
	12	14	13	11	
Arithmetic mean dust concentration in OG8 (mg/m ³)	1.3	11.4	26.5	46.7	
Number in group	8	47	47	31	135
Chronic bronchitis	37.5	21.3	12.8	25.8	20.0
Wheeze	75.0	63.8	51.1	58.1	57.8
Persistent rhinitis	12.5	51.1	23.4	54.8	40.0
Persistent itchy red eyes	12.5	23.4	10.6	48.4	23.7
Nosebleeds (any in last year)	0	38.3	14.9	25.8	24.4

It can be seen that the symptom frequencies at each mill do not follow exactly the order of dustiness of the backwinding departments in these mills. For example, rhinitis and itchy red eyes were most prevalent at mill 11 (the dustiest mill) but other symptoms were not. Mill 12 was by far the least dusty but there were only eight employed in backwinding at that mill.

5.3.11 Comparison of symptom prevalences in OG8 with other OGs

Because OG8 consists mostly of female workers the prevalence of symptoms reported in this group has been compared with prevalences reported in other groups in which there were significant numbers of women, namely OGs 6-11 and 16.

Cough and phlegm, rhinitis, wheeze, itchy red eyes and nosebleeds were more frequently reported amongst female backwinders than among women in other groups. Breathlessness and chills were reported with equal frequency by one or more groups, including backwinders, in whom the prevalence was most common (Figure 7).

5.3.12 Symptom prevalences amongst Asian workers by occupational group

Asians are employed in largest numbers in carding, combing, spinning, weaving and maintenance/general work. The frequencies with which symptoms were reported amongst Asians (interviewed in English or Urdu) in these occupational groups (5,6,9,10 and 14) were compared with those reported by all employees in each of these groups. There are differences between symptom prevalences for individual groups both for occasional and persistent symptoms, which are less frequent among Asians. These differences are, however, generally not as large as the differences within the population as a whole, suggesting that a factor related to occupational groups may be involved.

5.4 Logistic Regression Analysis

Since many of the risk factors discussed in section 5.3 above are associated with one another, it is possible that some of the apparent effects may be the consequence of these associations. In order to take into account such effects and to derive exposure-response curves standardised for covariates, logistic regression analyses were carried out as described in section 4.7.

The ten symptoms investigated are as follows:

1. Chronic bronchitis (persistent cough and phlegm)
2. Wheeze (or whistling in the chest, chest tightness, shortness of breath)
3. Breathlessness Grade 3 or more (i.e. when walking with other people of the same age on level ground)
4. Variable breathlessness (Difference of 2 grades between breathlessness at best and at worst)

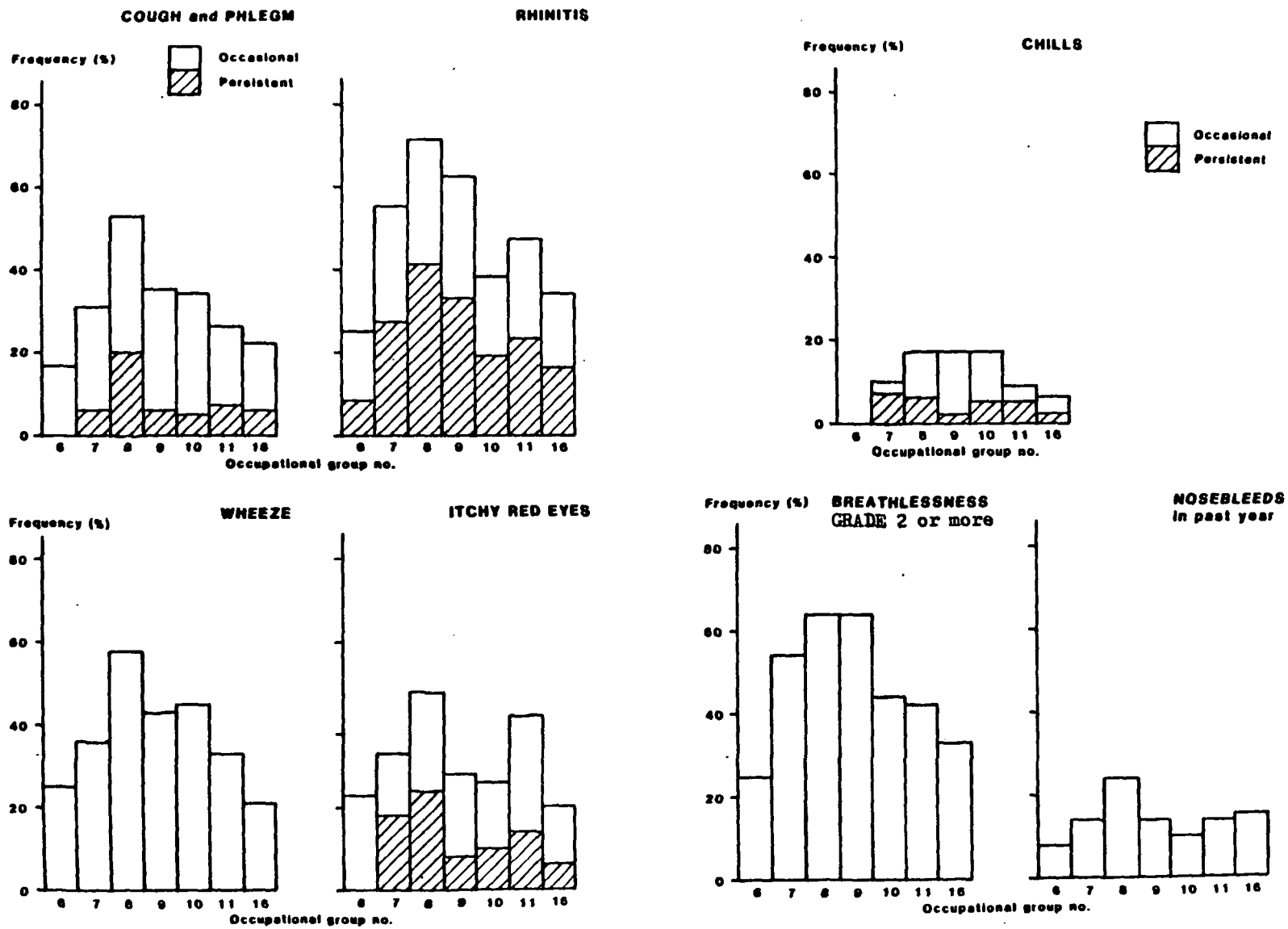


Figure 7

Frequency of reporting symptoms by female employees in selected current OGs containing significant numbers of women.

5. Persistent rhinitis]
6. Persistent itchy red eyes]- present for at least 3 months
7. Persistent chills] in the year
8. Nosebleeds (10 or more per year)
9. Dizziness (10 or more episodes per year)
10. Spells off work because of chest illnesses (two or more in last 3 years)

5.4.1 Regression models

A regression model was first fitted which included terms for age, sex, race, language and smoking status. Current cigarette consumption was also included, as this accounted for slightly more variation than cumulative cigarette consumption.

A further model was fitted, which included the dust concentration and another model included a quadratic term in dust concentration, in order to test for non-linear effects. Similar models were fitted substituting weekly exposure (which takes into account the hours worked) for dust concentration.

Additional terms and interactions were then included, so that the effects of current job, mill, time in the industry and time in job categories could be investigated successively. A total of 12 logistic regression models were fitted and the effects of each of these factors were determined for each symptom defined above.

The complete list of the logistic regression models used and the respective deviances and residual degrees of freedom for the ten symptoms are given in Appendix 8.

The following sections summarise our findings on this regression analysis, which has allowed the estimation of the relative risks for each symptom (relative to occupational group 16, non-process workers). These relative risks have been calculated for each occupational group, taking into account the effects of dust concentration, and are derived from model 6. A high relative risk for a particular occupational group implies that there is a risk associated with the job, which is not accounted for by the estimated dust exposure.

Relative risk has also been determined in relation to dust concentration, (estimated by model 3); time worked in the wool industry (model 11, which takes age into account), and finally by age (model 3, which does not take time in the industry into account).

5.4.1.1 Chronic bronchitis

Chronic bronchitis is closely associated with smoking, as expected, but there is very little relationship with age. There is a clear effect associated with dust exposure (Fig. 8a), which seems to be more related to current conditions than past occupational history, as the association with time worked in the industry was found to be very weak.

While the variance accounted for by current job is not statistically significant once dust exposure is taken into account, it is noticeable that non-process work has one of the lowest relative risks for chronic bronchitis (Fig. 8b), even when dust exposure is accounted for. Backwinders (OG8) on the other hand still have a very high relative risk.

5.4.1.2 Wheeze

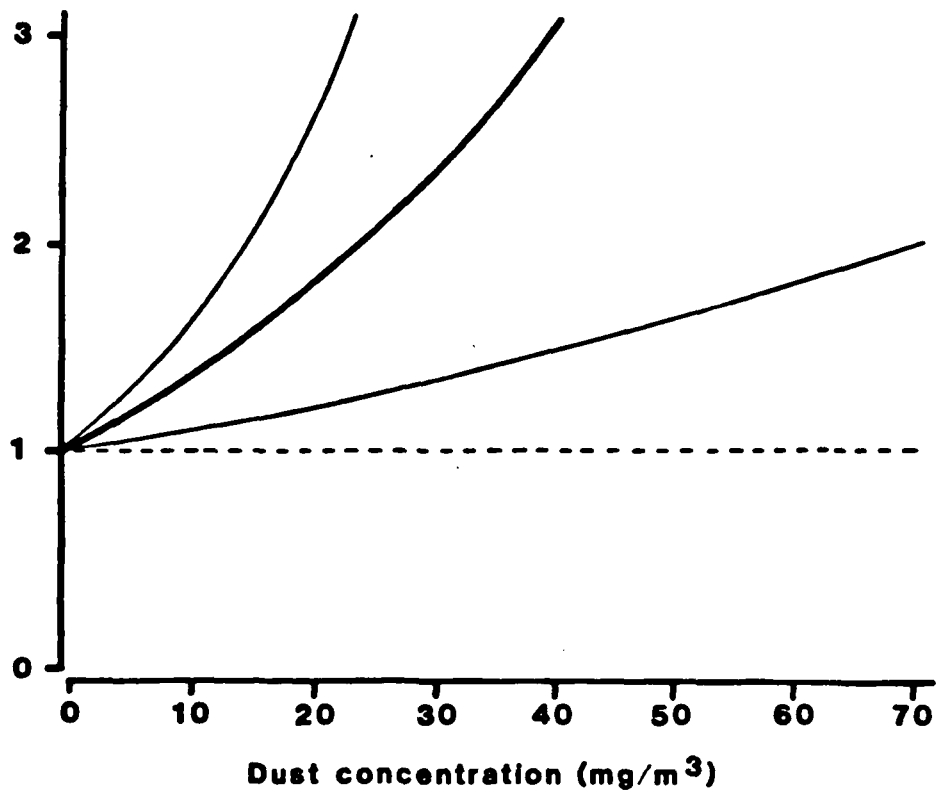
Wheezing and shortness of breath show a similar pattern to that for chronic bronchitis. However, current occupation appears to have a greater effect on relative risk for this symptom, probably because the larger number of people reporting wheeze has affected the level of statistical significance. In other respects the pattern is similar to bronchitis, wheeze being associated with high dust levels (Fig 9a) and with smoking. Non-process work has the lowest relative risk (Fig.9b).

5.4.1.3 Breathlessness

Although breathlessness is also related to dust concentration (Fig 10a), it differs from the other responses in showing a closer relationship to weekly exposure. This may, however, be due to chance. Breathlessness increases in relative risk with age (Fig 10b). Past occupational history, i.e. time in

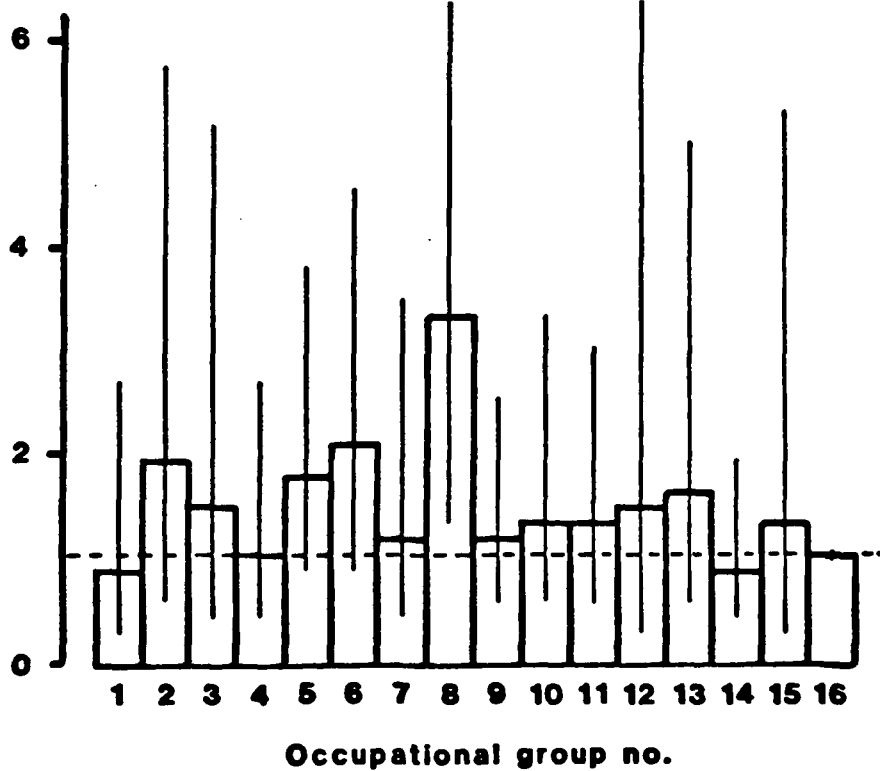
Relative risk of bronchitis

(a)



Relative risk of bronchitis

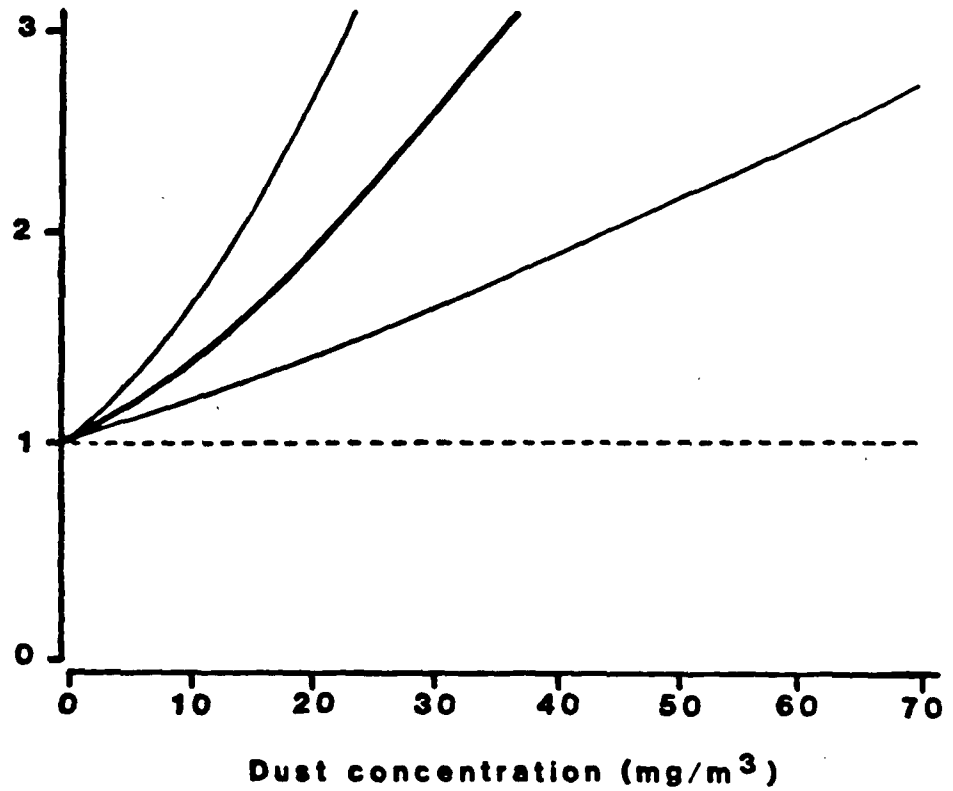
(b)

**Figure 8**

Relative risk of chronic bronchitis (a) by inspirable dust concentrations (b) by occupational group (after allowing for dust exposure).

Outer curves in upper figure and bars in lower figure represent two-tailed 95% confidence limits (and for subsequent figures)

Relative risk of wheeze



Relative risk of wheeze

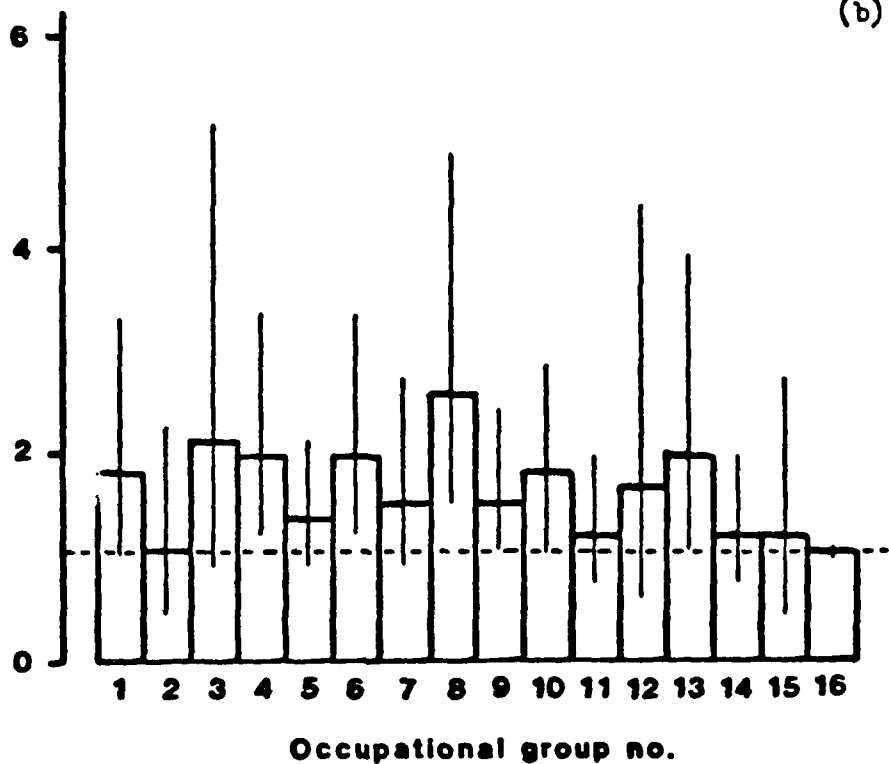


Figure 9

Relative risk of wheeze (a) by inspirable dust concentration (b) by occupational group (after allowing for dust exposure)
(See legend to Fig. 8 for further explanation)

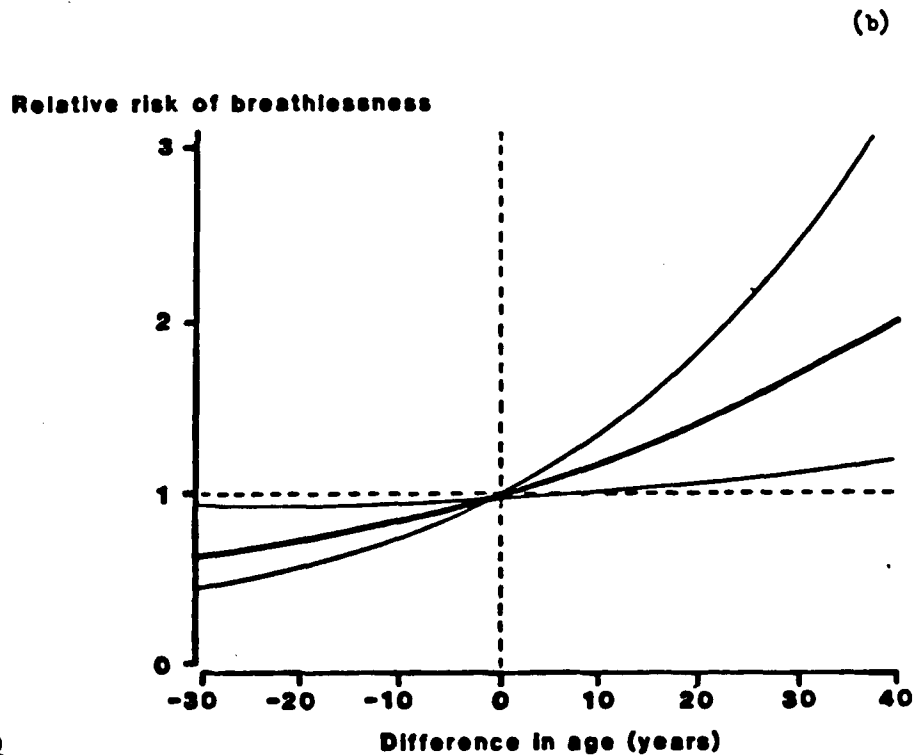
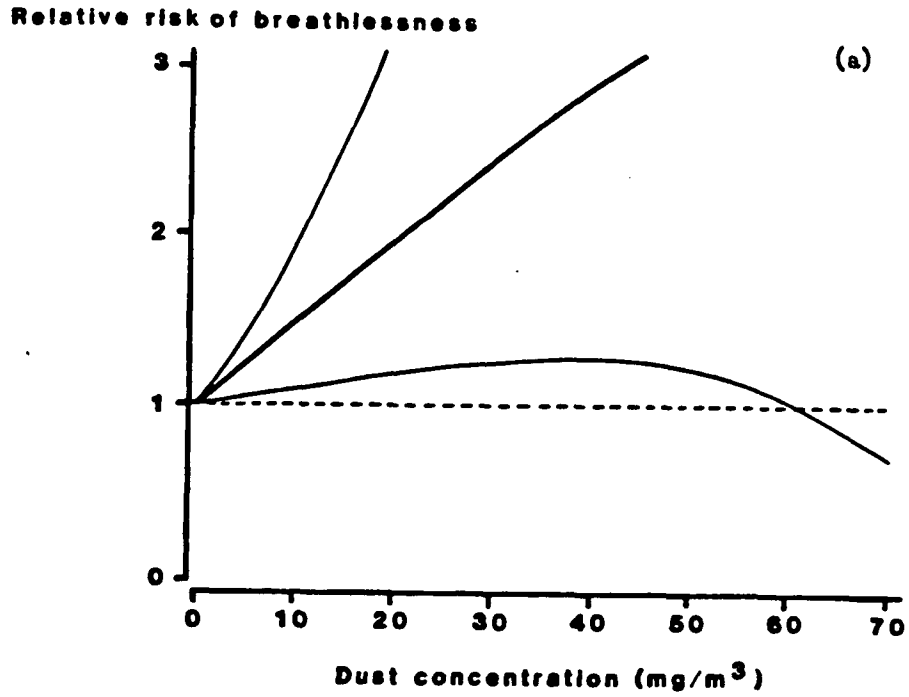


Figure 10

Relative risk of breathlessness (grade 3 or more) (a) by inspirable dust concentration (b) by age difference, where age = 0 represents any individual and difference in age above or below zero represents relative risks for other individuals older or younger than this (after allowing for dust exposure)

occupational groups, accounts for more variation than current job, suggesting that the effects may be cumulative. However, there is no clear association with time worked in the industry cumulated over all occupational categories.

5.4.1.4 Variable breathlessness

This is the only symptom for which the relative risk for non-process workers is among the highest. This fact, together with a non-significant downward trend in risk with time in the industry, is strongly suggestive that individuals who are susceptible to variable breathlessness do not remain in process work. OGs 3 and 8 again have large relative risks, indicating the increasing risk associated with high dust levels, which is confirmed by the nature of the relationship between increasing relative risk of variable breathlessness and dust levels: the relationship only becomes statistically significant, when the dust concentration rises above about 100 mg/m³.

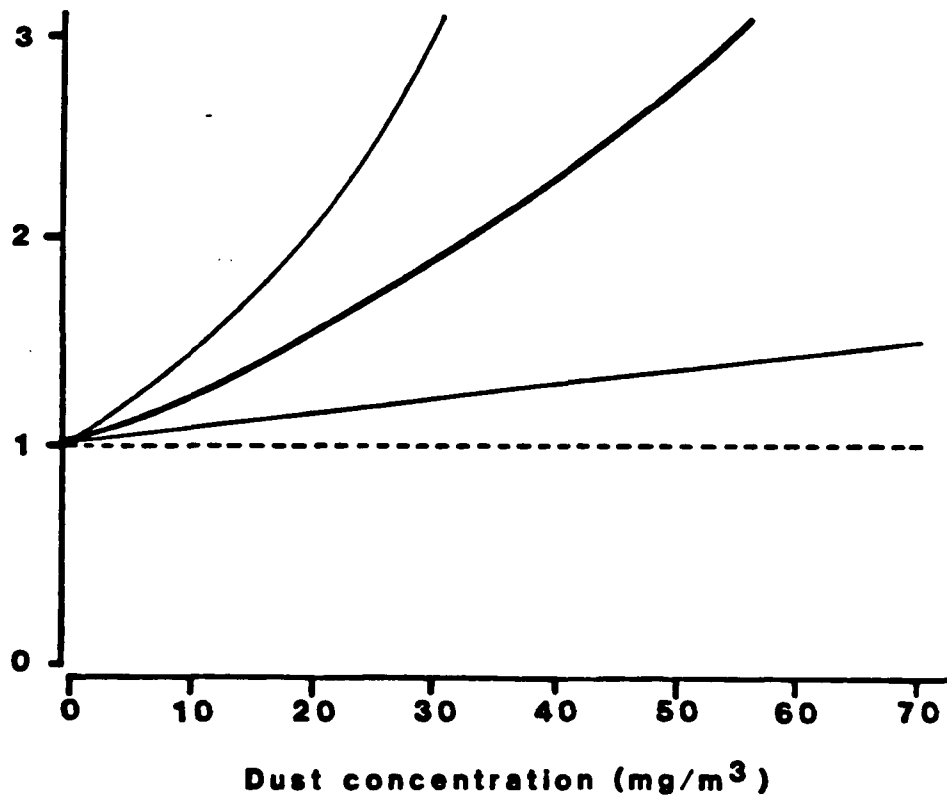
Although there appears to be a positive association with age, this and the other observed patterns must be interpreted with caution, because our definition of variable breathlessness is derived from responses to the questions on breathlessness, and this could well have introduced artefactual relationships.

5.4.1.5 Persistent rhinitis

There is again a clear association between relative risk of rhinitis and current dust exposure (Fig 11a), the risk increasing for workers who have been longer in the industry. There is also evidence for factors other than dust levels accounting for some of the risk. For example, there appears to be a general trend of decreasing risk with successive stages of processing of the wool and a large chi-squared value associated with the interaction of mill and occupational group, implying that the effects of occupation differ between mills. Non-process workers have by far the lowest risk of all occupational groups (Fig.11b) and the relative risk decreases significantly with age.

Relative risk of rhinitis

(a)



(b)

Relative risk of rhinitis

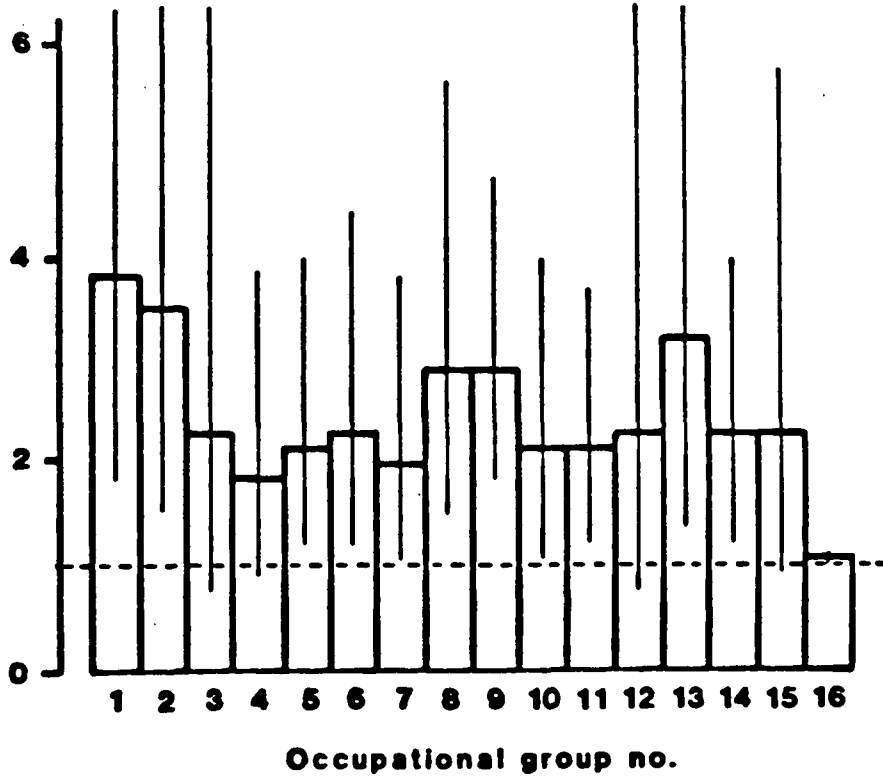


Figure 11

Relative risk of persistent rhinitis (a) by inspirable dust concentration
 (b) by occupational group (after allowing for dust exposure)
 (see legend to Fig.8 for further explanation)

5.4.1.6 Persistent itchy red eyes

This symptom shows an even stronger relationship to current dust levels than does rhinitis (Fig 12a) and a pronounced downward trend in risk associated with processing of the wool (Fig.12b). This latter effect is not as clearly distinct from the effect of dust level as is the case for rhinitis and the additional effects of occupation are not very different between mills. The downward trend with age and the non-significant effect of time in the industry suggests that the effect of the dust is not a cumulative one.

An association with smoking is again apparent.

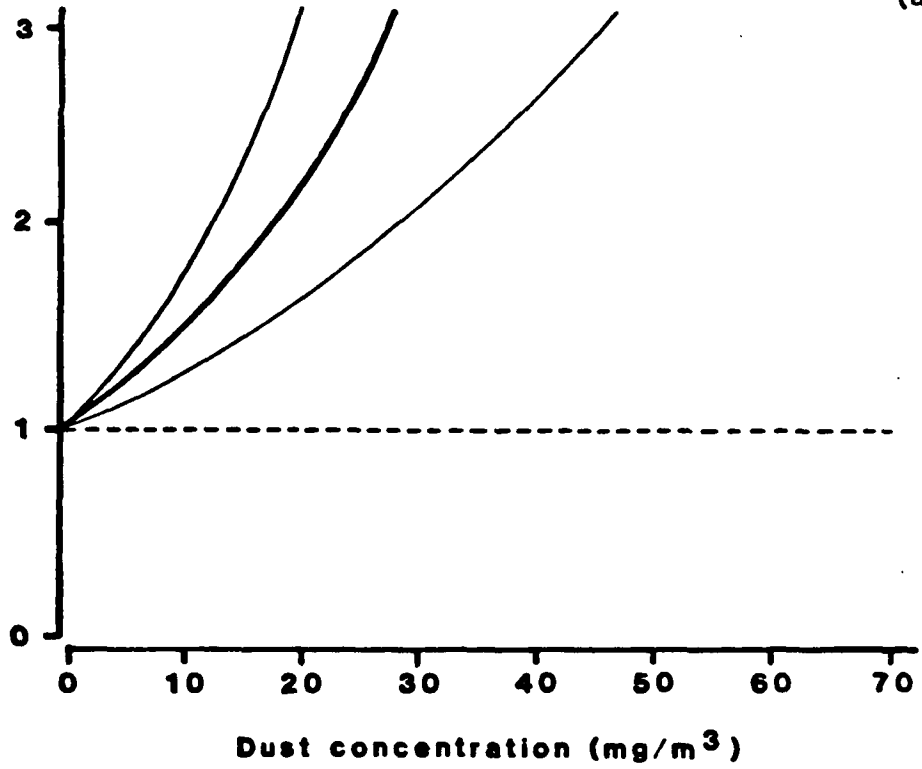
5.4.1.7 Persistent chills

The pattern of occurrence of chills is considerably different to that of other symptoms, as dust exposure has little association with the presence of chills, which were not reported by anybody in the early stages of processing. There is evidence that time worked in the industry may be important (Fig.13) but the comparative scarcity of reports of this symptom make further associations unreliable. However, carding in one mill and spinning in two other mills show more than the expected prevalence of this symptom.

5.4.1.8 Nosebleeds

The relationship between frequent (10 or more in past year) nosebleeds and dust exposure, although not statistically significant, is not straightforward. There is considerable variation between occupational groups, with some groups, including backwinders, having high relative risks and others low or zero relative risk (Fig.14a). This may be a consequence of the relatively low number of cases included in the analyses (only 45 respondents reported more than 10 nosebleeds in the last year): chance variation between jobs could account for much of the variation. There is a downward trend with age (Fig.14b).

Relative risk of itchy red eyes



(b)

Relative risk of itchy red eyes

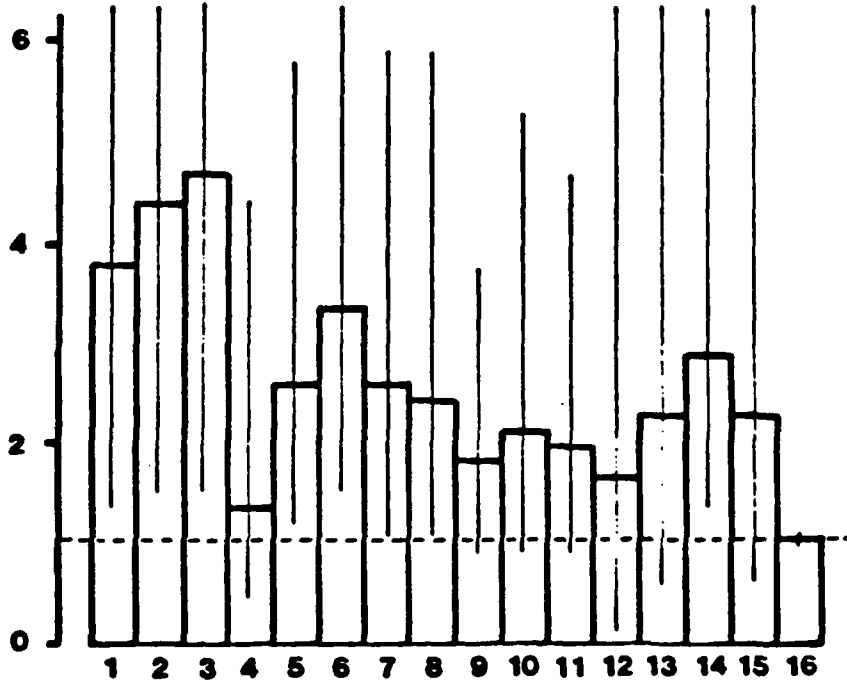
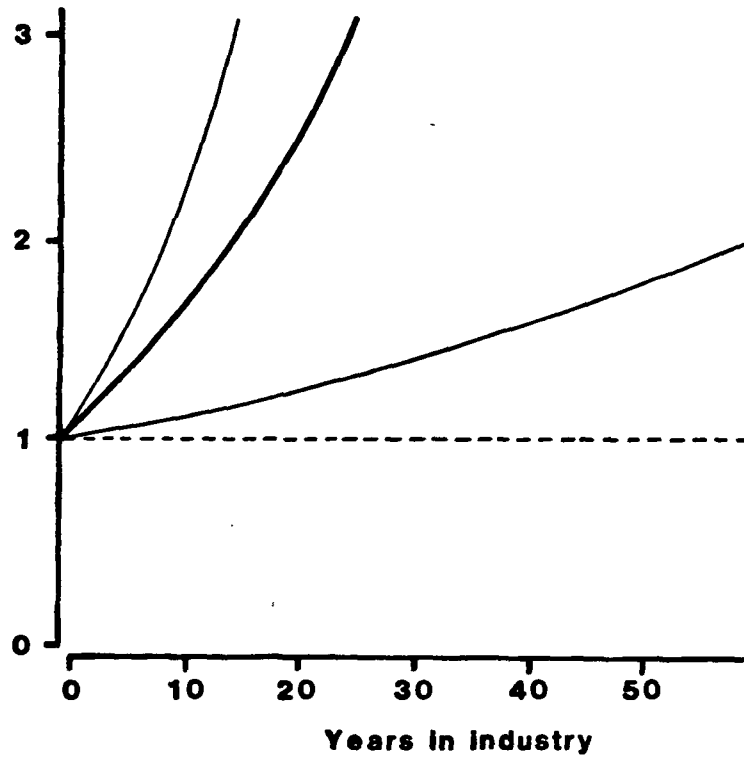


Figure 12

Occupational group no.

Relative risk of persistent itchy red eyes (a) by inspirable dust concentration (b) by occupational group (after allowing for dust exposure)

Relative risk of chills

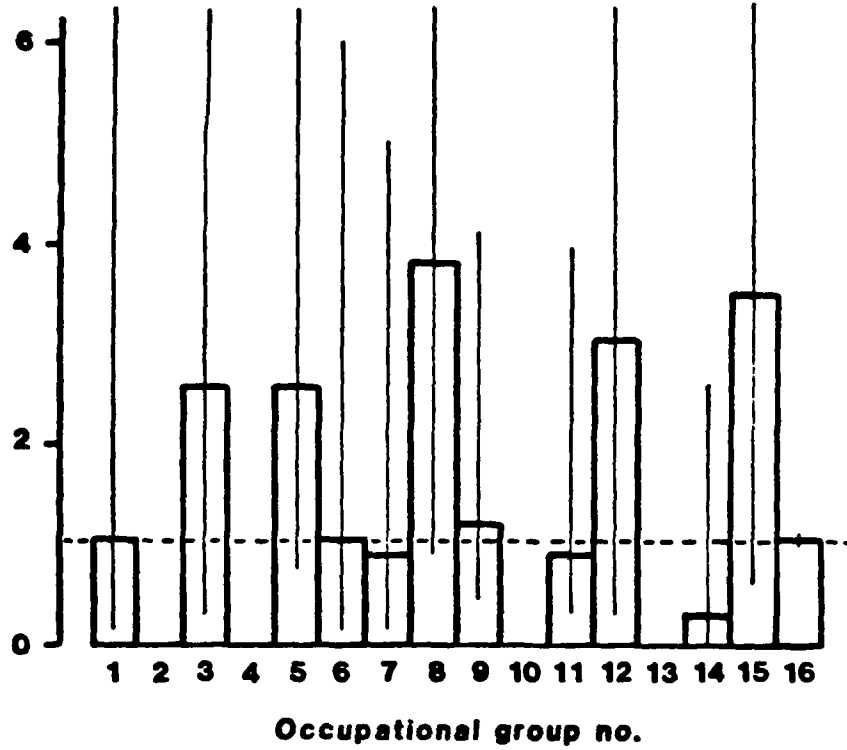
Figure 13

Relative risk of persistent chills by years in the wool industry

(See legend to Fig.8 for further explanation)

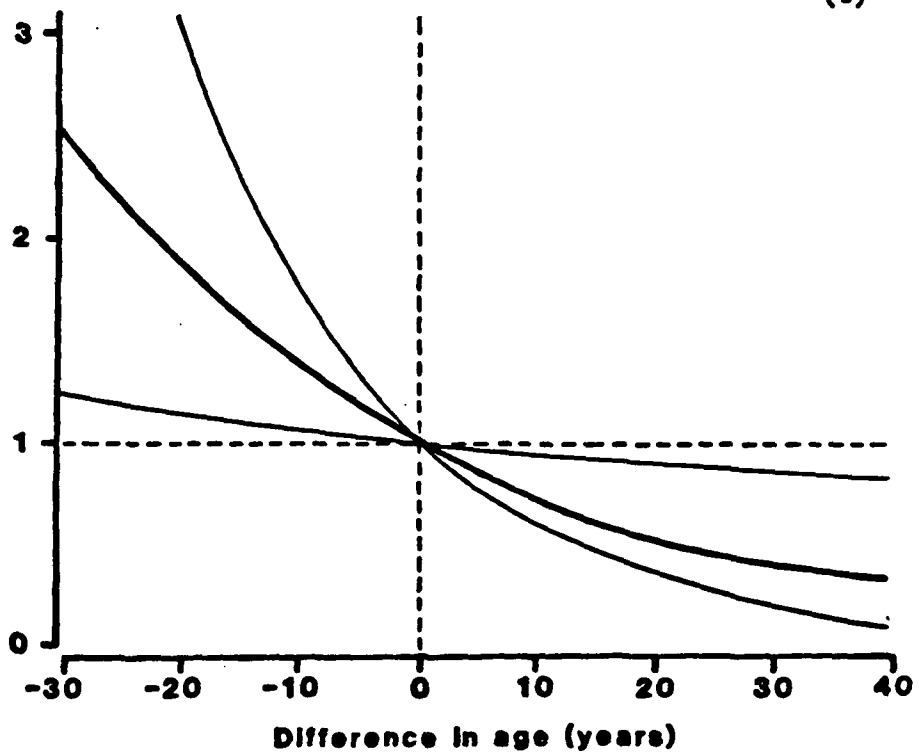
Relative risk of nosebleeds

(a)



Relative risk of nosebleeds

(b)

**Figure 14**

Relative risk of nosebleeds (10 or more per year) (a) by occupational group, (b) by age difference (after allowing for dust exposure)

(See legends to Figs.8 and 10 for further explanation)

5.4.1.9 Dizziness

Dizziness, included as a control symptom to test for response bias, is not related to dust exposure. However, the presence of an association with time in the industry and higher relative risks in certain occupational groups (not in non-process workers) suggests that there may be some occupational factors influencing response to questions on this symptom.

5.4.1.10 Chest illnesses

There is an increased risk for taking time off work because of chest illnesses (twice or more in past 3 years) with increasing dust exposure. There were also significant effects of current job (Fig.15a) and mill and a decreasing risk with age. When dust exposure is taken into account most occupational groups have similar risks of taking time off work (Fig.15a), except for groups 2 and 12 which have small numbers of workers, group 16 (non-process workers), which has a lower risk than most process jobs and group 4 (dyers and scourers), which has a very high risk, but one of the lowest dust exposures.

5.4.1.11 Non-occupational factors

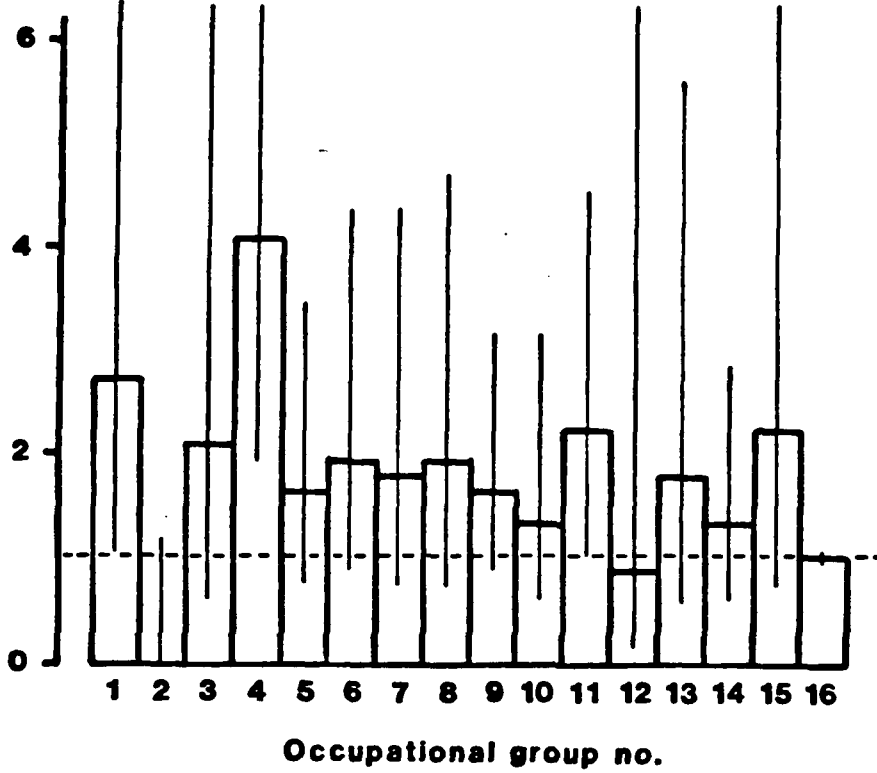
The relationships of these symptoms with smoking and age have already been mentioned where appropriate in the previous sections. It is also apparent from the coefficients derived from regression model 1 that sex, ethnic group and the language used for interview may also have some effect on the reporting of symptoms. This has already been alluded to in sections 5.3.2 and 5.3.3 and, generally speaking, the results of this regression analysis are very similar to the previous descriptive results.

Spells of sickness absence due to chest illnesses were not significantly related to gender, race or language, however, but cigarette smokers had a higher risk of taking time off work.

Women reported more symptoms than men except for chronic bronchitis, wheeze and variable breathlessness. In contrast to the data given in section 5.3.3 and Table 13 reporting of chronic bronchitis was not significantly influenced by ethnic group or

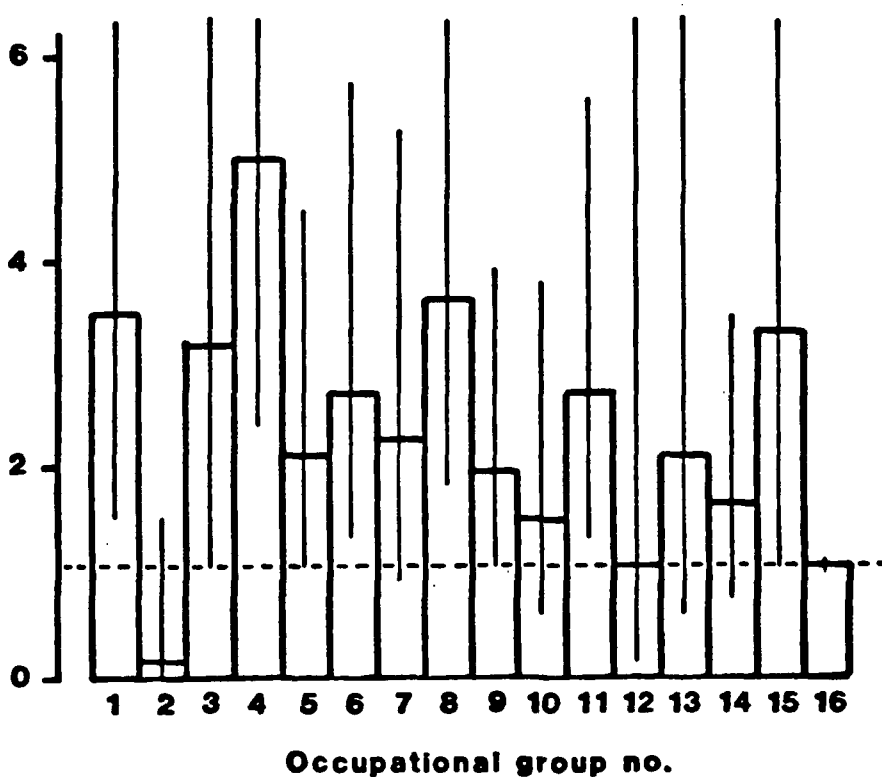
Relative risk of spells off

(a)



Relative risk of spells off

(b)

**Figure 15**

Relative risk of spells off work because of chest illnesses by occupational group.

(a) standardised for dust concentration and $(\text{concentration})^2$,

(b) not standardised for dust

language but Asians reported less wheeze/shortness of breath. In most other respects these ethnic and language effects were as previously described, having no consistent relationship one way or the other.

5.4.1.12 Exposure/response relationships in smokers and non-smokers

The possible influence of cigarette smoking on dust-disease relationships was investigated for chronic bronchitis by fitting a further logistic regression model for the symptoms similar to those listed in Appendix 8, which included interaction terms for dust concentration, smoking status and number of cigarettes smoked. There was no evidence of any difference in the dose/response relationship for bronchitis in smokers and non-smokers.

5.5 Predicted prevalences of symptoms in this population

In order that the relative risks of symptoms, derived from the logistic regression analysis (Section 5.4), can be expressed in terms of actual prevalences, predicted prevalences have been calculated for typical 40 year old male, European non-smokers and smokers of 20 cigarettes per day exposed to non-dusty and dusty conditions ($25\text{mg}/\text{m}^3$). $25\text{mg}/\text{m}^3$ represents the 95th percentile dust concentration.

Table 17 shows the predicted prevalences for these different examples and illustrates the magnitude of the effect of this dust concentration on symptom prevalences but does not allow for the presence of other symptoms. (The differences in these predicted prevalences between dusty and non-dusty workers are necessarily of similar proportions in smokers and non-smokers, since no interaction terms with smoking variables were included in the models). For instance, the prevalence of persistent rhinitis among dust exposed workers is predicted to be 1.5 times that of non-dusty workers for smokers and non-smokers alike.

TABLE 17

PREDICTED PREVALENCES OF SYMPTOMS IN SMOKERS (20 CIGARETTES PER DAY) AND
NON-SMOKERS WORKING IN DUSTY ($25\text{mg}/\text{m}^3$) AND NON DUSTY CONDITIONS (40 YEAR
OLD, MALE, EUROPEANS)

SYMPTOM	NON-SMOKERS				SMOKERS			
	Not dusty Predicted prevalence (%)	S.E.	Dusty Predicted prevalence (%)	S.E.	Not dusty Predicted prevalence (%)	S.E.	Dusty Predicted prevalence (%)	S.E.
Chronic bronchitis	4.0	0.8	7.8	1.9	14.5	1.6	25.5	3.7
Wheeze	19.9	1.9	34.8	4.0	43.3	2.1	62.2	3.7
Breathlessness	3.7	0.7	7.5	1.9	5.7	0.8	11.4	2.4
Persistent rhinitis	14.0	1.6	21.8	3.1	18.3	1.6	27.7	3.2
Persistent itchy red eyes	4.7	0.8	11.1	2.2	7.1	1.0	16.1	2.6
Persistent chills	1.0	0.4	1.3	0.6	1.3	0.4	1.6	0.7
Nosebleeds	1.6	0.5	3.5	1.6	1.2	0.4	2.5	1.1
Dizziness	3.4	0.8	3.4	1.3	3.2	0.7	3.3	1.2
Spells off work for chest illnesses	7.8	1.2	13.4	2.7	11.6	1.3	19.4	3.1

CHAPTER 6

DISCUSSION

We report the first comprehensive epidemiological study of the respiratory health of wool textile workers in the United Kingdom.

The study was designed to include a representative cross-section of the industry by selecting fifteen mills of varying size and conditions. The entire current workforce was encouraged to participate in the study and the overall response rate reflects the fulfilment of this aim.

Employees were interviewed about their respiratory health, smoking habits and past and present occupations using questionnaires developed at the Institute of Occupational Medicine and tested at various locations prior to use in the main study. A detailed programme of measurements of airborne dust concentrations enabled the estimation of individual current exposures, and allowed comparisons of such exposures with respiratory symptoms to be made. Attendance rates were in general highly satisfactory (an overall response of 85%). The four mills with attendance rates below 80% tended to be at the less dusty end of the range, and it is unlikely that these lower response rates will have much affected the estimates of dust/disease relationships at the higher dust ranges.

Even this large study has its limitations. For instance, only currently employed workers have been studied, and in view of the likelihood that workers who have left the industry are in less good health than those who remain (FOX & COLLIER 1976, SOUTAR & HURLEY, 1986), our study may have underestimated the amount of respiratory disease arising from work in the industry. Furthermore the assessment of respiratory health was based on a questionnaire only, without supporting objective observations, and the extent to which the answers may have been biased by knowledge of working conditions is uncertain. However, the

consistency of the results across all factories and other subgroups of the population, and consistency between symptom complexes is strong evidence that the associations between symptoms and dust concentrations are real. This conclusion is additionally supported by the answers to the question on a symptom unlikely to be related to occupation, which showed no relationship with dust exposure.

The questionnaire made use of material from well established and validated questionnaires to identify symptoms of chronic bronchitis (MRC, 1976) breathlessness (MRC, 1976) time off work from chest illness (RAE et al, 1971) and chest tightness (SCHILLING, 1956). The questions on other symptoms were exploratory. Financial and other constraints did not permit extensive validation of these new questions in terms of repeatability, though they were tested adequately for comprehensibility in both English and Urdu. However, the consistent relations between symptoms and dust exposure or occupation demonstrated in this work strongly suggest that the exploratory questions on rhinitis, itchy red eyes and variation in breathlessness do successfully identify effects of exposure to dust on the relevant organs. Errors arising from failures of understanding or from discrepancies between the symptoms experienced and the description offered by the questionnaire are likely, if anything, to have reduced the apparent magnitude of such exposure/response relationships. The questions on variation of breathlessness have been validated independently, and this will be reported separately.

The dust sampling instrument used to measure airborne dust concentration (IOM sampler, MARK & VINCENT, 1986), was designed to sample "inspirable" or "inhalable" dust, that fraction of the airborne dust which passes into the nose and mouth. This fraction includes the finer, "respirable" portion of dust, which can penetrate into the lungs. The reason for choosing the inspirable sampler is that we were concerned with health effects in the nose as well as the lung.

It was possible to derive an estimated dust concentration and weekly exposure for every individual in the study, based on measured dust concentrations and job descriptions. Nearly 9% of the study population seen were exposed to inspirable dust concentrations greater than $10\text{mg}/\text{m}^3$ on average, the currently accepted nuisance dust threshold. Table 2 shows in which jobs workers were likely to experience such concentrations.

The study has confirmed previous reports of respiratory illness related to exposure to dust in wool textile mills (JORDECZKA et al, 1970; BRYSIWICZ et al, 1970; MATHUR & MISRA, 1972; ZUSKIN et al, 1976; ALLARDICE et al, 1983). A striking number of subjects admitted to symptoms which were better at weekends and on holidays than during the working week, and said their symptoms were worse at work. This in itself suggested an occupational cause, and comparisons with dust exposure, after allowing for confounding factors such as age, smoking habit, and ethnic differences, confirmed that exposure to wool mill dust is related to respiratory symptoms.

The symptoms indicate dust related disease at all levels of the respiratory tract; rhinitis, chronic bronchitis and breathlessness as well as red itchy eyes. These symptoms indicate chronic irritation, inflammation or immunological disturbance of mucous membranes in the eye, nose and bronchial tree. Complaints of breathlessness probably indicate bronchial disease, but could be the result of disease in the bronchiolar or alveolar regions of the lung. It is not clear from these symptoms whether the pathogenesis of this response includes pharmacological, toxic or allergic mechanisms, or is merely a response to the physical dust load. The few subjects in dusty jobs who had variable breathlessness probably had asthma as a result of exposure to dust, although the high frequency of subjects with variable breathlessness among non-process workers suggests that the majority of such workers tended to avoid dusty jobs.

Other symptom complexes which were assessed included a history of spells off work because of chest illness. These illnesses were reported more commonly by process than non-process workers, but after allowing for this there was no clear evidence of an effect of exposure to dust. However, dyers and scourers, relatively dust free jobs, did experience a much greater risk of time off work than their colleagues (Fig. 15), and this warrants further investigation. Thus we cannot with confidence conclude that exposure to wool dust increases susceptibility to acute respiratory illnesses, though some further analysis of reported diagnoses of chest illness might provide a clearer answer. Answers to questions about chills, an attempt to identify symptoms of humidifier fever, did not show any obvious relationship with exposure to dust, although some occupational groups did demonstrate unduly high frequencies of this symptom, and a study of their working conditions would be advisable to see if there might be a source of nebulised contaminated water nearby.

The functional and prognostic implications of these wool-dust related symptoms complexes are not known. In other populations symptoms of chronic bronchitis have been associated with impairment of lung function (e.g. FLETCHER et al., 1976; ROGAN et al., 1973; SOUTAR & HURLEY, 1986) though not all those with chronic bronchitis have any functional abnormality (FLETCHER et al 1976). Some further study of selected members of the population to ascertain the functional effects of exposure to wool mill dust would be advisable, together with chest radiographs to seek any evidence of pulmonary fibrosis. Longitudinal studies would be necessary to establish prognosis.

The exposure/response relationships estimated for the various symptom complexes may aid decisions on appropriate dust control standards for the industry. The dust appears to be harmful even when exposure is kept to "nuisance dust" limits, for even at concentrations of $10\text{mg}/\text{m}^3$, relative risks of dust related symptoms range from 1.3 to 1.6 times the risk for non-process

workers. Some decisions would be necessary on what risks of symptoms are acceptable. Further analyses of existing data would enable tables to be prepared illustrating the dust concentrations related to a range of estimated risks of symptoms.

The composition of the dust was examined in a limited way. All samples consisted mostly of wool, but other materials including mineral dust, other organic material and dyes were also variably present. The contributions made by these to the pathogenesis of the symptoms has not been studied, though in the case of itchy red eyes and rhinitis, symptoms became less prevalent the further the wool progressed through the manufacturing process, suggesting that the dust was more harmful when the wool was in its less processed states. This is consistent with a symptom which may depend upon the presence of material which is progressively removed during processing and which may differ from one mill to another because of different raw materials and processes. Endotoxin from degraded bacteria was also found in some dust samples, but could not be shown to be related to symptoms.

The results of this study should be applicable to a wide range of different processes and factories manufacturing wool textiles, for the following reasons:

1. The mills selected for this study represented the full range of conditions to be found in the wool textile industry.
2. A high percentage of the current workforce was examined.
3. We measured inspirable dust concentrations, which are more likely to be associated with symptoms experienced throughout the respiratory tract and
4. We used a detailed questionnaire designed to elicit all the common respiratory symptoms and their possible associations with work in dusty conditions.

6.1 Conclusions

Inspirable dust levels in wool textile mills range from low to very high levels. Exposure tends to be highest in machine blending and waste processing, worsted carding, backwinding and some maintenance jobs.

Respiratory symptoms were commonly reported by the current working population, and these were clearly related to the inspirable dust concentration in current occupation, after allowing for other influences, and this indicates that exposure to dust in wool textile mills causes symptoms of inflammation or irritation throughout the respiratory tract. While some of these symptoms, though uncomfortable, may not cause serious disability, others such as symptoms of chronic bronchitis or breathlessness could have functional implications, and this requires further investigation, e.g., into the fraction of inhaled dust contributing to these different symptoms.

Estimates of risk of respiratory symptoms in relation to dust concentration indicate that even "nuisance dust" airborne dust limits are associated with appreciable risks. These estimates could be helpful in setting dust standards for the industry, though these may later need to be reviewed when more is known about the functional effects of wool mill dust on the lungs.

Other occupationally related factors are associated with the presence of symptoms in addition to or instead of airborne dust levels, once dust concentration in current jobs is taken into account. For example, the occurrence of wheeze and rhinitis are dependent on the current job, and chills, nosebleeds and variable breathlessness show considerable variation between different jobs.

6.2 Recommendations

Specific dust control standards should be set for the wool textile industry, and dust control measures and personal protection should be instituted where appropriate. Standards would be reviewed when more is known of the effects of wool mill dust on lung function. To aid the setting of a standard, tables on the dust concentrations related to a range of selected estimated risks of symptoms could be produced.

Further research should be aimed at estimating the lung functional effects of exposure to wool mill dusts, and further characterising the nature of the illnesses related to exposure. Studies of selected dusts should be performed to assess the type of inflammatory response evoked.

A follow-up mortality study of this population could be undertaken by 'flagging' the DHSS records of each individual examined in the present study. This would help overcome the lack of specific information on the mortality of wool textile workers.

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Employee information formINSTITUTE OF OCCUPATIONAL MEDICINEWOOL/TEXTILE INDUSTRY STUDYInstructions for completion of attached forms

Please complete the attached form for all employees on your payroll (including management and clerical staff). This need not be done in any particular sequence but should be one which is most suitable for you e.g. alphabetically. Using one line for each individual, enter the required information with block capital letters. The following examples are intended as guides to how information under the respective headings should be recorded :-

- | | |
|---|---|
| 1. List of employees present on ___/___/___ | Please enter date as day/month/year e.g. 06/11/84 |
| 2. Surname | e.g. STAINTON |
| 3. Initials | e.g. PCB |
| 4. Date of Birth | e.g. 03/06/59 (please enter as day/month/year.) |
| 5. Sex | enter M for male or F for female. |
| 6. Nat. Ins. No. | e.g. AX323456B |
| 7. Date of Joining | e.g. 12/05/76 (please enter date on which employee joined the company as day/month/year.) |
| 8. Job Title | e.g. FOREMAN WEAVER |
| 9. Department | e.g. WEAVING SHED |
| 10. Interpreter | Please indicate where an interpreter might be required to administer questionnaires by entering the appropriate language e.g. URDU, BENGALI, PUNJABI etc. Where there would definitely be no need for an interpreter leave blank. |

If further clarification of any of the above instructions is needed or if any of our requests cannot be complied with contact Dr. R. Love or Mr. D. Gurr at the I. O. M on 031-667-5131.

Telephone 031 667 5131

Our Ref
Your Ref

First letter of invitation

Institute of
Occupational MedicineRoxburgh Place
Edinburgh EH8 9SULetter of invitation to all employees at

Dear

The Government's Health and Safety Executive (HSE) has asked us to make a study of wool textile workers' health. This will involve visits to various mills in West Yorkshire including You are probably aware that some measurements of dust levels have already been made at your workplace and we now wish to ask some questions about your health, particularly any problems you may have had with your chest.

Our research team will shortly be visiting your place of work and one of our staff will be making an appointment to see you during working hours by arrangement with the company in the next week or so. We will also be asking about the different jobs you have had since leaving school and the kind of work you have been doing at since you joined. Please would you think about this a little before the interview; for example, approximate dates when you have changed jobs in the past. This will save a lot of time. The interview will take about 15 minutes.

All the information you give us will be held by us in the strictest confidence and will be used only for our research. When the work is completed, we will be publishing a report, which will describe in broad terms what we have found at the various mills we will be visiting. This will be made available for management, unions and other worker representatives but details about individuals will not be published and will not be passed on to anyone outside the Institute of Occupational Medicine. The Institute is an independent research organisation with a lot of experience in this kind of work.

Please would you complete the enclosed slip of paper, indicating whether or not you would be willing to attend, and hand it as soon as possible to Mr in the enclosed envelope, which will be passed on unopened to one of our staff.

I hope very much that you will help by agreeing to take part. The aim is to find out about how best to protect the health of all wool textile workers and, of course this is in everyone's interest.

Yours sincerely

Dr R.G. Love
(Medical Branch)

Telephone 031 667 5131

Our Ref
Your RefFollow-up letter to first
letter of invitationInstitute of
Occupational MedicineRoxburgh Place
Edinburgh EH8 9SUFurther letter of invitation to employees at

Dear

As you will know a team from the Institute has visited recently to ask all employees to take part in a survey of respiratory health in the wool textile industry. In order that reliable statements about health and conditions at work throughout the industry can be made, it is absolutely vital that as many staff as physically possible should have taken part in this survey. Otherwise we may overestimate or underestimate the possible effects of dusty conditions in the industry and that would not be in the best interests of anybody. Surveys of this kind do rely for their success on maximum cooperation from those involved in all jobs in the mill.

I am therefore appealing for your support again by asking if you would now consider taking part in our survey, which only involves 15-20 minutes of your time in working hours (you will not lose any pay). There will be no medical examination; we only wish to ask some simple questions about your chest. Even if you think you have no symptoms, it is important that you take part - EVERYBODY COUNTS - whether he or she is a manager, foreman, card minder, canteen worker, or any other worker.

May I emphasise again that your answers will be entirely confidential between you and the Institute and will only be used for our research. The aim is to find out how best to protect the health of all wool textile workers, which is the concern of everyone in the industry. This work has the full support of the Confederation of British Wool Textiles, the Unions and other textile industry groups.

If you are now willing to take part, please would you return the enclosed slip to the Personnel Office and we will arrange a suitable appointment for you. I very much hope you will be able to attend. Many thanks for your attention.

Yours sincerely

R.G. Love
(Medical Branch)

Second letter of invitation

Telephone 031 667 5131

Our Ref
Your RefInstitute of
Occupational MedicineRoxburgh Place
Edinburgh EH8 9SU

HEALTH SURVEY

at

Dear

You can help other workers in the wool textile industry, as well as yourself, by cooperating with a health survey of workers in the industry.

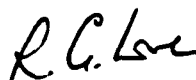
We wish to ask some simple questions about the health of your lungs and about the jobs you have done in the past. It will only take a few minutes, during working hours, and the information is confidential.

This Institute is an independent research charity with a lot of experience in this kind of work. The study has the approval of management and unions and is supported by the government. The results will be published without identifying any individual person.

Please come to the survey whether or not you have had any problems with your health. We need to include you all to get the facts right. The survey will be held at the beginning of October and we will contact you nearer the time.

Please help. EVERYBODY COUNTS

Yours sincerely



Dr R.G. Love
(Medical Branch)

APPENDIX 2Personal dust sampling instruments used in the studyGelman Sampling Head

The sampling head is an open-fronted unit, moulded in Delrin, with a sampling area of 3.7cm². The recommended flow rate is 1.9 l/min., at which the mean air velocity of entry into the sampler is 0.1 m/s. It takes a 25 mm diameter filter.

When used as a personal sampler the device is normally worn on the lapel, and oriented facing downwards.

HSE 7 Hole Sampling Head

This sampling head was developed from the Casella Model T13032 head (commonly known as the UKAEA head, after its original developers) by increasing the number of sampling orifices from one to seven. It takes a 25 mm filter, which is located in a recessed chamber behind a circular aluminium cover drilled with seven sampling orifices, each of 4 mm diameter. The sampling area is 0.9cm² and the mean air entry velocity is 0.4 m/s. at a flow rate of 2 l/min.

When used as a personal sampler it is normally worn on the lapel, with the sampling orifices facing outwards.

IOM Inspirable Dust Sampling Head

The IOM personal inspirable dust sampler is a small cylindrical sampler incorporating a 25 mm filter and a 15 mm lipped circular entry orifice. The lips and orifice form integral parts of a weighable dust collecting cassette which is located mainly inside the body of the sampler. At the recommended flow rate of 2 l/min. the entry velocity is 0.19 m/s.

When used as a personal sampler it is worn on the lapel, with the sampling orifice facing outwards.

Comparison of performance of instruments used to sample wool dust

These three different types of personal samplers were used in the survey of dust levels at wool textile mills. In addition, some of these instruments were modified to exclude 'fly dust' by covering the orifice with a guard made from 2mm wire mesh*, in order that the contribution of 'fly dust' to the inspirable dust fraction could be estimated. A mill was chosen that had been selected for the main survey and was believed to have a suitably wide range of processes to allow a representative cross-section of dust levels to be sampled. Samples were taken with all three

* as used for cotton dust

instruments, and on the basis of these results and of the known sampling characteristics of the instruments, the IOM instrument was selected for the main surveys. However, since the HSE sampler has been used in previous surveys of woollen mills, it was considered desirable to obtain further data on the comparative performance of the HSE and IOM instruments. Side-by-side comparisons of the HSE and IOM instruments were therefore carried out in some other mills during the main sampling programme, some workers wearing instruments on both lapels.

A total of 84 workers participated in these comparisons. Following the rejection of one sample for technical reasons 83 remaining cases were compared. (See Table A1)

Table A1

Numbers of worker-shifts for each combination of instruments

		Instrument 1					Gelman	Total
		IOM	IOM (Guard)	HSE	HSE (Guard)			
Instrument 2	IOM	1	-	-	-	-	1	
	IOM(Guard)	28	0	-	-	-	28	
	HSE	30	0	9	-	-	39	
	HSE(Guard)	6	0	6	0	-	12	
	Gelman	1	0	1	0	1	3	
Total		66	0	16	0	1	83	

The dust concentration values were logarithmically transformed, which gave an approximately symmetrical distribution, and the geometric mean concentrations were then calculated for each sampler type. (Table A2). However, these means do not adequately describe the relative performance of the instruments owing to the different dust conditions in which the different instruments were used. e.g. one very high reading using the Gelman sampler.

Table A2

Mean measured concentrations by sampler type (all samplers, irrespective of site of work)

Sampler Type	Number of samples	Mean log concentration	Geometric mean concentration (mg/m ³)
IOM	67	-0.15	0.86
IOM(Guard)	28	-0.56	0.57
HSE	55	-0.42	0.66
HSE(Guard)	12	-0.35	0.70
Gelman	4	0.93	2.53
Total	166	-0.30	0.74

The relative amount of dust sampled by each instrument (a) was then compared to that sampled by the IOM sampler (without guard), this value being taken to be unity. A model was fitted (by least squares) to the concentration data as follows:

$$\log \hat{Y} = \log \hat{a} + \log \hat{X}$$

where \hat{Y} is the fitted concentration, \hat{a} is the estimate of a , and \hat{X} is an expected concentration which would have been obtained with the IOM sampler (without guard). Four different values of \hat{a} were therefore obtained. (Table A3)

Table A3

Sampler Type	log a	standard error	\hat{a}	95% confidence limits for \hat{a}	
IOM	-	-	-	-	-
IOM(Guard)	-0.23	0.16	0.79	0.58	1.09
HSE	-0.22	0.15	0.80	0.60	1.08
HSE(Guard)	-0.21	0.26	0.81	0.49	1.35
Gelman	-0.72	0.62	0.49	0.15	1.63

The presence of a guard appears to reduce the dust concentration sampled by the IOM instrument ($\hat{a} = 0.79$). However, the concentration in the HSE sampler, though lower than the IOM sampler, is not further reduced by the presence of a guard. The Gelman sampler also gives lower estimates of concentration.

The standard errors of these estimates are too large to allow any of these values of \hat{a} to be significantly different from unity. Without further information it is not possible to make any firm conclusions that there were any reproducible differences in the sampling properties of these instruments. The indicators are, however, that (1) the HSE instrument in general gives a lower measurement than the IOM sampler and (2) the presence of a mesh guard reduces the uptake of dust for the IOM sampler but has little effect on the HSE sampler.

Appendix 3Possible causes of respiratory disease in wool workers

Since the respiratory tract can express symptoms of disease in only a limited number of ways, many of the common respiratory symptoms can be the result of several different diseases. Patients' symptoms have therefore been grouped according to well-known symptom complexes, and while these may not have an exact relationship with possible underlying diseases, some attempt in this study has been made to distinguish between asthma and other causes of breathlessness, and to recognise the symptoms of humidifier fever. The questionnaire also permits the recognition of individuals who are predisposed to allergy, by their history of atopic symptoms and seasonal variation in these, and also permits the recognition of byssinotic type symptoms, by the characteristic timing of the symptoms at the beginning of the working week. The following symptom complexes might be recognised in this study:

1. Chronic inflammatory and degenerative responses

Chronic inflammatory responses in the upper respiratory tract may be recognised by symptoms of rhinitis. This could be the result of allergic or irritant mechanisms, though a history of other allergies such as hay fever would indicate that the individual was predisposed to allergy.

Chronic inflammatory responses in the lower respiratory tract are recognised by symptom complexes such as chronic bronchitis (persistent cough with persistent phlegm), a history of frequent chest infections, or a history of breathlessness (which implies some functional impairment). When these symptoms are associated with specific diseases such as asthma or pneumoconiosis, they are considered to be part of those diseases. When they occur in the absence of specific disease, they are called by such names as "chronic bronchitis", "chronic airflow obstruction", "chronic non-specific lung disease" etc.

2. Hypersensitivity lung disease

This may present as allergic rhinitis, asthma or extrinsic allergic alveolitis. These may coexist in the same individual. They are often associated with constant low level exposure to organic material of animal or vegetable origin e.g. budgerigar proteins or fungal spores. Asthma and rhinitis are often associated with an immediate, IgE mediated hypersensitivity, though short-acting IgG has been demonstrated to be involved in some circumstances. Allergic alveolitis, in contrast, occurs as a result of delayed hypersensitivity with involvement both of complement-fixing IgG mediated and of cell-mediated reactions. (Parkes, 1982)

We recognise the difficulties in defining asthma. By this we mean variable airflow obstruction accompanied by variable breathlessness. In analysing the results of the questions about breathlessness we have adopted arbitrary thresholds of variability though we recognise that most subjects with airflow obstruction have some variability, and that the distinction between asthma and chronic "fixed" airflow obstruction is not clear in many individuals.

An occupational asthma of the immediate type was reported more than fifty years ago (Moll, 1933) in workers in the woollen industry. An asthmatic response within minutes of exposure, at a maximum after 10-20 minutes and with recovery after 1½ to 2 hours was described, with wheeze and chest tightness nearly always present. Almost identical symptoms and time course were experienced by one of the present authors (RGL) while standing near to a wool opening machine after it started operating during the course of this study.

A number of other types of asthmatic reaction can be looked for.

1. Progressive deterioration throughout the working week.
2. A similar degree of deterioration on each working day, reversed by the next morning.
3. Progressive deterioration week by week.
4. Maximum deterioration on the first day of the week.
5. Recurrent nocturnal asthma.

3. Air conditioner disease (Humidifier Fever)

This may be associated with work in some processes in textile production (Flaherty et al, 1984). Its features are symptoms of malaise, fever, myalgia, cough, chest tightness and exertional breathlessness which usually resolve within 24 hours away from exposure. If symptoms are due to work exposure, they are usually worse at the start of the week, gradually decreasing by the weekend but increasing again on Monday. (Parkes, 1982) This positive recurrence on re-exposure and clear asthmatic features show similarities to 'mill fever', which is caused by first contact with cotton, flax, hemp and kapok dust, probably due to endotoxins of the contaminating Gram negative bacteria in vegetable dust and mill air, (e.g. Rylander et al, 1985)

A minority are usually affected, there are no radiographic changes, no airborne dust need be visible and illness is associated with exposure to aerosols of recirculated water contaminated with bacteria, fungi and protozoa (Medical Research Council, 1977).

4. 'Furrier's lung'

Inhalation of animal hair can give rise to immunological reactions in the respiratory tract, affecting the naso-tracheo-bronchial regions and giving rise to asthma-like syndromes. Pimentel et al (1970) described a case of furrier's lung in a woman handling animal furs (mostly fox) for eighteen years. The pathological appearance of a granulomatous interstitial pneumonia was very similar to that described in other diseases related to inhalation of organic dusts (farmer's lung, bird fancier's lung). Hair shafts were found in the granulomatous lesions and a host factor of a probable immunological nature was suggested. Two other cases out of 1000 pulmonary resections reviewed by Pimentel et al indicated a similar work history.

INSTITUTE OF OCCUPATIONAL MEDICINEWOOL/TEXTILE INDUSTRY STUDYRESPIRATORY SYMPTOMS/SMOKING QUESTIONNAIRE (CONFIDENTIAL)

	<u>Cols.</u>
Form Type (Respiratory Symptoms Questionnaire)	----- IRISIQ: 1-3 -----
Mill Code _____	----- 4-5 -----
 <u>Interviewee Details</u>	
Study Identity No.	----- 6-8 -----
National Insurance No.	----- 9-17 -----
Surname _____	18-32
Initials _____	33-36
Date Of Birth	d d m m y y ----- 37-42 -----
Sex (enter M for Male or F for Female)	- 43-43 -
Ethnic Origin (interviewer observation only -	- 44-44 -

enter 1 if European
2 if Asian
3 if African
4 if Other)

Preamble :

I would like to ask you some questions about cough , phlegm , breathlessness and any other trouble you might have had with your chest. I expect that this will take about 10 minutes.

I can assure you that all your answers will be treated in the strictest confidence.

Please try and answer questions by stating 'Yes' or 'No' whenever possible.

COUGH

Cols.

1. Do you usually cough first thing in the morning? | | 45-45
-
2. Do you usually cough during the day or at night? | | 46-46
-
(if NO to both Q1 and Q2 go to Q4)
3. Do you cough like this on most days for as much
as three months each year? | | 47-47
-
(now go to Q5)
4. Do you cough at all on most days for as much as
three months each year? | | 48-48
-
(if NO go to Q15)
5. Is your cough worse than normal at any particular
time or times of the day or night? | | 49-49
-
(if NO go to Q7)
6. At what time or times is it worse?
- | | | | | | | | | | | | | | |
|----|---|---|---|---|---|---|---|---|---|----|----|----|-----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| | - | - | - | - | - | - | - | - | - | - | - | - | |
| am | | | | | | | | | | | | | <-- 50-61 |
| | - | - | - | - | - | - | - | - | - | - | - | - | |
| pm | | | | | | | | | | | | | <-- 62-73 |
| | - | - | - | - | - | - | - | - | - | - | - | - | |
7. Is your cough worse than normal on any particular
day or days of the week? | | 74-74
-
(if NO go to Q9)
8. On which day or days is it worse?
- | | | | | | | | | |
|--|-----|-----|-----|-----|-----|-----|-----|-----------|
| | Mon | Tue | Wed | Thu | Fri | Sat | Sun | |
| | - | - | - | - | - | - | - | |
| | | | | | | | | <-- 75-81 |
| | - | - | - | - | - | - | - | |
9. Is it better than normal on any particular day
or days of the week? | | 82-82
-
(if NO go to Q11)
10. On which day or days is it better?
- | | | | | | | | | |
|--|-----|-----|-----|-----|-----|-----|-----|-----------|
| | Mon | Tue | Wed | Thu | Fri | Sat | Sun | |
| | - | - | - | - | - | - | - | |
| | | | | | | | | <-- 83-89 |
| | - | - | - | - | - | - | - | |
11. Is your cough worse than normal when you are in any
particular place? | | 90-90
-
- (if NO go to Q13)
12. Where?
- specify _____ | | | 91-92

COUGH (continued)

Cols.

13. Is your cough better than normal when you are on holiday for a week or more? : : 93-93

(if YES go to Q15)

14. Is it worse than normal when you are on holiday for a week or more? : : 94-94

PHLEGM

15. Do you usually bring up any phlegm from your chest first thing in the morning? : : 95-95

16. Do you usually bring up any phlegm from your chest during the day or at night? : : 96-96

(if NO to both Q15 and Q16 go to Q18)

17. Do you bring up phlegm like this on most days for as much as three months each year? : : 97-97

WHEEZING AND SHORTNESS OF BREATH

18. Does your chest ever sound wheezing or whistling? : : 98-98

19. Do you ever have tightness in the chest or shortness of breath? : : 99-99

(if NO to both Q18 and Q19 go to Q30)

You have just told me that you suffer from *.....
 (* wheezing / whistling / tightness in the chest / shortness of breath note symptoms and phrase appropriately)

20. Is this (are these) worse than normal at any particular time or times of the day or night? : : 100-100

(if NO go to Q22)

21. At what time or times is it (are they) worse?

	1	2	3	4	5	6	7	8	9	10	11	12	
	-	-	-	-	-	-	-	-	-	-	-	-	
am													<-- 101-112
	-	-	-	-	-	-	-	-	-	-	-	-	
pm													<-- 113-124
	-	-	-	-	-	-	-	-	-	-	-	-	

22. Is it (are they) worse than normal on any particular day or days of the week? : : 125-125

(if NO go to Q24)

23. On which day or days is it (are they) worse?

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
	-	-	-	-	-	-	-	
								<-- 126-132
	-	-	-	-	-	-	-	

24. Is it (are they) better than normal on any particular day or days of the week? : : 133-133

(if NO go to Q26)

WHEEZING ETC. (continued)

Cols.

25. On which day or days is it (are they) better?

Mon	Tue	Wed	Thu	Fri	Sat	Sun
-	-	-	-	-	-	-
-	-	-	-	-	-	-

<-- 134-140

26. Is it (are they) worse than normal when you are in any particular place?

| | 141-141

(if NO go to Q28)

27. Where?

specify _____

| | | 142-143

28. Is it (are they) better than normal when you are on holiday for a week or more?

| | 144-144

(if YES go to Q30)

29. Is it (are they) worse than normal when you are on holiday for a week or more?

| | 145-145

LEVEL AND VARIABILITY OF BREATHLESSNESS30. INTERVIEWER OBSERVATION ONLY - Is the subject obviously disabled from walking by any condition other than heart or lung disease?

| | 146-146

(if YES go to Q39)

I would now like you to think about your best and worst times with respect to being short of breath.

31. At your best are you troubled by shortness of breath when either hurrying on level ground or walking up a slight hill?

| | 147-147

(if NO go to Q35)

32. At your best do you get short of breath when walking with other people of your own age on level ground?

| | 148-148

(if NO go to Q35)

33. At your best do you have to stop for breath when walking at your own pace on level ground?

| | 149-149

(if NO go to Q35)

34. At your best do you get short of breath when resting?

| | 150-150

35. At your worst do you get short of breath when resting?

| | 151-151

(if YES go to Q39)

36. At your worst do you have to stop for breath when walking at your own pace on level ground?

| | 152-152

(if YES go to Q39)

37. At your worst do you get short of breath when walking with other people of your own age on level ground?

| | 153-153

(if YES go to Q39)

BREATHLESSNESS (continued)

Cpls.

38. At your worst are you troubled by shortness of breath when either hurrying on level ground or walking up a slight hill? : : 154-154

RHINITIS

39. Do you ever have an itchy nose with sneezing and stuffiness? : : 155-155

(if NO go to Q41)

40. Do you have this on most days for as much as three months each year? : : 156-156

41. Do you ever have itchy red eyes? : : 157-157

(if NO to both Q39 and Q41 go to Q55 or if NO to Q41 and YES to Q39 go to Q43)

42. Do you have this on most days for as much as three months each year? : : 158-158

You have just told me that you suffer from *..... (* itchy nose with sneezing / itchy red eyes) note symptoms and phrase appropriately)

43. Is this (are these) worse than normal at any particular time or times of the day or night? : : 159-159

(if NO go to Q45)

44. At what time or times is it (are they) worse?

	1	2	3	4	5	6	7	8	9	10	11	12	
am													<-- 160-171
pm													<-- 172-183

45. Is it (are they) worse than normal on any particular day or days of the week? : : 184-184

(if NO go to Q47)

46. On which day or days is it (are they) worse?

Mon	Tue	Wed	Thu	Fri	Sat	Sun	
							<-- 185-191

47. Is it (are they) better than normal on any particular day or days of the week? : : 192-192

(if NO go to Q49)

48. On which day or days is it (are they) better?

Mon	Tue	Wed	Thu	Fri	Sat	Sun	
							<-- 193-199

49. Is it (are they) worse than normal when you are in any particular place? : : 200-200

(if NO go to Q51)

RHINITIS (continued)

Cols.

50. Where?

specify _____

| | | 201-202

51. Is it (are they) better than normal when you are on holiday for a week or more?

| | 203-203

(if YES go to Q53)

52. Is it (are they) worse than normal when you are on holiday for a week or more?

| | 204-204

53. Is it (are they) worse than normal during any particular season or seasons of the year?

| | 205-205

(if NO go to Q55)

54. During which season or seasons is it (are they) worse?

Spring Summer Autumn Winter

| | | |

<-- 206-209

55. Does anything in particular make you sneeze, when you don't have a cold?

| | 210-210

(if NO go to Q57)

56. What?

specify _____

| | | 211-212

NOSEBLEEDS

57. Does your nose ever bleed without it having been hit or scratched?

| | 213-213

(if NO go to Q59)

58. How many times has this happened in the last year?

| | | 214-215

DIZZINESS

59. Do you ever feel dizzy?

| | 216-216

(if NO go to Q61)

60. How many times has this occurred in the last year?

| | | 217-218

CHILLS

61. Do you sometimes feel feverish or shivery even though you don't have a cold?

| | 219-219

(if NO go to Q73)

62. Has this occurred on most weeks for as much as three months in the year?

| | 220-220

63. Is this worse than normal at any particular time or times of the day or night?

| | 221-221

(if NO go to Q65)

CHILLS (continued)

Cols.

64. At what time or times is it worse?

	1	2	3	4	5	6	7	8	9	10	11	12	
	-	-	-	-	-	-	-	-	-	-	-	-	
am													<-- 222-233
	-	-	-	-	-	-	-	-	-	-	-	-	
pm													<-- 234-245
	-	-	-	-	-	-	-	-	-	-	-	-	

65. Is it worse than normal on any particular day or days of the week? | | 246-246

(if NO go to Q67)

66. On which day or days is it worse?

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
	-	-	-	-	-	-	-	
								<-- 247-253
	-	-	-	-	-	-	-	

67. Is it better than normal on any particular day or days of the week? | | 254-254

(if NO go to Q69)

68. On which day or days is it better?

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
	-	-	-	-	-	-	-	
								<-- 255-261
	-	-	-	-	-	-	-	

69. Is it worse than normal when you are in any particular place? | | 262-262

(if NO go to Q71)

70. Where?

specify _____ | | | 263-264

71. Is it better than normal when you are on holiday for a week or more? | | 265-265

(if YES go to Q73)

72. Is it worse than normal when you are on holiday for a week or more? | | 266-266

(now go to on to next page)

CHEST ILLNESSES

Cols.

73.	How many times have you missed work because of a chest illness in the last 3 years (if interviewee has not missed work - enter 00 and go to Q75)	--- ! ! ! 267-268 ---
74.	What did your doctor say this (these) illness(es) was (were)?	
	Asthma	- ! ! 269-269 -
	Bronchitis	- ! ! 270-270 -
	Cold	- ! ! 271-271 -
	Influenza	- ! ! 272-272 -
	Some other chest illness(es) specify _____	- ! ! 273-273 -
	Not a chest illness(es) specify _____	- ! ! 274-274 -

Have you ever had any of the following i-

75.	Heart trouble?	- ! ! 275-275 -
76.	Bronchitis?	- ! ! 276-276 -
77.	Pneumonia?	- ! ! 277-277 -
78.	Pleurisy?	- ! ! 278-278 -
79.	Tuberculosis?	- ! ! 279-279 -
80.	Bronchial asthma?	- ! ! 280-280 -
81.	Hay fever?	- ! ! 281-281 -
82.	Other chest trouble?	- ! ! 282-282 -
83.	Any injury or operation affecting your chest or heart?	- ! ! 283-283 -

(now go on to next page)

SMOKING HABITSCols.

I would now like to ask you some questions about smoking. Again please try and answer questions by stating 'Yes' or 'No' whenever possible.

84. Do you smoke? -
: | 284-284
-
(if NO go to Q90)
85. How old were you when you first started smoking regularly? ---
: | | 285-286

- Which of the following do you smoke :-
86. Manufactured cigarettes? -
: | 287-287
-
87. Hand rolled cigarettes? : | 288-288
-
88. Pipe? : | 289-289
-
89. Cigars , cheroots or bidi (biri) ? : | 290-290
-
(now go to Q92)
90. Have you ever smoked as much as one cigarette a day (or one cigar or cheroot or bidi(biri) a week or one ounce of tobacco a month) for as long as a year? : | 291-291
-
(if NO omit remaining questions and conclude the questionnaire)
91. How old were you when you last stopped smoking? ---
: | | 292-293

- Which of the following have you ever smoked regularly :-
92. Manufactured cigarettes? -
: | 294-294
-
93. Hand rolled cigarettes? : | 295-295
-
94. Pipe? : | 296-296
-
95. Cigars , cheroots or bidi (biri) ? : | 297-297
-

(now go on to next page and complete relevant sections in appropriate tenses)

SMOKING HABITS (continued)

Cols.

MANUFACTURED CIGARETTES

- | | <u>yrs</u> <u>mts</u> | |
|--|-----------------------|---------|
| 96. For how many years have (did) you regularly smoked (smoke) manufactured cigarettes? | TOT= : : : : | 298-301 |
| 97. How many manufactured cigarettes do (did) you usually smoke per day on Mondays to Fridays? | : : : | 302-303 |
| 98. How many manufactured cigarettes do (did) you usually smoke per day at weekends? | : : : | 304-305 |

- | | <u>yrs</u> <u>mts</u> | |
|---|-----------------------|---------|
| 99. For how many years have (had) you been smoking this amount? | A= : : : : | 306-309 |

(if A = TOTAL go to Q101)

- | | | |
|---|-------|---------|
| 100. How many manufactured cigarettes did you usually smoke daily in those other years? | : : : | 310-311 |
|---|-------|---------|

HAND ROLLED CIGARETTES

- | | | |
|--|---------|---------|
| 101. How many ounces of tobacco do (did) you usually smoke per week as hand rolled cigarettes? | : . : : | 312-314 |
|--|---------|---------|

PIPE

- | | | |
|---|---------|---------|
| 102. How many ounces of pipe tobacco do (did) you usually smoke per week in this way? | : . : : | 315-317 |
|---|---------|---------|

CIGARS , CHERROOTS or BIDI (BIRI)

- | | | |
|---|---------|---------|
| 103. How many cigars or cheroots or bidi(biri) do (did) you usually smoke per week? | : : : : | 318-320 |
|---|---------|---------|

END OF QUESTIONNAIRE

That was the last question. Thank you for your co-operation.

- | | <u>d</u> <u>d</u> <u>m</u> <u>m</u> <u>y</u> <u>y</u> | |
|------------------------------|---|---------|
| Date Questionnaire Completed | : : : : : : | 321-326 |

- | | | |
|---|-----|---------|
| Indicator (enter 1 if interview conducted in English or 2 if interview conducted in Urdu) | : : | 327-327 |
|---|-----|---------|

Interview Clerk _____ (initials only)

WOOL/TEXTILE INDUSTRY STUDYRESPIRATORY SYMPTOMS / SMOKING QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEETPAGE 1 OF 4Section 1 - Interviewee Details

- Cols. 1-3 will always be pre-printed with RSQ;
- 4-5 if not pre-printed - specify mill name in BLOCK CAPITAL letters and enter appropriate code in range 01-15
- 6-8 if not pre-printed - leave blank;
- 9-17 if not pre-printed - enter Nat. Ins. No. with Cols. 9-10 alphabetic, 11-16 numeric and 17 taking the value A, B, C or D. Where Nat. Ins. No. is not known leave blank;
- 18-32 if not pre-printed enter surname with BLOCK CAPITAL letters;
- 33-36 if not pre-printed enter initials with BLOCK CAPITAL letters;
- 37-42 if not pre-printed enter as DDMMYY (e.g. 070206 to represent 7th February 1906);
- 43-43 if not pre-printed - enter M (=male) or F (=female);
- 44-44 if not pre-printed - enter appropriate code in range 1-4 (see questionnaire for definitions);

WOOL/TEXTILE INDUSTRY STUDYRESPIRATORY SYMPTOMS / SMOKING QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEET

PAGE 2 OF 4

Section 2 - Respiratory Symptoms

Cols. 45, 46, 95, 96, 98, 99, 146, 155, 157, 210, 213, 216, 219, 275, 276, 277,
278, 279, 280, 281, 282, 283

enter Y (=yes) or N (=no);

47, 48, 49, 74, 82, 90, 93, 94, 97, 100, 125, 133, 141, 144, 145, 147, 148,
149, 150, 151, 152, 153, 154, 156, 158, 159, 164, 192, 200, 203, 204,
205, 220, 221, 246, 254, 262, 265, 266

enter Y (=yes) , N (=no) or leave blank where
not applicable);

50-61, 62-73, 101-112, 113-124, 160-171, 172-183, 222-233,
234-245

enter Y in appropriate box(es) where time(s) stated
or leave blank where not applicable;

75-81, 83-89, 126-132, 134-140, 185-191, 193-199, 247-253,
255-261

enter Y in appropriate box(es) where day(s) stated
or leave blank where not applicable;

91-92, 142-143, 201-202, 211-212, 263-264

specify in BLOCK CAPITAL letters but leave boxes
blank (will be coded on return to IOM);

269, 270, 271, 272

enter Y in appropriate box(es) where illness(es)
stated or leave blank where not applicable;

273, 274

specify in BLOCK CAPITAL letters and enter Y in
appropriate box against illness stated or leave
blank where not applicable;

206-209

enter Y in appropriate box(es) where seasons(s)
stated or leave blank where not applicable;

214-215, 217-218

enter numeric value in range 01-99 or leave
blank where not applicable;

267-268

enter numeric value in range 00-99;

WOOL/TEXTILE INDUSTRY STUDYRESPIRATORY SYMPTOMS / SMOKING QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEET

PAGE 3 OF 4

Section 3 - Smoking HistoryCols. 284

enter Y (=yes) or N (=no);

285-286, 292-293enter age (years) in range 01-99 or leave blank
where not applicable;287, 288, 289, 290, 291, 294, 295, 296, 297enter Y (=yes) , N (=no) or leave blank where
not applicable;298-301, 306-309enter time as years/months (e.g. 0106 to represent
1 year 6 months) with cols. 298-299 in range 00-99 ,
and cols. 300-301 in range 00-11 or leave blank where
not applicable;302-303, 304-305, 310-311enter numeric value in range 01-99 or leave
blank where not applicable;312-314, 315-317enter numeric value (with two decimal places e.g.
0.50 to represent a 1/2 ounce) with cols. 312, 315 in
range 0-9 and cols. 313-314, 316-317 = 00, 25, 50, 75 or
leave blank where not applicable;318-320enter numeric value in range 001-999 or leave
blank where not applicable;

WOOL/TEXTILE INDUSTRY STUDYRESPIRATORY SYMPTOMS / SMOKING QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEETPAGE 4 OF 4Section 3 (continued) - Additional Instructions

1. For current smokers ask Questions 92, 93, 94, 95 only where answers to Questions 86, 87, 88, 89 were No respectively.
2. Questions 96-100 should only be asked if a Yes response was given to either Question 86 or Question 92 using appropriate tense.
3. Question 101 should only be asked if a Yes response was given to either Question 87 or Question 93 using appropriate tense.
4. Question 102 should only be asked if a Yes response was given to either Question 88 or Question 94 using appropriate tense.
5. Question 103 should only be asked where a Yes response was given to either Question 89 or Question 95 using appropriate tense.

Section 4 - End of QuestionnaireCols. 321-326

enter date as DDMMYY (e.g. 010285 to represent 1st February 1985);

327

enter appropriate code in range 1-2 (see questionnaire for definitions);

Notes on the questionnaire

The logic of this questionnaire should be clear to users from its layout. To enable the interviewer to follow the correct sequence of questions during use, specific routing instructions were included at strategic points throughout the questionnaire. The interviewer was also provided with instructions detailing the coding conventions to be employed when recording information on to the questionnaire.

A preamble is given by the interviewer in a standard manner and general operating instructions are as would be given for other questionnaires, for example, the Medical Research Council questionnaire of respiratory symptoms (MRC, 1976).

Cough and phlegm

The questions 1-3 and 15-17 (on cough and phlegm) use standard wording, but omit the phrase 'in the winter' which is sometimes used, since occupationally related symptoms would not necessarily be seasonal. Question 4 was included speculatively because some subjects, who do not think of themselves as having a regular cough usually, do admit to having a cough on most days at some time or other.

Wheezing and shortness of breath

Questions 18 and 19 are designed to ascertain by different approaches symptoms of brochospasm or airflow obstruction by asking separately about the sound and also about the subjective feeling.

Level and variability of breathlessness

Questions 31-38 are aimed to establish not only the level of breathlessness on exertion but also the degree of variability. It is only necessary to ask a maximum of five of these questions. The degree of variability can be expressed as an arbitrary score based on the answers to these questions.

It was hoped that this assessment of the variability of breathlessness would enable the recognition of asthma.

Rhinitis and itchy red eyes

Questions 39 and 41 are intended to identify rhinitis and itchy red eyes, and questions 53 and 54 help to identify allergic rhinitis by its seasonal variation.

Nosebleeds

Questions about nosebleeds were included in view of previous anecdotal reports of frequent events of this nature among the workforce of wool textile mills.

Chills

Symptoms of feverishness and/or shivering (intended to identify humidifier fever) might occur in response to exposure to organic products or conditions of artificially humidified or warmed air.

'Combined' questions

Questions 19 and 39 may both be considered to require one answer to a double question, tightness in the chest and shortness of breath in question 19, itchy nose with sneezing and stuffiness in question 39.

This approach was adopted partly to save space and time but also because it was felt that each part of these two questions complemented the other and represented aspects of the same group of symptoms. No confusion was caused to the interviewee and in practice the interviewer would underline the specific word(s) mentioned by the interviewee, so that assessment of particular aspects of these symptoms in question 19 could, if necessary, be carried out.

Subsidiary questions on symptoms and their relationship to work

Four of the sections have a sequence of ten additional questions which ask successively whether the symptom in question is worse (and better in some cases) at particular

times, days or places or when the subject is off work for more than a week. Though lengthy, the questions can ascertain whether the presence of a symptom is related to time or place of work, while avoiding leading questions.

By using the information from these and additional questions (on the occupational history form discussed later) about times when work begins and ends, shift changes and time of going to bed (relevant for night shift workers), it should be possible to establish temporal and situational relationships between symptoms and work.

Although many of the questions are based on previous questionnaires used in establishing symptoms of chronic non-specific respiratory and allergic or asthmatic conditions, requiring a simple 'yes' or 'no' answer, there are a number of additional questions where the reply may be equivocal and requires further probing. The interviewer has to avoid asking biased questions at this stage. For example, at Q6, 21, 44 and 64 the question 'At what time (or times) is it worse?' may lead to answers such as 'When I get up' or 'At the end of the day'. The recommended probing question would be 'And what time would that be?', rather than 'Do you mean, before you go to work?' or 'You mean, after you've finished work?'. In other words, specific references to work were to be avoided.

Definition of respiratory symptoms

Each section of the questionnaire has two or more questions devoted to establishing the presence of a symptom or combination of symptoms. Several of these sections are then followed by additional questions to establish temporal and situational variability.

The following variables have been derived from the responses to questions in each section and graded into two or more categories as appropriate.

1. Cough and phlegm

A single variable with categories as follows:

- 1) No cough or phlegm
(i.e. NO to q1, 2, 3, 4, 15, 16 and 17)
- 2) Any combination that is neither 1 nor 3
- 3) Chronic bronchitis (MRC criteria)
(i.e. YES to q1 or 2 and 3, and YES to q15 or 16 and 17)

2. Wheezing and shortness of breath

A binary variable with categories as follows:

- 1) No wheezing or shortness of breath
(i.e. NO to q18 and 19)
- 2) Wheezing or shortness of breath
(i.e. YES to q18 or 19)

3. Level and variability or breathlessness

(i) An ordered categorical variable denoting level of breathlessness 'at best' with the following categories or grades.

- 1) NO to q31 (i.e. not breathless even when hurrying)
- 2) YES to q31 (i.e. breathless when hurrying)
- 3) YES to q32 (i.e. breathless keeping up with own age group)
- 4) YES to q33 (i.e. breathless at own pace on level ground)
- 5) YES to q34 (i.e. breathless when resting)

(ii) Variability of breathlessness is measured by ranking each 'at best' and 'at worst' response in relation to the difference between them on the above grades.

Those with grades 4 and 5 breathlessness at best are considered to be too breathless to be able to have significant variability. Those with any other grades are assigned to the following categories.

- 1) No difference between 'at best' and 'at worst' response
- 2) Difference of one grade between 'at best' and 'at worst' = possible variability
- 3) Difference of two grades between 'at best' and 'at worst' = likely variability.

4. Rhinitis and itchy red eyes (conjunctivitis)

Rhinitis is described according to the following categories:

- 1) No to q39 (No rhinitis)
- 2) YES to q39, NO to q40 (i.e. occasional rhinitis)
- 3) YES to q39 and 40 (i.e. persistent rhinitis)

Itchy red eyes is similarly described below:

- 1) NO to q41
- 2) YES to q41, NO to q42
- 3) YES to q41 and 42

5. Chills

These are described by the following categories:

- 1) NO to q61 (no chills)
- 2) YES to q61, NO to q62 (occasional chills)
- 3) YES to q61 and 62 (persistent chills)

6. Nosebleeds

These have been categorised according to their frequency during the last year as follows:

- 1) None in last year
- 2) 1-9 in last year
- 3) 10 or more in last year

7. Dizziness

This control or dummy variable has been treated in exactly the same way as nosebleeds with the same categories (i.e. number of episodes in last year).

8. Chest illnesses

Questions 73 and 74 may give an indication that subjects have experienced particular chest illnesses during the last three years but the result does depend on the individual's correct understanding of a doctor's diagnosis. Similarly questions 75 - 83 depend on a diagnosis given to the individual but these questions may be considered as additional indicators of susceptibility to respiratory diseases and allergies, e.g. in those giving positive answers to questions about asthma and hay fever.

9. Smoking habits

The population has been divided according to smoking habits as follows:

- 1) Lifetime non-smoker (NO to q84 and 90)
- 2) Current cigarette smoker (YES to q84 and 86 or 87)
- 3) Current other smoker (YES to q84 and 88 or 89)
- 4) Ex-smoker (NO to q84, YES to q90 and any of q92 - 95)

Cigarette smokers are further subdivided into the number they have smoked per week and a cumulative index of numbers of cigarettes smoked is derived as pack years. One ounce of tobacco smoked as hand-rolled cigarettes was considered to be equivalent to 37.5 manufactured cigarettes.

Translation into Urdu

Since part of the working population of many wool textile mills in West Yorkshire is originally from Pakistan, where the predominant language is Urdu or the related languages Punjabi and Mirpuri, the questionnaire was translated into Urdu for use with employees who were not fluent in English.

The respiratory symptoms questionnaire was translated by a doctor familiar not only with the language and its variations but also with respiratory diseases associated with occupations (Dr.M.Zuberi). A non-medical Urdu speaker independently translated this back into literal English, as a check on the questionnaire's comprehensibility and comparability with the English version (Mr A.S. Kanwar). There was in general very good correspondence between the original and retranslated English version of the questionnaire. A few amendments to the Urdu version were then made where clarification was required.

INSTITUTE OF OCCUPATIONAL MEDICINE

WOOL/TEXTILE INDUSTRY STUDY

OCCUPATIONAL HISTORY QUESTIONNAIRE (CONFIDENTIAL)

	<u>Cols.</u>
Form Type (Occupational History Questionnaire)	----- OIH Q 1-3 -----
Mill Code _____	----- 4-5 -----
 <u>Interviewee Details</u>	
Study Identity No.	----- 6-8 -----
National Insurance No.	----- 9-17 -----
Surname _____	
Initials _____	
Date Of Birth	----- d d m m y y 18-23 -----
Sex (enter M for Male or F for Female)	----- 24-24 -----
Ethnic Origin (interviewer observation only - enter 1 if European 2 if Asian 3 if African 4 if Other)	----- 25-25 -----

Preamble :

I would like you to give me details of your working history from the date on which you left school up to and including your present employment. This history should include any periods of further education, unemployment, service in H. M. Forces etc.

I can assure you that all your answers will be treated in the strictest confidence.

EMPLOYMENT HISTORY

Record Type 1 (one record per period of employment)

Cols. 26 27-30 31-34 35-36 37-39 40-41 42-44 45-46

Name of Employer/Employers Business (Industry)	Nature of (Industry)	Occupation (Job Title)	Workplace (Department/Area)	F	From	To	C	O	P	Occ	Rec
				P	mtlyr	mtlyr	t	c	c	Grp	No.
month and year of birth to month and year left school											01
											02
											03
											04
											05
											06
											07
											08
											09
											10
											11
											12
											13
											14
											15
											16
											17
											18
											19
											20
											21
											22

Study Id. No. -

Name -

Date of Birth / /

Date of Joining Company / /

Question

Which (if any) of the occupations you have given me details for were on a part time basis?

(Clerk to enter P if part time against appropriate occupations in column marked * , otherwise full time will be assumed.)

DAYS AND HOURS WORKED DETAILS

Record Type 2

Study Id. No. -

Preamble :

I would now like to ask you about the days and hours that you work?

1. Which days and hours are you working this week?

	<u>start time</u>		<u>am/pm</u>	<u>duration</u>			
	<u>hr</u>	<u>mn</u>		<u>hrs</u>	<u>mns</u>		
Monday			-			<--	26-34
Tuesday			-			<--	35-43
Wednesday			-			<--	44-52
Thursday			-			<--	53-61
Friday			-			<--	62-70
Saturday			-			<--	71-79
Sunday			-			<--	80-88

2. Are these your usual days and hours of work? | | 89-89
 (if NO enter N and conclude questionnaire or if YES enter Y and continue)

3. For how long have you been working these days and hours? | | | | | | | | 90-95
 yrs mts wks

For current * nightshift workers only

(* current defined by response to Q.1)

4. At what time do you normally go to bed when you are working nightshift | | | | | | | | 96-100
 hr mn am/pm

END OF QUESTIONNAIRE

That was the last question. Thank you for your co-operation.

Date Questionnaire Completed | | | | | | | | 101-106
 d d m m y y

Indicator (enter 1 if interview conducted in English or 2 if interview conducted in Urdu) | | 107-107

Interview Clerk _____ (initials only)

WOOL/TEXTILE INDUSTRY STUDYOCCUPATIONAL HISTORY QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEETPAGE 1 OF 4Section 1 - Interviewee Details

- Cols. 1-3 will always be pre-printed with OHQ;
- 4-5 if not pre-printed - specify mill name in BLOCK CAPITAL letters and enter appropriate code in range 01-15
- 6-8 if not pre-printed - leave blank;
- 9-17 if not pre-printed - enter Nat. Ins. No. with cols. 9-10 alphabetic, 11-16 numeric and col. 17 taking the value A, B, C or D. Where Nat. Ins. No. is not known leave blank;
- 18-32 if not pre-printed enter surname with BLOCK CAPITAL letters;
- 33-36 if not pre-printed enter initials with BLOCK CAPITAL letters;
- 37-42 if not pre-printed enter as DDMMYY (e. g. 070206 to represent 7th February 1906);
- 43-43 if not pre-printed - enter M (=male) or F (=female);
- 44-44 if not pre-printed - enter appropriate code in range 1-4 (see questionnaire for definitions);

WOOL/TEXTILE INDUSTRY STUDYOCCUPATIONAL HISTORY QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEETPAGE 2 OF 4Section 2 - Employment History

1. For each occupation , details should be entered as fully as possible under the respective headings Name of Employer/ Business , Occupation and Workplace.
2. Col. 26 should be completed with P (=part time) or left blank in accordance with the instructions for the additional question at the bottom right of the questionnaire (page2). This question should be asked of all employees.
3. From/To dates for each occupation should be entered in Cols. 27-30 and 31-34 respectively as MMY (e.g. 01680969 to represent January 1968 to September 1969). If date(s) not known leave blank.
4. Cols. 35-44 will be coded on return to IDM.
5. Where not pre-printed - enter name (BLOCK CAPITALS) , date of birth and date of joining appropriately at bottom left of questionnaire (page2).

WOOL/TEXTILE INDUSTRY STUDYOCCUPATIONAL HISTORY QUESTIONNAIRECODING CONVENTIONS INSTRUCTION SHEETPAGE 3 OF 4Section 3 - Days And Hours WorkedCols. 26-29, 35-38, 44-47, 53-56, 62-65, 71-74, 80-83

enter time(s) as HHMM (e.g. 0305 to represent five minutes past three) or leave blank where not applicable;

30, 39, 48, 57, 66, 75, 84

enter A (=a.m.) , P (=p.m.) or leave blank where not applicable;

31-34, 40-43, 49-52, 58-61, 67-70, 76-79, 85-88

enter duration as HHMM (e.g. 0805 to represent eight hours and five minutes) or leave blank where not applicable;

89

enter Y (=yes) or N (=no);

90-95

enter time as YYMMWW (e.g. 010206 to represent one year, two months and six weeks) or leave blank where not applicable;

96-99

enter time as HHMM (e.g. 0900 to represent nine 'o' clock) or leave blank where not applicable;

100

enter A (=a.m.) , P (=p.m.) or leave blank where not applicable;

WOOL/TEXTILE INDUSTRY STUDY

OCCUPATIONAL HISTORY QUESTIONNAIRE

CODING CONVENTIONS INSTRUCTION SHEET

PAGE 4 OF 4

Section 4 - End of Questionnaire

Cols. 101-106

enter date as DDMYY (e.g. 010285 to represent 1st
February 1985);

107

enter appropriate code in range 1-2 (see questionnaire
for definitions);

Appendix 6Questionnaire trials and training of Urdu-speaking clerksQuestionnaire trials

Following consultation with the HSE it was decided that a pilot study should be arranged at a mill not selected for the main study, so that the suitability of the respiratory symptoms and occupational history questionnaires could be assessed against a realistic background.

A wool textile mill producing mainly knitting yarns was chosen for this trial. It was outside the geographical area of the other mills (Wakefield), in order to minimise the possibility of contact between employees at this mill and other mills where dust sampling was also to be performed. The management was approached and agreed to the survey being carried out, although at no time was it described as a 'pilot' survey, since it was felt that this might bias responses to invitations to take part and also prejudice answers to questions during the trial itself.

Approximately 120 people were employed at the mill and it was decided to invite all staff on the assumption that 50-60% would want to take part. However, before the survey was conducted the parent company announced the imminent closure of the mill (to take effect about two weeks after our survey). As a result there was very little interest in the survey and several staff left the mill before the survey took place. Only 37 employees were seen but it was felt that this was sufficient to allow an adequate trial of the procedures and questionnaires.

Although the responses are not included in the main analysis, it was clear that several employees did experience a number of respiratory symptoms, some of which they directly attributed to work in specific areas or with specific materials (particularly Angora wool). It was therefore felt that a similar range of responses could be expected from the selected mills, some of which appeared to be dustier than the trial mill.

It was considered unnecessary to modify the questionnaires as a result of this trial as no major difficulties were experienced with them.

Recruitment and training of Urdu-speaking clerks

It was estimated that about 500 employees at the mills selected for this study would be of Asian origin, mostly from Pakistan. It was also known that a large proportion of these workers (almost entirely male) would not be sufficiently fluent in English to be able to understand the questions in the respiratory symptoms and occupational history questionnaires.

Rather than bias the sample by excluding such workers, locally based Urdu speakers were recruited to ask the questions in Urdu. Since Urdu is the most common written/spoken language amongst the Asian community, the questionnaires were translated into Urdu, after final drafts of the English version had been agreed.

Following a suggestion of Dr. M. Zuberi, former employment medical adviser at HSE Leeds, an approach was made to Ms Mirza of Bradford Metropolitan Council to publicise our requirement for (at least) two Urdu-speaking clerks. A brief description of the planned study and job description was circulated in Bradford, mainly through the Council for Mosques. In addition advertisements were displayed in Job Centres in Bradford and neighbouring towns.

Interviews were held either at HSE offices in Leeds or the Bradford main Job Centre. Applicants were tested for their ability to translate from the Urdu version of the respiratory symptoms questionnaire into English and for their fluency at reading in Urdu. Subsequently four men, born in Pakistan but, in all but one case, largely educated in Britain, were employed on a part-time basis to conduct interviews at mills where Urdu speakers worked.

These four clerks were given the questionnaires to study at home in English and Urdu and were trained in their correct use at this Institute for two days. Two of those clerks underwent a further two days' training a few weeks later.

The training consisted of a description of the purpose of the study and the questionnaires; detailed discussion about their structure and wording; and of the importance of using the correct wording, following the described, logical sequence of questions. The training continued until complete familiarity had been attained. Trials were then undertaken, in which each clerk delivered questions in English to Institute staff in the presence of either one of the authors (RGL) or other Institute staff experienced in administering epidemiological questionnaires under survey conditions. Comments on performance were made and areas of difficulty were discussed.

When we were satisfied that their understanding and verbal delivery (in English) was satisfactory, each clerk conducted one or more interviews on each other in Urdu. These interviews were tape-recorded and assessed by an Urdu speaker (Dr M. Zuberi) for quality and fluency.

During the earlier field surveys at mills containing no Urdu speakers the clerks were able to observe interviews being conducted in English, so that the correct procedures for completion of questionnaires could be followed. A few interviews in Urdu were undertaken at one mill and the completed questionnaires were examined (by RGL). Detailed comments were made not only to the relevant clerks, when mistakes had been made (mainly in written recording procedures), but further guidelines were given to all clerks on procedures for completing both questionnaires correctly.

After initial experimentation in the field it was found convenient to divide the four clerks into two groups, with one in each group always doing the occupational histories and the other the symptoms/smoking questionnaires. Whenever possible supervision was given and questionnaires checked by the experienced clerks, so that irremediable errors would be minimised.

Tape recordings of interviews were also made on a few occasions during the surveys. However, such recordings were usually either technically difficult to arrange, or impossible because of refusal on the part of individuals, who were either suspicious of our motives or worried that the recording breached confidentiality.

These recordings were assessed by Dr. Zuberi and compared with the written version of the questionnaire. In most cases only a few discrepancies were detected.

Appendix 7: List of Occupations by Occupational Group page 1 of 4

- 01 sorters and/or openers (manual)
 -- blenders (working in bins)
 balers
 blenders (weighing)
 teaser and blenders
 willeyers
 teasers
 foremen/supervisors in blending
 foremen/supervisors in sorting
 foremen/supervisors in willeying
 overlookers in blending
-
- 02 garnetters
 -- wool pullers
 baggers
 blenders (m/c automated)
 driers
 blenders (packing in bins)
 blenders (colourists/colour matchers)
 overlookers in drying
-
- 03 opener and blenders (m/c automated)
 -- blenders (not specified)
 blenders (fork lift operators)
 openers (m/c automated)
 rag pullers/rag grinders/rag cutters
 shakers
 shoddy operatives
 waste workers
-
- 04 scourers/scouring operatives (e.g. bowl minders, soap boilers, hopper
 -- feeders/attendants)
 scourer and millers
 washers/backwashers
 bleachers
 dyers/dyehouse operatives (e.g. carters, pan men)
 colouring operatives/colour weighers/colour mixers
 foremen/supervisors in dyehouse
 foremen/supervisors in scouring/milling
 overlookers in scouring
-
- 05 carders/card minders/card feeders/card hopper attendants
 -- fettleers
 condensers/condenser minders
 card grinders/card strippers
 other carding operatives (e.g. sparemen, pickers, burr pullers,
 burr lads, card nailers, box fillers)
 foremen/supervisors in carding
 foremen/supervisors in carding and spinning
 overlookers in carding
-
- 06 combers/comb minders
 -- gillers/gill box minders
 drawers
 rovers
 preparatory m/c operatives
 combing technicians
 other combing operatives (e.g. pin setters, sparemen, ball runners,
 punch minders)
 finishing minders/operatives
 press minders/operatives

Appendix 7: List of Occupations by Occupational Group page 2 of 4

- 06 can boxers/can dodgers
 -- box minders
 foremen/supervisors in combing
 overlookers in drawing
 overlookers in combing
 overlookers in roving
 overlookers in combing, gilling & carding
-
- 07 winders (Schlafhorst)
 -- winders (type not specified)
 soft winders
 winder and twisters
 winders (Mettler)
 other winding operatives (e.g. banders, cone sorters, improvers, yarn men,
 weft carriers, ticket printers)
 foremen/supervisors in winding
 overlookers in winding
-
- 08 back winders
 -- bundlers (in backwinding)
 pickers-up (in backwinding)
 other backwinding operatives (e.g. bin emptiers, shrink wrappers)
 overlookers in backwinding
 foremen/supervisors in backwinding
-
- 09 spinners (type not specified)
 -- cap/ring spinners
 mule spinners
 other spinning operatives (e.g. doffers, turse pilers, roving carriers,
 sparemen, cart men)
 bobbin operatives (e.g. liggers, leaders, carriers, lads, men, weighers,
 sorters, strippers, fillers)
 cone cleaners
 doublers
 twisters (Volkman)
 twisters (Hirschberger)
 twisters (type not specified)
 twister and reelers
 reelers
 twister and doublers
 other twisting operatives (e.g. brushers, sparemen, reachers, yarn men)
 creelers
 warp twisters (machine)
 warp twisters (hand)
 warp twisters (type not specified)
 foremen/supervisors in spinning
 foremen/supervisors in twisting
 overlookers in spinning
 overlookers in twisting
 overlookers in reeling & winding
-
- 10 weavers (shuttle loom)
 -- weavers (loom type not specified)
 weavers (rapier loom)
 weavers (somet loom)
 pattern weavers
 loom tuners
 other weaving operatives (e.g. reachers, weft carriers, sparemen, bookmen,
 tyer-ons, twister-ins, shaft lifters,
 improvers, gear drawers, mail boys etc.)
 warpers (type not specified)

- 10 other warping operatives (e.g. reachers, warp tyers)
 -- beam setters/beamer offs
 knitters
 pattern warpers
 healders
 foremen/supervisors in weaving
 foremen/supervisors in warping
 overlookers in weaving
 overlookers in warping
-
- 11 weighers/weigher offs
 -- picker and menders
 burler and menders
 perchers
 sewers up (perch)
 other mending operatives (e.g. assessors, pieceners)
 knotters
 menders
 burlers
 warehousemen/warehouse operatives/storemen/loading gangs
 packers/top packers
 wool graders
 Roy packers
 foremen/supervisors in warehouse
 foremen/supervisors in mending/sewing
 overlookers in burling/mending
 overlookers in warehouse
-
- 12 blowers
 -- dry finishing operatives (not specified)
 cutters
 pressers/press operatives
 beaters
 KD machine operatives
 croppers
 dampers
 foremen/supervisors in dry finishing
-
- 13 brusher and rollers
 -- rigger and rollers
 millers
 wet finishing operatives (type not specified)
 raisers
 teazlers
 tenterers/calender operatives
 tufters
 finishing operatives (wet or dry not specified)
 foremen/supervisors in finishing (wet/dry not specified)
 foremen/supervisors in wet finishing
 autoclave operatives
-
- 14 servicemen
 -- fork lift operatives (not in blending)
 piece carriers
 jobbers/labourers/odd job men/sparemen (not dept specific)
 handymen (not dept specific)
 mechanics (not dept specific)
 electricians (not dept specific)
 plumbers (not dept specific)
 maintenance (type not specified/not dept specific)
 greasers (not dept specific)

- 14 fitters (not dept specific)
 -- technicians (not dept specific)
 joiners (not dept specific)
 cleaners (not dept specific)
 engineers (not dept specific)
 painters (not dept specific)
 jobbers/labourers/odd job men (dept specific)
 mechanics (dept specific)
 maintenance (type not specified/dept specific)
 greasers (dept specific)
 fitters (dept specific)
 cleaners (dept specific)
 boilermen (dept specific)
 foremen/supervisors (all areas)
 foremen/supervisors in maintenance
 overlookers (all areas)
 overlooker mechanics
 overlooker electricians
 overlookers in converting
 overlookers in worsted
 machine operatives (type not specified)
 miscellaneous (e.g. brush makers,backers,heat setters,rubber mixers,
 moulders,felters,wool compilers,carpet setters,
 cradlers,vulcanisers,wiremen etc.)
-
- 15 technicians (dept specific)
 -- engineers (dept specific)
 yarn inspectors
-
- 16 work study/progress chasers
 -- quality controllers/inspectors/samplers
 wool testers/wool samplers
 colour matchers/colour samplers
 laboratory workers
 dept heads/managers
 overall mill managers/directors/owners
 working managers/directors
 clerical/office workers (including pattern designers)
 drivers/delivery men/chaffeurs
 security men/gate keepers
 canteen workers/tea ladies
 sales reps./buyers
 nurses, medical officers
 gardeners
-
- 17 time up to first stated occupation (or unemployment/period abroad)
-
- 18 likely noxious occupation (outside the wool industry)
-
- 19 unlikely noxious occupation (outside the wool industry)
-
- 20 insufficient information to enable classification as 18 or 19
-
- 21 unemployed , retired , off sick
-
- 22 periods abroad (e.g. holidays in Pakistan)
-

Appendix 8

Logistic Regression Models used to analyse the effect of various occupational factors on nine respiratory symptoms or syndromes and chest illnesses (two or more in past 3 years)

Model	Additional explanatory variables included	Response (symptom or syndrome)						Variable	
		Chronic bronchitis		Wheeze		Breathlessness		Breathlessness	
		Deviance	R.d.f.	Deviance	R.d.f.	Deviance	R.d.f.	Deviance	R.d.f.
1*		1146	2125	2392	2127	1266	2113	572.4	2100
2	Dust concentration	1134	2124	2376	2126	1264	2112	563.8	2099
3	Concentration & conc. squared	1129	2123	2364	2125	1255	2111	562.4	2098
4	Weekly dust exposure	1136	2124	2379	2126	1265	2112	562.3	2099
5	Exposure & exposure squared	1132	2123	2367	2125	1252	2111	560.8	2098
6	Conc,conc squared & current job	1115	2108	2342	2110	1237	2096	-	-
7	Current job	1119	2110	2347	2112	1242	2098	550.4	2085
8	Mill & current job	1098	2096	2307	2098	1220	2084	533.0	2071
9	Mill	1121	2111	2349	2113	1248	2099	559.4	2086
10	Current job/mill interaction	1011	1996	2196	1998	1123	1984	453.7	1971
11	Time in industry	1146	2124	2391	2126	1265	2112	570.5	2099
12	Time in job categories	1123	2109	2341	2111	1227	2097	551.2	2084

Response (symptom or syndrome)

Model	Rhinitis		Itchy red eyes		Chills		Nosebleeds		Dizziness		Chest illnesses	
	Deviance	R.d.f.	Deviance	R.d.f.	Deviance	R.d.f.	Deviance	R.d.f.	Deviance	R.d.f.	Deviance	R.d.f.
1	1935	2124	1344	2113	426.5	2127	413.4	2127	671.7	2127	1375	2105
2	1930	2123	1317	2112	426.4	2126	412.7	2126	671.5	2126	1373	2104
3	1922	2122	1306	2111	426.1	2125	409.4	2125	671.3	2125	1364	2103
4	1932	2123	1323	2112	426.5	2126	413.1	2126	671.4	2126	1374	2104
5	1927	2122	1309	2111	426.3	2125	409.7	2125	671.3	2125	1366	2103
6	1894	2107	1287	2098	410.7	2110	-	-	655.8	2110	1337	2088
7	1896	2109	1299	2098	410.9	2112	389.1	2112	657.2	2112	1340	2090
8	1874	2095	1271	2084	388.4	2098	373.7	2098	637.0	2098	1313	2076
9	1915	2110	1313	2099	402.7	2113	395.3	2113	650.4	2113	1345	2091
10	1732	1995	1173	1984	328.5	1998	315.3	1998	556.0	1998	1199	1976
11	1913	2123	1343	2112	420.0	2126	411.2	2126	666.1	2126	1374	2104
12	1900	2108	1304	2097	391.7	2111	392.2	2111	653.9	2111	1340	2083

* Model 1 includes terms for age, sex, ethnic group, language, smoking status and amount smoked.
R.d.f. = Residual degrees of freedom

ERRATA

The following corrections have been made since the original version of this report was published.

- P.48 Section 5.3.3 last line changed from "5.3.11" to "5.3.12".
- P.49 Section number inserted: "5.3.5"
- P.63 Section 5.3.12, Line 9, "for" changed to "the differences within"
- Section 5.4, Line 1, "6.3" changed to "5.3"
Line 7, "4.6" changed to "4.7"
- P.76 Section 5.4.1.10, Line 6, "15b" changed to "15a"
- 5.4.1.11, Line 13, "asthma" changed to "variable
breathlessness"

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