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Research Report TM/97/05
1997

A community-based case-control study of asthma and chronic bronchitis in relation to occupation

Buchanan D, Donnan PT, Cowie HA, Miller BG, Soutar CA

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Report No. TM/97/05

INSTITUTE OF OCCUPATIONAL MEDICINE

A COMMUNITY-BASED CASE-CONTROL STUDY OF ASTHMA AND CHRONIC BRONCHITIS IN RELATION TO OCCUPATION

by

D Buchanan, PT Donnan, HA Cowie, BG Miller, CA Soutar

Final Report on HSE contract no. 3149/R58.053

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CONTENTS

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SUMMARY

Background

A community-based epidemiological study was conducted in the West Lothian and Central regions of Scotland in 1994 by postal questionnaire to seek information on the prevalences of occupationally related asthma and chronic bronchitis (Cowie *et al*, 1997). A total of 16990 valid questionnaires were returned, which represented a 50% response rate. The prevalence of asthma of all kinds was estimated to be 8% and the prevalence of chronic bronchitis was estimated to be 15%. The prevalence of asthma, and of chronic bronchitis, related to work was estimated to be 0.5% and 2.2% respectively. Clinical assessments of a sample of respondents confirmed the reliability of diagnoses of asthma using a self-administered questionnaire, but suggested that the work-relatedness of asthma was less reliably diagnosed.

Each respondent was asked to complete a full occupational history including all jobs held since leaving school. The purpose of the current study was to investigate the associations between occupations previously held and prevalent symptoms of asthma and chronic bronchitis. A further aim was to use the occupational histories to investigate the effect of the onset of asthma symptoms on career progression.

Methods

A case-control design was used, with cases and controls selected from respondents to the earlier prevalence study. A total of 424 asthma cases (224 work-related, 200 non-work-related) were individually matched by age to 424 controls, to within one year of age. In separate analyses, 408 chronic bronchitis cases (208 work-related, 200 non-work-related) were compared, unmatched, to the same set of controls. Asthma cases were diagnosed using responses to standard questions on wheezing and whistling in the previous twelve months. Chronic bronchitis cases were diagnosed from responses to standard MRC questions on regular coughing and phlegm production. In both analyses, all work-related cases identified in the prevalence study were included, together with a random sample of non-work-related cases. Controls were randomly sampled from those respondents reporting no history of respiratory symptoms. Occupations and industries in the occupational histories were coded and categorised into a smaller number of occupational groups which have commonly been used to report occupational respiratory disease rates.

Results

Smoking status was an important predictor of respiratory symptoms in the analysis of asthma

and, in particular, chronic bronchitis. Those reporting symptoms of asthma or chronic bronchitis were more likely to be smokers than non-smokers or ex-smokers. Those reporting symptoms of chronic bronchitis were more likely to be male than female, but the proportions were similar among cases of asthma.

After adjustment for smoking, significantly raised odds of asthma symptoms were reported among those who had previously been employed in food processing, particularly bakers, and as caterers, cleaners, textiles processors and general labourers. In part due to the profile of local industries, those employed as food processors were commonly involved in the processing of meat products, in particular poultry meat, while textiles processors were most often employed in the manufacture of clothing. Also associated with raised odds of asthma symptoms were print workers, metal treatment workers and spray painters, but estimates were imprecise due to the small numbers involved.

After adjustment for smoking, raised odds of chronic bronchitis symptoms were associated with a wider range of occupations than were asthma symptoms. These occupations included bakers, farmers, coalminers, construction workers, painters and chemical industry processors. A wide variety of occupations in the processing of metal and electrical products were associated with raised odds of chronic bronchitis, in particular welding, metal treatment and the motor vehicle trades.

Most of those who reported symptoms of asthma generally reported that those symptoms first occurred in the few years prior to the postal survey. Therefore, very few cases or their matched controls started new jobs in the short period after the onset of symptoms until questionnaire completion. There was no evidence that cases started a greater number of jobs after the onset of symptoms compared to their age-matched controls over the same period. Cases who did start a new job after the onset of symptoms generally did not experience a change in the Social Class of the occupation, and there was no strong evidence, given the small numbers involved, that the movements between Social Classes was different compared to the controls. The time spent in employment after the onset of symptoms was only slightly lower for asthma cases than for their matched controls over the same period. The difference amounted to 1 year less for male case-control pairs and 2 years less for female case-control pairs, when only pairs with a minimum of 10 years follow-up (mean 19 years) were used in analysis. Neither of these differences was large in relation to the degree of variation among case-control pairs.

Conclusions

The reporting of symptoms of asthma, and of chronic bronchitis, was associated with employment in a number of occupations held previously, even after allowing for different smoking habits. There was overlap between the occupations associated with symptoms of asthma and with symptoms of chronic bronchitis due to the difficulty in diagnosing the two conditions using a self-administered questionnaire. However, asthma symptoms were particularly implicated with employment in the food processing, catering and textiles manufacturing industries. Chronic bronchitis symptoms were associated with a wider range of occupations than were asthma symptoms, and, in particular, with employment in known dusty jobs such as coalmining, and occupations in the metal processing industries and manufacturing of electrical products. Both work-related and non-work-related asthma cases separately showed similar associations with occupations. Therefore, given also the generally poor agreement with clinical assessments in the earlier prevalence study, the use of the self-administered questionnaire by itself may not have been a reliable method of determining the work-relatedness of asthma symptoms. Based on a paired comparison of career progression in prevalent cases and controls with limited follow up, there was no strong evidence that the onset of asthma symptoms had later adverse effects on employment prospects.

1. INTRODUCTION

1.1 Background

Occupational asthma has become increasingly prevalent in the past two decades, partly due to the increasing number of new chemicals used in the workplace which can cause asthma. Chan-Yeung and Malo (1994) reported around 200 agents which have been implicated in causing occupational asthma across a wide range of occupations. In the U.K. and other countries, better recognition and surveillance are also responsible for the increase in reported prevalence. A scheme for the surveillance of work-related occupational respiratory disease (SWORD) set up in the U.K. in 1989, has consistently found asthma to be the most common occupational respiratory disorder (Meredith *et al*, 1991). The true prevalence of work-related respiratory diseases such as asthma and chronic bronchitis in the working population is uncertain and appears to depend a great deal on the diagnostic method. It is known, though, that incidence rates for these disorders vary a great deal by occupation and industry and are caused by exposure to a wide variety of agents found in the workplace (Meredith, 1993).

In recent years two population-based studies of the relationship between occupation and asthma have been reported in the literature. Ng *et al* (1994) reported a community-based case-control study in Singapore using adult cases who reported to government-run clinics for treatment, and controls who were being treated for conditions other than asthma. Comparing those who had been employed in each occupational group to those remaining, the highest relative risks were associated with manufacturing occupations particularly textile workers, cleaners, electrical production workers, printers and construction workers. Mastrangelo *et al* (1997) compared the results of repeated case-control studies which used incident cases and controls referred over two different time periods (from 1974 to 1978 and from 1989 to 1993). Coding only the occupation at the time of referral, they found more occupations associated with a high relative risk of asthma in the later time period. The highest risks were associated with isocyanate painters and polyurethane foam industry workers. Other occupations with high relative risks of asthma were farmers, bakers, workers in the textile, wood furniture, leather, food and chemical industries, painters, hairdressers and welders. The estimated relative risks were higher than those reported by Ng *et al* (1994), and one reason given was that, unlike in Ng *et al* (1994), comparison was with a specific low-risk control group of occupations.

Follow-up studies of those diagnosed with occupational asthma indicate that, for many, the development of the disease means that they become asthmatic and continue to have episodes of bronchoconstriction even when no longer exposed to the sensitising agent (Meredith and Nordman, 1996). A study of 112 workers previously diagnosed with occupational asthma, identified from the records of a specialist lung disease clinic, found 32% remained exposed to the causative agent (Gannon *et al*, 1993). The authors concluded that while removal from exposure had a beneficial effect on lung function, it was also associated with a loss of income, and suggested that this was a reason for workers remaining exposed after diagnosis. Cannon *et al* (1995) reported a follow-up study of 225 asthma cases, 66% of whom had occupational asthma or asthma exacerbated by work, with the remainder having non-work-related asthma. They found that, since diagnosis, earnings had been adversely affected, more so for occupational and work-exacerbated asthma cases. These cases also reported more disruption to their jobs due to asthma and greater difficulty in finding new work, particularly among those in the lower socioeconomic groups.

Chronic bronchitis is, like asthma, a disease which is known to be more prevalent in dusty occupations. Chronic bronchitis is generally characterised by a persistent cough with sputum production. The symptoms can be very similar to asthma and, indeed, bronchitis is both a cause and an effect of asthma. The most important causative factor is tobacco smoke, and this must be taken account of in any epidemiological study of occupational factors. Various occupations have been associated with a high incidence of chronic bronchitis, most notably in the coalmining industry (Soutar *et al*, 1989). Niven *et al* (1997), in a study of textile workers, reported that chronic bronchitis was more prevalent in cotton workers due to cotton dust, in comparison with man-made fibre workers. Other studies have shown a high incidence of bronchitis among both foundry workers (Karava *et al*, 1976) and steel workers (Hunting and Welch, 1993).

A large cross-sectional study of the prevalence of asthma and chronic bronchitis in the working-age population has recently been completed in districts of West Lothian and Central Regions (Cowie *et al*, 1997). The survey was by postal questionnaire which included questions on the work-relatedness of the respiratory symptoms and, for the first two of three mailings, a full occupational history. The prevalence of asthma, diagnosed by wheezing and whistling, was 8%. The prevalence of chronic bronchitis, diagnosed using standard MRC questions on coughing and phlegm, was 15%. The response rate, at around 50%, was lower than that for an earlier pilot study with a similar, but shorter, questionnaire (Love *et al*, 1990) which included fewer occupation-related questions. The estimated prevalence of work-related asthma in the study population was 0.5%. The estimated prevalence of work-related chronic bronchitis was higher at 2.2%.

The West Lothian and Central regions of Scotland were chosen for study because of the broad range of occupations and industries based there. This study included a preliminary investigation of the association between symptoms of asthma and occupation at the date of first symptoms. The authors compared the proportion of work-related cases with the proportion of non-work-related cases within industries and occupations but were unable to arrive at any firm conclusions due to the small numbers on which the comparisons were based and the lack of consideration of potential confounding variables.

The current study was set up specifically to use all past employment information to identify occupations and industries which were common to those reporting prevalent symptoms of asthma and chronic bronchitis. This was designed to allow for a possible latent period between first exposure to the causative agent and the appearance of full respiratory symptoms. It was also necessary to analyse full occupational histories rather than depend on self-reported dates and occupations at the onset of first symptoms. Identifying occupations associated with a high prevalence of respiratory symptoms in a community-based study such as this will direct future efforts to update the growing list of causative agents in the workplace by highlighting the occupations and industries where the collecting of detailed exposure histories would be informative.

Data on the questionnaire responses of all 16990 valid respondents from the prevalence study had already been processed and entered into computer files ready for analysis. This included data on personal details such as sex, age and smoking status as well as data on the occurrence of respiratory symptoms and whether these were related to work. A full occupational history was included in the majority of the questionnaires sent out by Cowie *et al* (1997) but these data had not been processed since they were not required for the statistical analyses. Given the relatively low prevalence of asthma in the population, and the focus on identifying associations between occupations and symptoms, a case-control design was an efficient use of resources and meant that only a subset of the total returned occupational histories required data processing.

The availability of full occupational histories also allowed a comparison to be made between the career progression of asthmatic and non-asthmatic individuals, with particular attention to how career was affected among asthmatics after the onset of symptoms. Although no direct questions were asked in the questionnaire about periods of unemployment, these could be inferred indirectly from gaps in the occupational histories.

1.2 Aims and objectives

The overall aims of the study were:

(i) to assess the reliability of self-reports of occupational asthma and chronic bronchitis attributable to occupation;

(ii) to assess the approximate frequency of clinically verifiable occupational asthma and chronic bronchitis attributed to occupation in the general population in an industrial area;

(iii) to identify, for possible subsequent studies, specific occupations, industry sectors and employers where study of exposures and exposure histories might provide helpful information relevant to relationships between exposure and the occurrence of asthma and chronic bronchitis.

The report of Cowie *et al* (1997) addressed aims (i) and (ii) above. The work described in this report addressed aim (iii), together with some further work which was agreed to provide additional information on the socioeconomic effects of asthma in the context of work.

In full, the objectives were to examine the following aspects of occupation and to compare, with asymptomatic individuals, (a) in individuals with symptoms of asthma and, (b) in individuals with symptoms of chronic bronchitis:

(i) the distributions of time spent, up to the onset of symptoms, in occupations and industry sectors generally,

(ii) the distributions of time spent, up to the onset of symptoms, in specific occupations and industries previously reported to be hazardous to respiratory health,

(iii) the rate of change of occupation (including seniority) following the onset of respiratory symptoms,

(iv) the proportion of individuals leaving employment to become unemployed or on sick leave following the onset of respiratory symptoms.

2. MATERIALS AND METHODS

2.1 Introduction

The current study followed on from the community-based epidemiological study of Cowie *et al* (1997) and much of the data from the respiratory symptoms questionnaire necessary for the current study had already been processed and were ready for statistical analysis. The main component remaining to be processed was the data from the full occupational histories which required coding and transcription to computer files. Full details of the study design and survey methods of the community-based epidemiological study are described in the report of that study (Cowie *et al*, 1997), which will be referred to throughout this report as 'the prevalence study'. A summary only is given here and this report concentrates on the additional work that was carried out as part of this follow-on study.

Individuals were selected for inclusion in this study as cases of asthma, cases of chronic bronchitis or as controls who reported symptoms of neither condition. Cases and controls were diagnosed on the basis of their responses to questions on respiratory symptoms in the postal questionnaire sent out during the prevalence study. Cases of asthma and chronic bronchitis were compared to the single control set in separate statistical analyses. This chapter describes the conduct of the postal questionnaire and the criteria for the selection of the cases and controls for inclusion in this study. This is followed by details on the processing of the occupational histories and the methods by which the occupational information was used to investigate associations with respiratory symptoms.

2.2 The postal survey

The prevalence study took the form of a cross-sectional survey, by postal questionnaire, of a sample of the working-age population in the contiguous districts of Livingston, Bathgate, Broxburn and Linlithgow in West Lothian and Grangemouth and Bo'ness in Central Region, Scotland. The full questionnaire that was sent out in the first two mailings (Cowie *et al*, 1997: Appendix 1) was designed to gather information on personal details, including smoking habits, and information on the occurrence of respiratory symptoms. In addition, a full occupational history was requested to record each job held since leaving school. Labour Force Survey (LFS) questions on self-reported work-related illness were included, modified for self-administration. International Union against Tuberculosis and Lung Disease (IUATLD, 1986) bronchial symptoms questionnaire questions on asthma symptoms in the last twelve months were included to establish whether the symptoms were perceived to be work-related, and to identify when the symptoms first began. Direct questions were asked concerning medical diagnoses of asthma. MRC (1986) respiratory symptoms questionnaire questions on cough and phlegm production were included, abbreviated and adapted for self-administration. Smoking questions were included, at least sufficient to categorise subjects as current smokers, ex-smokers or non-smokers.

Eligible individuals were aged 16-64 and resident in one of 18 postcode sectors at 31 March 1994. Data on all 92715 eligible individuals were forwarded to the IOM on floppy disk from the combined Community Health Indices of Lothian Health and Forth Valley Health Board. A simple random sample of 40000 individuals was extracted from this database for mailing of the questionnaire.

After two mailings of the full questionnaire, the questionnaire was shortened and mailed a third and final time to non-responders in an attempt to encourage greater participation. The major change from the first two mailed questionnaires was to omit the occupational history (Cowie *et al*, 1997: Appendix 2.3).

Overall the response rate for the prevalence study was 50% of those questionnaires delivered, with a total of 17487 questionnaires returned. There was a low response among younger recipients and, in particular, younger males. After exclusions based on a series of computerised validation checks, a study group of 16990 responders remained. These responders formed the pool of potential case and control subjects for inclusion in the current study.

2.3 Selection of case and control subjects

2.3.1 Selection of cases of asthma and chronic bronchitis

In the prevalence study, diagnosis of cases was on the basis of responses to questions on respiratory symptoms. Symptoms of asthma were diagnosed if, in the last 12 months, individuals admitted to wheezing and whistling in their chest, and at least two from the following complaints: tightness in the chest first thing in the morning, shortness of breath during the day when not doing anything strenuous, and being woken at night by shortness of breath.

Further questions were used to determine whether the symptoms of asthma were likely to be work-related or not. Individuals whose symptoms improved when they were away from work for a week or more and got worse on working days compared to non-working days were defined to have symptoms of work-related asthma. If their symptoms improved when away from work for a week or more and stayed the same on work days compared to non-work days, individuals were defined to have "possible work-related" asthma. This latter category was also used for individuals who did not fulfil either of the above conditions but described a work-related activity or place which brought on their symptoms.

Individuals were classified as having symptoms of chronic bronchitis if they answered positively to at least one of (a), usually coughing up phlegm from their chest first thing in the morning and doing so on most days for at least three months each year, or (b), usually coughing up phlegm from their chest during the rest of the day or at night and doing so on most days for at least three months each year.

For each individual with symptoms of chronic bronchitis, the replies to questions 'Do you think that your cough and phlegm have been caused by something you breathed in at work', and (if YES), 'What do you think caused your cough' were examined. Individuals were defined to have work-related chronic bronchitis if they answered positively to the former, or if they left the former blank and gave a work-related answer to the latter. Up to three causes of cough were coded. Some individuals thought that their cough was caused by something they breathed in at work, but, when asked to specify what caused it, gave a clearly non-work-related answer (usually their own smoking habits). These individuals were not classified as having work-related bronchitis.

In the prevalence study 261 individuals with work-related or "possible work-related" asthma were identified, and all of these were selected for inclusion in the current study as cases of work-related asthma. Additionally, 200 non-work-related asthma cases were selected for inclusion. Since a far greater number of non-work-related cases were identified in the prevalence study, these cases were randomly selected from among all those eligible. A total of 1171 non-work-related asthma cases were identified in the prevalence study. Of these, the 200 cases were selected from 849 eligible cases who had returned a long questionnaire (i.e. including occupational history), completed the questions on chronic bronchitis symptoms, and reported a date for the onset of first symptoms.

Among the 261 work-related asthma cases, 47 had responded to the shortened questionnaire in the third mailing and therefore had not returned an occupational history. These individuals were mailed again and asked to complete and return an occupational history identical to that included in the original (long) questionnaire.

Although 360 cases of work-related chronic bronchitis were identified in the prevalence study, a number of these individuals also described symptoms of work-related asthma and so were already selected as asthma cases. After discounting the work-related asthma cases, and those for whom no occupational history was available, the remaining 209 cases of work-related chronic bronchitis were selected for inclusion. The prevalence study identified 2068 non-work-related chronic bronchitis cases, of whom 1217 had no symptoms of asthma and had returned a long questionnaire. From this subset, a random sample of 200 cases was selected for inclusion in this study.

2.3.2 Selection of controls

A single control was individually matched by age to each asthma case, to within one year on either side. Controls were selected at random from all eligible individuals identified as being free of any respiratory symptoms in the prevalence study. Specifically, an eligible control responded 'No' to all the IUATLD questions on chest symptoms and to the all the MRC questions on coughing and phlegm, and 'No' and 'Never' to the direct questions on asthma. Additionally, an eligible control responded 'No' to having had a work-related illness, or, if 'Yes', gave non-respiratory conditions for the doctor's diagnosis, or for their own diagnosis if a doctor was not consulted. According to the above criteria, 7893 eligible controls, who returned long questionnaires, were identified in the prevalence study. Eligible controls, and asthma cases, were stratified into single-year age bands and controls selected at random within each stratum to match the number of asthma cases.

Matching asthma cases and controls in this way allowed valid paired comparisons of career progression to be made with reference to the age of onset of asthma symptoms given by the case. The sample of controls matched to the asthma cases were also compared, unmatched, with the chronic bronchitis cases in separate statistical analyses.

2.4 Coding of occupations

Occupational histories for the selected cases and controls were coded blind by an experienced coding clerk. For each job, the job sequence number, start and end dates, occupation and employer's industry were coded as a single record in the job history data sheets. Dates were coded as reported, as combinations of day, month and year. Occupations were coded using the Standard occupational classification (OPCS, 1990), which, consists of three-digit codes for 371 occupational groups (OG), based on the comparability of skills required for each occupation. The Standard occupational classification (SOC) has an hierarchical structure with similar OGs grouped into 77 minor groups based on the first two digits. These minor groups are grouped further into 9 major groups. The employer's industry was coded with reference to the Standard industrial classification of economic activities (CSO, 1992) The Standard industrial classification (SIC) is an hierarchical classification of industries into 60 divisions, 222 groups and 503 classes. Coding was based, where possible, on the four-digit codes for classes.

Respondents were asked for all jobs held, both part-time and full-time, since leaving school. Jobs were coded as they were reported, with no attempt to interpolate missing information. Where a respondent indicated that they were still employed in a particular job, the date of questionnaire completion was inserted as the end date. Where entries for occupation or industry did not fall within the SOC or SIC classifications, additional codes were created. These codes covered periods of unemployment, sickness, retirement and full-time education.

When a series of jobs were indicated within a single box referring to a single employer, each job was coded as a separate job history record in the sequence in which they were given. The overall start date for the employer was taken as the start date for the first job in sequence, and the overall end date taken as the end date of the final job. Dates for intermediate jobs were coded as missing. Where a respondent indicated that, for a single time period, he/she had held a number of jobs of the same occupation (but possibly different employers), the series of jobs was coded as if a single job but was flagged with a code to indicate multiple jobs.

The SOC classifies occupations purely on the skills and qualifications required to carry out the occupation and not on the rank or status of the person within the occupation. Separate codes exist for managerial jobs, where management is viewed as the principal function of the job. Also coded was an additional suffix to the three-digit code which is used to distinguish jobs with managerial ('M') and foreman ('F') status, and which is necessary to determine socio-economic status based on occupation.

Any job history which was left blank or contained large gaps was omitted from the study and a replacement drawn at random from the remaining eligible cases and controls. Work-related cases were not replaced in this way since all eligible cases from the prevalence study were originally selected for inclusion.

2.5 Data processing

The coded occupational history data of the selected cases and controls were entered into computer data files and checked for consistency. All other relevant information on cases and controls that could be extracted from the questionnaires had already been processed during the prevalence study. This information included details on the sex, date of birth and smoking status of all individuals, and the responses to questions on respiratory symptoms and the corresponding diagnosis based on these, including the work-relatedness of symptoms. The coded occupational history data were entered into a computer database by an experienced data entry operator using Key Entry III on a PC. All those sent a questionnaire in the prevalence study were assigned an identity number, printed on the questionnaire, and this was entered with each occupational history record to allow this information to be linked with the data already entered against individuals during the prevalence study. Simple range checks and checks on valid codes were carried out as data were entered. The job sequence number was checked for correspondence with the starting date of jobs to allow jobs to be ranked chronologically with regard to the starting date.

2.6 Statistical methods

2.6.1 Occupational histories

Cases and controls were compared on the basis of whether or not they had ever been employed in each of a number of occupations. Before any comparison was made, it was necessary to group the occupations in the SOC to give adequate numbers of cases and controls in each group, while ensuring occupations within groups were, to a certain extent, exposed to the same potential agents of asthma or chronic bronchitis. In keeping with the stated objectives of the study, two groupings of occupations were used. The first corresponded to the two-digit minor groups as defined in the SOC. These minor groups were used for a general sweep through all occupations in an attempt to find any with evidence of an increased risk of asthma and/or chronic bronchitis. The second grouping was based on the reporting of new cases of occupational asthma within the SWORD project. This grouped occupations into occupational sets based on prior associations with increased risks of occupational respiratory problems, particularly asthma. Meredith (1993) defined 20 occupational sets based on the Classification of occupations (OPCS, 1980), which was the predecessor of the SOC used in this study. For this study, the number of occupational sets was expanded to include additional groups for textile workers and print workers, and previously-combined groups like construction and mining, and transport and storage were separated. The correspondence between the SOC OG codes and these modified occupational sets is shown in Table 2.1. Several extra codes were required to cover periods of unemployment, retirement, full-time education and unknown jobs, and these are shown under major group 0.

All jobs for each asthma case were labelled into one of three categories which related to the date of onset of asthma. A job was labelled as definitely starting before onset if the start date or end date were prior to the date of onset, or if the job sequence number was less than the maximum job sequence number of all jobs with start date prior to onset. A job was labelled as definitely starting after onset if the start date was after the date of onset, or if the job sequence number was greater than the minimum job sequence number of all jobs with start date after onset. Jobs were labelled as indeterminate in relation to onset if, due to missing start or end dates or missing date of onset, they were not known to have definitely started before or after the date of onset. This categorisation of jobs was also carried out for the individually-matched controls in relation to the age of onset of symptoms of the case to which they were matched. Since the date of onset of symptoms was only available for asthma symptoms, jobs were not distinguished in this way for chronic bronchitis cases.

2.6.2 Relationship between occupation and respiratory symptoms

The statistical analysis of relationships between occupations and respiratory symptoms was based on the case-control design of this study (Schlesselman, 1982). For the analysis of asthma symptoms, this took the form of a matched-pairs design, with a single control matched, by age (within ± 1 year), to each of the 461 cases. For the analysis of chronic bronchitis symptoms, this took the form of an unmatched design, with 409 cases and the same 461 controls as used in the asthma analysis.

Occupations that were previously associated with respiratory symptoms were investigated using the SWORD-based classification of occupational sets. A more general scan of all occupations was made using the minor groups classification within the SOC. The questionnaire asked about chest symptoms relating to asthma occurring in the previous 12 months. To include all possible occupations which might have aggravated these symptoms, and to increase the power of the investigation given the wide range of jobs which may have been held over a working lifetime, all jobs notified in the returned occupational histories were included in the analysis of associations.

Basic measures of the degree of association between each occupation and symptoms of asthma were calculated from the number of case-control pairs where the case, but not the control, had been employed in an occupation, and the number of pairs where the control, but not the case, had been employed in the same occupation. The ratio of these numbers of discordant pairs gave an estimate of the crude odds ratio (OR) for an occupation. Each OR was the odds of the prevalence of asthma among those ever employed in an occupation, relative to the same odds among those never employed in that occupation. An OR greater than 1 indicated raised odds of asthma associated with employment in an occupation. The numbers of discordant matched pairs was also used to calculate a standard error for the OR. An approximate 95% confidence interval was calculated on the log scale (log OR ± 1.96SE) and back-transformed to the original scale.

The association between occupation and prevalence of asthma symptoms was investigated by fitting, for each occupational group, a conditional logistic regression model (Collett, 1991) which included terms for potential confounding variables like sex and smoking status. Current smoking status was determined using the questionnaire and categorised as either current smoker, ex-smoker or non-smoker. To each model including confounders, occupation was added as a binary variable distinguishing those who had been employed, from those who had never been employed in an occupation. Therefore, each model produced an estimate of the prevalence odds of asthma among those who had been employed in a specific occupation relative to the same odds among those who had never been employed in that occupational group, adjusted for potential confounders. These conditional logistic regression models were fitted using the statistical computer package BMDP (Dixon, 1992).

Basic measures of the degree of association between occupations and symptoms of chronic bronchitis were calculated from the number who had been employed in each occupation relative to the number who had not, separately for cases and for controls. The ratio of the odds for cases relative to the odds for controls gave an estimate of the crude OR. Using the standard error, an approximate 95% confidence interval could be calculated.

Adjustment for the potential confounding variables of age (at 31/3/94, just prior to the first mailing), smoking status and sex was carried out using (unconditional) logistic regression. Each regression model produced an estimate of the adjusted odds ratio of chronic bronchitis symptoms for each occupation along with their 95% confidence intervals, similar to the conditional analysis of asthma cases. These logistic regression models were fitted using the generalised linear modelling facilities within the Genstat statistical package (Genstat 5 Committee, 1993).

2.6.3 Relationship between asthma and career progression

To determine the effect of the onset of asthma on employment prospects, paired comparisons were made between asthma cases and their age-matched controls based on the number of jobs held, and the time spent in full- or part-time employment. Within-pair comparisons were made of these variables after the age of onset of symptoms in the case and after the same age in the matched control. To avoid bias, analysis of the number of jobs held after onset was restricted to cases-control pairs with enough information on job dates to rank all jobs in relation to the age of onset symptoms, and with no coded multiple jobs. For time spent in employment, analysis was restricted to cases and controls with a complete set of job history dates.

Comparison of career progression before and after the onset of asthma symptoms was also carried out using the socio-economic status derived from the final job held prior to the onset of symptoms and the first new job started after onset. There are two commonly-used classifications of socio-economic status in the U.K., the six-category social class (SC) scale and the socio-economic group (SEG) scale with 17 categories. Both can be derived from a two-way breakdown of occupation (based on SOC) and employment status, where the latter distinguishes the self-employed (with or without employees), managers (in large or small establishments) and foremen, from all other employees. Since employment status has less effect on social class, which consists of broad divisions based on skills, and given that the large number of SEG categories would result in sparse tables of distributions of case-control pairs, the SC scale was used to compare the status (or seniority) of occupations. A description of the SC scale is given in Table 2.2. It was necessary to include an additional category labelled 'Other' to cover periods of unemployment and for members of the Armed Forces who are not assigned to a social class. No accurate knowledge of the self-employed or the size of the employer's establishment was available, so jobs were allocated to the social class of the occupation corresponding to other employees, unless managerial or foreman status was indicated, in which case the relevant class was assigned.

3. RESULTS

3.1 Study sample

3.1.1 Coding of occupations

The re-mailing of 47 work-related asthma cases without an occupational history from the prevalence study resulted in 10 completed histories being returned and 2 histories returned undelivered due to the addressees having moved away. Therefore, 224 work-related asthma cases were available for inclusion in the study sample for analysis. Among the completed questionnaires of the 209 work-related chronic bronchitics selected, one had been filed out of sequence and was not readily available for data entry. This left 208 available work-related chronic bronchitis cases for inclusion in the study sample.

Of the 200 randomly-selected non-work-related asthma cases, 14 had blank or largely incomplete occupational histories and so were replaced by additional cases drawn from the pool of eligible cases. Of these replacements, a further 2 had to be replaced for the same reason. Likewise, of the 200 randomly-selected non-work-related chronic bronchitis cases, 8 were replaced when they were found to have blank or largely incomplete occupational histories. Among the control sample age-matched replacements were required for 19 controls with missing occupational histories.

The total study sample for statistical analysis therefore comprised 1256 individuals, consisting of 424 asthma cases (224 work-related, 200 non-work-related), their 424 individually-matched controls, and 408 chronic bronchitis cases (208 work-related, 200 non-work-related).

A total of 5507 occupational history records were coded for the 1256 individuals in the study sample, resulting in an average of 4.4 jobs per individual. Of these records, 10 were coded as unknown occupation, while 39 were flagged as multiple jobs of the same occupation (that occupation being most often in the construction industry). The start and end dates of jobs in the job history were not always given: 78% of all jobs coded had both dates given, 4% had only the end date, 10% only the start date and 8% had neither date. These relative proportions did not differ among jobs held by cases and controls separately.

3.1.2 Characteristics of study sample

A breakdown of the 1256 cases and controls in the study sample by sex, age and smoking status is shown in Table 3.1. Within the control group, there were marginally more females (58%) than males, while among asthma cases, males and females were in roughly equal proportions. Among chronic bronchitis cases as a whole, males (66%) were more prevalent than females. Within both conditions, males were relatively more common among work-related cases than among non-work-related cases.

Current smokers were much more common among chronic bronchitics (51%) and asthmatics (35%) than among controls (17%). A low proportion of smokers among the controls was expected since these individuals had been selected on the basis that they had responded positively to having had no respiratory symptoms at all in the 12 months prior to the questionnaire. On the other hand, a high proportion of smokers among bronchitic cases was expected since smoking is commonly associated with symptoms of chronic bronchitis, more so in relation to current smoking status than to past smoking history.

All individuals were between ages 15 and 65 years, and, since they were age matched within one year, the mean ages of asthma cases and controls were the same at 39 years. The mean age of chronic bronchitis cases was slightly older at 42 years. There was an almost uniform distribution of cases and controls spread across the 10-year age groups.

Those who reported symptoms of asthma were asked for the date when those symptoms first occurred. Of the 424 asthma cases, 31 did not give a date of first symptoms. Figure 3.1 shows the distribution of calendar year of the date of onset of symptoms for those that did give a date. Clearly, symptoms were most likely to have been reported to first appear in the years immediately preceding the mailing of the questionnaire, i.e. the years leading up to 1994. In fact, 205 cases (52%) reported first symptoms in the years since 1990, and 323 (82%) since 1980, although dates of first symptoms are reported going back to the 1940's. There were small peaks at 1985 and, particularly, at 1980, which suggest that some of those with symptoms may have been crudely approximating the date of first symptoms. The short follow-up time since the onset of asthma for the majority of cases limited the investigation of how employment status had changed since first symptoms.

Figure 3.2 shows the distribution of age at first symptoms for asthma cases. This distribution was evenly spread across all age groups, and included 58 cases who reported first symptoms between birth and age 15 years. The pattern indicates that asthma commonly first occurs in younger rather than older people and, therefore, in this cross-sectional population, there was a preponderance of recent starts.

3.1.3 Summary of industries

Table 3.2 shows, for each industry sector, the numbers of both cases and controls who had ever been employed in that industry. Industries were grouped based on the divisions within the SIC classification to produce tabulated numbers large enough to allow meaningful comparisons. Since each distinct occupation in an individual's occupational history was counted, the same individuals may appear in the counts for different industries, and so the percentages will not necessarily sum to 100% among cases or controls.

It can be seen that around a quarter of all study sample members had been employed in public administration and a similar proportion in the retail trade. Other industries well represented in the sample were construction, manufacture of food products, and health and social work. The ratio of the percent of cases relative to the percent of controls in each industry gives a simple measure of the relative risk (RR) associated with past employment in each industry. With regard to asthma, there were proportionally more cases than controls in the hotel and restaurant industry (RR=2.0), and the food processing industry (RR=1.7). Equally there were noticeably proportionally more chronic bronchitis cases than controls in the land transport (RR=3.0), metal manufacturing (RR=2.0) and construction (RR=1.7) industries.

These crude measures of risk based on the SIC classification of industry did not take into account the matching of asthma cases to controls, nor the wide variety of occupations possible within each industry. Since, for many skilled and unskilled jobs, the SOC classification of occupation also inherently took account of the nature of the employer's business, more precise and meaningful comparisons between cases and controls were carried out using groupings of occupations rather than industries.

3.2 Relationship between occupation and respiratory symptoms

3.2.1 Overview

As mentioned in Section 2.6.2, both crude ORs and ORs adjusted for potential confounding variables were calculated for each occupation of interest. Adjustment for confounders required a model-fitting approach that allowed for the matched pairs design of the asthma analysis and the unmatched design of the chronic bronchitis analysis. It is common in exposure-response studies to include all potential confounders in a model before adding the exposure variable, which, in these analyses, was a simple binary variable indicating whether an occupation had been held. To be defined as a confounder, a variable should be associated with the exposure variable and, independently, with the response variable, which, in these analyses, was a binary variable indicating the presence or absence of prevalent symptoms of either asthma or chronic bronchitis. Due to the large number of occupational groups of interest in these analyses, and therefore the large number of models to be fitted, a standard model-fitting procedure was required to produce ORs for each occupation adjusted for the same relevant confounders across all occupations.

As an example of model fitting using a single occupation, Table 3.3 shows the output of four regression models which could be used to analyse the effect of employment as a food processor on the prevalence of asthma. Terms were included for smoking status (current or ex-smokers versus non-smokers), sex and employment (ever versus never), with automatic adjustment for age due to it being the matching variable. Each coefficient is an estimate of the log odds ratio of asthma adjusted for all other variables with terms in the model. Confidence intervals were calculated from the log OR plus and minus 1.96 standard errors, which were then back-transformed to the original scale using the exponential transformation. Equivalently, the ratio of coefficient to standard error, as given in Table 3.3, could be used to test whether, with a value greater than 1.96 or less than -1.96, the confidence interval approach indicated that the estimated OR was significantly greater than, or less than, 1 respectively. In Table 3.3, the coefficient for smoking status was not greatly affected by the inclusion or exclusion of the other terms, which suggested that the confounding between smoking and the other variables was negligible. In model A, with no other terms, these coefficients translated to ORs of 3.1 for current smokers and 1.4 for ex-smokers, both in relation to non-smokers. The inclusion of sex in model B confirmed a slightly higher proportion of males among cases than among controls, although not statistically significant based on the 95% confidence interval. The addition of a term for employment in food processing, both before (model C) and after (model D) the inclusion of sex was significant, and in both instances predicted an odds ratio of 2.2 associated with employment in this occupation.

As for the asthma example above, Table 3.4 shows the output of four regression models which could be used to analyse the effect of employment as a construction worker on the prevalence of chronic bronchitis. As age was no longer a matching variable, it was included as a potential confounder. Smoking status was highly significant, with current smokers much more common among cases than controls. In model A, with terms for age and smoking status, the odds ratio for current smokers relative to non-smokers was 6.7, and for ex-smokers the odds ratio was 1.8. The linear term for age was also significant in model A, but the size of the effect was reduced with the inclusion of sex suggesting association between these two variables. The term for sex, included after smoking and age was significant (model B) and indicated that cases were more likely to be male than controls. This was expected, since the prevalence study found that work-related chronic bronchitis, which accounted for around half of the cases selected for this analysis, was four times more prevalent among males than females, whereas the control set was more approximately evenly split between the sexes. The term for employment as a construction worker was significant when included after smoking and age (model C) but not after sex also (model D), a consequence of construction being an almost exclusively male occupation.

For several occupations sex was strongly associated with employment in that occupation. For example, cleaners and nurses were mostly female occupations, and wood workers and construction workers were almost exclusively male occupations. Because these strong associations may have lead to spurious results, and because there was no strong evidence in the earlier study of a difference between the sexes in the prevalence of non-work-related respiratory symptoms, it was decided not to adjust for sex when analysing the effect of each occupation.

Statistical inference was based on 95% confidence intervals within each model fitted using a specific occupation. The problem of multiple significance testing, due to the large number of occupations analysed, is discussed in Section 4.1.

3.2.2 Asthma

Table 3.5 shows, for each occupational set in the SWORD classification, estimates of the crude unadjusted odds ratios, calculated from the numbers of discordant matched pairs where the case, but not the control, had been employed in each occupation (denoted b), relative to the number of pairs where the control, but not the case, had been employed in that occupation (denoted c). A series of regression models similar to model C in Table 3.3 were fitted, each adjusting for smoking status, and each including a term for a different occupational set. Table 3.5 shows, for each occupation, the adjusted odds ratios and 95% confidence intervals calculated from the coefficients and standard errors of these fitted models.

Several occupational sets showed high unadjusted odds ratios of greater than 2.0. In general, the same occupational sets had significantly raised odds after adjustment for smoking, based on individual 95% confidence intervals. The relatively small reductions in the ORs after adjustment for smoking in most occupational sets indicated that smoking was only weakly associated with these occupations and could not explain the significantly raised odds in many occupations. By far the highest prevalence odds were associated with bakers, with adjusted OR 7.34 (95% CI from 1.63 to 33.20). They were followed by general labourers, adjusted OR 3.00 (95% CI from 1.14 to 7.92), and food processors, adjusted OR 2.19 (95% CI from 1.04 to 4.61). Cleaners, textiles workers and construction workers had significantly raised ORs of around 1.8 (although the lower confidence limit for construction workers was marginally less than 1.0). Some occupations were associated with high ORs, but, due to small numbers, were very imprecisely estimated. These included spray painters, adjusted OR 3.34 (95% CI from 0.61 to 18.30), and also metal treatment workers and print workers both with estimated ORs of around 2.4.

Of those employed in food processing, more than half had worked in the production and processing of meat products, with a significant number specifically processing poultry meat. Most of those who had worked in textiles processing, had been employed as machinists in the manufacture of clothing. The category for labourers and general workers was a catch-all group of occupations within a variety of mostly dusty and dirty industries. The cleaners category contained mostly domestic and office cleaners, while construction workers consisted of a variety of manual jobs in the building trade.

The last four occupational sets in Table 3.5 (numbers 50,60,70,80) were included for completeness but, since information on these periods of unemployment was volunteered and not requested, estimates of odds ratios were unreliable.

Table 3.6 shows another series of unadjusted ORs, estimated separately for each occupation as in Table 3.5, with occupations classified by SOC minor groups. Since there are almost 80 minor groups, many comprised very small numbers of cases and controls. Because of this, and because adjustment for smoking in the main reduced the estimated ORs only slightly, this table was used to scan for additional occupations, not distinguished in the SWORD classification, which were associated with high odds of asthma symptoms. However, it was not possible to aggregate the results of these minor groups to exactly correspond with the SWORD classification since, like the occupational sets, membership of each minor group was not mutually exclusive.

Catering occupations (Minor Group 62) had an unadjusted OR of 2.62 which dropped to 2.30 (95% CI from 1.26 to 4.22) after adjustment for smoking. In this study sample this group comprised chefs, waiters and bar staff in roughly equal numbers. Armed Forces NCOs also appeared to be associated with raised odds of asthma symptoms after adjustment for smoking. This group included both regular soldiers and, particularly among older males, those who had experienced periods of national service. Electrical and electronic trades (Minor Group 52), in this study almost exclusively electricians, had an OR of 2.37 which fell to 1.93 (95% CI from 0.82 to 4.55), which was not significantly greater than one, after adjustment for smoking. No other occupations were associated with high odds ratios that had not already been identified as such using the SWORD-based classification of occupational sets.

The odds ratios associated with the occupations in Tables 3.5 and 3.6 were estimated using asthma cases, regardless of their being diagnosed as work related or not related to work based on questionnaire responses. Table 3.7 shows the results of fitting regression models, each including an occupational set associated with a raised odds of asthma, that allow for a different associations between the prevalence of asthma and occupation among work-related cases and non-work-related cases. The structure of the model includes a term for the effect of occupation among non-work-related cases, and a term for the difference in effect of occupation between non-work-related and work-related cases. The coefficients of these terms can then be used to estimate the log OR for non-work-related cases ($coeff_{NW}$) and, separately, work-related cases ($coeff_{NW}+coeff_{DIF}$). The difference in degree of association between occupation and asthma was tested based on the size of the difference coefficient ($coeff_{DIF}$) relative to its standard error (SE).

Only among wood workers was there strong evidence that work-related cases had a higher OR than non-work-related cases (1.72 and 0.38 respectively). There was less conclusive evidence of a similar pattern among other metal and electrical processors (OR 1.83 for work-related cases and 0.87 for non-work-related cases). Among textiles processors there was evidence that the OR for non-work-related cases was significantly higher than that for work-related cases (3.89 and 0.94 respectively). Among the other occupations there was no evidence that the association between asthma symptoms and occupation was different for non-work-related cases compared to work-related cases.

3.2.3 Chronic bronchitis

Chronic bronchitis cases were analysed in relation to occupation similarly to asthma cases except that the regression models fitted took account of the unmatched structure of the design. A series of models similar to model C in Table 3.4 was fitted, each adjusting for age and smoking, and each including a term for a different occupational set from the SWORD-based classification. The resulting estimated odds ratios for each occupation, adjusted for smoking and age, are shown in Table 3.8 with 95% confidence intervals. Also shown are estimates of the unadjusted odds ratios calculated using the number of cases (n_1) and controls (n_2) employed in each occupational group.

In comparison with asthma, a larger number of occupations showed raised unadjusted odds ratios, in particular, ORs greater than 2.0. Smoking patterns within these occupations did not generally account for these raised odds, although ORs were generally reduced after adjustment for smoking status and age. Bakers were again associated with the highest prevalence odds ratio, despite the small number involved, with adjusted OR 5.28 (95% CI from 1.11 to 25.20). The next highest prevalence odds ratios were associated with painters, adjusted OR 4.88 (95% CI from 1.58 to 15.03), and mining, adjusted OR 4.68 (95% CI from 1.58 to 13.86). Other occupations with significantly raised ORs, which were greater than 2.0, were metal treatment workers, welders and other metal/electrical processors, chemical processors and farmers. Construction workers and non-road transport and storage workers had estimated ORs marginally less than 2.0. Nurses and other professional workers were associated with ORs significantly below 1.0, when compared separately against those in all other occupations.

Chemical processors were generally represented by plant operatives in oil refineries or basic chemical manufacturers, while metal treatment workers consisted of a mixture of moulders, furnace workers and electroplaters. Those classed under farmers were mostly farm workers, but the type of farm was often not indicated. Other metal/electrical processors covered a great variety of occupations, although metal workers, motor mechanics, electricians and plumbers accounted for over half the individuals in this category. Almost half of those in the non-road transport and storage worked as warehousemen or storekeepers. Those employed in mining and quarrying were almost exclusively mining underground for hard coal.

Table 3.6 shows the unadjusted odds ratios for chronic bronchitis associated with each minor group in the SOC classification. Aside from those occupational groups already identified with raised ORs, workers in the electrical and electronic trades (Minor Group 52), who were mostly electricians, and vehicle trades (Minor Group 54), mostly motor mechanics, had high unadjusted odds ratios. Adjusted for smoking, the ORs for these two groups were still significantly raised, being 2.84 (95% CI from 1.19 to 6.78) and 5.26 (95% CI from 1.68 to 16.47) respectively. Other craft and related occupations (Minor Group 59), consisted of a mixture of occupations previously associated with high ORs. As with asthma symptoms, Armed Forces NCOs (Minor Group 60) were associated with a high unadjusted OR, although this was reduced considerably after adjustment for smoking and age. Road transport operatives (Minor Group 87) had an unadjusted OR of 2.15, but this was reduced to 1.56 (95% CI from 0.88 to 2.78) after adjustment for smoking and age.

3.3 Relationship between asthma and career progression

3.3.1 Rate of change of jobs

Case-control paired comparisons were made of the number of new jobs taken up after the age of onset of asthma symptoms reported by the case, to look for evidence that those who suffered from asthma may have found it more difficult to hold down jobs and therefore have a higher rate of new jobs started. Analysis was restricted to a subset of 329 asthma case-control pairs for whom all jobs could be dated in relation to the reported date of first symptoms and who had no multiple jobs. This subset had comparable sex and age distribution to the full set of cases and controls.

Figures 3.3(a) and 3.3(b) show the distributions, for cases and controls, of the number of new jobs started after the date of onset of asthma. The horizontal axes in both these figures have been truncated at 13 jobs to the exclusion of single values of 21 and 16 jobs in the case and control distributions respectively. It is clear that very few cases or controls started new jobs after the date of onset, which may have been a consequence of many reporting first symptoms occurring just prior to receiving the postal questionnaire. Figure 3.3(c) shows the paired differences in the number of jobs started (case minus control) and, not surprisingly, there is a large peak at zero. Overall, the distribution of differences was approximately symmetric, suggesting no tendency for cases to start more or less jobs than controls. Table 3.9(a) shows summary statistics for these paired differences tabulated by the sex combination of the case-control pair and the work-relatedness of the asthma symptoms of the case. The standard error of any mean difference was useful for testing the size of the difference and was calculated from the standard deviation (SD) divided by the square root of the number of pairs (n). Overall, for the 329 pairs, the mean difference was only 0.1 jobs, close to zero, and equivalent in size to one standard error. To allow for different working practices among males and females, same-sex comparisons were more valid, but these showed a similar picture with the mean differences very close to zero. To allow for the effects of a longer follow up period from the date of onset, Tables 3.9(b) and 3.9(c) show the same summary statistics but for further subsets of pairs within which the date of onset of the case was prior to 1990 and prior to 1985 respectively. Table 3.9(c) shows that, even with at least ten years follow up, there was no discernible difference in the number of new jobs started between cases and controls.

3.3.2 Time spent in employment

A paired comparison of the time spent in employment after the reported date of first symptoms of asthma was carried out to investigate whether the onset of asthma resulted in more and longer periods of unemployment compared with zero-symptom controls. The basic structure of the analysis was similar to that used to compare the number of jobs in Section 3.3.1. Analysis was restricted to a subset of 181 case-control pairs with full job histories, that contained no missing dates, unknown or multiple jobs. This subset had comparable sex and age distributions to the full set of cases and controls.

Figures 3.4(a) and 3.4(b) show the distributions, for cases and controls, of time spent in employment after the date of onset of asthma of the case. The time axes in both these figures have been truncated at 32 years for presentation, to the exclusion of 4 cases and 3 controls all with values between 32 and 40 years. It was clear that the majority of cases and controls had at most only a few years of follow up within which a comparison can be made, although the tails of both distributions were very long. Figure 3.4(c) shows the distribution of paired differences (case minus control). As with the analysis of new jobs started, there was a large peak at around zero difference. There was slight evidence of a longer negative tail to the distribution than positive one, representing more cases having less time in employment than controls. Table 3.10(a) shows summary statistics for these paired differences for all 181 valid pairs by the paired sex combination and work-relatedness of the case. From the mixed sex pairs there was evidence of females spending less time in employment generally than males. Across all case-control pairs, the mean difference was 6 fewer working months for cases compared to controls. Among male-male pairs the difference was greater at 10 fewer working months for cases. Both these mean differences were approximately 1.5 standard errors below zero, which represents no difference. Mean differences were greater, in a negative direction, for non-work-related pairs than for work-related pairs, which was expected since cases diagnosed as not related to work were more likely to contain those not in employment compared with work-related cases. Mean differences became more increasingly negative as the date of onset was restricted back in time to before 1990 (Table 3.10(b)) and to before 1985 (Table 3.10(c)). Comparison of work-related pairs with date of onset prior to 1985 (Table 3.10(c)) gave a male-male mean difference of about 1 year less for cases, and female-female mean difference of about 2 years less for cases. Neither of these mean differences was large in relation to the variation among paired differences, both less than one standard error below zero mean difference. To further place these differences in context, mean follow-up time, from date of onset to 31/3/94, was 7, 14 and 19 years for the case-control pairs used in Tables 3.10(a)-(c) respectively.

3.3.3 Social class

The effect of the onset of asthma symptoms on employment status was investigated by cross-tabulating the social class of the last known job prior to the age of onset, against the social class of the first job started after onset, for cases and controls separately. For controls, the age of onset of the matched asthma case was used. Table 3.11(a) shows the cross-tabulation of the social class (SC) for asthma cases, and Table 3.11(b) for controls.

Almost half of all asthma cases, and a similar proportion of controls, did not start a new job after the date of onset of asthma, a result already highlighted in the paired comparison of new jobs started after onset in Section 3.3.1. For 17% of cases and 13% of controls, there were insufficient dates given in the occupational histories to determine whether any job did in fact commence after the date of onset. Also, 15% of cases and 17% of controls had no job for comparison prior to the date of onset.

Of the 94 cases and 91 controls with known jobs before and after the date of onset, 50 cases (53%) and 53 controls (58%) started a job of the same social class after the age of onset as the last known job before onset. Of the 94 cases, 40 were work-related cases of which 65% started a job of the same social class. The remaining 54 were non-work-related cases, of which 44% started a job of the same social class. Precise comparisons of the change in social class among cases and controls was made difficult by the small numbers present in the cells of Tables 3.11(a) and 3.11(b), even when work-related and non-work-related cases were analysed together.

Among the 25 SC IV or V cases pre-onset who started new jobs after onset, 6 (24%) moved to SC III jobs and 2 (8%) moved to SC II jobs. Proportional changes were similar for the corresponding 20 SC IV or V controls pre-onset, with 5 (25%) moving to SC III jobs and 2 (10%) moving to SC II jobs. Of the 55 SC III cases pre-onset, 4 (7%) moved to SC II jobs and 13 (24%) moved to SC IV or V. In comparison, movements among the 43 SC III controls pre-onset suggested more upward mobility, with 8 (19%) moving to SC II jobs and 8 (19%) to SC IV or V jobs. Given the small numbers involved though, it would be difficult to argue that there were marked differences between cases and controls.

There was a difference in the comparison of the 64 cases and 72 controls with no job prior to the reported date of onset, who were, not surprisingly, on average younger than the remainder, with mean age about 30 years for cases and controls. The proportion entering skilled (SC III) jobs after onset was higher among controls (67%) than among cases (47%), more of whom started unskilled (SC V) or partly-skilled (SC IV) occupations. Further analysis revealed that of these 64 cases, exactly 50% were work-related cases, which suggested that for a significant number of the 224 work-related cases, their symptoms were exacerbated by work rather than caused by it.

3.4 Summary of results

3.4.1 *Asthma and occupation*

Those who were current smokers at the time of the questionnaire were more likely to report symptoms of asthma than non-smokers, with a relative risk of approximately 3, while for ex-smokers the relative risk was about half this value. The following occupations were found to be associated with raised odds of prevalent symptoms of asthma, greater than expected by chance, and not explained by smoking habits (adjusted ORs in brackets): bakers (7.3), food processors (2.2), textiles processors (1.8), cleaners (1.8), labourers and other general workers (3.0) and caterers (2.3). Food processors consisted, in the main, of workers in the meat and poultry meat processing industries, while textiles workers were most often machinists in the manufacturing of clothing. Caterers were a mixed group consisting of chefs, waiting and bar staff. The following occupations were also associated with raised odds ratios although, due to small numbers in the sample, not significantly raised when compared to those in all other occupations: print workers (2.4), metal treatment workers (2.4) and spray painters (3.3). In the majority of these occupations, the degree of association with asthma did not depend on the work-relatedness of the symptoms as they were reported in the questionnaire.

3.4.2 Chronic bronchitis and occupation

Current smokers were far more likely to report symptoms of chronic bronchitis than non-smokers, with a relative risk of almost 7. Ex-smokers were only slightly more likely to report symptoms compared to non-smokers, with a relative risk of less than 2. The prevalence of chronic bronchitis symptoms was associated with a greater number of occupations than was asthma symptoms. The following had high prevalence odds ratios, greater than expected by chance, and taking smoking habits into account (adjusted ORs in brackets): farmers (3.1), bakers (5.3), chemical processors (3.2), welding and electronic assembly (2.4), metal treatment workers (3.8), various other metal and electrical processors (2.2), painters (4.9), construction workers (2.0), coal-miners (4.7), various storage occupations (1.8), labourers and general workers (4.1), electricians (2.8) and vehicle repairers (5.3). With raised ORs for chronic bronchitis, similar to the corresponding ORs for asthma, but not significantly raised when compared to those in all other occupations were: food processors (1.7) and cleaners (1.6).

3.4.3 Asthma and career progression

Three characteristics of career progression were compared between asthma cases and controls in relation to the age of onset of asthma symptoms among the cases: the number of new jobs started after onset, the time spent in employment after onset, and the change in social class of jobs from pre- to post-onset. A large proportion of both cases and controls did not start new jobs after the date of onset so the overall mean difference was negligible. Even within same-sex pairs of work-related cases with a minimum of 10 years follow up, the mean differences were no greater than around 1 job and not significantly different from zero given the variation among case-control pairs.

Of those that did start new jobs, the majority started jobs of the same social class as the last job held before onset. There was a suggestion that skilled controls were more likely than cases to move to managerial jobs and less likely to move to unskilled jobs. There was also slight evidence that controls without a job prior to the date of onset were more likely to start a skilled job and less likely to start an unskilled job in comparison with cases without a job prior to the date of onset. Neither of these differences were large though and, given the small numbers involved, the evidence was not at all conclusive.

Differences in time spent in employment after the onset of symptoms in the case were, on average, very low due to the relatively short follow-up periods from date of onset of asthma. Cases did, on average, spend less time in employment than controls but the difference only amounted to 6 months among all case-control pairs. Among same-sex pairs, this difference did increase with lengthening follow up resulting in mean differences of 1 year and 2 years for male pairs and female pairs respectively, all with a minimum of 10 years follow up. However, the mean follow-up time was 19 years for these pairs and this, plus the large variation among case-control pairs meant that these differences were practically and statistically insignificant.

4. DISCUSSION

4.1 Relationship between occupation and respiratory symptoms

Diagnosis of cases and controls

The diagnosis of cases and controls in this study was based on responses to the standard questions on respiratory symptoms included in the questionnaire for the prevalence study (Cowie *et al*, 1997). Asthma and chronic bronchitis are closely related diseases and can display very similar symptoms making it difficult to make a correct diagnosis. The diagnoses based on the respiratory symptoms questionnaire were not mutually exclusive so individuals could be classed as potential cases of either or both diseases. In fact, due to the inclusion of all work-related cases identified in the prevalence study, almost half of the asthma cases used in the matched-pairs analysis of occupations were also diagnosed with symptoms of chronic bronchitis. Only a small proportion of chronic bronchitis cases however were also diagnosed with symptoms of asthma.

An attempt was made in the prevalence study to check the reliability of the diagnoses based on self-reports, for both the symptoms and LFS questionnaire responses. A clinical assessment was made by a consultant chest physician on a sample of those reporting respiratory symptoms of asthma or chronic bronchitis.

There was good agreement between the diagnoses of asthma by physician and by symptoms questionnaire responses. Of the 72 cases of self-reported asthma presented, 75% were clinically diagnosed as having asthma, 10% chronic bronchitis, and 15% other respiratory disease. However, the identification of work-related asthma was not so reliable; only 35% of the 54 self-reported cases of work-related asthma were clinically diagnosed to have occupational asthma or asthma aggravated by work. Similarly, only 50% of the 18 self-reported cases with non-work-related asthma were clinically diagnosed as having a respiratory disease that was not related to work. This misclassification of the work-relatedness of respiratory symptoms using only the symptoms questionnaire responses helps to explain why, in the present study, apparent associations between occupations and asthma symptoms differed little according to whether cases were work-related or not related to work.

There was less information on the reliability of diagnoses of chronic bronchitis cases based on self-reports. However, of the 14 cases with self-reported chronic bronchitis who attended the clinic, only 5 (36%) were diagnosed with clinical chronic bronchitis and 5 (36%) with clinical asthma.

Since controls were selected from among those responding positively to having no respiratory symptoms, it is unlikely that any cases of asthma or chronic bronchitis have been misclassified as controls, or controls as cases of either condition.

Due to the difficulty in diagnosis from self-reports, some of those included in the analysis as asthma cases may in fact have been cases of chronic bronchitis and vice versa. There will also have been some who genuinely suffered from both conditions. If this was true, this blurring of the distinction between the two diseases will have weakened the power of the statistical analyses to detect true associations with occupations where they exist. This may also explain the appearance of some occupations with raised odds ratios for both diseases. Most notable among these were bakers, who are known to suffer from occupational asthma through exposure to flour dust, but who were associated with very high odds of chronic bronchitis. Also, this diagnostic uncertainty may explain why some occupations like farmers, painters and, possibly, chemical industry processors were associated with raised odds of chronic bronchitis when asthma would have been expected.

Selection of cases and controls

The sampling frame for the selection of cases and controls in the current study was the 16990 individuals who returned validated respiratory symptoms questionnaires in the prevalence study. This represented around 50% of the total number who were sent out a postal questionnaire, which itself was almost a 50% random sample of those registered in a selection of postcode districts within the databases of Lothian and Forth Valley Health Boards. For inclusion in the study sample, all work-related cases, and a random sample of non-work-related cases, of both asthma and chronic bronchitis, were selected. Additionally, a random sample of controls, from among those with zero respiratory symptoms, was selected.

The target population in this study comprised all those of working age living in the districts from which samples were taken at the time of the questionnaire. Inevitably, the same biases which existed for the prevalence study in relation to this target population will also exist here. In that study, the young and males, for example, were under-represented among responders. However, in a case-control study, the analysis is conditional on those cases and controls selected, and even differential response rates between potential cases and controls in the target population do not necessarily lead to biased results. As long as response rates are the same for those exposed and those unexposed *within* the populations of potential cases and potential controls, response rates can be different *between* potential cases and controls without introducing a bias into the estimation of odds ratios. In this study, there was anecdotal evidence from comments written on returned questionnaires with missing occupational history information that some who believed their respiratory symptoms were occupationally related, did not want to disclose information on their past or present employers. However, we see no reason why response rates would have differed greatly, across occupations among potential cases and or among controls.

Exposure estimation

Since occupational histories were self-administered, there was inevitably the potential for recall bias resulting in unreliable data. In the prevalence study, one suggestion for the low response rate (at least in comparison with an earlier pilot study which had an 80% response), was that some individuals were unwilling to give occupational details in conjunction with information on health. In general, the occupational histories of those selected for the study sample, and hence coded and processed, appeared to be relatively complete, although information on dates was patchy, probably because of difficulty in recalling precise dates for jobs held up to several decades in the past. The large proportion of asthma cases who reported a date of onset of asthma symptoms in the few years just prior to the first mailing might suggest that there was difficulty in recalling reliably when symptoms first occurred. Low and comparable proportions of non-work-related cases and controls were rejected and replaced at random because occupational histories had been left blank or appeared to contain large gaps. By the same criteria, only a small number of work-related cases would have been replaced had replacements been available. All except one of these cases reported information on at least one job held. A potential source of bias in the statistical analyses could have arisen from a difference in the reliability of recall of occupations between cases and controls, but there was little evidence for this among the completed occupational histories.

Interpretation of results

The odds ratios (ORs) quoted in this study are estimates of the odds of prevalent symptoms among those who have been employed in each occupation relative to the odds among those who have never been employed in that occupation. These ORs are not estimates of the relative risks in each occupation, since they were not based on incident cases and controls within a well-defined population during a follow-up period. Nor are these odds ratios necessarily comparable across occupations. This is because prevalence is a function of both incidence and the average duration that incident cases remain prevalent and within the sampling frame. Therefore, differences in prevalence could reflect differences in incidence or differences in the durations that incident cases remain prevalent. The latter might occur, for example, if asthma caused by different agents resulted in different temporal patterns of symptoms, or if cases of occupational asthma were more likely to remain exposed to the sensitising agent in some occupations compared with others. The use of prevalent cases also ignores the potentially complex movements of individuals into and out of the study area, and also the effect of mortality. However, since the study was community based, there should have been no healthy worker effect to influence the estimated risks.

Some individuals will have been employed in more than one occupation and so the regression models fitted to each occupation separately were not statistically independent. No attempt was made to model jointly how the risks associated with each occupation combined to explain the overall prevalence of respiratory symptoms. One problem with this multiple model-fitting approach was that the number of models fitted was dictated by the number of occupational groups analysed. Therefore, inference based on a fixed significance level, or, as here, a fixed confidence level for each model, suffers from the problem of multiple significance testing when applied to a large number of fitted models. This means that the overall probability of at least one false positive (Type I) result among all occupations analysed will be considerably higher than the probability of a false positive conclusion for any specific occupation. Using significance tests based on 95% confidence intervals as we have here, by definition, we would expect to find 1 false positive result for every 20 occupations analysed.

Neither of the two limitations mentioned above, lack of independence among occupations and multiple testing, was foreseen to be a problem, since this study was concerned with identifying as wide as possible a range of candidates for occupations that would warrant further investigation for causative agents of asthma. It was less important to produce a false positive result than to produce a false negative result and therefore fail to find an association between occupation and asthma which in fact may have been real.

Since all jobs held on or before the date of questionnaire completion were analysed, if there was a tendency for cases to move to certain occupations after first symptoms this might result in an unexpectedly high OR for these occupations. But, since very few cases reported a change of job after the date of first symptoms, this is unlikely to account for any of the strong associations that were found for many occupations.

Comparison with other studies

There have been few community-based studies that report the risk of asthma related to occupations, although there have been many studies reporting the incidence rates of occupational asthma based on surveillance schemes in various countries. Two recent examples of community-based studies are Mastrangelo *et al* (1997) and Ng *et al* (1994). In Mastrangelo *et al* (1997) the authors reported much higher risks for many occupations than the latter study and suggested that this was because they had used incident cases rather than prevalent cases and had calculated the odds of asthma for the occupation held at first symptoms relative to the odds in a pre-defined low-risk group of occupations. As expected, the ORs estimated in the present study were closer to those reported by Ng *et al* (1997) since we also used prevalent cases and calculated the odds of asthma among those who had held each occupation ever held relative to the odds among those who had not. This latter method may underestimate ORs because the comparison group of occupations will include occupations with a high risk of asthma.

Any comparison between the results of community-based studies needs to take account of the different occupational profile of the target population, since certain locally-based occupations and industries which can be responsible for a large proportion of prevalent cases may give rise to associations which are not apparent in regions where these occupations and industries are not common, or are absent. Isocyanates, which cause asthma in spray painters, for example, accounted for 22% of all cases reported to the SWORD scheme in 1989 and 1990 (Meredith, 1993). In the current study however we found very few individuals with past or present exposure as coach or spray painters, and so no firm conclusions could be drawn.

Baker's asthma, due to exposure to flour and grain, is a common type of occupational asthma and we found strong evidence of higher prevalence of asthma cases in bakers compared with those in other occupations. Food processors and textiles processors, with raised odds ratios in the current study, were also associated with raised odds of asthma in Mastrangelo *et al* (1997) and Ng *et al* (1994), although in the former the main source of the food-related cases was due to fish and eggs, while in this study the dominant occupations were in the meat and poultry meat processing industries. Occupational asthma has been previously associated with poultry workers (Bar-Sela *et al*, 1984), and also with exposure to PVC packaging (shrink-wrap) common in the meat-packing industry. Cleaners were also associated with a high odds of asthma in Ng *et al* (1994) as in the present study, although Meredith (1993) reported a low incidence from the SWORD scheme. As here, Ng *et al* (1994) also report high odds ratios for print workers and motor mechanics, while Meredith (1993) found metal treatment workers to have the fifth highest incidence rate, attributing the source to various metal fumes from smelting and foundry work.

Similar and comparable community-based studies of chronic bronchitis have not been reported in the literature, probably because bronchitis accounts for far fewer cases of work-related respiratory disease reported by the SWORD scheme each year. Nevertheless, a commonly cited causative agent is welding fumes, a finding that is backed up by the high estimated ORs for welders in this study. Others have found evidence of an excess of chronic bronchitics among steel workers (Hunting and Welch, 1993) and foundry workers (Karava et al, 1976), and the current study also found high ORs associated with metal treatment and processing occupations. Dusty jobs have been associated with high incidence of chronic bronchitis, most notably coalmining, which the current study also found to be strongly associated with symptoms of chronic bronchitis. Exposure to dust may also explain the raised odds of symptoms in construction workers found in this study.

4.2 Relationship between asthma and career progression

Previous studies have implicated the onset of asthma with substantial loss of earnings and difficulty in finding new work (Cannon *et al*, 1995; Gannon *et al*, 1993; Venables *et al*, 1989). These studies, unlike the present study, used direct questions on changes in employment, in follow-up surveys of workers who had previously been confirmed with diagnoses of asthma.

In the current study we compared three characteristics of career progression between asthma cases and their paired controls with zero symptoms, with reference to the age of onset of asthma symptoms of the case: the number of new jobs started after onset, the time spent in employment after onset, and the change in Social Class of jobs before and after onset. In none did we find evidence of a large overall difference between cases and controls, and indeed we found a large degree of variation between case-control pairs. Taken together, there was no compelling evidence that the onset of asthma, whether work-related or not, was detrimental to employment prospects as a whole, although much of this may have been due to a general lack of a long follow-up period among case-control pairs.

The major limitation of these analyses was the use of prevalent cases, which necessitated a retrospectively-defined follow-up period (i.e. from prevalence of symptoms back to onset of symptoms). Thus it was not possible to take account fully of the effects through time of mortality and migration of workers in and out of the study area. It may be that part of the reason for the small number starting new jobs after onset, apart from lack of follow-up time, was because we could not include those who once lived in the study area but who moved out of the area to find new work.

These analyses were prone to the same potential biases as the analyses of occupation and respiratory symptoms. A substantial misclassification of work-related cases will have weakened the power of the analyses to find differences between cases and controls if, as reported in Cannon *et al* (1995), the effect of asthma is more likely to be detrimental to the careers of work-exacerbated cases than to non-work-related cases. However, restriction of cases and controls would have introduced a hidden bias only if career progression and the completeness of information in the occupational history were related differently for cases and controls, and this is unlikely to have happened.

5. CONCLUSIONS

The principal conclusions which result from this study are summarised below.

(i) Symptoms of asthma and, in particular, of chronic bronchitis were more likely to have been reported by smokers compared to non-smokers or ex-smokers. Symptoms of chronic bronchitis were more commonly reported among males than among females.

(ii) The reporting of symptoms of asthma was associated with previous occupations held, even after allowing for different smoking habits within occupations. Symptoms of asthma were particularly implicated with occupations in food processing, catering and textiles manufacturing industries.

(iii) The reporting of symptoms of chronic bronchitis was associated with a wider range of occupations than for symptoms of asthma. After adjusting for smoking status, chronic bronchitis symptoms were associated, in particular, with occupations in dusty environments, such as coalmining, and occupations exposed to chemical and metal fumes, such as welding.

(iv) Some occupations were associated with symptoms of both conditions, most notably bakery workers. Other occupations, such as farmers, had raised odds of chronic bronchitis when asthma might have been expected. This indicated that there was a degree of misclassification between cases of asthma and chronic bronchitis due to the difficulty in diagnosing the two conditions from self-reports.

(v) The relationship between occupations and the prevalence of asthma symptoms did not depend on the work-relatedness of symptoms as diagnosed using the postal questionnaire. In light of this, and the generally poor agreement with the clinical diagnoses in the prevalence study, the use of the self-administered questionnaire by itself may not have been a reliable method of distinguishing work-related asthma from non-work-related asthma.

(vi) From the information that could be inferred from the occupational histories on career progression, there was no strong evidence that the occurrence of asthma symptoms had later adverse effects on employment prospects. However, without a longer period of follow-up, it has not been possible to investigate this aspect fully.

6. FURTHER WORK

One area of further work resulting from this study would be to examine in more detail the information given on the occupational histories to help identify, within specific high-risk occupations, the types of workplace which contribute most to the raised risks. Additional information on employers that is available in the public domain could be incorporated, such as size of company and methods of manufacturing. Separate studies of typical types of work places could than lead to a better understanding of the sensitising agents and how exposures in the workplace lead to symptoms of asthma among employees.

Another area for future work is to investigate further how questionnaire responses could be used to give improved diagnosis of cases of asthma and chronic bronchitis. There is the potential, using the results of the clinical assessments from the prevalence study, to investigate the combinations of responses that best discriminate between the two conditions, and between those with and without either of these conditions, while minimising the likelihood of misclassification. To this end it may be of value to conduct clinical examinations of more questionnaire respondents with symptoms of chronic bronchitis, to clarify any diagnostic confusion between chronic bronchitis and asthma.

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Table 2.1 Correspondence between the SOC occupational group (OG) codes and the modified SWORD-based classification of occupational sets

Major Group	SOC OG Codes	Occupational Set
1 Managerial and Administrators	100-199	
Farm owners/managers, horticulturists	160	6. Farmers
Other managers in farming, hort. and fishing	169	7. Other agric., forestry & fishing
Remainder	Remainder	9. Other prof., clerical & service
2 Professional Occupations	200-293	
Natural scientists	200-209	2. Other science & technology
Engineers and technologists	210-219	2. Other science & technology
Health Professionals	220-224	5. Other health prof. and assoc.
Remainder	Remainder	9. Other prof., clerical & service
3 Associate professional and technical occs.	300-399	
Laboratory technicians	300	1. Laboratory technicians
Scientific technicians	300-309 (ex 300)	2. Other science & technology
Nurses	340	4. Nurses
Health associate professionals	340-349 (ex 340)	5. Other health prof. and assoc.
Remainder	Remainder	9. Other prof., clerical & service
4 Clerical and secretarial occupations	400-491	
Storekeepers and warehousemen	441	31. Other transport & storage
Remainder	Remainder	9. Other prof., clerical & service
5 Craft and related occupations	500-599	
Painter and decorators	507	24. Other painters
Construction trades	500-509 (ex 507)	27. Construction
Metal machining trades	510-519	22. Other metal & electrical proc.
Electrical/electronic trades	520-529	22. Other metal & electrical proc.
Smiths and forge workers	530	21. Metal treatment
Moulders, coremakers, die casters	531	21. Metal treatment
Welding trades	537	20. Welding & electronic assembly
Metal forming, welding and related trades	532-536	22. Other metal & electrical proc.
Vehicle trades	540-544	22. Other metal & electrical proc.
Textiles, garments and related trades	550-559	16. Textiles proc.
Printing and related trades	560-569	17. Print workers
Woodworking trades	570-579	11. Wood workers
Bakers, flour confectioners	580	13. Bakers
Food preparation trades	580-582 (ex 580)	12. Other food proc.
Gardeners/groundsmen	594	7. Other agric., forestry & fishing
Horticultural trades	595	6. Farmers
Coach painters, other spray painters	596	25. Spray painters
Face-trained coalmining workers	597	28. Mining & quarrying
Office machinery mechanics	598	22. Other metal & electrical proc.
Remainder	Remainder	18. Other materials proc.
6 Personal and protective service occupations	600-699	
Assistant nurses and auxiliaries	640	4. Nurses
Hairdressers, barbers	660	8. Hairdressers
Caretakers	672	3. Cleaners
Remainder	Remainder	9. Other prof., clerical & service
7 Sales Occupations	700-792	9. Other prof., clerical & service

Table 2.1 (Continued)

Major Group	SOC OG Codes	Occupational Set
8 Plant and machine operatives	800-899	
Bakery and confectionery process oper.	800	13. Bakers
Other food, drink, tobacco process oper.	809	12. Other food proc.
Textiles and tannery process oper.	810-814	16. Textiles proc.
Chemical, gas, petroleum process plant oper.	820	15. Chemicals proc.
Plastics process oper., moulders & extruders	825	14. Plastics proc.
Metal making and treating process oper.	830-839	21. Metal treatment
Metal working process oper.	840-844	22. Other metal & electrical proc.
Assemblers/lineworkers (electrical goods)	850	20. Welding & electronic assembly
Assemblers/lineworkers (metal goods)	851	22. Other metal & electrical proc.
Routine laboratory testers	864	1. Laboratory technicians
Road transport oper.	870-875	30. Road transport
Other transport and machinery oper.	880-889	31. Other transport & storage
Printing machine minders	891	17. Print workers
Water and sewerage plant attendants	892	27. Construction
Electrical, energy and boiler plant oper.	893	22. Other metal & electrical proc.
Oilers, greasers, lubricators	894	22. Other metal & electrical proc.
Mains and service pipe layers and jointers	895	27. Construction
Construction and related oper.	896	27. Construction
Woodworking machine oper.	897	11. Wood workers
Mine (ex coal) and quarry workers	898	28. Mining & quarrying
Remainder	Remainder	18. Other materials proc.
9 Other occupations	900-999	
Farm workers	900	6. Farmers
Other occs. in agric., forestry and fishing	900-904 (ex 900)	7. Other agric., forestry & fishing
Coal mine labourers	910	28. Mining & quarrying
Labourers in foundries	911	21. Metal treatment
Labourers in engineering and allied trades	912	22. Other metal & electrical proc.
Mates to metal/electrical and related fitters	913	22. Other metal & electrical proc.
Other labourers in processing industries	919	40. Labourers & general workers
Mates to woodworking trades workers	920	11. Wood workers
Other occupations in construction	920-929 (ex 920)	27. Construction
Driver's mates	934	30. Road transport
Other occupations in transport	930-934 (ex 934)	31. Other transport & storage
Window cleaners/Road sweepers/Cleaners	956-958	3. Cleaners
All other labourers and related workers	990	40. Labourers & general workers
All other miscellaneous workers	999	18. Other materials proc.
Remainder	Remainder	9. Other prof., clerical & service
0 Non-SOC codes		
Student (tertiary)	960	50. Students
Student (secondary)	961	50. Students
Resident abroad (occupation unknown)	962	80. Unknown occupation
Unknown occupation	970	80. Unknown occupation
Unemployed	980	60. Unemployed
Sick leave/ Invalidity	981	60. Unemployed
Maternity leave	982	60. Unemployed
Retired	983	60. Unemployed
Training schemes	984	70. Training schemes

Abbreviations:

agric.	agriculture	assoc.	associates	ex	excluding
hort.	horticulture	occs.	occupations	oper.	operatives
proc.	processors	prof.	professionals		

Table 2.2 Categories of social class based on occupation

Class	Description
I	Professional, etc occupations
II	Managerial and Technical occupations
III	Skilled occupations
	(N) non-manual
	(M) manual
IV	Partly-skilled occupations
V	Unskilled occupations

Notes:

(a) each occupation is given a basic social class;
(b) persons of foreman status whose basic social class is IV or V are allocated to social class III;
(c) persons of manager status are allocated to social class II with certain exceptions;
(d) members of the Armed Forces are not assigned to a specific social class.

Table 3.1 Distribution of study sample subjects by sex, smoking status and age. Percentages for sex and smoking status are given in italics. Age is years at 31/3/94 and summaries include standard deviation (SD) and sample size (n).

Characteristic		Asthma Cases			Chronic Bronchitis Cases			Controls
		Work	Non-work	All	Work	Non-work	All	
Sex	Female	103	111	214	43	95	138	245
		46.0	*55.5*	*50.5*	*20.7*	*47.5*	*33.8*	*57.8*
	Male	121	89	210	165	105	270	179
		54.0	*44.5*	*49.5*	*79.3*	*52.5*	*66.2*	*42.2*
Smoking Status	Current	73	76	149	86	122	208	71
		32.6	*38.0*	*35.1*	*41.3*	*61.0*	*51.0*	*16.7*
	Ex-	46	48	94	62	23	85	96
		20.5	*24.0*	*22.2*	*29.8*	*11.5*	*20.8*	*22.6*
	Non-	102	75	177	58	53	111	253
		45.5	*37.5*	*41.7*	*27.9*	*26.5*	*27.2*	*59.7*
	Missing	3	1	4	2	2	4	4
		1.3	*0.5*	*0.9*	*1.0*	*1.0*	*1.0*	*0.9*
Age	15 - 24	38	37	75	19	37	56	75
	25 - 34	63	47	110	43	47	90	110
	35 - 44	51	36	87	45	43	88	87
	45 - 54	46	35	81	46	42	88	81
	55 - 64	26	45	71	55	31	86	71
	Mean	38.2	40.5	39.3	43.5	39.6	41.6	39.3
	SD	12.6	14.3	13.4	13.1	13.8	13.5	13.4
	n	224	200	424	208	200	408	424

Table 3.2 Summary of the numbers (n) of cases and controls ever employed in each industry. The percentage of the total number (N) in each comparison group is shown in italics.

	Industry Division	asthma cases (N=424)		chronic bronchitis cases (N=408)		controls (N=424)	
		n	%	n	%	n	%
1	Agriculture and related service activities	10	*2.4*	20	*4.9*	10	*2.4*
2	Forestry, logging	0	*0.0*	0	*0.0*	1	*0.2*
5	Fishing	1	*0.2*	2	*0.5*	0	*0.0*
10-12	Mining of energy producing materials	20	*4.7*	38	*9.3*	13	*3.1*
13-14	Mining of non-energy producing materials	2	*0.5*	15	*3.7*	1	*0.2*
	Manufacturing:						
15-16	food products, beverages and tobacco	87	*20.5*	59	*14.5*	51	*12.0*
17-18	textiles and textiles products	52	*12.3*	38	*9.3*	37	*8.7*
19	leather products	2	*0.5*	0	*0.0*	0	*0.0*
20	wood products	8	*1.9*	10	*2.5*	14	*3.3*
21-22	pulp and paper products; publishing	30	*7.1*	27	*6.6*	23	*5.4*
23	coke and refined petroleum products	9	*2.1*	14	*3.4*	19	*4.5*
24	chemical products	22	*5.2*	34	*8.3*	26	*6.1*
25	rubber and plastic products	9	*2.1*	23	*5.6*	11	*2.6*
26	other non-metallic mineral products	23	*5.4*	28	*6.9*	17	*4.0*

Table 3.2 (continued)

	Industry Division	asthma cases (N=424) n	%	chronic bronchitis cases (N=408) n	%	controls (N=424) n	%
27-28	basic metals and metal products	52	*12.3*	67	*16.4*	34	*8.0*
29	machinery and equipment NEC	16	*3.8*	19	*4.7*	14	*3.3*
30-33	*electrical and optical equipment*	49	*11.6*	47	*11.5*	41	*9.7*
34-35	transport equipment	21	*5.0*	37	*9.1*	25	*5.9*
36-37	manufacturing NEC	10	*2.4*	11	*2.7*	9	*2.1*
40	Electricity and gas supply	11	*2.6*	12	*2.9*	12	*2.8*
41	Water supply	0	*0.0*	1	*0.2*	1	*0.2*
45	Construction	72	*17.0*	100	*24.5*	61	*14.4*
50	Sale and maintenance of motor vehicles	23	*5.4*	34	*8.3*	21	*5.0*
51	Wholesale trade	34	*8.0*	34	*8.3*	23	*5.4*
52	Retail trade	129	*30.4*	95	*23.3*	99	*23.3*
55	Hotels and restaurants	58	*13.7*	35	*8.6*	29	*6.8*
60	Land transport	29	*6.8*	48	*11.8*	17	*4.0*
61	Water transport	6	*1.4*	5	*1.2*	7	*1.7*
62	Air transport	1	*0.2*	2	*0.5*	2	*0.5*
63	Auxiliary transport activities	16	*3.8*	28	*6.9*	14	*3.3*

Table 3.2 (continued)

	Industry Division	asthma cases (N=424)		chronic bronchitis cases (N=408)		controls (N=424)	
		n	%	n	%	n	%
64	Post and telecommunications	22	*5.2*	14	*3.4*	20	*4.7*
65	Financial intermediation	24	*5.7*	11	*2.7*	26	*6.1*
66	Insurance and pension funding	6	*1.4*	2	*0.5*	19	*4.5*
67	Auxiliary financial activities	9	*2.1*	9	*2.2*	1	*0.2*
70	Real estate activities	1	*0.2*	1	*0.2*	4	*0.9*
71	Renting of machinery and equipment	9	*2.1*	8	*2.0*	9	*2.1*
72	Computer and related activities	6	*1.4*	3	*0.7*	8	*1.9*
73	Research and development	2	*0.5*	3	*0.7*	3	*0.7*
74	Other business activities	58	*13.7*	48	*11.8*	45	*10.6*
75	Public administration and defence	111	*26.2*	101	*24.8*	97	*22.9*
80	Education	46	*10.8*	53	*13.0*	54	*12.7*
85	Health and social work	77	*18.2*	45	*11.0*	76	*17.9*
90	Sewage and refuse disposal	0	*0.0*	1	*0.2*	3	*0.7*
91	Activities of membership activities NEC	8	*1.9*	13	*3.2*	11	*2.6*
92	Recreational, cultural and sporting activities	18	*4.2*	13	*3.2*	24	*5.7*
93	Other service activities	19	*4.5*	17	*4.2*	12	*2.8*

Table 3.2 (continued)

	Industry Division	asthma cases (N=424)		chronic bronchitis cases (N=408)		controls (N=424)	
		n	%	n	%	n	%
95	Private households	9	*2.1*	5	*1.2*	8	*1.9*
99	Extra-territorial organisations	0	*0.0*	0	*0.0*	1	*0.2*
	Unknown industry	10	*2.4*	6	*1.5*	5	*1.2*
	No industry (students, unemployed, etc.)	40	*9.4*	21	*5.1*	20	*4.7*

NEC Not elsewhere classified

Table 3.3 Estimated coefficients (coeff) and ratio of coefficient to standard error (SE) for conditional logistic regression models fitted to asthma cases and controls.

Terms	Model A		Model B		Model C		Model D	
	coeff	coeff/SE	coeff	coeff/SE	coeff	coeff/SE	coeff	coeff/SE
Smoking (vs. Non)								
Current	1.117	*6.04*	1.106	*5.97*	1.087	*5.84*	1.077	*5.76*
Ex	0.367	*1.98*	0.358	*1.93*	0.339	*1.82*	0.330	*1.77*
Sex (vs.Females)								
Males			0.258	*1.80*			0.269	*1.86*
Occupation (vs. never)								
Food processor					0.786	*2.08*	0.809	*2.13*

Table 3.4 Estimated coefficients (coeff) and ratio of coefficient to standard error (SE) for unconditional logistic regression models fitted to chronic bronchitis cases and controls.

Terms	Model A		Model B		Model C		Model D	
	coeff	coeff/SE	coeff	coeff/SE	coeff	coeff/SE	coeff	coeff/SE
Smoking (vs. Non)								
Current	1.900	*10.62*	1.829	*10.04*	1.861	*10.35*	1.815	*9.93*
Ex	0.600	*3.13*	0.493	*2.51*	0.550	*2.84*	0.475	*2.40*
Age ($\times 10^{-1}$ years)	0.144	*2.50*	0.108	*1.83*	0.144	*2.51*	0.109	*1.86*
Sex (vs.Females)								
Males			0.859	*5.50*			0.824	*5.13*
Occupation (vs. never)								
Construction worker					0.674	*2.16*	0.284	*0.89*

Table 3.5 Estimated asthma odds ratios (OR) for SWORD-based occupational sets, adjusted for smoking status, with approximate 95% confidence limits. Numbers of discordant matched pairs are denoted b (case employed, control not) and c (control employed, case not).

Occupational Set	b	c	Unadjusted OR	Unadjusted Lower Limit	Unadjusted Upper Limit	Adjusted OR	Adjusted Lower limit	Adjusted Upper limit
1 Lab. technicians	12	14	0.86	0.40	1.85	0.86	0.38	1.94
2 Other science & technology	23	23	1.00	0.56	1.78	1.04	0.57	1.90
3 Cleaners	37	17	2.18	1.23	3.87	1.85	1.02	3.37
4 Nurses	22	26	0.85	0.48	1.49	0.94	0.51	1.71
5 Other health professionals	5	12	0.42	0.15	1.18	0.59	0.20	1.73
6 Farmers	8	5	1.60	0.52	4.89	1.99	0.60	6.53
7 Other agric., forestry and fishing	11	9	1.22	0.51	2.95	1.11	0.43	2.86
8 Hairdressers	10	11	0.91	0.39	2.14	0.67	0.27	1.68
9 Other prof., clerical and service	68	89	0.76	0.56	1.05	0.88	0.63	1.23
11 Wood workers	20	23	0.87	0.48	1.58	0.83	0.44	1.57
12 Food processors	28	11	2.55	1.27	5.11	2.19	1.04	4.61
13 Bakers	16	2	8.00	1.84	34.79	7.34	1.63	33.20
14 Plastics processors	2	1	2.00	0.18	22.06	1.78	0.16	20.00
15 Chemical processors	3	3	1.00	0.20	4.95	1.16	0.19	6.89
16 Textiles processors	40	22	1.82	1.08	3.06	1.79	1.03	3.11
17 Print workers	15	6	2.50	0.97	6.44	2.43	0.90	6.58
18 Other materials processors	60	39	1.54	1.03	2.30	1.33	0.87	2.05
20 Welding and electronic assembly	18	11	1.64	0.77	3.46	1.39	0.62	3.11
21 Metal treatment	10	4	2.50	0.78	7.97	2.44	0.71	8.38

Table 3.5 (continued)

Occupational Set	b	c	Unadjusted OR	Unadjusted Lower Limit	Unadjusted Upper Limit	Adjusted OR	Adjusted Lower limit	Adjusted Upper limit
22 Other metal and electrical proc.	55	41	1.34	0.90	2.01	1.25	0.82	1.92
24 Painters	6	4	1.50	0.42	5.32	0.99	0.26	3.71
25 Spray painters	6	2	3.00	0.61	14.86	3.34	0.61	18.30
27 Construction	39	17	2.29	1.30	4.06	1.76	0.96	3.21
28 Mining and quarrying	8	4	2.00	0.60	6.64	1.83	0.51	6.61
30 Road transport	29	21	1.38	0.79	2.42	1.19	0.65	2.19
31 Other transport and storage	31	25	1.24	0.73	2.10	1.19	0.68	2.08
40 Labourers and general workers	19	6	3.17	1.26	7.93	3.00	1.14	7.92
50 Students	19	9	2.11	0.96	4.67	2.39	1.05	5.46
60 Unemployed	15	9	1.67	0.73	3.81	1.39	0.57	3.36
70 Training schemes	12	2	6.00	1.34	26.81	5.63	1.22	26.00
80 Unknown occupation	8	0	*	*	*	*	*	*

* No reliable estimate due to zero denominator for number of discordant pairs

Table 3.6 Estimated unadjusted odds ratios (OR) for SOC-based minor groups with approximate 95% confidence limits. Numbers of discordant matched pairs for asthma analysis are denoted b (case employed, control not) and c (control employed, case not). Also given are the number of chronic bronchitis cases (n_1) and controls (n_2) who have ever been employed in each occupation, based on a total of 408 chronic bronchitis cases and 424 controls.

	Minor Group	Asthma					Chronic Bronchitis				
		b	c	OR	Lower Limit	Upper Limit	n_1	n_2	OR	Lower Limit	Upper Limit
10	General Managers and Administrators	8	7	1.14	0.41	3.15	4	7	0.59	0.17	2.03
11	Production Managers	12	16	0.75	0.35	1.59	12	17	0.73	0.34	1.54
12	Specialist Managers	17	16	1.06	0.54	2.10	12	16	0.77	0.36	1.65
13	Financial Institution and Office Managers	15	19	0.79	0.40	1.55	5	20	0.25	0.09	0.67
14	Managers in Transport and Storing	6	6	1.00	0.32	3.10	7	6	1.22	0.41	3.65
15	Protective Service Officers	2	4	0.50	0.09	2.73	3	4	0.78	0.17	3.50
16	Managers in Farming, Hort., Forestry and Fishing	1	1	1.00	0.06	15.99	7	1	7.38	0.90	60.29
17	Managers and Proprietors in Service Industries	22	24	0.92	0.51	1.63	22	24	0.95	0.52	1.72
19	Managers and Administrators NEC	4	5	0.80	0.21	2.98	6	5	1.25	0.38	4.13
20	Natural Scientists	1	3	0.33	0.03	3.20	1	4	0.26	0.03	2.32
21	Engineers and Technologists	12	11	1.09	0.48	2.47	10	11	0.94	0.40	2.25
22	Health Professionals	1	2	0.50	0.05	5.51	0	2	*	*	*
23	Teaching Professionals	12	21	0.57	0.28	1.16	17	22	0.79	0.42	1.52
24	Legal Professionals	1	0	*	*	*	0	0	*	*	*

Table 3.6 (continued)

	Minor Group	Asthma					Chronic Bronchitis				
		b	c	OR	Lower Limit	Upper Limit	n_1	n_2	OR	Lower Limit	Upper Limit
25	Business and Financial Professionals	2	6	0.33	0.07	1.65	3	6	0.52	0.13	2.08
26	Architects, Town Planners and Surveyors	2	5	0.40	0.08	2.06	2	5	0.41	0.08	2.14
27	Librarians	0	0	*	*	*	1	0	*	*	*
29	Professional Occupations NEC	1	2	0.50	0.05	5.51	0	2	*	*	*
30	Scientific Technicians	17	20	0.85	0.45	1.62	13	22	0.60	0.30	1.21
31	Draughtspersons, Quantity and other Surveyors	6	8	0.75	0.26	2.16	4	8	0.51	0.15	1.72
32	Computer Analyst/Programmers	2	6	0.33	0.07	1.65	3	6	0.52	0.13	2.08
34	Ship and Aircraft Officers	19	27	0.70	0.39	1.27	13	29	0.45	0.23	0.88
33	Health Associate Professionals	1	3	0.33	0.03	3.20	3	3	1.04	0.21	5.18
35	Legal Associate Professionals	1	0	*	*	*	0	0	*	*	*
36	Business and Financial Associate Professionals	6	4	1.50	0.42	5.32	5	4	1.30	0.35	4.89
37	Social Welfare Associate Professionals	5	4	1.25	0.34	4.66	4	4	1.04	0.26	4.18
38	Literary, Artistic and Sports Professionals	5	11	0.45	0.16	1.31	6	11	0.56	0.21	1.53
39	Assoc. Professional and Technical Occupations NEC	7	6	1.17	0.39	3.47	8	6	1.39	0.48	4.05
40	Administrative/Clerical Officers	27	36	0.75	0.46	1.24	13	39	0.32	0.17	0.62
41	Numerical Clerks and Cashiers	52	47	1.11	0.75	1.64	23	53	0.42	0.25	0.70

Table 3.6 (continued)

	Minor Group	Asthma					Chronic Bronchitis				
		b	c	OR	Lower Limit	Upper Limit	n_1	n_2	OR	Lower Limit	Upper Limit
42	Filing and Records Clerks	18	19	0.95	0.50	1.81	9	20	0.46	0.20	1.01
43	Clerks (not otherwise specified)	37	56	0.66	0.44	1.00	31	61	0.49	0.31	0.77
44	Stores and Despatch Clerks, Storekeepers	16	18	0.89	0.45	1.74	24	18	1.41	0.75	2.64
45	Secretaries	19	35	0.54	0.31	0.95	15	38	0.39	0.21	0.72
46	Receptionists	20	13	1.54	0.77	3.09	10	14	0.74	0.32	1.68
49	Clerical and secretarial NEC	17	15	1.13	0.57	2.27	11	15	0.76	0.34	1.66
50	Construction Trades	20	12	1.67	0.81	3.41	33	12	3.02	1.54	5.94
51	Metal Machining and Instrument Making Trades	19	23	0.83	0.45	1.52	41	26	1.71	1.03	2.85
52	Electrical/Electronic Trades	19	8	2.37	1.04	5.43	22	8	2.96	1.30	6.74
53	Metal Forming/Welding Trades	19	11	1.73	0.82	3.63	42	12	3.94	2.04	7.60
54	Vehicle Trades	10	4	2.50	0.78	7.97	17	4	4.57	1.52	13.69
55	Textiles/Garments Trades	34	21	1.62	0.94	2.79	26	25	1.09	0.62	1.91
56	Printing Trades	13	5	2.60	0.93	7.29	8	6	1.39	0.48	4.05
57	Woodworking Trades	15	20	0.75	0.38	1.46	24	20	1.26	0.69	2.32
58	Food Preparation Trades	17	0	*	*	*	19	0	*	*	*
59	Other Craft NEC	27	15	1.80	0.96	3.38	40	15	2.96	1.61	5.45

Table 3.6 (continued)

	Minor Group	Asthma b	c	OR	Lower Limit	Upper Limit	Chronic Bronchitis n_1	n_2	OR	Lower Limit	Upper Limit
60	NCOs and other ranks, Armed Forces	38	16	2.37	1.32	4.26	40	18	2.45	1.38	4.35
61	Security and Protective Service	14	9	1.56	0.67	3.59	19	10	2.02	0.93	4.40
62	Catering	42	16	2.62	1.48	4.67	28	20	1.49	0.82	2.69
63	Travel Attendants	1	7	0.14	0.02	1.16	5	7	0.74	0.23	2.35
64	Health	27	20	1.35	0.76	2.41	12	22	0.55	0.27	1.13
65	Childcare	10	18	0.56	0.26	1.20	9	19	0.48	0.21	1.08
66	Hairdressers/Beauticians	10	12	0.83	0.36	1.93	11	12	0.95	0.41	2.18
67	Domestic Staff	13	6	2.17	0.82	5.70	10	6	1.75	0.63	4.86
69	Personal and Protective Service NEC	2	2	1.00	0.14	7.10	0	2	0.00	*	*
70	Buyers/Brokers	3	2	1.50	0.25	8.98	1	2	0.52	0.05	5.74
71	Sales Representatives	12	14	0.86	0.40	1.85	17	14	1.27	0.62	2.62
72	Sales Assistants	77	59	1.31	0.93	1.83	59	74	0.80	0.55	1.16
73	Mobile/Market Salespersons	9	7	1.29	0.48	3.45	5	7	0.74	0.23	2.35
79	Sales Occupations NEC	7	4	1.75	0.51	5.98	2	4	0.52	0.09	2.84
80	Food, Drink and Tobacco Process Operatives	31	17	1.82	1.01	3.29	19	19	1.04	0.54	2.00
81	Textiles and Tannery Process Operatives	8	2	4.00	0.85	18.84	7	2	3.68	0.76	17.84

Table 3.6 (continued)

	Minor Group	Asthma					Chronic Bronchitis				
		b	c	OR	Lower Limit	Upper Limit	n_1	n_2	OR	Lower Limit	Upper Limit
82	Chemicals/Paper/Plastics Process Operatives	13	8	1.62	0.67	3.92	31	9	3.79	1.78	8.07
83	Metal Making and Treating Process Operatives	7	2	3.50	0.73	16.85	7	3	2.45	0.63	9.54
84	Metal Working Process Operatives	8	2	4.00	0.85	18.84	9	2	4.76	1.02	22.16
85	Assemblers/Lineworkers	19	14	1.36	0.68	2.71	25	14	1.91	0.98	3.73
86	Other Routine Process Operatives	40	32	1.25	0.79	1.99	39	36	1.14	0.71	1.83
87	Road Transport Operatives	28	20	1.40	0.79	2.49	43	22	2.15	1.26	3.67
88	Other Transport and Machine Operatives	13	10	1.30	0.57	2.96	20	10	2.13	0.99	4.62
89	Plant and Machine Operatives NEC	22	10	2.20	1.04	4.65	30	10	3.29	1.58	6.81
90	Other Occupations in Agric., Forestry and Fishing	11	8	1.37	0.55	3.42	14	8	1.85	0.77	4.45
91	Other Occupations in Mining and Manufacturing	14	8	1.75	0.73	4.17	26	9	3.14	1.45	6.78
92	Other Occupations in Construction	21	8	2.62	1.16	5.93	26	9	3.14	1.45	6.78
93	Other Occupations in Transport	5	5	1.00	0.29	3.45	17	5	3.64	1.33	9.97
94	Other Occupations in Communication	8	2	4.00	0.85	18.84	2	2	1.04	0.15	7.41
95	Other Occupations in Sales and Services	52	22	2.36	1.44	3.89	40	27	1.60	0.96	2.66
99	Other Occupations NEC	20	5	4.00	1.50	10.66	27	5	5.94	2.26	15.58

* No reliable estimate due to zero number of discordant pairs NEC Not elsewhere classified

Table 3.7 Estimated coefficients for non-work-related cases ($coeff_{NW}$) and for the difference between work-related and non-work-related cases ($coeff_{DIF}$). The ratio of coefficient to standard error (SE) is shown in italics. Based on these coefficients are estimated odds ratios (ORs) for non-work-related cases ($\log OR = coeff_{NW}$) and work-related cases ($\log OR = coeff_{NW} + coeff_{DIF}$).

Occupational set		Non-work-related cases		Difference (work minus non-work)		Estimated ORs	
		$coeff_{NW}$	*$coeff_{NW}$/SE*	$coeff_{DIF}$	*$coeff_{DIF}$/SE*	Non-work	Work
3	Cleaners	0.855	*2.00*	-0.518	*-0.84*	2.35	1.40
4	Nurses	0.127	*0.28*	-0.346	*-0.56*	1.14	0.80
11	Wood workers	-0.962	*-1.91*	1.506	*2.19*	0.38	1.72
12	Food processors	1.002	*1.67*	-0.370	*-0.48*	2.72	1.88
16	Textiles processors	1.358	*2.89*	-1.420	*-2.34*	3.89	0.94
20	Welding & electronic assembly	0.411	*0.74*	-0.180	*-0.22*	1.51	1.26
22	Other metal & electrical proc.	-0.144	*-0.47*	0.746	*1.69*	0.87	1.83
27	Construction	0.360	*0.78*	0.357	*0.58*	1.43	2.05
40	Labourers & general workers	1.600	*1.97*	-0.865	*-0.84*	4.93	2.07

Table 3.8 Estimated chronic bronchitis odds ratios (OR) for SWORD-based occupational sets, adjusted for smoking status and age, with approximate 95% confidence limits. Also given are the number of cases (n_1) and controls (n_2) who have ever been employed in each occupation, based on a total of 408 cases and 424 controls.

Occupational Set	n_1	n_2	Unadjusted OR	Unadjusted Lower Limit	Unadjusted Upper Limit	Adjusted OR	Adjusted Lower limit	Adjusted Upper limit
1 Lab. technicians	5	14	0.36	0.13	1.01	0.37	0.12	1.09
2 Other science and technology	20	24	0.86	0.47	1.58	1.00	0.52	1.94
3 Cleaners	32	18	1.92	1.06	3.47	1.65	0.87	3.13
4 Nurses	13	28	0.47	0.24	0.91	0.42	0.20	0.87
5 Other health professionals	3	12	0.25	0.07	0.91	0.46	0.12	1.75
6 Farmers	16	6	2.84	1.10	7.32	3.14	1.16	8.51
7 Other agric., forestry and fishing	18	9	2.13	0.95	4.78	2.14	0.90	5.09
8 Hairdressers	11	11	1.04	0.45	2.43	0.86	0.34	2.16
9 Other prof., clerical and service	263	330	0.52	0.38	0.70	0.58	0.41	0.81
11 Wood workers	36	23	1.69	0.98	2.90	1.47	0.81	2.66
12 Food processors	26	13	2.15	1.09	4.24	1.72	0.82	3.61
13 Bakers	10	2	5.30	1.16	24.29	5.28	1.11	25.20
14 Plastics processors	3	1	3.13	0.33	30.15	2.66	0.26	27.29
15 Chemical processors	15	4	4.01	1.32	12.18	3.23	1.01	10.32
16 Textiles processors	31	26	1.26	0.73	2.16	1.13	0.63	2.03
17 Print workers	9	7	1.34	0.50	3.64	1.28	0.44	3.69
18 Other materials processors	68	46	1.64	1.10	2.45	1.35	0.87	2.09
20 Welding and electronic assembly	31	12	2.82	1.43	5.57	2.36	1.15	4.86
21 Metal treatment	18	5	3.87	1.42	10.51	3.78	1.32	10.84

Table 3.8 (continued)

Occupational Set	n_1	n_2	Unadjusted OR	Unadjusted Lower Limit	Unadjusted Upper Limit	Adjusted OR	Adjusted Lower limit	Adjusted Upper limit
22 Other metal and electrical proc.	104	52	2.45	1.70	3.52	2.15	1.45	3.18
24 Painters	20	4	5.41	1.84	15.95	4.88	1.58	15.03
25 Spray painters	3	2	1.56	0.26	9.36	1.69	0.24	11.84
27 Construction	42	18	2.59	1.47	4.57	1.96	1.07	3.61
28 Mining and quarrying	28	4	7.73	2.72	21.96	4.68	1.58	13.86
30 Road transport	44	23	2.11	1.25	3.55	1.55	0.88	2.73
31 Other transport and storage	54	25	2.43	1.49	3.99	1.81	1.06	3.08
40 Labourers and general workers	30	6	5.53	2.28	13.41	4.13	1.65	10.36
50 Students	7	9	0.80	0.30	2.18	1.08	0.37	3.12
60 Unemployed	13	11	1.24	0.55	2.79	0.87	0.36	2.11
70 Training schemes	9	2	4.76	1.02	22.15	2.79	0.56	13.96
80 Unknown occupation	3	0	*	*	*	*	*	*

* No reliable estimate due to zero denominator for number of discordant pairs

Table 3.9 Paired differences in number of jobs held after the date of onset of asthma symptoms, expressed as case minus control, showing mean, standard deviation (SD) and number of pairs (n).

(a) All cases

Sex		Work			Non-work			All		
Case	Cont	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*
M	M	0.4	2.6	*32*	-0.1	1.7	*29*	0.2	2.2	*61*
F	M	0.4	1.4	*28*	0.4	2.5	*44*	0.4	2.2	*72*
M	F	-0.2	1.8	*48*	-0.4	2.4	*47*	-0.3	2.2	*95*
F	F	0.2	1.6	*49*	0.1	1.3	*52*	0.2	1.5	*101*
Margin		0.2	1.9	*157*	0.0	2.1	*172*	0.1	2.0	*329*

(b) Cases with date of onset prior to 1990

Sex		Work			Non-work			All		
Case	Cont	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*
M	M	0.6	3.5	*16*	-0.5	2.1	*17*	0.0	2.9	*33*
F	M	1.0	2.5	*7*	0.7	3.8	*19*	0.8	3.4	*26*
M	F	-0.2	2.5	*26*	-0.8	3.0	*29*	-0.5	2.7	*55*
F	F	0.4	2.3	*23*	0.1	1.9	*20*	0.2	2.1	*43*
Margin		0.3	2.7	*72*	-0.2	2.8	*85*	0.0	2.7	*157*

(c) Cases with date of onset prior to 1985

Sex		Work			Non-work			All		
Case	Cont	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*
M	M	1.2	3.7	*11*	-0.6	2.5	*12*	0.3	3.2	*23*
F	M	2.0	3.6	*3*	0.9	4.3	*14*	1.1	4.1	*17*
M	F	-1.0	2.7	*13*	-1.0	3.7	*16*	-1.0	3.3	*29*
F	F	0.0	2.4	*14*	0.3	2.5	*11*	0.1	2.4	*25*
Margin		0.2	3.0	*41*	-0.2	3.4	*53*	0.0	3.2	*94*

Table 3.10 Paired differences in the time spent in employment (months) after the date of onset of asthma symptoms, expressed as case minus control, showing mean, standard deviation (SD) and number of pairs (n).

(a) All cases

Sex		Work			Non-work			All		
Case	Cont	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*
M	M	-7	45	*17*	-14	29	*18*	-10	37	*35*
F	M	6	18	*16*	-27	80	*24*	-14	65	*40*
M	F	28	52	*27*	-24	48	*19*	6	56	*46*
F	F	-6	56	*31*	-10	30	*29*	-7	45	*60*
Margin		6	50	*91*	-18	51	*90*	-6	52	*181*

(b) Cases with date of onset prior to 1990

Sex		Work			Non-work			All		
Case	Cont	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*
M	M	-11	62	*9*	-20	32	*10*	-16	47	*19*
F	M	32	31	*3*	-68	123	*9*	-43	115	*12*
M	F	47	70	*13*	-31	53	*15*	5	72	*28*
F	F	-15	80	*15*	-22	46	*11*	-18	67	*26*
Margin		9	74	*40*	-34	68	*45*	-14	74	*85*

(c) Cases with date of onset prior to 1985

Sex		Work			Non-work			All		
Case	Cont	mean	SD	*n*	mean	SD	*n*	mean	SD	*n*
M	M	-14	71	*7*	-17	34	*6*	-15	55	*13*
F	M	19	31	*2*	-90	133	*7*	-65	125	*9*
M	F	77	94	*6*	-32	67	*8*	15	94	*14*
F	F	-25	94	*10*	-25	32	*7*	-25	73	*17*
Margin		6	91	*25*	-41	80	*28*	-19	88	*53*

Table 3.11 Cross-tabulation of the Social Class of the last-known occupation before onset of asthma against the first new occupation started after the onset of asthma, with categories for no occupation (none) and occupation not known (NK).

a) Asthma cases

Pre-Onset	Post onset									Total
	NK	None	I	II	IIIN	IIIM	IV	V	Other	
NK	55	0	0	0	0	0	1	0	1	57
None	0	0	1	11	23	7	17	1	4	64
I	1	6	0	0	1	0	0	0	0	8
II	1	49	0	10	1	0	1	0	0	62
IIIN	7	47	0	3	16	1	6	1	1	82
IIIM	4	42	0	1	4	14	5	1	2	73
IV	3	27	0	2	2	4	10	1	1	50
V	1	14	0	0	0	0	3	0	2	20
Other	0	7	0	1	0	0	0	0	0	8
Total	72	192	1	28	47	26	43	4	11	424

b) Controls

Pre-onset	Post onset									Total
	NK	None	I	II	IIIN	IIIM	IV	V	Other	
NK	40	0	0	0	0	0	1	0	0	41
None	0	0	2	10	33	16	9	2	0	72
I	0	6	3	1	0	0	0	0	0	10
II	2	62	0	17	2	1	2	0	1	87
IIIN	1	61	0	7	17	1	4	2	1	94
IIIM	4	32	0	1	0	6	2	0	2	47
IV	5	29	0	2	3	1	8	2	1	51
V	1	9	0	0	0	1	0	1	1	13
Other	1	7	0	0	0	0	0	0	1	9
Total	54	206	5	38	55	26	26	7	7	424

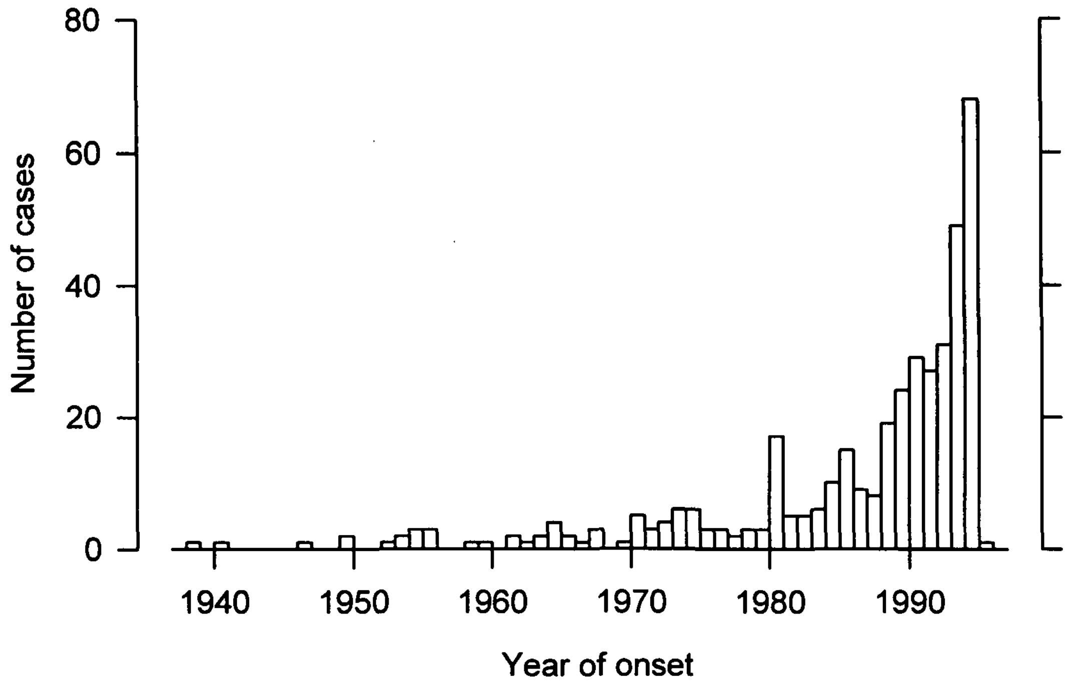

Figure 3.1 Histogram of the date of onset of first symptoms reported by asthma cases.

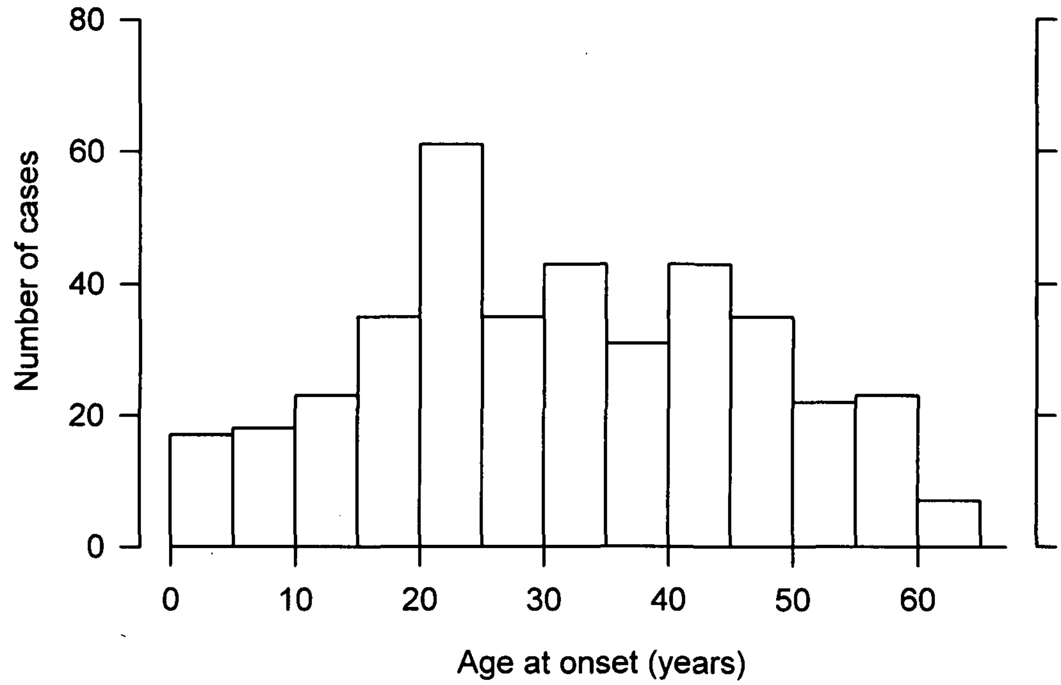

Figure 3.2 Histogram of the age of asthma cases at the date of onset of first symptoms.

Figure 3.3 Histograms of the number of new jobs started after the age of onset of asthma symptoms among (a), asthma cases, and (b), paired controls, and as (c), paired differences (case minus control).

(a) (b) (c)

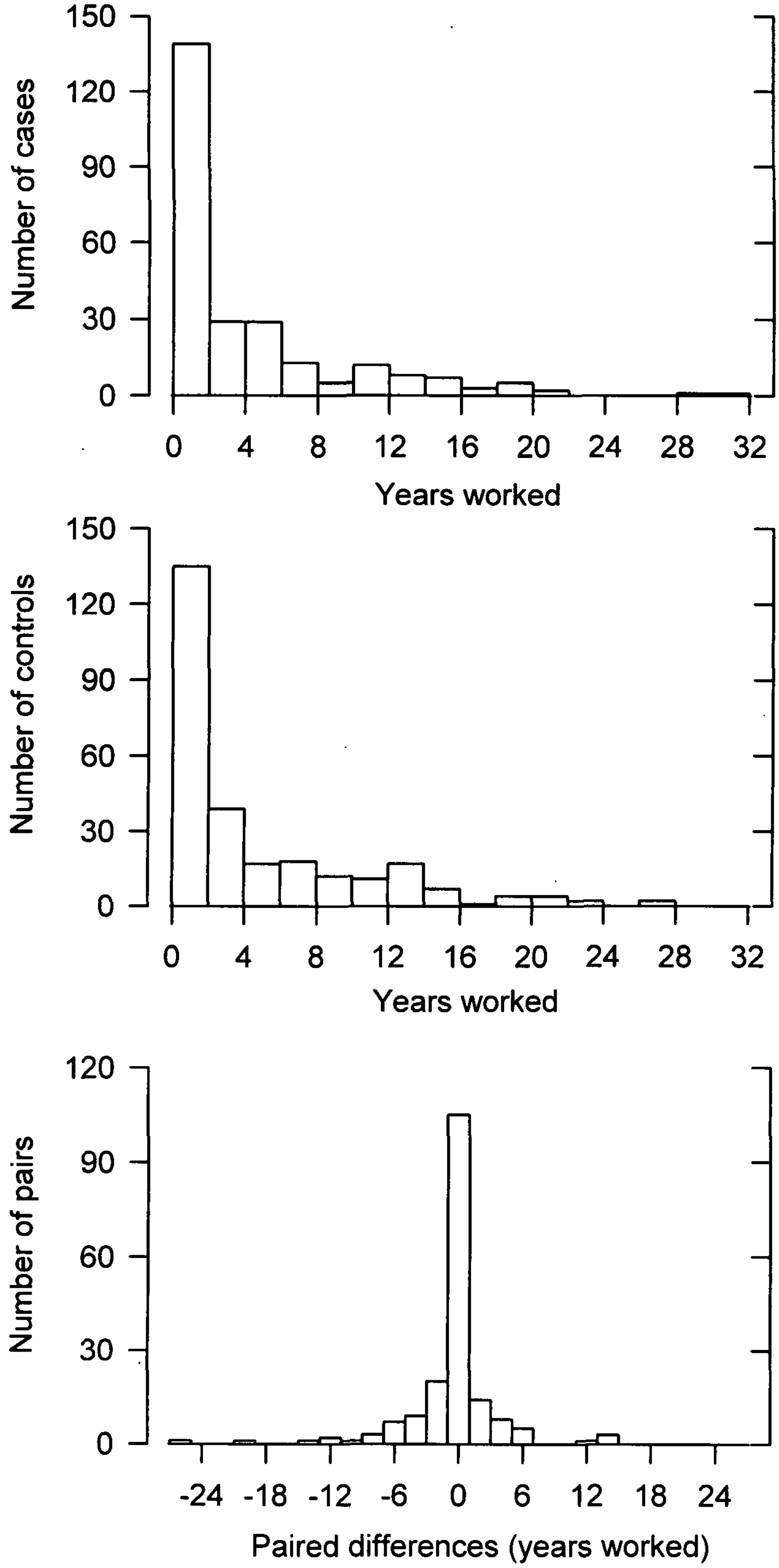

Figure 3.4 Histograms of the years spent in work after the age of onset of asthma symptoms among (a), asthma cases, and (b), paired controls, and as (c), paired differences (case minus control).

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