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LUNG DISEASES AMONG CARPENTERS

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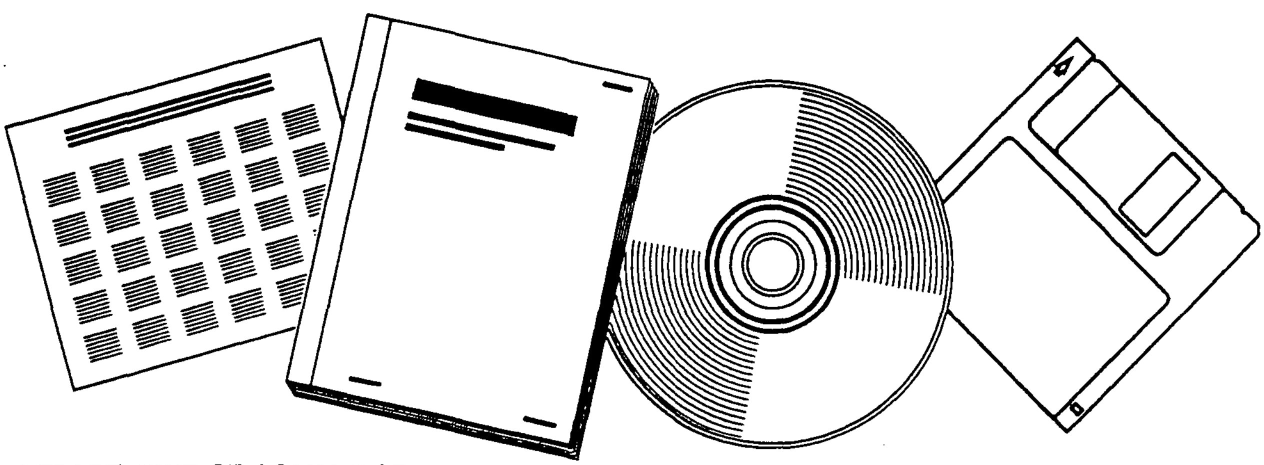

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LUNG DISEASES AMONG CARPENTERS

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16. Abstract (Limit: 200 words) Existing data sources, including health insurance claims and worker's compensation claims, were integrated to develop a more comprehensive data system for the study of respiratory disorders of possible occupational origin among members of the United Brotherhood of Carpenters and Joiners. The study cohort included 10,938 active union carpenters who had worked at least 3 months of union hours between 1989 and 1992 in Washington. Bronchitis accounted for over 50% of the lung disease cases among this cohort, occurring at a rate of 1.8 per 1,000 months of insurance eligibility, followed by asthma, chronic obstructive airway disease, and chronic bronchitis. Carpenters associated with a local whose predominant task was residential carpentry had the highest crude rates of asthma. Rates of asthma increased with increasing age and women had higher rates of asthma than men. Bronchitis increased with increasing age most dramatically in the model treating bronchitis as an acute disorder. The risk of asthma appeared greater in the first year of union membership and for women. The authors conclude that information gathered from health insurance claims and workers' compensation claims, can be used for epidemiologic research.

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SIGNIFICANT FINDINGS

This study demonstrated that administrative data sources, including health insurance claims and workers' compensation claims, can be utilized for epidemiologic research. Various ways of using external comparison data including the Occupational Supplement to the National Health Interview Survey; National Ambulatory Medical Care Survey; and Surveillance, Epidemiology, and End Results Program data were demonstrated. Among the most significant findings concerning lung diseases among carpenters are the following.

Crude incidence and prevalence

- The most common non-malignant lung diseases among these carpenters were bronchitis, asthma, chronic obstructive pulmonary disease, and chronic bronchitis with nearly all of the disease claims occurring in private health insurance files.
- Carpenters who were affiliated with a local whose predominant task was residential carpentry had the highest crude rates of asthma.

Internal comparisons

In Poisson regression models used for internal comparisons adjusting for age, sex, time in union, (and predominant task in bronchitis models only):

- Rates of asthma increased with increasing age and women had higher rates of asthma than men, but not at a statistically significant level.
- Bronchitis increased with increasing age most dramatically in the model treating bronchitis as an acute disorder (allowing individual to have more than one episode and remain at risk after first diagnosis). Carpenters whose locals did predominantly light commercial work had significantly higher rates of bronchitis than the overall group mean (RR= 1.6; CI 1.3, 1.9) in this repeat events model.
- Chronic bronchitis and chronic obstructive airway disease increased with age in fairly dramatic monotonic fashions. Women, again, had higher rates of chronic bronchitis and chronic obstructive airway disease than men, but not at statistically significant levels.

External comparisons

- The prevalence percent of asthma for male carpenters ages 45-64 was similar to prevalence percent reported in the National Health Interview Survey Occupational Supplement 1988 yet lower for all other age groups. Due to the fact that NHIS prevalence is based on self-report and the union study was based on the more restrictive ICD-9 diagnosis requiring a doctor visit this may reflect an increase in prevalence of asthma among these 45-64 year old male carpenters.
- Using the National Ambulatory Medical Care Survey for comparisons these carpenters, after the age of 50 appear to have more outpatient visits for asthma, bronchitis, and chronic bronchitis (but not chronic obstructive airway disease) than national estimates for men of the same age.

- An elevated Standardized Incidence Ratio (SIR) for lung cancer among male carpenters between the ages of 45-54.

Asthma Case-control analyses

- Using an asthma case definition based on either a provider assigned ICD-9 code or Burney's discriminant function predictor, based on symptom data, the odds ratio for grouped exposures to organic dusts was significantly elevated and the odds ratio for paints, varnishes and stains approached significance. Odds ratios for exposure to hay, epoxy paints, enzymes, animals, and molds were significantly elevated using either case definition.
- Using Burney's asthma case definition, which is considered more sensitive, the risk of asthma appeared greater in the first year of union membership and for women. Odds ratios were elevated for ever smoking history and a dose response relationship was seen for hours of passive smoke exposure per day. The odds of exposure were significantly elevated for a number of additional occupational exposures including grain, cement dust, drywall dust, lime, silica, vermiculite, wood bark dusts, polyurethane products, caulks, aluminum dusts or fumes, nickel, chromium, acids, alkali, concrete form oils, and fumes from plastics, printing inks, styrene, and urethane foam. Several of these are exposures to which over half of the subjects reported exposure.

USEFULNESS OF FINDINGS

These analyses demonstrated ways that combined administrative data, including health insurance claims and workers' compensation claims, can be utilized for epidemiologic research. These include methods of internal analyses which allow the use of all data up until censorship. Sources of external comparison were explored including the Occupational Supplement to the National Health Interview Survey; National Ambulatory Medical Care Survey; and Surveillance, Epidemiology, and End Results Program data.

The findings give some indication of excess respiratory problems among this working cohort of union carpenters particularly after the age of 45. This is documented in external comparisons by an increased incidence of lung cancer among males age 45-54, a possible excess in the period prevalence of asthma among men age 45-64, and higher rates than national estimates for outpatient doctor visits for asthma, bronchitis, and chronic bronchitis after the age of 50. Using internal comparisons, the four most common respiratory problems of these carpenters seem to increase with increasing age with chronic bronchitis and chronic obstructive airway disease increasing in a dramatic monotonic fashion with age.

A number of common exposures were identified which appear to be associated with asthma in this population. Grouped exposures to paints, varnishes, and stains consistently were associated with asthma among these union carpenters, as were organic dusts. Due to the number of carpenters exposed to many of the agents associated with asthma in the case-control analyses potential implications for prevention could be great even in the face of modestly elevated odds ratios. Results of this research also have identified possible exposures among carpenters which should be addressed through hazard surveillance studies which measure exposure levels and frequency of exposure. These data, using health insurance claims, could be used for compariosns to other worker groups.

ABSTRACT

Purpose

The purpose of this study was to integrate existing data sources to develop a more comprehensive data system for the study of respiratory disorders of possible occupational origin among members of the United Brotherhood of Carpenters and Joiners. Lung diseases among union carpenters in Washington State were studied through the combined use of union administrative records, private health insurance claims, and workers' compensation records.

Methods

A cohort of 10,938 active union carpenters was identified who had worked at least 3 months of union hours between 1989 and 1992 in Washington. All claims for lung diseases of interest filed by the cohort were identified for this time period from workers' compensation and private health insurance claims. Incidence density rates were calculated for each disorder using person-months of health insurance eligibility as the denominator, or time at risk. Event histories were constructed allowing internal comparisons to be made by age, sex, time in the union, and predominant task of the union local with which the carpenter was affiliated using stratified rates and Poisson regression techniques for simultaneous adjustment of the covariates. External comparisons were made to the Occupational Supplement of the National Health Interview Survey 1988 (NHIS), to the National Ambulatory Medical Care Survey (NAMCS) 1991 and 1992, and to Surveillance, Epidemiology, and End Results Program (SEER) data for 1991.

The enumerated cohort defined the study base for a nested case-control study of asthma among these carpenters with cases initially identified by an ICD-9 code of 493 for asthma. Data were collected from cases and controls on a wide number of exposures in the home and the workplace, as well as information on their medical and occupational histories. Including the questions used by Burney to define his discriminant function predictor (DFP) of a bronchial response to histamine in our questionnaire allowed the cases and controls to be reclassified for further analyses with this more sensitive case definition.

Results

Bronchitis accounted for over 50% of the lung disease cases among this cohort occurring at a rate of 1.8 per 1000 months of insurance eligibility, followed by asthma, chronic obstructive airway disease, and chronic bronchitis.

In Poisson regression models used for internal Comparisons adjusting for age, sex, time in union, (and predominant task in bronchitis models only):

1) Rates of asthma increased with increasing age and women had higher rates of asthma than men, but not at a statistically significant level.
2) Bronchitis increased with increasing age most dramatically in the repeat events model treating bronchitis as an acute disorder (allowing an individual to have more than one episode and remain at risk after the first diagnosis). Carpenters whose locals did predominantly light commercial work had significantly higher rates of bronchitis than the overall group mean (RR= 1.6; CI 1.3,1.9) in this model.
3) Chronic bronchitis and chronic obstructive airway disease increased with age in a fairly dramatic monotonic fashion. Women again had higher rates of chronic bronchitis and chronic obstructive airway disease than men, but not at statistically significant levels.

Using SEER rates from 1990 for indirect adjustment a significantly elevated SIR for lung cancer was seen among male carpenters between the ages of 45-54. Prevalence percent of asthma for male carpenters ages 45-64 was similar to prevalence percent reported in NHIS Occupational Supplement yet lower for all other age groups. Due to the fact that NHIS prevalence is based on self-report and ours was based on the more restrictive ICD-9 diagnosis requiring a doctor visit this may reflect an increase in prevalence of asthma among these male carpenters. Using NAMCS for comparisons these carpenters after the age of 50 appear to have more outpatient visits for asthma, bronchitis, and chronic bronchitis (but not chronic obstructive airway disease) than national estimates for similar aged men.

In case-control analyses using either case definition (ICD-9 or Burneys' DFP) the odds ratio for grouped exposures to organic dusts was significantly elevated and the odds ratio for paints, varnishes and stains approached significance. In addition, odds ratios were consistently elevated for exposure to hay, epoxy paints, enzymes, animals, and molds at a level of statistical significance. Using Burney's definition, which is more sensitive, odds ratios were significantly elevated for a number of additional occupational exposures including grain, cement dusts, drywall dusts, hay, lime, silica, vermiculite, wood bark dusts, polyurethane products, caulks, aluminum dusts or fumes, nickel, chromium, acids, alkali, concrete form oils, fumes from plastics, printing inks, styrene, and urethane foam. The odds ratio for ever smoking was elevated and a dose response relationship was seen for hours of passive smoke exposure per day. Risk appeared greater in the first year of union membership and for women.

BACKGROUND

Construction workers may be exposed to a number of substances placing them at increased risk for a number of lung disorders. Exposures include dusts such as silica, asbestos, man-made mineral fibers, cement dusts, dusts from drywall finishing and other mineral dusts. These workers are exposed to solvents, components of paints, coatings, glues and fillers. They may be exposed to cutting and welding fumes, and workers involved with renovation may have additional exposures to molds, dust mites and other organic dusts. They may also have serious occupational exposures to respiratory irritants not commonly associated with construction which may be present in industries in which they are working construction (Courteau, 1994).

Available surveillance data demonstrate increased lung disease risks for construction workers. Occupational respiratory disease surveillance data for 1973-1988, calculated from Bureau of Labor Statistics data, demonstrate annual incidence rates to range from 1.8 to 3.7 cases per 10,000 full-time workers for the construction industry. These rates are typically the second highest among industrial sectors and second only to manufacturing (NIOSH, 1991). Additionally, industries such as ship and boat building and repair, which employ carpenters and other construction crafts, had the highest rate of reported occupational dust diseases of the lung in 1990 (33.5 cases per 10,000 full-time workers) (NIOSH, 1992). Analyses of multiple cause of death listings show the construction industry to be one the industry's most frequently listed for deaths mentioning asbestosis, malignant neoplasms of the pleura, coal workers pneumoconiosis and silicosis (NIOSH, 1992).

Epidemiological data concerning occupational lung disease hazards among carpenters and other construction trades are limited. The following sections provide a brief review of epidemiological data concerning lung diseases among carpenters and other construction workers.

LUNG CANCER AND PNEUMOCONIOSES AMONG CONSTRUCTION CRAFTS

Occupational factors play an important role in the development of lung cancer independently and interactively with smoking with excess risk seen in carpenters and construction workers (Kawachi, 1989; Feldman, 1990; Morabia, 1992; Teschke, 1992; Yamaguchi, 1992, Bovenzi 1993). The percentage compensated by worker's compensation boards has been confirmed to fall short of occupationally related cases (Teschke, 1992). These data strongly suggest the need for alternative data sources for occupational lung disease surveillance and epidemiology.

A number of population-based studies have reported moderately elevated risks of death from lung cancer among carpenters including an early mortality study of union carpenters done by Milham (1978) and Olsen and Sabroe's study of Danish cabinet makers (1980). More recent studies report this as a consistent finding among construction workers (Dong, 1995; Stern, 1995; Robinson, 1995) and specifically among carpenters (Milham, 1983; Zahm, 1989; Firth, 1993; Stellman, 1984). A recent NIOSH study revealed a proportionate mortality ratio (PMR) for lung cancer among union carpenters who died between 1987 and 1990 of 123 (95% CI 118-128). The proportionate cancer mortality ratio (PCMR) for lung cancer was 106 (95% CI 102-111) indicating a significant excess of lung cancer deaths among these workers (Robinson NIOSH 1995 draft). Similar findings have been reported among women in construction with white women less than 65 years old at death having an elevated PMR of 118 (95% CI 102-134) for lung cancer (Robinson and Burnett, 1994).

The PMR for deaths between 1979 and 1990 for cancer of the pleura (163 mesothelioma) among white men usually employed in construction in 28 U.S. States was 154 (CI 114-203) for those who died under the age of 65 and 163 (CI 137-142) for all deaths (Robinson, 1995). Shipbuilders and shipyard workers with known asbestos exposure have an increased risk of mesothelioma (Coggon, 1986; Muscat, 1991; Yamaguchi, 1992, Harries, 1968). No threshold level has been defined for asbestos-induced lung cancers and mesotheliomas and cases are reported in people with low exposures (Garrahan, 1987).

Several studies have identified carpenters who are employed in shipyards to be at increased risk for asbestos related diseases (Harries, 1968; Puntoni, et.al., 1979; Selikoff and Hammond, 1978). Carpenters who perform drywall finishing have been shown to be at significant risk for asbestosis due to past exposures to asbestos from drywall finishing compounds (Fischbein et.al., 1979). Individuals exposed to in-place asbestos containing building materials (ACBM) including teachers and school maintenance workers are at increased risk for asbestos related diseases (Anderson, 1991; Levin, 1991; Oliver, 1991; Balmes, 1991). Carpenters are a group with likely exposure to ACBM and are known to work around asbestos regularly, even if not directly.

Highly significant mortality for mesothelioma was seen among furniture workers in Switzerland (exp=4.4, obs=12; RR=2.7, $p<.004$) without histories of asbestos exposure. Although the authors report conflicting data on wood dust exposure as a risk factor for mesothelioma in humans, wood compounds can produce a type of mesothelioma (tunica albuginea) in rats (Minder, 1988).

Pleural placques, followed by interstitial fibrosis, were the most prevalent asbestos related disease identified in a recent cross-sectional study of active and retired union construction carpenters in Massachusetts. The study included predominantly commercial carpenters exposed to insulation and fireproofing, millwrights who worked on asbestos covered steam lines, and a small number from shipyards. Most (97.5%) reported exposure to asbestos (Garcia-Closas, 1995).

Among ironworkers even though ex-smokers had the highest prevalence of pleural lung changes, in multivariate analyses duration of employment, a likely surrogate for higher exposure to asbestos, was the most important factor in predicting pleural abnormalities on chest x-ray (Fischbein, 1991). Pleural abnormalities on chest x-ray and abnormal pulmonary function tests have been documented among workers in metal related trades who are employed at construction sites but who do not routinely use asbestos (Fischbein, 1991; Welch, 1991). This has implications for carpenters who experience similar indirect exposures.

CHRONIC OBSTRUCTIVE PULMONARY DISEASES (COPD) AMONG CONSTRUCTION CRAFTS

Exposure to wood dust or some broncho-reactive substance linked with woodworking can induce COPD. A dose response relationship between reduced lung function and wood dust exposure has been demonstrated (Carosso, 1987). Airflow obstruction has been documented in current and retired construction insulators (Kennedy, 1991) and in painters (White, 1988; Schwartz, 1988). There was a significant relationship between years of exposure to paint and amount of obstruction measured by FEV1 and FEV1/FVC (Schwartz, 1988). Reduced airflow in small airways suggestive of obstruction with air trapping has been described as the earliest measurable consequence of asbestos exposure among asbestos workers without documentation of asbestosis (Kilburn, 1994). Among sheet metal workers exposure to welding was positively associated with chronic obstructive lung disease while asbestos had inconsistent effects and seemed to differ by smoking exposure. The data were suggestive that some attribution of disease to smoking in the past may in part be due to asbestos exposure (Hunting and Welch, 1993). These findings may have implications for carpenters as well, again, because of their known exposures to asbestos in the workplace. Many carpenter related trades result in exposures similar to those experienced by painters and sheet metal workers.

The most frequent functional impairment seen in the above mentioned study of Massachusetts carpenters with known exposures to asbestos was an obstructive pattern, followed by restrictive and mixed patterns (Garcia-Closas, 1995). Similar patterns of lung function decrements were seen in metal-workers with pleural disease despite lack of direct exposures to asbestos (Fischbein, 1993).

WHEEZING/CHRONIC BRONCHITIS/ASTHMA/NON-SPECIFIC LUNG DISEASE

Chronic non-specific lung disease, marked by chronic bronchitis or regular cough/phlegm of greater than 3 months duration or episodes of wheezing, was seen among construction workers, painters, and woodworkers in a longitudinal study over a 25 year period (Heederick, 1990). Phlegm was found to be more prevalent among welders (stainless steel and mild steel) than among a comparison group of vehicle assemblers and dyspnea occurred more frequently in stainless steel welders and ex-mild steel welders. Active welding was associated with increased prevalence of phlegm and dyspnea after consideration of smoking habits, and both types of welding were associated with relatively high incidence of asthma (Wang, 1994). The prevalence of chronic bronchitis in a cross sectional study of painters was reported to increase with increasing use of spray application methods. (White, 1988). This type of exposure could potentially expose others working in the immediate vicinity. Exposure to asbestos and high intensity exposure to fiberglass were predictive of chronic bronchitis among sheet metal workers (Hunting and Welch, 1993).

In a community-based case-control study of asthma in Singapore the odds ratio for being a construction/renovation worker was 2.2 (1.3-3.4) (Ng, 1994). Increased asthma prevalence has been observed in workers spray applying paints containing mixed isocyanates (Seguin, 1987). Two cases of occupational asthma have been reported to be caused by TDI pre-polymer in wood varnish (Vandenplus, 1992). Increased bronchial hyper responsiveness has been described among painters compared to referents with a decreased FEV1 and FVC during the workday in young painters exposed to water-based paints (Weislander, 1994). Exposure to a number of wood dusts have been associated with diagnoses of asthma (Norrish, 1992), most commonly red cedar (Chan-Yeung , 1990; Siracusa, 1995), but also eastern white cedar (Malo, 1994), oak (Malo, 1995) and possibly pine and spruce (Hessel, 1995). In the latter report sawmill workers were 2.5(0.76-8.3) times more likely than oil field workers to report current asthma despite respirable dust levels below the present occupational standard. Other exposures in this sawmill operation have also been hypothesized as possible asthmagens including terpenes, fungi produced in debarking, and aerosolized oils used to lubricate saws. Children living in homes in Denmark with "much particle board" were at risk for asthma (Daugbjerg, 1989). This type of exposure may be significant in workers who handle this material regularly.

Increased mortality due to asthma has been demonstrated among carpenters in California (Peterson, 1980; Schnecker, 1993). One fatal case of asthma has been reported of a patient with documented isocyanate-induced asthma who continued to work after diagnosis (Chan-Yeung, 1986). Urethane containing paints have found widespread use in many industries including the furniture industry (Chan-Yeung, 1990).

SUMMARY

While there is relatively little epidemiologic data on lung diseases among carpenters, excess deaths due to lung cancer have consistently been reported for this occupational group and for construction workers in general. This excess has typically been attributed to asbestos. Pleural abnormalities have been reported to be the most common asbestos related disease among carpenters and there is evidence that this finding is associated with obstructive lung disease. It is not clear whether this is related to pleural changes or to underlying, unrecognized interstitial disease. Asthma and more non-specific lung diseases are reported to be associated with various construction trades. Exposures of painters, welders, sheet metal workers, insulators, and sawmill workers which have been reported to be associated with lung disease are of potential importance due to the diverse nature of union carpentry work and the possibility of exposures while working in close proximity to these trades.

USE OF CLAIMS DATA FOR EPIDEMIOLOGIC RESEARCH

With no single comprehensive database available for surveillance of occupational disorders and injuries, a number of avenues have been explored including the use of administrative data such as workers' compensation files (Mathias, 1990; Franklin, 1991; Tanaka, 1988) and health insurance claims (Bernacki, 1986 and 1989; Van Peenen, 1986; Blose, 1991; Pell, 1985 and 1986; Bond 1983). In using health insurance claims data the assumption cannot be made that claims are necessarily filed in the appropriate system -- workers' compensation (WC) or private health insurance. This is of particular concern in trying to capture all claims for diseases of occupational origin. Physicians typically receive little training in the recognition of diseases associated with occupation. Blessman (1991) has described claims for occupational disease as being more likely to be rejected than ones for occupational injury. He conjectures that long latency between exposure and disease; multiple causes of disease, some of which are non-occupational; difficulty associating the occupational disease with employment at a specific place; and exposures which are difficult to quantify may contribute to the problem of occupational disease coverage by workers' compensation. For occupational lung disorders, in which recognition of the disorder as being related to the workplace is not likely, the use of workers' compensation data alone would provide a very incomplete picture. This is not only the case in the United States. The British surveillance of work related and occupational respiratory disease (SWORD) project estimated that the frequency of acute occupational respiratory disease in the UK may be three times greater than reported even with their increased surveillance endeavors (Meredith, 1991). In addition, claims data can provide information about events of interest but, alone, they do not provide information on the population from which these claims arose.

Practical problems that make surveillance of construction workers difficult including frequently changing employers, irregular and temporary employment, and often small and dispersed work sites make the possible use of existing data sources particularly appealing for this group of workers.

SPECIFIC AIMS

The major objective of this research project was to study work-related respiratory disorders among members of the United Brotherhood of Carpenters (UBC) international union. Specific aims were:

1) To integrate several existing databases in order to develop a comprehensive data system useful for study of work-related respiratory disorders among carpenters. These databases include: a) medical claims data, b) worker's compensation data, and c) UBC national membership file data. This study was conducted using data for Washington State.

2) To develop epidemiological methods for analyses of medical claims data. This included development of appropriate case definitions for purposes of surveillance and etiologic epidemiology of respiratory diseases.

3) To analyze these integrated data with respect to incidence and prevalence of occupational lung diseases among carpenters in Washington State. Internal analyses were conducted to identify high risk carpenter sub-trades.

4) To conduct an asthma case-control study of carpenters for purposes of identifying possible etiologic associations with specific occupational exposures.

RESEARCH DESIGN AND METHODS

DATABASES AND COHORT DEFINITION

A major objective of this study was to develop a protocol for use of several data sets including UBC membership files, medical claims and worker's compensation data in combination for surveillance and epidemiological studies of occupational lung diseases among carpenters. This study used data from Washington State and integrated several databases together in order to provide a more complete picture of the incidence and prevalence of lung diseases of possible occupational origin and their associations with the occupational exposures of carpenters.

On a national level members of The United Brotherhood of Carpenters and Joiners of America (UBC) are engaged in a number of different industries and trades with potential occupational exposures to respiratory hazards. The October 1992 membership report for Washington State was reviewed in preparation for this study. This file lists 19,425 UBC members in Washington distributed by the following classifications:

Classification	Number of Workers
Construction	13,549
Cabinet-fixture-millwork	891
Lumber-sawmill-plywood	4,153
Log Scaling	172
Marine	332
Misc. Wood Prod.	49
Industrial	5,597
Maintenance	169
Navy Yard	110
Government	110

The varied nature of work performed by these carpenters make them a particularly useful group of workers for study of occupational diseases possibly related to construction work.

Databases used for this study included: a) health insurance eligibility files from the Carpenter's Trust of Western Washington (CTWW), b) UBC national membership files,
c) medical insurance claims files from the CTWW, and d) worker's compensation data from the Washington State Department of Labor and Industries (L&I). These databases were linked with each other in order to establish a cohort of workers at risk of lung diseases, to define types of carpentry work done by the cohort and their periods of risk, and to measure the occurrence of lung diseases among this defined carpenter population. Data were linked on an individual basis through use of personal identifiers. The data sources used for this study are described below.

Carpenter's Trust of Western Washington and UBC National Membership Files

The Carpenter's Trust of Western Washington provides medical insurance coverage for the 27 UBC locals in Washington State. Eligibility for UBC medical insurance is based on working a required number of union hours each quarter (275 hours per quarter or 1250 hours in the past 12 months). A complex work hour "banking" procedure is used in order to provide continued medical insurance coverage during periods of reduced employment. The CTWW maintains several data files for each individual who works union hours in the State of Washington. Demographic data (date of birth, sex, and current Washington State UBC local) is maintained for each carpenter. Another file contains the number of hours worked for each calendar month and a variable which indicates each month in which the member is eligible for medical insurance coverage. All data from these files were abstracted for the period January 1, 1988 through December 31, 1992.

The UBC national membership files contain demographic information (date of birth, sex), membership status, current union local affiliation, initiation date into the union and historical data concerning union activity. These files were used to provide missing information from CTWW files. The national membership files also were used to identify the Washington State UBC local for 1988 to 1992 for those persons who were no longer union members or who were no longer working in Washington State at the time of data abstraction for this study.

UBC Health Insurance Medical Claims Data

Computerized medical claims data were available through CTWW for the years 1988-1992. All records were abstracted which had a primary ICD-9 code for a list of specific lung diseases of interest, which are discussed later. All file data elements were abstracted for each claim (line item) including age, sex, date of service on claim, ICD-9 primary and secondary diagnosis codes, length of stay for hospitalizations, type of hospital admission, CPT codes where used and code for place of treatment.

Workers' Compensation Data

Washington State has extensive computerized data from worker's compensation claims. As one of few state self-administered funds these records include the actual medical claims, or line items, including ICD-9 codes and treatment codes for conditions covered under workers' compensation. These data were made available through collaboration with the Safety and Health Assessment & Research Program (SHARP), Department of Labor and Industries. These data included any claim filed for each worker from January 1, 1988 through December 31, 1992.

Data linkage

A computer file containing name, social security number and date of birth for all carpenters covered by the CTWW at any time from 1988 to 1992 was generated. This list was provided to the National UBC office and the Washington State Department of Labor and Industries for abstraction of relevant data on these individuals. The matching algorithm required any combination of two identifiers (last name, social security number, date of birth). All data were initially provided with a blind identifier which was assigned by the trust. This blinded identifier was later broken to provide names and addresses of individuals for the case control portion of the study. These data sources do not provide information on race.

Carpenter Cohort and Case Definitions

The CTWW first started maintaining its current computer data system in 1988. A review of claims by year suggested that 1988 was not typical due to initial startup of the computerized system of record keeping. In order to avoid potential bias and loss of data for the initiation year, the decision was made to restrict the study to claims for lung diseases filed during the four year period January 1, 1989 through December 31, 1992. Using the health insurance eligibility files from the Carpenters' Trusts of Western Washington an historical cohort of carpenters was identified who worked at least three months of union time between 1989 and 1992. No restriction was placed on a minimum number of hours of work per month and the three months did not have to be consecutive. The cohort was dynamic with both entrances and exits allowed over the four year period. Some of these individuals were union members in 1989 at the beginning of the study period, while others joined at a later time. Likewise, some members dropped out at variable times over the four years.

The definition of disease cases was based on ICD-9 diagnosis codes on medical claims. Specific ICD-9 codes considered by this investigation are shown in Table 1. Lung conditions studied included malignant and non-malignant respiratory conditions.

ANALYSES OF INCIDENCE AND PREVALENCE OF LUNG DISORDERS

Crude Incidence Density Rates

Using ICD-9 codes attached to medical claims prevalent and incident cases of each target lung disorder for 1989 to 1992 were identified using both worker's compensation data and UBC health insurance data. A case was defined the first time each diagnosis was made for each individual in a month in which they had insurance eligibility. Crude incidence density rates were calculated for each of the lung diseases for which we had claims data. Incidence density was defined as the number of cases of each lung disease, defined by three digit ICD-9 codes, per 1000 months of insurance eligibility. In addition, incidence density rates of all claims (i.e. line items) were also calculated per 1000 months of insurance eligibility and the mean number of claims per person for each diagnosis was calculated.

Internal Comparisons by Stratification and Using Poisson Regression

For internal comparisons, incidence density rates and crude rate ratios were calculated for each lung disorder for which there were greater than 50 cases observed during this four year period of observation stratified by age categories, sex, time in the union, and predominant type of carpentry work of the union local with which each carpenter was affiliated. A case was defined as the first time a person filed a claim for a disorder in a month of insurance eligibility. These diagnoses included bronchitis, asthma, chronic bronchitis, and chronic obstructive airway disease.

In addition to stratified analyses, adjusted rate ratios were then calculated for each of these disorders using Poisson regression (Kleinbaum, 1988). Prior to regression analyses, person months of insurance eligibility and the number of cases were stratified by age, sex, time in the union, and predominant type of carpentry work. Age and time in the union were treated as time varying variables with person time and events appropriately distributed as these variables changed over the 48 month follow up period. Person time at risk stopped accumulating at the time a person first became a case. For the predominant type of carpentry deviation from the mean coding was used to allow comparisons to an overall group mean since no a priori low risk group was identified (Lemeshow, 1984).

In addition, repeat event analyses were done for bronchitis using each claim (one line item per unique date per individual) for the disorder as opposed to only the first event. In this case, person-time continued to accumulate as long as the person was observed. This type of analyses did not seem appropriate for the other three disorders which are clearly chronic in nature.

The same incidence density rates and crude rate ratios were calculated restricted to individuals who had been in the union at least ten years. Because of the sparseness of the data the Poisson regression models would not converge and adjusted rate ratios for these individuals could not be calculated. The crude rates and rate ratios did not appear different from those using all cohort members and are not presented.

SAS (SAS Institute) was used for descriptive analyses, crude rates and data stratification. EGRET (Epidemiological Graphics, Estimation and Testing, 1991) was used for Poisson regression analyses.

External Comparisons

In addition to internal comparisons, several data sources were used for purposes of external comparison including the National Ambulatory Medical Care Survey (NAMCS) (U.S. Dept Health and Human Services, 1989), the National Health Interview Survey Occupational Supplement (NHIS) (U.S. Dept. Health and Human Services, 1989), and Surveillance, Epidemiology, and End Results (SEER) Program (Ries, 1994). External referent population comparisons are needed to study possible occupational lung disorders which might affect a high proportion of carpenter sub-populations. Using internal comparisons alone under these circumstances would tend to underestimate some risks.

Comparisons to National Ambulatory Medical Care Survey

Background on National Ambulatory Medical Care Survey
The sampling unit for the National Ambulatory Medical Care Survey (NAMCS) is the outpatient physician patient encounter. The survey includes licensed doctors of medicine and doctors of osteopathy currently in practice who devote most of their practice to caring for ambulatory patients at an office location. Visits of patients seen by the physician in any institution (including outpatient clinics of hospitals) for which the institution has the primary responsibility for the care of the patient over time are not included. Physicians who treat patients only indirectly, including specialists in anesthesiology, pathology, forensic pathology, radiology, therapeutic radiology, and diagnostic radiology are out-of-scope and thus are not included (U.S. Dept of Health and Human Resources, 1994).

Process used to identify appropriate carpenter medical visits for comparisons to NAMCS
Both workers' compensation records from the Department of Labor and Industries (L&I) and the health and welfare (H&W) records, or private insurance records, from the Carpenters'

Trust of Western Washington provide line items for each medical encounter. The goal was to identify visits to appropriate provider types in appropriate outpatient settings. Only one visit per day to a given provider was counted. As claims could appear in both L&I files and H&W files, duplicates were identified and counted only once.

The following process was used to identify the appropriate claims from the H&W records.

1) All line items which had ICD-9 codes of interest for lung disorders were identified.
2) All line items marked as outpatient claims with 'place of treatment' variable were identified.
3) Provider types were identified, if possible, dropping all line items from inappropriate provider types as listed above.
4) Looking at CPT codes for all line items that had no provider type or place of treatment identified, invasive radiology procedures, ultrasound/CT, radiation therapy line items were deleted. Plain x-rays (chest x-rays, sinus films, etc.) remaining which were generated by unknown provider types were problematic as they may have been done in physicians offices which are within the scope of the survey. For this reason separate files were created which included and excluded these line items for comparison.
5) Using the 'provider number' variable in the H&W files -- a unique physician identifier code - the first line item per day per provider was identified for each carpenter.
6) CPT codes were also reviewed in an attempt to identify visits which were unlikely to have occurred in offices of doctors within the scope of the study which should be deleted. (radiation therapy for example).

A similar, though not identical, process was used to identify the appropriate claims from the L&I records.

1) All line items were identified which had ICD-9 codes of interest for lung disorders from the outpatient claims file.
2) Provider type was identified, if possible, dropping all line items from inappropriate provider types as listed above.
3) Using the 'provider type' variable in the L&I files the first line item per day per provider type was identified for each carpenter since there was no unique provider ID in these files.

These two sets of records were combined and then searched for possible duplicates. A claim was considered a duplicate if the date and ICD codes matched and the provider types were the same. Three claims were deleted which met these criteria (i.e. they were counted only once instead of in both files). This was done twice -- once with the file which omitted all x-ray codes and once with the file which included potential office x-rays. The file including the questionable x-ray codes had only 14 additional doctor-patient encounters above the visits already identified. The difference in the count of cases in any one age strata was not more than two and did not change the rates appreciably. For these reasons the results are only presented excluding the questionable x-ray encounters.

Calculation of rates
Person-months of insurance eligibility were identified for 10 year age and sex specific groups for each year 1989-1992 and converted to person-years of observation. Rates were calculated as number of visits for each ICD-9 code of interest divided by person-years of observation. Using data from the NAMCS 1990, 1991, 1992 provided by the National Center for Health Statistics on CD-ROM (ref) estimates of population rates of doctor visits per 1000 were calculated for the same age and sex specific strata. (The survey was not done in 1989). We discovered a problem in the program for calculating stratified rates on the 1990 CD-ROM data provided by the National Center for Health Statistics which did not allow us to generate age or sex specific rates accurately (Personal communication, David Woodwell, Survey Statistician, NCHS). For this reason comparisons to national rates are not made for 1990.

By calculating health care utilization rates for each year of study, the stability of the rates over the four year time period could be assessed for the carpenters, as well as the national estimates. Carpenter rates were compared to the rates generated from the NAMCS for primary diagnoses of asthma (493), bronchitis (490), chronic bronchitis (491), and chronic obstructive airway disease (496).

Comparisons to National Health Interview Survey, Occupational Health Supplement 1988

Background On National Health Interview Survey, Occupational Health Supplement
The National Health Interview Survey (NHIS) is a household survey designed to provide estimates representative of the U.S. civilian non-institutionalized population (U.S. Dept. Of health and Human Services, 1994). One adult (aged 18 years or over) in each sampled household was selected at random to be interviewed with the NHIS Occupational Health Supplement 1988 questionnaire. Currently employed persons 18 years of age and over were asked if they had certain health conditions during the past 12 months, including asthma and chronic bronchitis. These estimates thus represent 12 month period prevalence rates for these conditions based on self reports.

Process used for comparisons to prevalence data from NHIS, Occupational Health Supplement
Within each age and sex category the first claim filed for each disorder of interest (asthma and chronic bronchitis) by each carpenter was identified each year. Person- months of insurance eligibility, converted to person years of observation, were calculated for each year. Twelve month period prevalence rates were calculated for each disorder for each of the four years defined as number of cases in that year divided by person years of observation for age and sex specific groups. Due to the small numbers in our cohort we did not include individuals less than 18 or over 69 in our comparisons. In this manner, the stability of the period prevalence

(prevalence percent) in our cohort could be assessed over these four years and compared to data from the 1988 occupational supplement. Comparison age and sex specific period prevalence were generated from original data with appropriate weights provided on CD-ROM by NCHS using provided age groups (U.S. Dept. Of Health and Human Services, 1994). The carpenter data on women were too sparse for comparisons to NAMCS or NHIS and only results for men are presented.

Analyses of lung cancer incidence and comparisons to Surveillance, Epidemiology, and End Results (SEER) Program

Background on SEER

A continuing project of the National Cancer Institute, the SEER Program collects cancer data on a routine basis from designated population-based cancer registries in various areas of the country. Areas were selected primarily for their ability to operate and maintain a population-based cancer reporting system and for their epidemiologically significant population subgroups. With respect to selected demographic and epidemiologic factors, they are reasonably representative subsets of the U.S. population. Trends in cancer incidence, in addition to mortality and survival data, are derived from this database. Yearly cancer incidence rate is the number of new cancers of a specific site/type occurring in a specified population during a year, expressed as the number of cancers per 100,000 people. Cancer of the lung and bronchus, for our comparisons, include ICD-9 codes 162.2-162.99 (Ries, NIH, 1994).

Process used for comparisons to SEER data for cancer of lung and bronchus

Standardized Incidence Ratio analyses (indirect adjustment) were used to compare rates of cancer of the lung and bronchus among these carpenters to SEER data 1990 to 1991. All claims filed for cancer of the lung or bronchus (ICD-9 162.2-162.99) were identified among the carpenters cohort. No cases of cancer were identified among the 2% of women in this cohort and the analyses were limited to men. Person-months of insurance eligibility were calculated for age categories used in the SEER summary data. National incidence rates were used as these were essentially the same as those for the State of Washington. These figures were then converted to person-years of observation over this four year time period. Person-time at risk stopped accumulating after the person became a case. Age was treated as a time varying variable with person-time accumulating in the appropriate age strata over time with a person capable of changing no more than one strata over our short period of observation. SEER rates were applied to the cohort person-years by age and sex to calculate expected numbers of cases. These expected cases were compared to observed cases for each age category (standardized incidence ratio=observed/expected). The overall standardized incidence ratio and approximate 95% confidence limits were then calculated for the entire population (Checkoway, 1989).

Some of the lung cancer claims in our data could have resulted from treatment of prevalent rather than incident cases. To more closely approximate incidence the same analyses were performed after discounting the first three months of person-time observed for each member of the cohort. This ignored both person-time and cases that occurred in the first three months of eligibility which we were able to observe, making the assumption that it would be unlikely for an individual with lung cancer to go longer than three months without medical care.

ASTHMA CASE-CONTROL STUDY

Selection of Cases and Controls

An asthma surveillance case definition for the NIOSH Sentinel Health Notification System for Occupational Risks (SENSOR) program has been published (Klees, 1990; Hoffman, 1990). It is recognized that the SENSOR case definition may miss many cases due to the need for information not collected by primary care providers. The case definition of asthma used for the case-control study was a primary ICD-9 diagnosis code of 493. Cases were identified by a claim for medical care for asthma defined by a primary ICD-9 code of 493 attached to a claim from either workers' compensation or health and welfare records. Individuals who were known to be dead at the time of sampling were omitted from the cohort of 10,938 construction workers each of whom had worked at least three months of union time 1989 to 1992. This reduced the cohort to 10,860 individuals. Among this restricted cohort 223 individuals filed claims for asthma. Three of these individuals filed claims in months before they entered the cohort and they were also omitted. The 220 individuals who had claims for asthma were defined as the **cases of interest**.

For selection of controls, individuals were sorted by the date of the claim with "diagnosis date" assigned at the date of the first claim. Controls were matched by sex and age, plus or minus two years, at the time of the diagnosis date of the case. Individuals must have entered the cohort, as marked by a month of hours worked, when the case was diagnosed in order to serve as a control for that case. This was the same criteria required for the cases of interest as described above. A potential pool of controls was identified for each month. After appropriate matching criteria were met, two controls were selected randomly for each case.

This control selection procedure allowed a person to serve as a control more than once and for cases to be controls prior to the date they became a case ("diagnosis date") as long as they had entered the cohort by that date. Once a person was diagnosed as a case they were dropped from the potential pool of controls.

Asthma Symptoms and Exposure History Questionnaire

A questionnaire soliciting information on occupational history, respiratory symptoms, occupational exposures to specific substances and lifestyle factors such as smoking was developed for this study. A copy of this questionnaire is given in the Appendix of this report.

The respiratory symptom questionnaire included questions adopted from the American Thoracic Society (ATS) DLD-78 questionnaire with modifications used by the Agency for Toxic Substances and Disease Registry (ATSDR) for study of residents near hazardous waste sites (Ferris, 1978; ATSDR, 1993). Additional refinements to the ATS symptom questionnaire proposed by Burney for assessment of asthma were included in the final questionnaire (Burney and Chin, 1987; Burney et.al., 1987). In addition, selected questions from the questionnaire used by NIOSH for the SENSOR program for asthma surveillance were included.

The occupational/environmental exposure questionnaire included questions concerning exposures to a wide variety of substances used in construction or substances such as wood dusts, isocyanates, anhydrides, metals, soldering fluxes, paints, solvents, plants, animal products and other biological and chemical materials known to be associated with asthma. The extensive review of agents associated with asthma published by Chan-Yeung (Chang-Yeung, 1990) as well as detailed literature evaluations were used in developing the exposure questionnaire (Reilly, 1994; Meredith, 1991).

The respiratory symptom and occupational exposure questionnaire were pilot tested on three occasions with revisions made between tests. The first draft of the questionnaire was reviewed in detail with a focus group of carpenters located at Duke University. Each question was reviewed with this group for ease of understanding and context validity. The exposure questions were reviewed with this group in order to identify other possible exposures experienced by carpenters which could be related to lung diseases.

A modified questionnaire, based on input from the Duke focus group, was administered to a UBC local in Tennessee. Approximately 25 workers participated in this second pilot test. After completing the questionnaire with only basic instructions, a focus group discussion was held in order to secure additional input. The completed questionnaires and focus group input were reviewed and used in developing the next draft of the questionnaire.

A final pilot test, to assess response rate primarily, consisted of sending the questionnaire by mail to a sample of 25 UBC carpenters in Minnesota. The questionnaires were mailed using the same instruction letter and informed consent statement proposed for the final study. The response rate was felt to be of a reasonable level to proceed with the use of the questionnaire with a few additional modifications.

Address information for cases and controls were provided by the CTWW and the UBC national office. Cases and controls were contacted by mail and asked to complete the self-administered questionnaire shown in Appendix A. In order to enhance participation, the letter introducing the study and requesting participation was jointly signed by the UBC General President and the Duke Principal Investigator. As an additional incentive for participation, five dollars and an inexpensive pen with the UBC Health & Safety Fund logo were provided in the mailings. A total of three separate mailings occurred. In a final effort to enhance participation, each non-responding carpenter was contacted by telephone by a member of the Duke study team. No attempt was made to gather information over the phone. The call was used to answer any questions the individuals might have about the study and to encourage their participation by completing the questionnaire in the same manner as the other respondents.

Analyses of Asthma Case-Control Data

To assess the representativeness of the pool of individuals selected for the case control study, the Poisson regression analyses of asthma were repeated as previously described using the cases and controls selected for the asthma study as opposed to the entire cohort.

Data from the asthma case-control study were quality control checked and entered into a database using Epi Info (Dean, 1994). The data were then converted to a SAS data file for statistical analyses using PC-SAS.

The initial analyses undertaken consisted of generation of descriptive data comparing cases and controls as well as respondents and non-respondents to the mailed questionnaire. In addition to standard descriptive statistics for cases and controls, analyses included calculation of univariate crude odds ratios and confidence intervals based on 'ever' versus 'never' exposure to substances at work as well as substances found in the home. The case definition for these analyses was an ICD-9 code for asthma in the medical claims file. Further stratified analyses consisted of calculating odds-ratios by age, sex, smoking, etc. Unconditional multiple logistic regression was used to analyze the association between asthma diagnosis, based on ICD-9 code, and exposures to various substances controlling for age, sex and smoking (Checkoway, 1989; Pearce, 1988). Additional analyses investigated the risk of asthma relative to the duration of UBC membership. An unconditional logistic model was chosen in order to make maximum use of the questionnaire data completed by cases and controls.

Further analyses were conducted utilizing asthma symptom data from the respiratory questionnaire. Cases and controls were redefined based on items included in the respiratory symptom questionnaire by Burney (1989) to define his discriminant function predictor of a bronchial response to histamine (in last twelve months one of following: wheeze, waking with attack of shortness of breath, and tightness in chest on contact with animals, feathers or dust; or intermittent or regular breathing problems). All analyses described above were repeated using this definition of an asthma case.

RESULTS

DESCRIPTION OF THE COHORT

From union eligibility files 10,938 active union carpenters were identified who had worked at least three months between 1989 and 1992. Among the cohort 10,628 (98%) were men and 222 (2%) were women. Their ages at entry into the cohort ranged from 15 to 76 years with a mean of 36 years and a median of 34 years. Mean age at entry into the cohort for men was 35.5 years and the median was 34 years. For women the mean age at entry was 31 years and the median was 35 years. Time in the union at the time of entry into the cohort ranged from less than one year to 48 years with a mean of 6.2 years and a median of one year.

The distribution of the cohort by predominant type of carpentry work of the union local with which each carpenter was affiliated is presented below. The locals were placed into these categories with the assistance of a District Environmental Coordinator in Washington State with the Carpenters Health and Safety Fund.

Distribution of cohort by predominant type of carpentry work of the union local

Predominant work of local	N	%
light commercial	2831	25.6
heavy commercial	3922	35.9
drywall	1525	13.9
millwrighting	190	1.7
piledriving	602	5.5
cabinet and fixture work	72	0.7
residential	282	2.6
lumber and sawmill	3	0.0
"mixed" tasks	960	8.8
unknown	551	5.0

Over this four year period of time the cohort worked 39,000,692 union hours. The number of hours worked ranged from 31-13,698 with a mean number of hours worked over this time period of 3566 hours, or 892 hours worked per person per year. There was only one individual reporting over 11,000 hours during this four year period. Omitting this individual does not change the mean hours worked per individual due to the size of the cohort. There were 117 individuals reporting over 8500 during this four year period.

The number of months of insurance eligibility ranged from none to 48, with a mean and median of 27 months. Since 1991, carpenters who work a minimum of 275 hours, for which contributions were received, in a consecutive three month period are eligible for coverage. Prior to 1991 the minimum requirement was 250 hours in a consecutive three month period. Hours may be "banked" allowing individuals who have worked as many as 1250 hours in a 12 month period to maintain benefits even though they may not have worked the required number of hours in the preceding three month period. Prior to 1991 this 12 month minimum was 1000 hours.

Due to the dynamic nature of this cohort, with both entrances and exits over this 4 year period, the above mean values should not be assumed to be representative of mean hours worked or mean months of insurance coverage per year of these union carpenters.

CRUDE INCIDENCE DENSITY RATES

Incidence density rates of cases and claims of lung diseases per 1000 months of insurance eligibility are presented in Tables 2 and 3 respectively. Bronchitis (ICD-9 490) accounted for over 50% of the lung disease cases among this cohort between 1989 and 1992. This was followed by asthma (ICD-9 493), chronic obstructive airway disease (ICD-9 496), and chronic bronchitis (ICD-9 491). The 931 cases of lung disease occurred among 812 different individuals. The greatest number of claims (line items) were for neoplasms of the trachea, bronchus and lung (ICD-9 162), and this diagnosis resulted in, by far, the greatest number of mean claims per person.

INTERNAL COMPARISONS

Stratified crude rates and rate ratios and adjusted rate ratios

In Tables 4-8 the distribution of cases stratified by age, sex, time in the union, and predominant type of carpentry work, crude rates and rate ratios, and adjusted rate ratios are presented for asthma, bronchitis, chronic bronchitis, and chronic obstructive airway disease. Due to the limited number of individuals (n=3) whose local did predominantly lumber or sawmill work, these individuals were omitted from further analyses. Table 5 presents results of analyses of bronchitis using only the first claim per person with time at risk accruing only until the person became a case, while Table 6 presents the results of the repeat events model with time at risk continuing to accrue as long as the individual maintained insurance eligibility.

These internal comparisons demonstrated that rates of **asthma** increased with increasing age. Women had 1.7 times the rate of asthma as men, although the difference is not statistically significant as reflected in the wide confidence interval. Time in the union appears to be protective with those who have been in greater than 10 years having about a 40% decreased rate of asthma. The rate ratio was highest for residential carpenters (1.7), but none of the predominant work categories are significantly different than the overall group mean.

Bronchitis overall also increased with age but not in a monotonic fashion. Women had a 35% lower rate of bronchitis than men, but again it is not statistically significant. By 10 years in the union the rate was decreased but not to a significant extent, and no differences were seen among the different types of predominant work. When using a **repeat events model for bronchitis,** which allowed individuals to be counted more than once if they filed another claim for bronchitis and their person time at risk continued to accumulate, the results were somewhat different. The rate ratios for age were of greater magnitudes but the patterns were similar, and the differences by sex remained unchanged. Time in the union did not appear to have any effect. Carpenters whose locals performed predominantly light commercial work had rates of bronchitis which were significantly different from the overall group mean (RR 1.6 CI 1.3, 1.9).

Chronic bronchitis clearly increased with increasing age with a rate ratio for those over 60 years of 5.6 (1.5, 20.2). Rates were not significantly different based on time in the union or sex, though women had a rate 3.7 times that of their male counterparts and those in the union between one and ten years had 1.6 times the rate of those in the union less than a year. Cabinet and fixture workers had 2.7 times the rate of the overall group mean, but this high rate ratio was based on only one case and is very unstable.

Chronic obstructive airway disease dramatically increased with increasing age. Women had three times the rate of men and rates increased with time in the union, but neither to a significant level. Again cabinet makers had high rate ratios but this was based on two cases among a small group of workers and must be regarded with caution.

No statistically significant differences were seen for men and women for the four lung diseases we evaluated with these internal comparisons -- not surprising since the women represent only 2% of the cohort. The direction of the effect of sex is different for different diseases. Women had higher rates of the more chronic disorders of asthma, chronic bronchitis, and chronic obstructive airway disease, but lower rates for bronchitis in both models. Older individuals had higher rates of all four lung disorders with age increasing in a clearly monotonic fashion for asthma, chronic bronchitis and chronic obstructive airway disease -- all chronic conditions. Time in the union appeared to be protective only for asthma. Individuals whose locals do predominantly light commercial work had higher rates of bronchitis, most dramatically seen in the repeat events model. The rate ratio of 1.6 is diminished compared to what it would be if comparisons had been made to a low risk reference group as opposed to the overall group mean, a point which should be borne in mind in assigning importance to the results. Higher rates of chronic bronchitis and chronic obstructive lung disease were seen among cabinet makers and higher rates of asthma were seen for residential carpenters but these differences were based on very small numbers and are not statistically significant. The data were too sparse to include the predominant type of carpentry work in the models except for bronchitis, so the rate ratios for task for these disorders are unadjusted.

EXTERNAL COMPARISONS

Comparisons to NHIS Occupational Supplement 1988

The 12 month period prevalence of asthma and chronic bronchitis are presented for male carpenters by year and compared to the population estimates derived from the NHIS Occupational Supplement 1988 in Tables 9 and 10, respectively. Comparable tables were constructed for women but the data were too sparse to be meaningful. The carpenters' percent prevalence of chronic bronchitis was less in each of the four years for comparable age groups of men than that reported in the NHIS Occupational Supplement. The prevalence of asthma was less for male carpenters than for other working men in the U.S. except between the ages of 45-65. The carpenters prevalence in this age category is more similar to the prevalence reported among other working age men of the same age (1.6%) with the carpenters' prevalence increasing gradually from 1.5 in 1989 to 2.1 in 1992.

It should be appreciated that the prevalence reported from the NHIS is based on self-report, not on a physician diagnosis as are ours. This could explain the lower prevalence we see in general, but raises concern about the possibility that carpenters between the ages of 45-64 may actually have a higher prevalence of asthma than the national prevalence.

Comparisons to NAMCS

For asthma, bronchitis, chronic bronchitis, and chronic obstructive airway disease the rates of doctor-patient encounters per 1000 persons are presented in Tables 11-14 for males by 10 year age groups for each year of observation. These rates are compared to rates generated from NAMCS data for 1991 and 1992. The NAMCS was not done in 1989. Comparisons were attempted for 1990, but due to an error on the CD-ROM from the NCHS stratified rates were unable to be generated for that year (Woodwell, 1996). Again, the data for women carpenters were too sparse to be meaningful and are not presented.

There were very few records for chronic bronchitis or chronic obstructive airway disease contained in the NAMCS data. These data were so sparse that comparisons could not be made for all of the age categories. Rates of ambulatory doctor-patient visits for these carpenters after the age of 50 were greater than those reported in NAMCS for asthma, bronchitis, and chronic bronchitis. These results are particularly interesting since the NAMCS is not limited to working adults who would be expected to be in better health.

Comparisons to SEER data for lung cancer

Standardized incidence ratios for cancer of the lung or bronchus using SEER rates for indirect adjustment are presented in Table 15. The overall standardized incidence ratio (SIR 1.3 when using all cases and time at risk or 1.2 when discounting the first three months to approximate incidence more closely) comparing these carpenters to national SEER rates 1990 -1991 is not significant. However, the SIR is significantly increased for carpenters between the ages of 45 and 54.

ASTHMA CASE-CONTROL RESULTS

Pool of cases compared to controls

There were no significant differences between the pool of cases and controls by age, sex, time in the union, percent unable to locate or response rates (Table 16). Poisson regression analyses performed using the pool of cases and controls revealed results comparable to those obtained when analyzing the entire cohort, indicating that the controls were comparable to the non-cases in the entire cohort in respect to age, sex, and time in the union.

Response rates

Of the 660 individuals in the entire pool of cases and controls, 377 (57.1%) individuals returned the questionnaire. Fifty-two individuals were unable to be located or deceased at the time of follow up (8.6% of controls and 6.4% of cases). Among individuals that we were able to contact the response rate was 62%. Forty-three percent (43%) of the matched triads (95/220) did not have a matched pair that responded. To maximize the use of the available data the decision was made to perform an unmatched analysis.

As seen in Table 16, respondents were older than non-respondents (mean 41.7 years vs. 37.9 years, $p=0.02$) and they had been in the union longer (mean 12.3 years vs. 6.9 years, $p<0.001$). They were not different in regard to sex or the percentage of cases.

Comparison of case definitions - ICD-9 diagnosis of asthma vs. Burney's Discriminant Function Predictor (DFP) based on responses to medical questionnaire

Based on the case definition of a medical claim with the ICD-9 code of asthma (493) there were 118 cases and 259 controls among the respondents. Based on Burney's discriminant function predictor (DFP), there were 141 cases and 236 controls. The cases and controls defined in these two different ways are compared in Table 17. Using Burney's definition, which has been validated for its ability to predict bronchial response to histamine (Burney 1989), as a gold standard the sensitivity of the ICD-9 diagnosis used to initially identify cases and controls was 0.56 and the specificity was 0.83. (Positive predictive value ICD-9 493=0.67, negative predictive value ICD-9 493=0.76).

Demographic data for cases and controls with cases defined by ICD-9 code 493 and Burney's DFP

Demographic characteristics of cases and controls are compared for both case definitions in Tables 18 and 19. Cases and controls were not significantly different from each other using either case definition in regards to age, time in the union, sex, race, educational levels, or months of insurance eligibility.

Responses to medical history questions by ICD-9 code 493 and Burney's DFP

Responses to questions regarding respiratory problems based on the two case definitions are summarized for all subjects and by case-control status for both case definitions in Tables 20 and 21. For both case definitions, cases had more positive responses to all questions regarding respiratory problems than did controls although none of the subjects reported a prior diagnosis of silicosis. Using an ICD-9 diagnosis as the case definition, 62.4% of cases reported a prior diagnosis of asthma as did 10.2% of controls. Using the DFP, 56.5% of cases reported a prior diagnosis of asthma as did 9.0% of controls. More DFP defined cases than ICD-9 cases responded positively to all the respiratory questions which define the DFP (in last 12 months one of the following: wheeze, waking with attack of shortness of breath, and tightness in the chest on contact with animals, feathers or dust; or intermittent or regular breathing problems).

Thirty-seven individuals reported a diagnosis of asthma before the age of 20. This included 25 cases (21.2%) and 12 controls (4.6%) defined by ICD-9 493 or 27 cases (19.1%) and 10 controls (4.2%) defined by Burney's DFP. Thirteen (35%) of these 37 individuals reported their age at the time of first asthma diagnosis as under the age of four years and nine (24%) reported a diagnosis of asthma under the age of two.

Crude odds ratios for demographic variables, tobacco exposures and household conditions

In Table 22 crude odds ratios and 95% confidence intervals (logit) are presented for demographic variables, tobacco use, and various household conditions for cases defined by an ICD-9 diagnosis of asthma. Significantly reduced odds ratios were seen for smokers in the home and use of a fireplace or wood stove in the home. In Table 23 the same data are presented based on Burney's DFP case definition. The odds ratio for time in the union for one to 10 years was significantly less than for those in less than 1 year. Similar to findings using the household exposures were not of significance. However, the history of ever smoking was significant (OR 1.7; 95% CI 1.1, 2.8), as was exposure to smokers at work (OR 2.0; 95% CI 1.3, 3.2). The odds ratios for passive smoking exposure increased with increasing hours of exposure, becoming significant at over four hours of passive smoke exposure per day.

Distribution of exposures and odds ratios for occupational and miscellaneous exposures

The distribution of occupational exposures by case-control status, crude odds ratios and odds ratios adjusted for age, sex, time in the union, and ever smoking history are presented in Table 24 for cases defined by ICD-9 code. In Table 25 odds ratios are presented for this case definition for groupings of occupational exposures. Odds ratios for exposures to hay, enamel paints (oil based), epoxy paints, latex paints (water based), varnishes/stains, enzymes, animal fur/wastes, and mold were all significantly different from one. In addition, the odds ratios for exposures to lacquers, polyurethane products, and wood sealers all closely approached significance at the 0.05 level. When grouping the occupational exposures, the odds ratios for exposure to organic dusts was 2.0 (95%CI 1.2, 3.5), and the odds ratio for exposure to paints, varnishes, and stains was 1.9 (95% CI 1.0, 3.5).

The same values are presented in Tables 26 and 27 using Burney's DFP case definition. Adjusted odds ratios for more exposures were significantly different from one for this case definition. Elevated odds ratios were seen for exposures to cement dust, drywall dust, grain or flour dust, hay, lime dust, silica, vermiculite/perlite filler materials, wood bark dusts, epoxy paints, polyurethane products, caulks, aluminum dusts, nickel dusts, stainless steel dusts or fumes, acids, alkali, concrete form oils, enzymes, fumes from heated plastics, printing inks and oils, styrene, urethane foam insulation, animals fur/wastes, seafood processing, exhaust from engines, and mold. Odds of exposure to particle board dusts and gasoline also approached significance. When grouping the occupational exposures the odds ratios for exposure to organic dusts was 3.3 (95% CI 1.9, 5.8), the odds ratio for exposure to metal fumes or dusts was 1.8 (95% CI 1.2, 2.9), and the odds ratio for paints and varnishes was 1.7 (95% CI 0.95, 3.1).

Behavior of Covariates in Adjusted Models Based on Different Case Definitions

In the adjusted models, using an ICD-9 case definition, the odds ratios for the covariates age, sex, time in the union, and ever smoking were never of significance. When using the DFP case definition age remained insignificant but the other covariates were different. The value for the odds ratio for women compared to men ranged from 3.2-4.4 and was of significance in the models for all exposures. The odds ratio for ever smoking ranged from 1.6-1.8 and was always of significance. Time in the union appeared to be protective with values ranging from 0.5-0.7 for 1-10 years and 10 plus years compared to those with less than one year of time in the union. The odds ratios were sometimes significantly less for those in the union 1-10 years but were not significant for those in the union greater than 10 years.

DISCUSSION

For much of our analyses we relied on existing data sources, specifically claims data, to provide the events of interest. The use of claims data does involve some lag in getting appropriate claims, and for a case to be recognized in these existing data sources a claim must have been filed. Anything which influences whether a person files a claim, or under what system they choose to file the claim, will influence the recognition of the case. Even for acute work-related injuries, which would seem likely to be filed in WC records, differences are reported by age in propensities to file claims. Younger workers have been reported to be more likely to seek care in an emergency room, but less likely to file a compensation claim (Fingar, 1992). To our knowledge differences in filing for possible diseases of occupational origin by demographic characteristics have not been described. We tried to minimize problems by ascertaining cases from both workers' compensation records and the workers' private health insurance files. These analyses do not allow us to document the magnitude of lung disorders that can be attributed to the workplace among these carpenters. Diagnoses assigned to claims may be presumptive and later ruled out and coding errors occur no doubt, and the magnitude of these problems cannot be discerned without access to actual medical records.

Despite some limitations claims data analyses have some advantages. They do not require the personal cooperation of subjects and the recall of events is not a problem, both of which can be helpful in surveillance endeavors. Claims allow access to a lot of information about morbidity of disorders of possible occupational origin -- an area in which information is lacking among occupational cohorts. Also, through the use of these combined data sources we were able to define a clear study base which could be used for nested case-control analyses -- an important principal to adhere to in order to get unbiased results in case control studies (Wacholder, 1992).

The use of combined data sources allowed the identification of both numerator (events of interest) and denominator (time at risk) data. In an attempt to gather both numerator and denominator data in comparable ways we analyzed claims that occurred in months in which the individual had health insurance coverage, using person-months (or -years) as the time at risk. Since very few claims were identified through WC records this use of months of insurance eligibility seems a more appropriate denominator than hours of work. The ability to generate rates through the use of these combined data sources provides information that can be used for monitoring trends, but changes in health insurance benefits or requirements must be considered in comparing rates based on medical claims over time.

The excess incidence of lung cancer among 45-54 year olds in this working cohort is consistent with mortality findings of others. Milham's early study of mortality among members of the UBC (Milham, 1973) first reported an elevated SMR for lung cancer and mesothelioma for construction carpenters, and the excess was largely attributed to exposure to asbestos. Since then a number of investigators have reported excess deaths due to lung cancer among carpenters (Firth, 1993; Zahm, 1989; Stellman, 1984). A recent PMR study by Robinson

(NIOSH, 1995) of UBC members who died 1987-1990 again documented excess lung cancer deaths among carpenters last employed in construction, but not among carpenters last employed in wood products. Excess deaths from lung cancer were seen in both PMR and PCMR analyses used to dampen the healthy worker effect. Our cohort is almost entirely construction carpenters with very few employed in the wood products industry (cabinet makers n=72 (0.7%)). The fact that we saw no excess of lung cancer incidence after age 54 could be related to very little observation of those over the age of 65 and the fact that we had restricted our cohort to active carpenters who had to have worked at least three months during our four year observation period.

We did not have information for the entire cohort on smoking, an obviously important risk factor for lung disease. In the Occupational Supplement to the National Health Interview Survey in 1988, 61% of blue collar workers reported being former or current regular smokers (U.S. Dept. Of Helath and Human Services, 1993). From the case-control questionnaire, 67% of the respondents reported a history of ever smoking and 48% reported that they worked around individuals who smoked.

Time in the union, which was controlled for in the Poisson regression analyses and in the case-control analyses, is not a marker of time as a carpenter since many carpenters join the union after years of experience. We have not been able to clearly decipher information from the job histories we collected to control for time as a carpenter accurately. Our classification of predominant task of the union locals could also create misclassification bias. This is a crude aggregate measure and the groupings are not discrete. Even though a local may perform predominantly one task this does not mean that is the only type of work done by members of that local, and there is likely to be significant overlap in the nature of the tasks that people from the different locals perform. This could explain our inability to more clearly discern differences by predominant type of carpentry work.

The case-control study explored a number of factors which might contribute to asthma among a group of, predominantly construction, union carpenters from the State of Washington. Initially cases were defined based on an ICD-9 diagnosis of asthma from private health insurance or workers compensation claims between 1989 and 1992. Later analyses were based on a reclassification of cases and controls based on response to items included in Burney's discriminant function predictor of a bronchial response to histamine.

Using either case definition, odds ratios were significantly elevated for exposure to hay, epoxy paints, enzymes, animals, and molds. Exposure to mold in the home was not of significance whereas exposure to mold in workplace exposures was of significance. For the grouped exposures the odds ratio was significantly elevated for organic dusts and approached significance for paints, varnishes and stains. Although the width of the confidence intervals varied across the two case definitions used, the odds ratios for paints, varnishes, and stains were consistently elevated with epoxy paint and polyurethane products consistently of statistical significance. Using Burney's DFP definition, odds ratios were elevated for women, ever smoking history, and a dose response was seen for hours per day of passive smoke exposure. Odds ratios for exposure to a number of additional exposures were significant using this case definition as well.

The exposures which were consistently associated with asthma among this study population using either case definition have been reported to be associated with asthma by others (Chan-Yeung 1990, Reilly 1994, Kanerwa 1994). The fact that we found exposures to molds in the workplace of significance but not in the home could relate to the amount of exposure. Exposures in the workplace, such as in the demolition of buildings, could expose the individual to a greater amount of mold spores. The group of paint, varnishes and stains explored included enamels, epoxy paints, lacquers, latex paints, polyurethane products, varnishes and stains, and woodsealers. Varnishes used in woodworking contain urea resins with formaldehyde as a curing agent, and the incorrect use of polyurethane can lead to the release of large quantities of isocyanates into the respiratory tract (IARC, 1981). Both formaldehyde and isocyanates are reported as causes of occupational asthma (Reilly, 1994). Latex, or water-based paints, have reduced concentrations of volatile organic compounds (VOC), which may cause inflammation or obstructive reactions in the airways, but the chemical composition of the VOCs emitted is different from those emitted from solvent based paints, with more polar compounds such as plastic monomers, glycols, and glycol ethers. Other additives in water-based paints include biocides, surfactants, pigments, binders, and amines which could present respiratory health hazards (Wieslander, 1994). Additionally, a number of exposures were identified as being associated with asthma among these carpenters which have not previously been described as causing asthma. These include cement, drywall, lime, silica, and vermiculite dusts; alkali; and concrete form oils.

Lower odds ratios were seen for grouped exposures than for single agents, a likely example of bias towards the null resulting from nondifferential misclassification (Kleinbaum, 1982). In the questionnaire development we discussed at length the merits and pitfalls of asking these carpenters to provide more specific exposure information as opposed to asking for information about exposures to groups of agents. If we had asked for reports of grouped exposures we would have lost not only the ability to identify individual items of importance but would also have seen a muted effect. On the other hand we might have had a less tedious questionnaire which could have resulted in a better response rate and increased study power. We attempted to balance these competing priorities through significant pilot testing of the questionnaire.

Despite numerous attempts to get these carpenters to complete the questionnaire data the response rate was only 62% among the respondents we were able to contact. However, due to the level of detail requested in the questionnaire, the response rate of 62% seems reasonably good. Respondents were older and had more union experience than non-respondents. Among the carpenters who were contacted by phone there was some concern expressed about the confidentiality of the data and fear of employers obtaining access to their responses. A number of these late responders were no longer in the union and had not felt their responses were desired. Although, all of these things raise some concern about bias, the Poisson regression analyses comparing respondents to the overall population revealed comparable results using the variables available for the entire cohort.

A problem in the study of asthma -- especially for surveillance purposes -- is the lack of a clear way to identify cases of asthma. The identification of appropriate cases is hampered by lack of a clear definition of asthma - although it is generally considered to be the presence of airflow obstruction that is largely reversed by treatment with bronchodilators or steroids. When lung function studies are normal, inhalation challenge testing can demonstrate the presence of non-specific bronchial hyper responsiveness (Dosman 1990, Chan-Yeung 1990). From our study base we were able to identify cases of asthma defined by an ICD-9 code only. For a person to have received an ICD-9 code diagnosis they must have visited a physician. Although this definition was fairly specific it was not very sensitive, using Burney's DFP as a "gold standard".

Burney's DFP is based on a series of questions from the International Union Against Tuberculosis and Lung Disease (IUATLD) questionnaire for its ability to predict bronchial response to histamine in adults aged 18-64. A predictive score based on the items included in this predictor was more sensitive and only slightly less specific than questions on wheezing alone. Questions about asthma were found to be more specific but considerably less sensitive. The items do not differentiate reactivity associated with a positive skin test and that associated with smoking (Burney, 1989). The questionnaire items for the DFP have the distinct advantage that they have been tested against a standard measurement, but bronchial reactivity is not itself specific to asthma. A negative test does not rule out asthma. While we feel that Burney's DFP improved our ability to appropriately classify cases, it is still a less than perfect measure and we could not use that definition to sample from our entire cohort.

By reclassifying our cases and controls based on Burney's DFP we realize that we did not capture all cases defined in this manner from the study base. In fact, we could not have done so without surveying the entire population of carpenters in our cohort, which was not feasible. Nondifferential misclassification of cases would be predicted to bias results toward the null (Kleinbaum, 1982). This is a possible explanation for the differences in the results we obtained using these two different definitions of cases with more exposures of significance using Burney's DFP case definition. This is also a likely explanation for the differences in the behavior of the covariates for the different definitions of asthma. The elevated odds ratio for women compared to men using Burney's DFP is consistent with our internal comparisons using Poisson regression in which the rate ratio for women was 1.7 (95% CI 0.68, 4.1), and with elevated rates of outpatient visits for asthma for women seen in NAMCS (U.S. Dept. of Health and Human Services, 1995). Also consistent with these findings, time in the union was significantly protective for asthma between one and 10 years compared to those in less than one year using Poisson regression. The decreased risk of asthma among those in the union less than one year could reflect self-selection out of carpentry by those experiencing respiratory problems.

Our original case definition was individuals who had an ICD-9 diagnosis of asthma between 1989 and 1992. Our questionnaire, collecting both medical information and exposure data, was mailed to subjects in 1995. Some of the individuals in our study may have received an ICD-9 diagnosis of asthma between our last observation of claims in December, 1992 and the time when the questionnaires were mailed in the spring of 1995. This would result in the misclassification of cases as controls. In addition, ICD-9 diagnoses could be presumptive diagnoses which are later ruled out by the treating physician. Without access to actual medical records we cannot assess the magnitude of this potential misclassification which would misclassify controls as cases.

Although all of our cases must have had a diagnosis of asthma as an adult or have met Burney's criteria in the last 12 months, the study was not restricted to individuals who only had asthma as adults. Thirty-seven individuals had a history of asthma before the age of twenty, an age when they were unlikely to have exposures as a carpenter. Nearly a quarter (24%) of the individuals in our study who reported asthma before age 20 had onset before age two and 35% had onset before age four. Respiratory syncytial virus is thought to be the primary cause of wheezing in the first two years of life, but these children are not at increased risk of asthma later (Wheatley, 1996). These early diagnoses of asthma, at least among this very young group, are unlikely to be related to respiratory problems for which they sought medical care as adults.

Although dose response relationships were explored for variables in which the adjusted odds ratio was significant, with no clear increase in risk with increasing exposure, our analyses were essentially of an ever/never exposure in the last 10 years. We tested the importance of a large number of exposures, many of which overlapped. When so many exposures overlap this makes it difficult to identify clearly the offending agent(s) and we could not realistically assess the interaction of multiple exposures.

A number of the additional exposures which were associated with asthma using Burney's definition are ones to which a majority of these carpenters were exposed. These included cement, drywall, and silica dusts, caulks, and concrete form oils. If they are asthmagens and appropriate controls are put in place the potential for prevention is great. Further work is need to clearly define which of these agents are asthmagens and to explore possible interactions.

Although this work does not establish causal relationships, a number of agents suspected to be associated with asthma in this occupational group have been identified. Further evaluation is needed of a longitudinal nature to clearly identify new cases of asthma as well as pre-existing asthma which is exacerbated by workplace exposures, and the exposures associated with these events.

CONCLUSIONS AND RECOMMENDATIONS

Bronchitis, asthma, chronic bronchitis, and chronic obstructive airway disease are the most common lung disorders seen among this group of carpenters all of whom worked at least three months during 1989-1992. The more chronic of these respiratory diseases -- asthma, chronic bronchitis and chronic obstructive airway disease -- appear to increase with age among this working population. Older workers (over age 50) had more outpatient visits than national estimates for the same age group for asthma, and acute and chronic bronchitis. Although the prevalence of asthma was very close to that reported in NHIS Occupational Supplement the actual prevalence of asthma among 45-65 year old male carpenters may be higher than other working males of the same age since the NHIS used self-report and we required an ICD-9 definition. An excess incidence of lung cancer was seen among 45-54 year old male carpenters consistent with others' reports of increased deaths due to lung cancer among carpenters. All of these things raise concern about the respiratory health of working carpenters 45 years old and greater.

Odds of exposure were elevated using either of our case definitions of asthma for hay, epoxy paints, polyurethane products, enzymes, animals and molds. Grouped exposures to paints, varnishes, and stains and organic dusts were also consistently elevated. Using Burney's more sensitive case definition, but without full case ascertainment, odds of exposure were elevated for a number of additional common exposures for these carpenters.

Results of these studies should be used to plan prospective longitudinal studies of carpenters and other construction trades. Such studies should focus on new cases of asthma with concurrent measurements of exposures of interest identified from this study.

LIST OF TABLES

LITERATURE CITED

Anderson HA, Hanrahan LP, Schrimer J, Higgins D, Sarrow P. Mesothelioma among employees with likely contact with in-place asbestos containing building materials. Annals of NY Acad Sci 643:550-572, 1991.

ATSDR. Study of symptom and disease prevalence, Caldwell Systems Inc. hazardous waste incinerator, Caldwell County, North Carolina. 1993 (Unpublished).

Balmes, JR, Daponte, A, Cone, JE. Asbestos-Related Disease in Custodial and Building Maintenance Workers from a Large Municipal School District. Ann. N.Y. Acad Sci 643:540-549, 1991.

Bernacki EJ, Tsai SP. Use of group health insurance claims data to assess morbidity among employed persons. JOM 31(8):677-678, 1989.

Bernacki EJ, Tsai SP, Reedy SM. Analysis of a corporation's health care experience: implications for cost containment and disease prevention. Corporate Health Care 28(7):502-508, 1986.

Blessman JE. Differential treatment of occupational disease vs occupational injury by workers' compensation in Washington State. JOM 33(2):121-126, 1991.

Blose JO, Holder HD. Injury-related medical care utilization in a problem drinking population. AJPH 81(12):1571-1575, 1991.

Bond GG, Ott MG, Brenner FE, Cook RR. Medical morbidity surveillance findings among employees potentially exposed to TCDD. Br J Indus Med 40:318-324, 1983.

Bovenzi M, Stanta G, Antiga G, Peruzzo P, Cavallieri. Occupational exposure and lung cancer risk in a coastal area of Northeastern Italy. Int Arch Occup Environ Health 65:35-41, 1993.

Burney, PGJ, Chinn, S. Developing a new questionnaire for measuring the prevalence and distribution of asthma. Chest. 91(suppl):79S-83S, 1987.

Burney, PGJ, Britton, JR, Chinn, S, Tattersfield, AE, Pappacosta, AO, Kelson, MC. Descriptive epidemiology of bronchial reactivity in an adult population: results from a community study. Thorax. 42:38-44, 1987.

Burney PGJ, Chinn S Britton JR, Tattersfield AE, Papacosta AO. What symptoms predict the bronchial response to histamine? Evaluation in a community survey of The Bronchial Symptoms Questionnaire (1984) of the International Union Against Tuberculosis and Lung Disease. Int J Epid 18(1):165-173, 1989.

Carosso A, Ruffino C, Bugiani M. Respiratory diseases in woodworkers. Br J Indus Med. 44:53-56, 1987.

Chan-Yeung M. A clinician's approach to determine the diagnosis, prognosis, and therapy of occupational asthma. Medical Clinics of NA 74(3):811-822, 1990.

Chan-Yeung M, Lam S. State of the art -occupational asthma. Am Rev Respir Dis 137:686-703, 1986.

Chan-Yeung, M. Occupational Asthma. Chest 98:148S-161S, 1990.

Checkoway H, Pearce N, Crawford-Brown D. Research Methods in Occupational Epidemiology. p125-128. Oxford Univ. Press, New York, New York, 1989.

Checkoway, H, Pearce, N. and Dement, J.M. The Design and Conduct of Occupational Epidemiology Studies: Part III Design Aspects of Case-Control Studies, Amer J Ind Med 15:395-402, 1989.

Checkoway, H., Pearce, N. and Dement, J.M. The Design and Conduct of Occupational Epidemiology Studies: Part IV The Analysis of Case-Control Data, Amer J Ind Med 15:403-415, 1989.

Coggon D, Pannett B, Osmond C, Acheson ED. A survey of cancer and occupation in young and middle aged men, I cancers of the respiratory tract. Br J Indus Med 49:721-727,1992.

Courteau J, Cushman R, Bouchard F, Quevillon M, et al. Survey of construction worker repeatedly exposed to chlorine over a three to six month period in a pulpmill: I. Exposure and symptomatology. Occup Environ Med 51:219-224, 1994.

Daugbjerg P. Is particle board in the home detrimental to health? Environ Res. 48:154-163, 1989.

Dean AG, Dean JA, Coulombier D, Brendel KA, et al. EpiInfo, Version 6: a word processing, database, and statistics program for epidemiology on microcomputers. Centers for Disease Control and Prevention, Atlanta, Ga. U.S.A., 1994.

Dong W, Vaughan P, Sullivan K, Fletcher T. Mortality study of construction workers in the UK, Int J Epid, 24(4):750-757, 1995.

Dosman JA, Kania J, Cockcroft D. Occupational obstructive disorders: nonspecific airways obstruction and occuaptional asthma. Medical Clinics of NA, 74(3):823-835, 1990.

Epidemiological Graphics, Estimation, And Testing Package. Analysis Model (PECAN), Version 0.26.6. Statistics and Epidemiology Research Corporation, Seattle, Washington 1985-1991.

Feldman JP, Gerber LM. Sentinel Health Events (Occupational): analysis of death certificates among residents of Nassau County, NY between 1980-82 for occupationally related causes of death. AJPH 80(2);158-161, 1990.

Ferris, BG. Epidemiology standardization project. Am Rev Respir Dis118:1-53, 1978.

Fingar AR, Hopkins RS, Nelson M. Work-related injuries in Athens county 1982-1986. Journal of Occupational Medicine. 34(8):779-787, 1992.

Firth HM, Herbison GP, Cooke KR, Fraser J. Male cancer mortality by occupation:1973-86. New Zealand Med J 106:328-30,1993.

Fischbein A, Rohl, AN, Langer, AM, Selikoff, IJ. Drywall construction and asbestos exposure. Am Ind Hyg Assoc J 40:402-407, 1979.

Fischbein A, Luo HC, Rosenfeld S, Lacher M, et al. Respiratory findings among ironworkers; results from a clinical survey in New York metropolitan area and identification of health hazards from asbestos in place at work. Br J Indus Med. 48:404-411, 1991.

Fischbein A, Luo HC, Lacher M, Rosenfeld S, Rosenbaum A, et al. Respiratory findings among millwrights and machinery erectors: identification of health hazards from asbestos in place at work. Environ Research 61: 25-35, 1993.

Franklin GM, Haug J, Heyer N, Checkoway H, Peck N. Occupational carpal tunnel syndrome in Washington State, 1984-1988. AJPH 81(6):741-746, 1991.

Garcia-Closas M., Christiani DC. Asbestos-related diseases in construction carpenters. Amer J Indus Med 27:115-125, 1995.

Garrahan K. Mesothelioma: ha the patient had contact with even small amount of asbestos? JAMA 257(12):1569-70, Mar 27, 1987.

Harries, PG. Asbestos hazards in naval dockyards. Ann Occup Hyg 11:135-145, 1968.

Heederik D, Kromhout H, Burema J, Biersteker K, Krohout D. Occupational exposure and 25-year incidence rate of non-specific lung disease: the Zutphen study. Int J Epid 19(4):945-952, 1990.

Hessel PA, Herbert A, Melenka LS, Yoshida K, et al. Lung health in sawmill workers exposed to pine and spruce. Chest 108: 642-646, 1995.

Hoffman, RE, Rosenmann, KD, Watt, F, Stanbury, M. National Institute for Occupational Safety and Health. Occupational disease surveillance: occupational asthma. MMWR 39:119-23, 1990.

Hunting KL, Welch LS. Occupational exposure to dust and lung disease among sheet metal workers. Br J Indus Med 50:432-442, 1993.

International Agency for Research on Cancer. IARC Monographs on the evaluation of the carcinogenic risk of chemicals to humans: wood, leather and some associated industries. WHO Vol. 25. Lyon, France, Feb, 1991.

Kanerva L, Jolanki R, Toikkanen J. Frequencies of occupational allergic diseases and gender differences in Finland. Int Arch Occup Environ Health 66:111-116, 1994.

Kawachi I, Pearce N, Fraser J. A New Zealand cancer registry-based study of cancer in woodworkers. Cancer 64(12):2609-2613, 1989.

Kennedy SM, Vedal S, Muller N, Kassam A, et al. Lung function and chest radiograph abnormalities among construction insulators. Amer J Indus Med 20:673-684, 1991.

Kilburn KH, Warshaw BA. Airways obstruction from asbestos exposure, effects of asbestosis and smoking. Chest 106(4):1061-1070, 1994.

Klees, JE, Alexander, M, Rempel, D, Beckett, W, Rubin, R, Barnhart, S, Balmes, JR. Evaluation of a Proposed NIOSH Surveillance Case Definition for Occupational Asthma. Chest 98 (suppl:212S-215S), 1990.

Kleinbaum D, Kupper L, Morgenstern H. Epidemiologic Research: Principles and Quantitative methods. Chapter 12: Information Bias p222-223. Van Nostrand Reinhold, NY, 1982.

Kleinbaum D, Kupper L, Mueller K . Applied Regression Analysis and Other Multivariate Methods, second ed., 497-512, PWS-Kent Publishing Co. Boston, Mass., 1988.

Lemeshow S, Hosmer DW. Estimating odds ratios with categorically scaled covariates in multiple logistic regression. AJE 119(2): 147-151, 1984.

Levin, SM, Selikoff, IJ. Radiological Abnormalities and Asbestos Exposure among Custodians of the New York Board of Education. Ann NY Acad Sci 643:530-539, 1991.

Malo J, Cartier A, Desjardins A, Weyer R, Vandenplas. Occupational asthma caused by oak wood dust. Chest 108:856-58, 1995.

Malo J, Cartier A, L'Archevque J, Trudeau C, et al. Prevalence of occupational asthma among workers exposed to eastern white cedar. Am J Respir Crit Care Med 150:1697-1701, 1994.

Mathias CGT, Sinks TH, Seligman P, Halperin WE. Surveillance of occupational skin diseases: a method utilizing worker's compensation claims. Amer J Indus Med 17:363-370, 1990.

Medical News and Perspectives. Mesothelioma: has the patient had contact with even a small amount of asbestos? JAMA 257(12):1569-1570, 1987.

Meredith SK, Taylor VM, McDonald JC. Occupational respiratory disease in the U.K. 1989: a report to the British Thoracic Society of Occupational Medicine: the SWORD project group. Br J Indus Med 48:292-298, 1991.

Milham S. Mortality experience of the AFL-CIO Brotherhood of Carpenters and Joiners of America, 1969-1970.HEW (NIOSH) publication 74-129, July, 1974.

Milham SJ. Cancer in Washington State woodworkers. Chapter 8 in Carcinogens and Mutagens in the Environment, p117-123. Hans Stich (ed) CRC Press, Boca Rotan, Fla.,1983.

Minder CE, Vader JP. Malignant pleural mesothelioma among Swiss furniture workers, a new high risk group. Scand J Work Environ Health 14:252-256, 1988.

Morabia A, Markowitz S, Garibaldi K, Wynder EL. Lung cancer and occupation: results of a multicentre case-control study. Br J Indus Med 49:721-727, 1992.

Muscat JE, Wynder EL. Cigarette smoking, asbestos exposure, and malignant mesothelioma. Ca Res 51:2263-2267, 1991.

NIOSH, Work Related Lung Disease Surveillance Report, DHHS(NIOSH) Publication No. 91-113, 1991.

NIOSH, Work Related Lung Disease Surveillance Report Supplement 1992, DHHS(NIOSH) Publication No. 91-113S, 1992.

Ng TP, Hong CY, Goh LG, Wong Ml, et al. Risks of asthma associated with occupations in a community-based case-control study. Amer J Indus Med 25:709-718, 1994.

Norrish AE, Beasley R, Hodgkinson EJ, Pearce N. A study of New Zealand wood workers; exposure to wood dust, respiratory symptoms, and suspected cases of occupational asthma. New Zealand Med J 105(934):185-187,1992.

Oliver, LC, Sprince, NL, Greene, R. Asbestos-related abnormalities in school maintenance personnel. Ann N.Y. Acad Sci 643:521-529, 1991.

Olsen J, Sabroe S. A followup study of non-retired and retired memberes of the Danish carpenter and cabinetmakers trade union. Int J Epid 8(4):375-382, 1980.

Pearce, N, Checkoway, H, Dement, J. Exponential models for analyses of time-related factors, illustrated with asbestos textile worker mortality data. JOM 30 (No.6):517-522, 1988.

Pell S. Health Insurance claims as a source of morbidity data, DuPont Company's experience (commentary). JOM 31(8):679-680, 1989.

Pell S, Fayerweather WE. Trends in the incidence of myocardial infarction and in associated mortality and morbidity in a large employed population, 1957-1983. NEJM 312(16):1005-1011,1985.

Petersen, GR, Milham, S. Occupational mortality in the state of california 1959-61. DHEW(NIOSH) Publication No. 80-104, 1980.

Puntoni, R, Vercelli, M, Merlo, F, Valerio, F, Santi, L. Mortality among shipyard workers in Genoa, Italy. Ann N.Y. Acad Sci 330:353-377, 1979.

Reilly MJ, Rosenman KD, Watt F, Schill D, et al. Surveillance for Occupational Asthma - Michigan and New Jersey, 1988-1992. MMWR 43 (No. SS-1):9-17, June 10, 1994.

Ries LAG, Miller BA, Hankey BF, Kosary CL, Harras A, Edwards BK (eds). SEER Cancer Statistics Review, 1973-1991: Tables and graphs, National Cancer Institute. NIH Pub. No. 94-2789. Bethesda, MD, 1994.

Robinson C, Stern F, Halperin W, Venable H, et al. Assessment of mortality in the construction industry in the U.S., 1984-1996. Amer J of Indus Med 28:49-70, 1995.

Robinson CF, Palu S, Petersen M, Halperin WE. Carpenters Uunion members employed in the U.S. construction or wood products industries, proportionate mortality 1987-1990, May 20, 1995 (draft).

Robinson CF, Burnett C. Mortality patterns of U.S. female construction workers by race, 1979-1990. JOM, 36(11):1228-1233, 1994.

Robinson CF, Halperin WE, Alterman T, Braddee RW, et al. Mortality patterns among construction workers in the U.S. Occupational Medicine: State of the Art Reviews 10(2):269-283, April 1995.

SAS Version 6.10, SAS Institute, Inc. Cary N.C.

Schenker MB, Gold EB, lopez RL, Beaumont JJ. Asthma mortality in California, 1960-1989. Demographic patterns and occupational associations. Am Rev Respir Dis 147:1454-1460, 1993.

Schwartz D, Baker EL. Respiratory illness in the construction industry, airflow obstruction among painters. Chest 45:523-531, 1988.

Seguin, P, Allard, A, Carier, A, Malo, JL. Prevalence of occupational asthma in spray painters exposed to several types of isocyanates, including polymethylene polyphenylisocyanates. JOM 29:340-44, 1987.

Selikoff, IJ, Hammond, EC. Asbestos-related disease in United States shipyards. Cancer 28:87-99, 1978.

Siracusa A, Kennedy SM, DyBuncio A, Lin FJ, at al. Prevalence and predictors of asthma in working groups in British Columbia. Amer J Indus Med 28:411-423, 1995.

Stellman SD, Garfinkel L. Cancer mortality among woodworkers. Amer J Indus med 5:343-357, 1984.

Stern F, Schulte P, Sweeney M, Fingerhut M, et al. Proportionate mortality among construction laborers. Amer J Indus Med 27:484-509, 1995.

Tanaka S, Seligman P, Halperin W, Thun M, et al. Use of worker's compensation claims data for surveillance of cumulative trauma disorders. JOM 30(6):488-492, 1988.

Teschke K, Barroetavena MC. Occupational cancer in Canada: what do we know? Can Med Assoc J 147(10):1501-1506, 1992.

U.S. Dept. Of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, National Center for Health Statistics. 1990 National Ambulatory Medical Care Survey. CD-ROM Series 13, No. 2, July 1994.

U.S. Dept. Of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, Health conditions among the currently employed: U.S., 1988: 32, July 1993.

U.S. Dept. Of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, National Center for Health Statistics. 1990 National Ambulatory Medical Care Survey. CD-ROM Series 13, No. 3, March 1995.

U.S. Dept. Of Health and Human Services, Public Health Services, Centers for Disease Control and Prevention, National Center for Health Statistics. 1990 National Ambulatory Medical Care Survey. CD-ROM Series 13, No. 4, October 1995.

U.S. Dept. Of Health and Human Services, PHS, Centers for Disease Control and Prevention, National Center for Health Statistics, 1988 National Health Interview Survey, CD-ROM Series 10, No. 2, SETS Version 1.22, reissued December 1994.

Vandenplus O, Cartier A, Lesage J, et al. Occupational asthma caused by a pre-polymer but not monomer of toluene diisocyanate. J Allergy Clin Immunol 89(6):1183-1188, 1992.

Van Peenen PFD, Blanchard AG, Wolonsky PM, Gill TM. Health Insurance claims of petrochemical company employees. JOM 28(3):237-240, 1986.

Wacholder S, McLaughlin JK, Silverman DT, Mandel JS. Selection of controls in case-control studies. I. Principles. AJE 135(9):1019-28, 1992.

Wang ZP, Larsson K, Malmberg P, Sjorgen B, et al. Asthma, lung function and bronchial responsiveness in welders. Amer J Indus Med 26:741-754, 1994.

Weislander G, Janson C, Norback D, Bjornsson E, Stalenheim G, Edling C. Occupational exposure to water-based paints and self-reported asthma, lower airway symptoms, bronchial hyperresponsiveness, and lung function. Int Arch Occup Environ Health 66: 261-267, 1994.

Welch LM, Michaels D, Zoloth, S. Asbestos-related disease among sheet-metal workers. Ann N.Y. Acad Sci 643:287-296, 1991.

Wheatley LM, Platts-Mills TAE. Perenial allergens and the asthma epidemic. Science and Medicine:6-13, May/June 1996.

White MC, Baker EL. Measurement of respiratory illness among construction painters. Br J Indus Med 45:523-531, 1988.

Woodwell D. Personal communication. Subsetting weighted population denominators for generation of rates using NAMCS 1990. Survey statistician, National Center for Health Statistics, April 1996.

Yamaguchi N, Kido M, Hohuyama T, et al. A case-control study on occupational lung cancer risks in an industrialized city of Japan. Jpn J Cancer Res 83:134-140, 1992.

TABLE 1
Respiratory Diseases of Interest Defined by ICD-9 codes

ICD-9 code	Description
039.1	Actinomycosis
114	Coccidiomycosis
117.3	Aspergillosis
162	Neoplasm trachea, bronchus, lung
163	Neoplasm pleura
165	Neoplasm ill-defined respiratory
239.1	Unspecified respiratory neoplasm
490	Bronchitis
491	Chronic bronchitis
492	Emphysema
493	Asthma
494	Bronchiectasis
495	Extrinsic allergic alveolitis
496	Chronic obstructive airway, NOC
500	Coal workers' pneumoconiosis
501	Asbestosis
502	Silicotic pnemoconiosis
503	Other pnemoconiosis
504	Pneumopathy (dust)
506	Respiratory condition due to fumes/vapors
507	Pneumonitis/ solids and liquids
508	Respiratory condition due to unspecified extrinsic agent

TABLE 2
Incidence density rates of cases* of lung diseases per 1000 months of insurance eligibility among union carpenters in Washington State 1989-1992

ICD-9 code (description)	N	% of lung diagnoses	Rate
117.3 (aspergillosis)	1	0.1	0.004
162 (neoplasm trachea, bronchus, lung)	13	1.4	0.046
165 (neoplasm, ill-defined respiratory)	1	0.1	0.004
239.1 (unspecified respiratory neoplasm)	9	1.0	0.032
490 (bronchitis)	511	54.9	1.81
491 (chronic bronchitis)	51	5.5	0.18
492 (emphysema)	22	2.4	0.08
493 (asthma)	213	22.9	0.76
494 (bronchiectasis)	1	0.1	0.004
496 (chronic obstructive airway, NOC)	90	9.7	0.32
500 (coal workers pneumoconiosis)	1	0.1	0.004
501 (asbestosis)	9	1.0	0.032
503 (pneumoconiosis)	1	0.1	0.004
505 (pneumoconiosis, unspecified)	1	0.1	0.004
506 (respiratory cond. due to fumes/vapors)	6	0.6	0.021
508 (respiratory, unspecified extrinsic agent)	1	0.1	0.004 TOTAL
	931		

* Uses only the first time each diagnosis was made for each individual and includes all person months of insurance eligibility in denominators.

TABLE 3
Incidence density rates of claims* for lung diseases per 1000 months of insurance eligibility among union carpenters in Washington State 1989-1992

ICD-9 code (description)	N	% of claims for lung diagnoses	Rate	Mean# claims per person
117.3 (aspergillosis)	5	0.12	0.02	5
162 (neoplasm trachea, bronchus,lung)	1202	28.9	4.3	92.5
165 (neoplasm, ill-defined respiratory)	43	1.0	0.15	43
239.1 (unspecified respiratory neoplasm)	36	0.87	0.13	4
490 (bronchitis)	1058	25.6	3.8	2
491 (chronic bronchitis)	142	3.4	0.51	2.8
492 (emphysema)	94	2.3	0.33	4.2
493 (asthma)	1076	25.9	3.8	5.1
494 (bronchiectasis)	2	0.05	0.007	2
496 (chronic obstructive airway, NOC)	365	8.8	1.3	4.1
500 (coal workers pneumoconiosis)	1	0.02	0.004	1
501 (asbestosis)	66	1.6	0.23	7.3
503 (pneumoconiosis)	2	0.05	0.007	2
505 (pneumoconiosis, unspecified)	14	0.34	0.05	14
506 (respiratory cond. due to fumes/vapors)	23	0.55	0.08	3.8
508 (respiratory, unspecified extrinsic agent)	27	0.65	0.10	27
TOTAL	4156			

*Claims=line items; includes all months of insurance eligibility in denominators.

TABLE 4
Crude rates and rate ratios and adjusted rate ratios for internal comparisons of rates of lung diseases among union carpenters
Washington State 1989-1992

ASTHMA (ICD-9 493)

Covariate	# Cases	Months of coverage	Crude rate^	Crude RR	Adjusted RR* 95% CI
Age					
< 30 years	33	54397	0.61	1	1
30-44 years	112	146116	0.77	1.3	1.6 (1.0, 2.4)
45-60 years	55	61463	0.90	1.5	2.0 (1.2, 3.4)
60 + years	13	14465	0.90	1.5	2.2 (1.1, 4.5)
Sex					
Males	207	272087	0.76	1	1
Females	6	4396	1.4	1.8	1.7 (0.68, 4.1)
Time in the union					
Up to 1 years	50	51289	0.98	1	1
1-10 years	66	89891	0.73	0.75	0.70 (0.48, 1.0)
> 10 years	82	110491	0.74	0.76	0.59 (0.40, 0.87)

Predominant work**	# Cases	Months of coverage	Rate (95% CI)+	Unadjusted RR*
light commercial	61	72670	0.84 (0.65, 1.1)	1.1
heavy commercial	78	106598	0.73 (0.58, 0.91)	0.94
drywall	30	41308	0.73 (0.49, 1.0)	0.94
millwrights	2	4698	0.43 (0.05, 1.6)	0.55
piledrivers	7	17535	0.40 (0.16, 0.82)	0.51
cabinet/fixture	0	2102	- -	-
residential	5	3709	1.3 (0.42, 3.0)	1.7
mixed	23	24117	0.95 (0.60, 1.4)	1.2

^ rate per 1000 months of insurance coverage
* predominant task not included in models
** RR= rate compared to overall group rate of 0.78 (0.68, 0.90)
+ Poisson 95% CI

Person-time at risk stopped accumulating after individual became a case
Uses first claim in an eligible month

TABLE 5
Crude rates and rate ratios and adjusted rate ratios for internal comparisons of rates of lung diseases among union carpenters Washington State 1989-1992

BRONCHITIS (ICD-9 490)

Covariate	# Cases	Months of coverage	Crude rate^	Crude RR	Adjusted RR 95% CI
Age					
< 25 years	20	18778	1.1	1	1
25-34 years	166	87255	1.9	1.8	1.8 (1.1, 3.1)
35-44 years	187	90829	2.1	1.9	2.1 (1.2, 3.5)
45-54 years	78	44408	1.8	1.7	1.8 (1.0, 3.2)
55-64 years	54	27559	2.0	1.8	2.1 (1.2, 3.8)
65 + years	6	2432	2.5	2.3	2.8 (1.1, 7.3)
Sex					
Males	502	266865	1.9	1	1
Females	9	4438	2.0	1.1	0.65 (0.27, 1.6)
Time in the union					
Up to 1 years	97	50874	1.9	1	1
1-10 years	179	87973	2.0	1.1	1.0 (0.78, 1.3)
> 10 years	195	108092	1.8	0.95	0.81 (0.62, 1.1)
Predominant work*					
light commercial	152	71031	2.1	1.1	1.2 (0.93, 1.5)
heavy commercial	197	104676	1.9	1	1.0 (0.82, 1.3)
drywall	73	40476	1.8	0.95	0.94 (0.70, 1.3)
millwrights	7	4672	1.5	0.79	0.85 (0.43, 1.7)
piledrivers	36	17026	2.1	1.1	1.1 (0.80, 1.6)
cabinet/fixture	4	2046	2.0	1.1	1.1 (0.46, 2.6)
residential	7	3624	1.9	1	1.1 (0.57, 2.2)
mixed	31	23949	1.3	0.68	0.72 (0.50, 1.0)

^ rate per 1000 months of insurance coverage
* RR=rate compared to overall group (crude rate=1.9)

Person-time at risk stopped accumulating after individual became a case
Uses first claim in an eligible month

TABLE 6
Crude rates and rate ratios and adjusted rate ratios for internal comparisons of rates of lung diseases among union carpenters
Washington State 1989-1992

BRONCHITIS (ICD-9 490)
Repeat Events Model

Covariate	# Cases	Months of coverage	Crude rate^	Crude RR	Adjusted RR 95% CI
Age					
< 25 years	24	18986	1.3	1	1
25-34 years	218	89793	2.4	1.9	2.1 (1.3, 3.4)
35-44 years	256	94542	2.7	2.1	2.4 (1.4, 3.7)
45-54 years	109	45847	2.4	1.9	2.0 (1.2, 3.4)
55-64 years	131	28935	4.5	3.6	4.0 (2.4, 6.7)
65 + years	17	2629	6.5	5.1	5.9 (3.0, 11.8)
Sex					
Males	744	276244	2.7	1	1
Females	11	4530	2.4	0.90	.60 (0.27, 1.4)
Time in the union					
Up to 1 years	124	51639	2.4	1	1
1-10 years	236	91485	2.6	1.1	0.99 (0.80, 1.2)
> 10 years	343	112625	3.0	1.3	0.93 (0.74, 1.2)
Predominant work**					
light commercial	263	73951	3.6	1.3	1.6 (1.3, 1.9)
heavy commercial	269	108235	2.5	0.93	1.1 (0.87, 1.3)
drywall	94	41908	2.2	0.81	0.97 (0.74, 1.3)
millwrights	7	4745	1.5	0.55	0.63 (0.32, 1.2)
piledrivers	56	17705	3.2	1.2	1.3 (0.96, 1.8)
cabinet/fixture	4	2102	1.9	0.70	0.72 (0.30, 1.7)
residential	9	3792	2.4	0.89	1.2 (0.65, 2.2)
mixed	49	24526	2.0	0.74	0.90 (0.51, 1.6)

^ rate per 1000 months of insurance coverage
** RR=rate compared to overall group rate of 2.7
Person-time at risk continued to accumulate throughout observation period
Uses all claims filed for bronchitis (allowed one event per day per person - counts unique visits not line items)

TABLE 7
Crude rates and rate ratios and adjusted rate ratios for internal comparisons of rates of lung diseases among union carpenters
Washington State 1989-1992

CHRONIC BRONCHITIS (ICD-9 491)

Covariate	# Cases	Months of coverage	Crude rate^	Crude RR	Adjusted RR* 95% CI
Age					
< 30 years	5	54706	0.10	1	1
30-44 years	18	148231	0.12	1.3	1.3 (0.46, 3.5)
45-60 years	21	62259	0.34	3.7	3.4 (1.2, 10.2)
60+ years	7	14662	0.48	5.2	5.6 (1.5, 20.2)
Sex					
Males	49	275408	0.18	1	1
Females	2	4492	0.45	2.5	3.7 (0.87, 15.5)
Time in the union					
Up to 1 years	6	51608	0.12	1	1
1-10 years	18	91195	0.20	1.7	1.6 (0.61, 3.9)
> 10 years	25	112111	0.22	1.9	1.1 (0.40, 2.8)

Predominant work**	# Cases	Months of coverage	Rate (95% CI)+		Unadjusted RR*
light commercial	15	73613	0.20	(0.11, 0.33)	1.1
heavy commercial	18	107955	0.17	(0.10, 0.27)	0.94
drywall	6	41830	0.14	(0.05, 0.31)	0.78
millwrights	0	4745	-	-	
piledrivers	6	17599	0.34	(0.13, 0.74)	1.9
cabinet/fixture	1	2081	0.48	(0.01, 2.6)	2.7
residential	0	3792	-	-	-
mixed	5	24475	0.20	(0.06, 0.47)	1.1

^ rate per 1000 months of insurance coverage
* predominant task not included in models
** RR= rate compared to overall group rate of .18 (0.13, 0.24)
+ 95% Poisson CI
Person-time at risk stopped accumulating after individual became a case
Uses first claim in an eligible month

TABLE 8
Crude rates and rate ratios and adjusted rate ratios for internal comparisons of rates of lung diseases among union carpenters
Washington State 1989-1992

CHRONIC OBSTRUCTIVE AIRWAY DISEASE, NOC (ICD-9 496)

Covariate	# Cases	Months of coverage	Crude rate^	Crude RR	Adjusted RR* 95% CI
Age					
< 30 years	5	54723	0.10	1	1
30-44 years	23	148039	0.16	1.7	2.3 (0.66, 7.8)
45-60 years	46	61797	0.74	8.2	10.3 (3.0, 35.5)
60 + years	16	14435	1.1	12.1	14.9 (4.0, 56.1)
Sex					
Males	88	274544	0.32	1	1
Females	2	4492	0.45	1.4	3.1 (0.75, 13.0)
Time in the union					
Up to 1 years	8	51549	0.16	1	1
1- 10 years	19	91094	0.21	1.3	1.1 (0.49, 2.6)
> 10 years	59	111461	0.53	3.4	1.4 (0.60, 2.9)

Covariate	# Cases	Months of coverage	Rate (95% CI)+	Unadjusted RR*
Predominant work**				
light commercial	25	73488	0.34 (0.22, 0.50)	1.1
heavy commercial	30	107649	0.27 (0.18, 0.39)	0.84
drywall	9	41708	0.21 (0.10, 0.40)	0.65
millwrights	2	4708	0.42 (0.05, 1.5)	1.3
piledrivers	9	17483	0.51 (0.23, 0.97)	1.6
cabinet/fixture	2	2100	0.95 (0.11, 3.4)	2.9
residential	0	3792	- -	
mixed	11	24345	0.45 (0.22, 0.80)	1.4

^ rate per 1000 months of insurance coverage
* Predominant task not included in models
** RR= rate compared to overall group rate of 0.32 (0.26, 0.40)
\+ Poisson 95% CI
Person-time at risk stopped accumulating after individual became a case
Uses first claim in an eligible month

TABLE 9
Twelve Month Period Prevalence Rates
Comparisons to National Health Interview Survey, Occupational Health Supplement 1988
ASTHMA (ICD 493)

AGE	1989			1990			1991			1992			% Prev ** NHIS
	P-YR	# Cases	Prev %	P-YR	# Cases	Prev %	P-YR	# Cases	Prev %	P-YR	# Cases	Prev %	
18-24 Males	331	1	0.3	438	7	1.6	391	3	0.8	405	1	0.2	2.3
25-44 Males	2875	38	1.3	3901	49	1.3	4005	46	1.1	4269	43	1.0	2.1
45-64 Males	1187	18	1.5	1578	25	1.6	1642	31	1.9	1778	38	2.1	1.6
65-69 Males	19	0	0	40	0	0	56	0	0	79	0	0	3.3

Age calculated for each person at mid-year of each year
Case = 1st claim for each carpenter for each diagnosis in that year
Prev %=# cases in each year divided by person-years of observation x 100
** Answered 'YES' to question "During the last 12 months have you had asthma?"

TABLE 10
Twelve Month Period Prevalence Rates
Comparisons to National Health Interview Survey, Occupational Health Supplement 1988
CHRONIC BRONCHITIS (ICD 491)

AGE	1989			1990			1991			1992			% Prev** NHIS
	P-YR	# Cases	Prev %	P-YR	# Cases	Prev %	P-YR	# Cases	Prev %	P-YR	# Cases	Prev %	
18-24 Males	331	1	0.30%	438	0	0%	391	1	0.26%	405	0	0%	0.86%
25-44 Males	2875	5	0.17%	3901	5	0.13%	4005	5	0.12%	4269	6	0.14%	1.0%
45-64 Males	1187	3	0.25%	1578	5	0.32%	1642	8	0.49%	1778	15	0.84%	1.7%
65-69 Males	19	0	0%	40	1	2.5%	56	0	0%	79	0	0%	3.9%

Age calculated for each person at mid-year of each year
Case = 1st claim for each carpenter for each diagnosis in that year
Prev %=# cases in each year divided by person-years of observation x 100
** Answered 'YES' to question "During the past 12 months have you had chronic bronchitis?"
(Among people who were currently working)

TABLE 11
Comparisons to National Ambulatory Medical Care Surveys
Outpatient Doctor Visits for Asthma (ICD-9 493)

Males

	Person-years	# of claims*	Carpenters' Rate**	NAMCS Rate**
1989				
Age groups				
20-29	910	12	13.2	
30-39	1730	39	22.5	
40-49	914	32	35.0	
50-59	624	12	19.2	
60-69	197	7	35.5	
1990				
Age groups				
20-29	1175	13	11.1	
30-39	2330	52	22.3	
40-49	1317	43	32.6	
50-59	815	10	12.3	
60-69	283	24	84.8	
1991				
Age groups				
20-29	1135	18	15.9	21.4
30-39	2337	35	15.0	15.9
40-49	1421	32	22.5	26.7
50-59	824	18	21.8	16.8
60-69	345	19	55.1	24.4
1992				
Age groups				
20-29	1143	6	5.2	16.5
30-39	2485	43	17.3	17.8
40-49	1631	47	28.8	21.3
50-59	853	37	43.4	32.5
60-69	386	40	103.6	32.8

* carpenter claims do not include questionable x-ray encounters
** visits per 1000 person-years of observation

TABLE 12
Comparisons to National Ambulatory Medical Care Surveys
Outpatient Doctor Visits for Bronchitis (ICD-9 490)

	Males			
	Person-years	# of claims*	Carpenters' Rate**	NAMCS Rate**
1989				
Age groups				
20-29	910	14	15.3	
30-39	1730	52	30.1	
40-49	914	23	25.1	
50-59	624	24	38.4	
60-69	197	6	30.5	
1990				
Age groups				
20-29	1175	11	9.4	
30-39	2330	58	24.9	
40-49	1317	25	19.0	
50-59	815	27	33.1	
60-69	283	18	63.6	
1991				
Age groups				
20-29	1135	27	23.8	19.4
30-39	2337	66	28.2	24.4
40-49	1421	36	25.3	17.3
50-59	824	27	32.8	27.4
60-69	345	19	55.1	29.0
1992				
Age groups				
20-29	1143	27	23.6	17.0
30-39	2485	68	27.4	20.7
40-49	1631	47	28.8	30.5
50-59	853	35	41.0	30.8
60-69	386	22	57.0	17.1

* carpenter claims do not include questionable x-ray encounters
** visits per 1000 person-years of observation

TABLE 13
Comparisons to National Ambulatory Medical Care Surveys
Outpatient Doctor Visits for Chronic Bronchitis (ICD-9 491)

Males

	Person-years	# of claims*	Carpenters' Rate**	NAMCS Rate**
1989				
Age groups				
20-29	910	2	2.2	
30-39	1730	3	1.7	
40-49	914	2	2.2	
50-59	624	1	1.6	
60-69	197	2	10.2	
1990				
Age groups				
20-29	1175	0	-	
30-39	2330	4	1.7	
40-49	1317	4	3.0	
50-59	815	3	3.7	
60-69	283	2	7.1	
1991				
Age groups				
20-29	1135	4	3.5	no records in NAMCS
30-39	2337	1	0.43	no records in NMACS
40-49	1421	4	2.8	no records in NAMCS
50-59	824	6	7.3	3.6
60-69	345	5	14.5	5.9
1992				
Age groups				
20-29	1143	0	-	0.7
30-39	2485	2	0.80	no records in NAMCS
40-49	1631	9	5.5	4.2
50-59	853	10	11.7	1.1
60-69	386	8	20.7	11.7

* carpenter claims do not include questionable x-ray encounters
** visits per 1000 person-years of observation

TABLE 14
Comparisons to National Ambulatory Medical Care Surveys
Outpatient Doctor Visits for Chronic Obstructive Airway Disease (ICD-9 496)

Males

	Person-years	# of claims*	Carpenters' Rate**	NAMCS Rate**
1989				
Age groups				
20-29	910	1	1.1	
30-39	1730	2	1.2	
40-49	914	6	6.6	
50-59	624	8	12.8	
60-69	197	0	-	
1990				
Age groups				
20-29	1175	1	0.85	
30-39	2330	2	0.86	
40-49	1317	6	4.6	
50-59	815	12	14.7	
60-69	283	19	67.1	
1991				
Age groups				
20-29	1135	1	0.88	no records in NAMCS
30-39	2337	6	2.6	1.6
40-49	1421	3	2.1	4.3
50-59	824	14	17.0	28.3
60-69	345	9	26.1	33.5
1992				
Age groups				
20-29	1143	1	0.87	no records in NAMCS
30-39	2485	4	1.6	no records in NAMCS
40-49	1631	10	6.1	5.1
50-59	853	30	35.2	45.5
60-69	386	7	18.1	34.1

* carpenter claims do not include questionable x-ray encounters
** visits per 1000 person-years of observation

TABLE 15
Cancer of Lung and Bronchus
(ICD-9 162.2-162.9)
Male Carpenters of Western Washington
1989-1992

Age category	Person-years+ of observation	SEER^ rate per 100,000 py's	OBS	EXP	SIR*
15-34 years old	8836	0.6	1	0.05	20.0
35-44 years old	7747	11.3	2	0.88	2.3
45-54 years old	3784	68.6	8	2.6	3.1***
55-64 years old	2405	236.8	2	5.7	0.35
65+ years old	219	499.3	0	1.1	----
Overall SIR (95% approximate confidence interval)			13	10.33	1.3 (0.67, 1.9)

Discounting the first 3 months of person time observed

Age category	Person-years+ of observation	SEER^ rate per 100,000 py's	OBS	EXP	SIR*
15-34 years old	7582	0.6	1	0.05	20.0
35-44 years old	7005	11.3	2	0.79	2.5
45-54 years old	3439	68.6	6	2.3	2.6**
55-64 years old	2232	236.8	2	5.2	0.38
65+ years old	212	499.3	0	1.1	----
Overall SIR (95% approximate confidence interval)			11	9.44	1.2 (0.59, 2.1)

^ SEER (Surveillance, Epidemiology, and End Results) Program rates are for 1990-1991
* SIR = Standardized Incidence Ratio
*** significantly different from 1 at .005 level (Chi Sq statistic)
** significantly different from 1 at .025 level (Chi Sq statistic)
\+ person time at risk stopped accumulating when the person became a case
notes: no cases of cancer of the lung or bronchus identified among women in the cohort
overall person years of observation for women=330
discounting first 3 months person years of observation=282

Overall SIR confidence limits represent 95% approximate estimates (Rothman KJ and Boise JD, 1979: Epidemiologic Analysis with a Programmable Calculator. NIH Publication No. 79-1649, Washington, D.C.: U.S. Dept of Health) from Checkoway, Research Methods in Occupational Epidemiology.

TABLE 16
Asthma Case-Control Analyses

Cases Compared to Controls
and
Respondents Compared to Nonrespondents

	Case	**Control**	**p value***
Total pool (n=660)	n=220	n=440	
Mean age	40.2	40.0	0.85
Mean time in union	9.6	10.2	0.51
Sex (% men)	96.8	97.3	0.75
Unable to locate (%)	6.4	8.6	0.31
% responded	53.6	58.8	0.20
% responded if able to contact	57.3	64.4	0.09

	Respondent	**Non-respondent**	**p value***
	n=377	n=283	
Mean age	41.7	37.9	p=.02
Mean time in union	12.3	6.9	p< .001
Sex (% men)	96.3	97.9	P=0.24
% cases	31.3	36.0	p=0.201

* p values based on T-tests for continuous variables and Chi Square for categorical variables

TABLE 17
Asthma Case-control Analyses

Comparison of ICD-9 Case Definition with Burney's Discriminant Function Predictor

ICD-9 Definition	**Burney's DFP**		
	Case	**Control**	**TOTAL**
Case	79	39	118
Control	62	197	259
TOTAL	141	236	377

TABLE 18
Asthma Case-Control Analyses

Cases Compared to Controls Among Respondents
(Cases defined by ICD-9 493)

Total (n=377)	**Cases** n=118	**Controls** n=259	
Mean age	42.2	41.5	0.79
Mean time in union	11.9	12.4	0.78
Sex (% men)	96.6	96.1	0.82
Race (% white)	94.1	96.1	0.39
Education			
% <high school	11.0	12.7	
% high school grad	46.6	42.5	
% >high school	42.4	44.8	0.73
Insurance eligibility			
%<=1year	54.2	50.2	
%1-2 years	22.9	27.4	
%2-3 years	11.9	13.9	
%3-4 years	11.0	8.5	0.93

* p values based on T-tests for differences in means for continuous variables and Chi Square for categorical variables

TABLE 19
Asthma Case-Control Analyses

Cases Compared to Controls Among Respondents
(Cases based on Burney's Discriminant Function Predictor)

	Case	Control	p value*
Total (n=377)	n=141	n=236	
Mean age	42.5	41.2	0.74
Mean time in union	12.2	12.3	0.66
Sex (% men)	94.3	97.5	0.13
Education			
%<high school	13.5	11.4	
%high school grad	45.4	42.8	
%>high school	41.1	45.8	0.65
Months of insurance			
%<= 1 year	52.5	50.8	
% 1-2 years	25.5	26.3	
% 2-3 years	14.9	12.3	
% 3-4 years	7.9	10.6	0.57

* p values based on T-tests for differences in means for continuous variables and Chi Square for categorical variables

TABLE 20
Asthma Case-Control Analyses

Responses to medical history questions
(Cases defined by ICD-9 code 493)

	Case (n=118)	Control (n=259)	Total (n=377)
Ques1			
Ever diagnosed with:			
Bronchitis	60 (50.8%)	82 (31.9%)	142 (37.9%)
Emphysema	8 (6.8%)	3 (1.2%)	11 (2.9%)
Lung cancer	1 (0.8%)	1 (0.4%)	2 (0.5%)
Asbestosis	5 (4.2%)	2 (0.8%)	7 (1.9%)
Silicosis	0	0	0
Chronic bronchitis	22 (18.8%)	18 (7.0%)	40 (10.7%)
Asthma	73 (62.4%)	26 (10.2%)	99 (26.6%)
Ques 2-8			
In last 12 months:			
Wheezing/whistling	96 (81.4%)	102 (39.5%)	198 (52.7%)
Tightness on waking	79 (66.9%)	88 (34.1%)	167 (44.4%)
SOB in day wo exertion	70 (59.8%)	45 (17.4%)	115 (30.7%)
SOB after exercise	72 (61.0%)	57 (22.1%)	129 (34.3%)
Awakened at nite SOB	46 (39.3%)	20 (7.8%)	66 (17.6%)
Awakened at nite by cough	66 (57.4%)	97 (37.7%)	163 (43.8%)
Ques 8-11			
General			
Usually cough in AM	56 (48.7%)	79 (30.9%)	135 (36.4%)
Best describes breathing:			
Never trouble	35 (29.7%)	190 (73.4%)	225 (59.7%)
Regular trouble	31 (26.3%)	31 (12.0%)	62 (16.4%)
Never right	51 (43.2%)	30 (11.6%)	81 (21.5%)
Chest tight with dust/animals	44 (40.4%)	32 (12.7%)	76 (21.1%)
SOB with dust/animals	50 (45.0%)	25 (10.2%)	75 (21.1%)
Ever had asthma attack?	67 (59.3%)	27 (10.8%)	94 (25.9%)
Asthma attack last 12 months?	57 (59.4%)	9 (7.8%)	66 (31.1%)

TABLE 21
Asthma Case-Control Analyses

Responses to medical history questions
(Cases defined by Burney's discriminant function predictor)

	Case (n=141)	Control (n=236)	Total (n=377)
Ques1			
Ever diagnosed with:			
Bronchitis	89 (63.6%)	53 (22.6%)	142 (37.9%)
Emphysema	10 (7.2%)	1 (0.4%)	11 (2.9%)
Lung cancer	2 (1.4%)	0	2 (0.5%)
Asbestosis	5 (3.6%)	2 (0.95%)	7 (1.9%)
Silicosis	0	0	0
Chronic bronchitis	35 (25.5%)	5 (2.1%)	40 (10.7%)
Asthma	78 (56.5%)	21 (09.0%)	99 (26.6%)
Ques 2-8			
In **last 12 months**:			
Wheezing/whistling	124 (87.9%)	74 (31.5%)	198 (52.7%)
Tightness on waking	105 (74.5%)	62 (26.5%)	167 (44.4%)
SOB in day wo exertion	89 (63.1%)	26 (11.1%)	115 (30.7%)
SOB after exercise	93 (66.0%)	36 (15.3%)	129 (34.3%)
Awakened at nite SOB	58 (41.4%)	8 (3.4%)	66 (17.6%)
Awakened at nite by cough	95 (67.9%)	68 (29.3%)	163 (43.8%)
Ques 8-11			
General			
Usually cough in AM	82 (59.0%)	53 (22.8%)	135 (36.4%)
Best describes breathing:			
Never trouble	3 (0.02%)	222 (94.1%)	225 (59.7%)
Regular trouble	62 (44.0%)	4 (1.7%)	62 (16.4%)
Never right	81 (57.4%)	1 (0.42%)	81 (21.5%)
Chest tight with dust/animals	47 (35.9%)	29 (12.7%)	76 (21.1%)
SOB with dust/animals	59 (43.7%)	16 (7.2%)	75 (21.1%)
Ever had asthma attack?	74 (55.2%)	20 (8.7%)	94 (25.9%)
Asthma attack last 12 months?	62 (55.9%)	4 (4.0%)	66 (31.1%)

TABLE 22
Asthma Case-Control Analyses
Crude Odds Ratios and 95% Confidence Intervals (logit)
(Cases defined by ICD-9 code 493)

	N	OR	(95% CI)
Demographic information			
Age	377		
<30	44	1	
30-39	138	1.0	(0.45, 2.0)
40-49	97	1.4	(0.67, 3.0)
50-59	67	0.83	(0.34, 1.9)
60 and >	31	1.5	(0.56, 4.0)
Race	370		
Other	355	1	
White	17	1.5	(0.57, 4.1)
Sex	377		
Male	363	1	
Female	14	0.87	(0.27, 2.8)
Time in the Union	346		
< 1 year	32	1	
1-<10 years	142	0.71	(0.32, 1.5)
10 years and >	176	0.62	(0.29, 1.4)
Months of insurance eligibility			
<=1year	194	1	
1-2 years	98	0.77	(0.45, 1.3)
2-3 years	50	0.77	(0.40, 1.6)
3-4 years	35	1.2	(0.56, 2.6)
Tobacco use			
Smoked in the last month	247		
No	146	1	
Yes	101	0.77	(0.45, 1.3)
Ever smoked	364		
No	121	1	
Yes	243	1.1	(0.70, 1.8)
Smokers at home	347		
No	247	1	
Yes	100	0.57	(0.34, 0.97) **
Smokers at work	340		
No	174	1	
Yes	166	1.2	(0.76, 1.9)
Passive smoke exposure	312		
None	62	1	
1-4 hours/day	119	1.3	(0.67, 2.6)
4-8 hours/day	94	1.7	(0.53, 3.4)
> 8 hours/day	37	0.91	(0.36, 2.4)

TABLE 22 (cont)

		N	OR	95% CI
Household conditions				
Lives in mobile home		371		
	No	332	1	
	Yes	39	0.52	(0.23, 1.2)
Water damage to home		370		
	No	297	1	
	Yes	73	0.55	(0.30, 0.99)
Basement in home		369		
	No	264	1	
	Yes	105	1.2	(0.70, 1.9)
Water in basement		187 (only answer if have basement)		
	No	167	1	
	Yes	20	0.50	(0.16, 1.6)
Mold in home		362		
	No	246	1	
	Yes	116	0.83	(0.51, 1.3)
Humidifier in home		364		
	No	330	1	
	Yes	34	1.0	(0.48, 2.2)
Fireplace/wood stove for heat		377		
	No	193	1	
	Yes	184	0.62	(0.40, 0.96) **
Gas fireplace heat		377		
	No	352	1	
	Yes	25	1.0	(0.43, 2.5)
Electric heat		377		
	No	198	1	
	Yes	179	0.95	(0.61, 1.5)
Gas furnace		377		
	No	269	1	
	Yes	108	1.1	(0.71, 1.8)
Oil furnace		377		
	No	334	1	
	Yes	43	0.83	(0.41, 1.7)
Heat pump		377		
	No	355	1	
	Yes	22	1.3	(0.52, 3.1)
Cook with gas		377		
	No	323	1	
	Yes	55	0.74	(0.38, 1.4)
Cook with electricity		377		
	No	64	1	
	Yes	313	1.5	(0.78, 2.7)
Asthmatic in home		367		
	No	331	1	
	Yes	36	1.4	(0.68, 2.8)

** significant at 0.05 level

TABLE 23
Asthma Case-Control Analyses
Crude Odds Ratios and 95% Confidence Intervals (logit)
(Cases defined by Burney's Discriminant Function Predictor)

	N	OR	(95% CI)
Demographic information			
Age	377		
<30	44	1	
30-39	138	1.0	(0.49, 2.0)
40-49	97	1.4	(0.67, 3.0)
50-59	67	1.1	(0.49, 2.4)
60 and >	31	1.6	(0.62, 4.1)
Race	370		
Other	17	1	
White	355	1.1	(0.41, 3.1)
Sex	377		
Male	363	1	
Female	14	2.3	(0.78, 6.8)
Time in the Union	346		
< 1 year	32	1	
1-<10 years	142	0.45	(0.21, 0.98) **
10 years and >	176	0.53	(0.25, 1.1)
Months of insurance eligibility			
<=1year	194	1	
1-2 years	98	0.94	(0.57, 1.6)
2-3 years	50	1.2	(0.62, 2.2)
3-4 years	35	0.65	(0.29, 1.4)
Tobacco use			
Smoked in the last month	247		
No	146	1	
Yes	101	0.99	(0.59, 1.7)
Ever smoked	364		
No	121	1	
Yes	243	1.7	(1.1, 2.8) **
Smokers at home	347		
No	247	1	
Yes	100	1.2	(0.74, 1.9)
Smokers at work	340		
No	174	1	
Yes	166	2.0	(1.3, 3.2) **
Passive smoke exposure	312		
None	62	1	
1-4 hours/day	119	1.7	(0.85, 3.3)
4-8 hours/day	94	2.5	(1.3, 5.1) **
> 8 hours/day	37	2.4	(1.0, 5.8) **

TABLE 23 (cont)

	N	OR	95% CI
Household conditions			
Lives in mobile home	371		
No	332	1	
Yes	39	0.71	(0.35, 1.4)
Water damage to home	370		
No	297	1	
Yes	73	0.64	(0.38, 1.1)
Basement in Home	369		
No	264	1	
Yes	105	0.66	(0.41, 1.1)
Water in basement	187 (only answer if have basement)		
No	167	1	
Yes	20	1.5	(0.57, 3.7)
Mold in home	362		
No	246	1	
Yes	116	1.0	(0.66, 1.6)
Humidifier in home	364		
No	330	1	
Yes	34	0.87	(0.42, 1.8)
Fireplace/wood stove for heat	377		
No	193	1	
Yes	184	1.3	(0.83, 1.9)
Gas fireplace heat	377		
No	352	1	
Yes	25	0.63	(0.26, 1.6)
Electric heat	377		
No	198	1	
Yes	179	1.3	(0.83, 1.9)
Gas furnace	377		
No	269	1	
Yes	108	0.93	(0.58, 1.5)
Oil furnace	377		
No	334	1	
Yes	43	0.70	(0.35, 1.4)
Heat pump	377		
No	355	1	
Yes	22	1.2	(0.49, 2.8)
Cook with gas	377		
No	323	1	
Yes	55	0.81	(0.44, 1.5)
Cook with electricity	377		
No	64	1	
Yes	313	1.4	(0.78, 2.5)
Asthmatic in home	367		
No	331	1	
Yes	36	1.9	(0.96, 3.8)

** significant at 0.05 level

TABLE 24
Asthma Case-Control Analyses
Occupational Exposures by Case Control Status and Crude Odds Ratios and 95% Confidence Intervals
(Cases defined by ICD-9 code 493)

	Numbers exposed			
	Cases(n=118) n (%)^	Controls(n=259) n (%)^	CrudeOR (95% CI)	Adjusted* OR (95% CI)
Dusts				
Asbestos	45 (39.5)	85 (34.3)	1.3 (0.80, 2.0)	
Cement dust	102 (88.7)	221 (86.7)	1.2 (0.61, 2.4)	1.3 (0.63, 2.5)
Coal dust	2 (1.8)	11 (4.5)	0.39 (0.09, 1.8)	
Cotton dust	6 (5.5)	7 (2.8)	2.0 (0.66, 6.1)	
Drywall dust (plaster)	104 (91.2)	220 (86.3)	1.7 (0.79, 3.5)	1.8 (0.85, 3.9)
Fiberglass/Mineral wool/rock wool	95 (81.9)	187 (73.6)	1.6 (0.94, 2.8)	1.7 (0.95, 2.9)
Grain or flour dust	12 (10.5)	19 (7.6)	1.4 (0.67, 3.0)	1.9 (0.83, 4.2)
Hay dust	21 (18.9)	28 (11.3)	1.8 (1.0, 3.4) **	2.1 (1.1, 4.1) **
Lime dust	27 (24.3)	49 (19.7)	1.3 (0.77, 2.2)	1.4 (0.80, 2.4)
Mixed dust - sweeping/demolition	108 (93.9)	239 (93.7)	1.0 (0.41, 2.6)	
Particle board dust	88 (75.2)	182 (71.4)	1.2 (0.74, 2.0)	1.2 (0.71, 2.0)
Plastic dust	24 (21.4)	66(26.4)	0.76 (0.45, 1.3)	
Silica	53 (46.9)	132 (52.6)	0.80 (0.51, 1.2)	0.82 (0.52, 1.3)
Talc dust	6 (5.5)	12 (4.9)	1.1 (0.41, 3.1)	
Vermiculite/Perlite filler materials	20 (18.0)	47 (19.1)	0.93 (0.52, 1.7)	0.96 (0.53, 1.7)
Wood bark dust	41 (37.3)	80 (32.9)	1.2 (0.76, 1.9)	1.2 (0.73, 1.9)
Wood dust	109 (94.8)	232 (91.3)	1.7 (0.68, 4.4)	
Paints,Varnishes and Stains				
Enamels (oil-based)	81 (71.7)	137 (54.4)	2.1 (1.3, 3.4) **	2.2 (1.4, 3.6) **
Epoxy paints	71 (62.8)	120 (47.4)	1.9 (1.2, 3.0) **	2.0 (1.3, 3.3) **
Lacquers	73 (64.6)	137 (54.2)	1.5 (0.98, 2.4)	1.6 (0.99, 2.5)
Latex paints (water based)	89 (77.4)	158 (62.7)	2.0 (1.2, 3.4) **	2.1 (1.3, 3.5) **
Polyurethane products	77 (68.1)	143 (56.3)	1.5 (0.97, 2.5)	1.6 (0.99, 2.5)
Varnishes/stains	77 (68.1)	143 (56.3)	1.7 (1.0, 2.6) **	1.8 (1.1, 2.9) **
Wood sealers	61 (52.6)	111 (43.7)	1.4 (0.92, 2.2)	1.5 (0.98, 2.4)
Glues/Resins/Caulks				
Glues	85 (76.6)	171 (69.8)	1.4 (0.84, 2.4)	1.5 (0.89, 2.6)
Resins (epoxy, foam, acrylic, polyester)	66 (58.4)	123 (49.8)	1.4 (0.90, 2.2)	1.4 (0.87, 2.2)
Caulks (epoxy, silicone, latex)	99 (86.8)	203 (82.5)	1.4 (0.74, 2.6)	1.4 (0.73, 2.7)
Metal Dusts or Fumes				
Aluminum dusts or fumes	32 (27.8)	65 (25.6)	1.1 (0.68, 1.8)	1.1 (0.67, 1.9)
Cobalt dusts or fumes	7 (6.3)	14 (5.6)	1.1 (0.44, 2.9)	
Nickel dusts or fumes	6 (5.3)	9 (3.6)	1.5 (0.52, 4.3)	1.6 (0.52, 4.7)
Platinum dusts or fumes	3 (2.6)	7 (2.8)	0.95 (0.24, 3.7)	
Stainless steel (Chromium dusts or fumes)	21 (18.4)	33 (13.1)	1.5 (0.82, 2.7)	1.7 (0.90, 3.1)
Tungsten Carbide dusts or fumes	14 (12.3)	29 (11.7)	1.1 (0.54, 2.1)	1.1 (0.54, 2.2)
Vanadium dusts or fumes	4 (3.6)	10 (4.1)	0.89 (0.27, 2.9)	

(cont) **TABLE 24**

	Numbers exposed Cases(n=118) n (%)^	Controls(n=259) n (%)^	CrudeOR	(95% CI)	Adjusted*OR	(95%CI)
Processes Using Metals						
Metal plating	10 (9.2)	18 (7.4)	1.3	(0.57, 2.8)		
Soldering or brazing fumes	53 (46.1)	96 (38.3)	1.4	(0.88, 2.2)		
Welding or cutting fumes	88 (75.9)	191 (74.9)	1.1	(0.63, 1.8)	1.1	(0.64, 1.8)
Other exposures						
Acids (muriatic, sulfuric)	31 (27.7)	51 (20.7)	1.5	(0.87, 2.5)	1.4	(0.85, 2.5)
Alkali (caustics, lye, sodium hydroxide)	17 (15.2)	28 (11.3)	1.4	(0.74, 2.7)	1.3	(0.66, 2.6)
Ammonia	31 (27.2)	48 (19.4)	1.5	(0.92, 2.6)	1.6	(0.94, 2.8)
Chlorine (pool maintainance, paper mill)	36 (31.6)	72 (29.0)	1.1	(0.70, 1.8)		
Concrete form oils	92 (78.60	184 (73.0)	1.4	(0.81, 2.3)	1.4	(0.80, 2.4)
Cutting oils (coolant/oil mists)	57 (49.6)	98 (39.5)	1.5	(0.96, 2.3)	1.5	(0.93, 2.3)
Drug pharmaceutical manufacturing	1 (0.87)	6 (2.4)	0.35	(0.04, 3.0)		
Dyes	4 (3.5)	7 (2.8)	1.3	(0.36, 4.4)		
Enzymes (detergent, plastic, or pharmaceutical industry)	21 (18.4)	28 (11.2)	1.8	(0.96, 3.3)	2.0	(1.0, 3.8) **
Formaldehyde or glutaraldehyde vapor	12 (10.8)	35 (14.0)	0.75	(0.37, 1.5)		
Fumes from heated plastics	23 (20.4)	42 (16.8)	1.3	(0.72, 2.2)	1.4	(0.78, 2.5)
Glycols (antifreeze, paints)	35 (31.0)	76 (30.7)	1.0	(0.63, 1.6)		
Pesticides, insecticides, herbicides	33 (29.0)	67 (26.8)	1.1	(0.68, 1.8)		
Printing inks and oils	10 (8.9)	14 (5.7)	1.6	(0.70, 3.8)	2.1	(0.84, 5.3)
Styrene	20 (17.4)	27 (10.9)	1.7	(0.92, 3.2)	1.7	(0.89, 3.2)
Tar (coal or petroleum)	38 (33.6)	90 (36.0)	0.90	(0.56, 1.4)		
Urethane foam insulation	56 (49.1)	98 (39.5)	1.5	(0.95, 2.3)	1.4	(0.90, 2.2)
Miscellaneous Exposures						
Animals (fur/wastes)	74 (64.4)	125 (50.0)	1.8	(1.1, 2.8) **	1.9	(1.2, 3.1) **
Seafood processing	4 (3.5)	19 (7.7)	0.44	(0.15, 1.3)	0.52	(0.17, 1.6)
Cigarette smoke	102 (87.2)	222 (87.8)	0.95	(0.49, 1.8)		
Gasoline (service station attendant, mechanic)	57 (49.1)	108 (43.4)	1.3	(0.81, 2.0)	1.3	(0.81, 2.1)
Exhaust from engines	93 (79.5)	205 (80.7)	0.93	(0.54, 1.6)	1.0	(0.57, 1.8)
Smoke from combustion	32 (27.6)	80 (32.1)	0.81	(0.50, 1.3)		
Mold	44 (38.9)	64 (26.1)	1.8	(1.1, 2.9) **	1.9	(1.2, 3.2) **

^ Percent exposed of those who responded to question
* adjusted for age, sex, time in the union, and ever smoking history
** significant at 0.05 level

Blank indicates crude OR was insignificant using either case definition

TABLE 25
Asthma Case-Control Analyses

Grouped Exposures by Case Control Status and Odds Ratios and 95% Confidence Intervals
(Cases defined by ICD-9 code 493)

	Numbers exposed			
	Cases(n=118)	Controls(n=141)		
	n (%)^	n (%)^	CrudeOR (95% CI)	Adjusted* OR (95% CI)
Dusts				
Organic	31 (26.3)	45 (17.4)	1.7 (1.0, 2.9) **	2.0 (1.2, 3.5) **
Mineral	112 (94.9)	252 (97.3)	0.52 (0.17, 1.6)	0.61 (0.19, 1.9)
Wood	110 (93.2)	235 (90.7)	1.4 (0.61, 3.2)	1.5 (0.64, 3.5)
Paints, varnishes, stains	103 (87.3)	207 (79.9)	1.7 (0.93, 3.2)	1.9 (1.0, 3.5) **
Glues, resins, caulks	103 (87.3)	224 (86.5)	1.1 (0.56, 2.1)	1.2 (0.60, 2.3)
Metal dusts or fumes	44 (37.3)	86 (33.2)	1.2 (0.76, 1.9)	1.2 (0.77, 2.0)
Metal processing	90 (76.3)	196 (75.7)	1.0 (0.62, 1.7)	1.0 (0.61, 1.8)

^ Percent exposed of those who responded to question
* adjusted for age, sex, time in the union, and ever smoking history
** significant at 0.05 level

Notes regarding groupings:

Organic dusts include cotton, grain or flour, and hay
Mineral dusts include asbestos, cement, coal, drywall dust or plaster, lime, particle board dust, silica, talc, and vermiculite or perlite
Wood dusts include wood dust or wood bark dust

Paints, varnishes,stains include enamels (oil-based), epoxy paints, lacquers, latex paints (water based), polyurethane products, varnishes or stains, and woodsealers

Glues, resins, caulks include glues, resins (epoxy, foam, acrylic, polyester), and caulks (epoxy, silicone, latex)

Metal dusts and fumes include dusts or fumes from aluminum, cobalt, nickel, platinum, stainless steel (chromium), tungsten carbide, vanadium

Metal processing includes metal plating, soldering or brazing fumes, and welding or cutting fumes

TABLE 26
Asthma Case-Control Analyses
Occupational Exposures by Case Control Status and Crude Odds Ratios and 95% Confidence Intervals
(Cases defined by Burney's Discriminant Function Predictor)

	Numbers exposed Cases(n=141) n (%)^	Controls(n=236) n (%)^	CrudeOR (95% CI)		Adjusted* OR (95%CI)	
Dusts						
Asbestos	54 (40.3)	76 (33.3)	1.4 (0.87, 2.1)			
Cement dust	128 (92.8)	195 (84.1)	2.4 (1.2, 5.1)	**	2.4 (1.1, 5.1)	**
Coal dust	6 (4.6)	7 (3.1)	1.5 (0.51, 4.6)			
Cotton dust	6 (4.7)	7 (3.1)	1.5 (0.50, 4.7)			
Drywall dust (plaster)	130 (94.2)	194 (84.0)	3.1 (1.4, 6.9)	**	3.5 (1.6, 7.9)	**
Fiberglass/Mineral wool/rock wool	105 (75.5)	177 (76.6)	0.94 (0.58, 1.5)		0.98 (0.59, 1.6)	
Grain or flour dust	17 (12.8)	14 (6.1)	2.3 (1.1, 4.8)	**	3.1 (1.4, 7.2)	**
Hay dust	27 (20.6)	22 (9.7)	2.4 (1.3, 4.5)	**	3.8 (1.9, 7.5)	**
Lime dust	42 (31.8)	34 (14.9)	2.7 (1.6, 4.5)	**	3.1 (1.8, 5.4)	**
Mixed dust - sweeping/demolition	135 (96.4)	212 (92.2)	2.3 (0.83, 6.3)			
Particle board dust	109 (78.4)	161 (69.1)	1.6 (1.0, 2.7)	**	1.6 (0.96, 2.6)	
Plastic dust	36 (27.5)	54 (23.4)	1.2 (0.76, 2.0)			
Silica	78 (58.2)	107 (46.5)	1.6 (1.0, 2.5)	**	1.6 (1.0, 2.4)	**
Talc dust	9 (7.1)	9 (4.0)	1.8 (0.71, 4.8)			
Vermiculite/Perlite filler materials	32 (25.0)	35 (15.3)	1.8 (1.1, 3.2)	**	2.3 (1.3, 9.7)	**
Wood bark dust	53 (40.8)	68 (30.5)	1.6 (1.0, 2.5)	**	1.7 (1.1, 2.8)	**
Wood dust	127 (92.7)	214 (92.2)	1.1 (0.48, 2.4)			
Paints,Varnishes and Stains						
Enamels (oil-based)	84 (64.1)	134 (57.3)	1.3 (0.86, 2.1)		1.4 (0.86, 2.2)	
Epoxy paints	83 (61.4)	108 (46.6)	1.9 (1.2, 2.9)	**	2.0 (1.3, 3.1)	**
Lacquers	82 (61.7)	128 (54.9)	1.3 (0.85, 2.0)		1.4 (0.87, 2.1)	
Latex paints (water based)	97 (71.3)	150 (64.9)	1.3 (0.85, 2.1)		1.4 (0.89, 2.3)	
Polyurethane products	90 (66.2)	130 (56.3)	1.5 (0.98, 2.4)		1.6 (1.0, 2.5)	**
Varnishes/stains	85 (63.4)	135 (57.9)	1.3 (0.81, 2.0)		1.3 (0.82, 2.0)	
Wood sealers	69 (50.0)	103 (11.4)	1.3 (0.82, 1.9)		1.3 (0.86, 2.1)	
Glues/Resins/Caulks						
Glues	102 (77.3)	154 (68.8)	1.5 (0.94, 2.5)		1.7 (1.0, 2.8)	
Resins (epoxy, foam, acrylic, polyester)	77 (58.3)	112 (49.1)	1.5 (0.94, 2.2)		1.4 (0.89, 2.2)	
Caulks (epoxy, silicone, latex)	119 (88.2)	183 (81.3)	1.7 (0.92, 3.2)		2.0 (1.0, 3.9)	**
Metal Dusts or Fumes						
Aluminum dusts or fumes	44 (32.6)	53 (22.7)	1.7 (1.0, 2.6)	**	1.8 (1.1, 3.0)	**
Cobalt dusts or fumes	11 (8.4)	10 (4.3)	2.0 (0.84, 4.9)			
Nickel dusts or fumes	9 (6.8)	6 (2.6)	2.7 (0.95, 7.9)		3.6 (1.2, 11.5)	**
Platinum dusts or fumes	6 (4.5)	4 (1.7)	2.7 (0.75, 9.8)			
Stainless steel (Chromium dusts or fumes)	31 (23.3)	23 (9.9)	2.8 (1.5, 5.0)	**	3.0 (1.6, 5.7)	**
Tungsten Carbide dusts or fumes	21 (15.8)	22 (9.6)	1.8 (0.93, 3.4)		1.9 (0.93, 3.7)	
Vanadium dusts or fumes	6 (4.7)	8 (3.5)	1.3 (0.45, 3.9)			

(cont) **TABLE 26**

	Numbers exposed Cases(n=141) n (%)^	Controls(n=236) n (%)^	CrudeOR (95% CI)			Adjusted* OR (95% CI)		
Processes Using Metals								
Metal plating	11 (8.7)	17 (7.5)	1.2	(0.53, 2.6)				
Soldering or brazing fumes	58 (43.3)	91 (39.2)	1.2	(0.77, 1.8)				
Welding or cutting fumes	109 (79.6)	170 (72.7)	1.5	(0.88, 2.4)		1.6	(0.91, 2.7)	
Other exposures								
Acids (muriatic, sulfuric)	37 (28.5)	45 (19.7)	1.6	(0.98, 2.7)		1.7	(1.0, 2.9)	**
Alkali (caustics, lye, sodium hydroxide)	24 (18.5)	21 (9.1)	2.3	(1.2, 4.2)	**	2.2	(1.1, 4.4)	**
Ammonia	37 (28.5)	42 (18.2)	1.8	(1.1, 3.0)	**	1.6	(0.92, 2.7)	
Chlorine (pool maintainance, paper mill)	44 (33.6)	64 (27.7)	1.3	(0.83, 2.1)				
Concrete form oils	112 (81.8)	164 (70.7)	1.9	(1.1, 3.1)	**	2.0	(1.2, 3.4)	**
Cutting oils (coolant/oil mists)	65 (48.5)	90 (39.3)	1.5	(0.94, 2.2)		1.4	(0.88, 2.2)	
Drug pharmaceutical manufacturing	3 (2.3)	4 (1.8)	1.3	(0.29, 5.9)				
Dyes	5 (3.8)	6 (2.6)	1.5	(0.44, 4.9)				
Enzymes (detergent, plastic, or pharmaceutical industry)	26 (19.4)	23 (10.0)	2.2	(1.2, 4.0)	**	2.3	(1.2, 4.5)	**
Formaldehyde or glutaraldehyde vapor	18 (13.7)	29 (12.6)	1.1	(0.59, 2.1)				
Fumes from heated plastics	30 (22.6)	35 (15.2)	1.6	(0.94, 2.8)		1.8	(1.0, 3.2)	**
Glycols (antifreeze, paints)	41 (30.4)	70 (31.0)	0.97	(0.61, 1.5)				
Pesticides, insecticides, herbicides	40 (29.6)	60 (26.2)	1.2	(0.74, 1.9)				
Printing inks and oils	16 (12.0)	8 (3.5)	3.7	(1.6, 9.0)	**	5.6	(1.9, 16.3)	**
Styrene	25 (18.7)	22 (9.7)	2.1	(1.2, 4.0)	**	2.1	(1.1, 4.0)	**
Tar (coal or petroleum)	48 (36.5)	80 (34.6)	1.1	(0.69, 1.7)				
Urethane foam insulation	68 (51.1)	86 (37.6)	1.7	(1.1, 2.7)	**	1.7	(1.1, 2.7)	**
Miscellaneous Exposures								
Animals (fur/wastes)	82 (61.2)	117 (50.7)	1.5	(1.0, 2.4)	**	1.7	(1.0, 2.6)	**
Seafood processing	13 (9.8)	10 (4.4)	2.4	(1.0, 5.5)	**	2.7	(1.0, 7.0)	**
Cigarette smoke	126 (90.7)	198 (85.7)	1.6	(0.82, 3.2)				
Gasoline (service station attendant, mechanic)	71 (52.6)	94 (40.9)	1.6	(1.0, 2.5)	**	1.6	(0.99, 2.5)	
Exhaust from engines	119 (86.2)	179 (76.8)	1.9	(1.1, 3.3)	**	2.1	(1.1, 3.7)	**
Smoke form combustion	42 (31.3)	70 (30.3)	1.1	(0.66, 1.7)				
Mold	55 (41.4)	53 (23.6)	2.3	(1.4, 3.6)	**	2.4	(1.5, 3.9)	**

^ Percent exposed of those who responded to question
* Adjusted for age, sex, time in the union, and ever smoking history
** signifies significant at 0.05 level

Blank indicates crude OR was insignificant using either case definition

TABLE 27
ASTHMA CASE-CONTROL ANALYSES
Grouped Exposures by Case Control Status and Odds Ratios and 95% Confidence Intervals
(Cases defined by Burney's Discriminant Function Predictor)

	Numbers exposed Cases(n=141) n (%)^	Controls(n=236) n (%)^	CrudeOR (95% CI)	Adjusted* OR (95% CI)
Dusts				
Organic	42 (29.8)	34 (14.4)	2.5 (1.5, 4.2) **	3.3 (1.9, 5.8) **
Mineral	139 (98.6)	225 (95.3)	3.4 (0.74, 15.6)	4.0 (0.87, 18.9)
Wood	129 (91.5)	216 (91.5)	1.0 (0.47, 2.1)	1.2 (0.54, 7.2)
Paints, varnishes, stains	121 (85.8)	189 (80.1)	1.5 (0.85, 2.7)	1.7 (0.95, 3.1)
Glues, resins, caulks	125 (88.7)	202 (85.6)	1.3 (0.70, 2.5)	1.5 (0.75, 2.3)
Metal dusts or fumes	60 (42.6)	70 (29.7)	1.8 (1.1, 2.7) **	1.8 (1.2, 2.9) **
Metal processing	112 (79.4)	174 (73.7)	1.4 (0.83, 2.3)	1.4 (0.83, 2.4)

^ Percent exposed of those who responded to question
* Adjusted for age, sex, time in the union, and ever smoking history
** signifies significant at 0.05 level

Notes regarding groupings:

Organic dusts include cotton, grain or flour, and hay
Mineral dusts include asbestos, cement, coal, drywall dust or plaster, lime, particle board dust, silica, talc, and vermiculite or perlite
Wood dusts include wood dust or wood bark dust

Paints, varnishes, stains include enamels (oil-based), epoxy paints, lacquers, latex paints (water based), polyurethane products, varnishes or stains, and woodsealers

Glues, resins, caulks include glues, resins (epoxy, foam, acrylic, polyester), and caulks (epoxy, silicone, latex)

Metal dusts and fumes include dusts or fumes from aluminum, cobalt, nickel, platinum, stainless steel (chromium), tungsten carbide, vanadium

Metal processing includes metal plating, soldering or brazing fumes, and welding or cutting fumes

POSSIBLE FUTURE PUBLICATIONS

Results of this research will be submitted to peer reviewed journals. We anticipate at least two publications from this research. One will be a descriptive paper describing occupational exposures experienced by carpenters and the other will be concerned with the cohort and case-control analyses. This latter publication may be broken into two separate manuscripts.

APPENDIX

OCCUPATIONAL HISTORY, RESPIRATORY SYMPTOM AND EXPOSURE QUESTIONNAIRE USED FOR ASTHMA CASE-CONTROL STUDY

(attached)

CARPENTERS OCCUPATIONAL HEALTH STUDIES
SECTION I--OCCUPATIONAL HISTORY

ALL ANSWERS ARE CONFIDENTIAL
INFORMATION WILL NOT BE RELEASED

We would like to get some information about your jobs over the last 10 years.

A. CURRENT JOB HISTORY

1. Are you a current union member of the United Brotherhood of Carpenters (UBC)? (please check (✓) the appropriate answer)

   Yes ____

   No ____

2. What is your current working status? (please check (✓) the appropriate answer)

   Currently working [ ]

   Currently not working [ ]

   Retired [ ]

B. JOB HISTORY FOR LAST 10 YEARS

We would like for you to fill out this job history table. It is split into 2 sections. In the first section, only list the jobs you have had while employed by a **union**. In the second section, list the jobs you had outside of the union (**non-union work**) or while being **self-employed.**

Please fill out the table below **starting with your current or most recent job and working backwards.** Proceed until you have covered the jobs you have had for the past 10 years. **Only include jobs that you have held for 3 months or longer.**

I. UNION WORK					
TYPE OF JOB	YEAR STARTED	YEAR STOPPED	AVERAGE HOURS WORKED EACH WEEK	NAME OF UNION	UNION LOCAL NUMBER
Examples: *CARPENTER*	*1992*	*Present*	*25*	*United Brotherhood of Carpenters (UBC)*	*2893*
BUSINESS AGENT	*1990*	*1992*	*40*	*UBC*	*2893*
Most recent or current union job					

II. NON-UNION WORK or SELF-EMPLOYMENT				
TYPE OF JOB	YEAR STARTED	YEAR STOPPED	AVERAGE HOURS WORKED EACH WEEK	EMPLOYER
Examples: *FARMER*	*1989*	*Present*	*20*	*SELF-EMPLOYED*
ELECTRICIAN	*1984*	*1987*	*40*	*ACE HARDWARE*
Most recent or current non-union or self-employed job				

C. OCCUPATIONAL EXPOSURES OVER LAST 10 YEARS

This section asks about your exposure to dusts, metals, paints, and other materials over the past 10 years. Please give us your "best guess" about your exposures. Consider exposures which you have had in **all** jobs including self-employment.

It is important that you respond to every question.

- If you were not exposed, please **circle** the "0" in the **"Definitely not exposed"** column.
- If you are not sure if you were exposed to a certain material, please **circle** the "4" in the **"Not sure about exposure"** column.
- If you worked near someone that was using a certain material, but you weren't actually using the material yourself, consider yourself exposed and mark the column that shows how often you were around this material. If you were wearing a respirator or dust mask still report the frequency you were around that material.

The following is an **example** of how to complete the exposure questions.

	Definitely not exposed	Exposed 1 to 3 times a month	Exposed 1 to 3 times a week	Exposed more than 3 times a week	Not sure about exposure
DUST					
Asbestos	(0)	1	2	3	4
Cement Dust	0	(1)	2	3	4
Coal Dust	0	1	2	(3)	4
Cotton Dust	0	1	(2)	3	4
Drywall Dust (Plaster Dust)	0	1	2	3	(4)

WORK EXPOSURES OVER THE PAST 10 YEARS

Please circle your "best estimate" of exposure for <u>each</u> item.

	Definitely not exposed	Exposed 1 to 3 times a month	Exposed 1 to 3 times a week	Exposed more than 3 times a week	Not sure about exposure
DUST					
Asbestos	0	1	2	3	4
Cement Dust	0	1	2	3	4
Coal Dust	0	1	2	3	4
Cotton Dust	0	1	2	3	4
Drywall Dust (Plaster Dust)	0	1	2	3	4
Fiberglass/Mineral Wool/Rock Wool	0	1	2	3	4
Grain or Flour Dust	0	1	2	3	4
Hay Dust	0	1	2	3	4
Lime Dust	0	1	2	3	4
Mixed Dust from Sweeping or Demolition	0	1	2	3	4
Particle Board Dust	0	1	2	3	4
Plastic Dust	0	1	2	3	4
Silica (sand, brick, sandblasting)	0	1	2	3	4
Talc Dust	0	1	2	3	4
Vermiculite/Perlite Filler materials	0	1	2	3	4
Wood Bark Dust	0	1	2	3	4
Wood Dusts	0	1	2	3	4
PAINTS, VARNISHES & STAINS					
Enamels (oil-based)	0	1	2	3	4
Epoxy Paints	0	1	2	3	4
Lacquers	0	1	2	3	4
Latex Paints (water-based)	0	1	2	3	4
Polyurethane Products (paints, varnishes, lacquers)	0	1	2	3	4
Varnishes/Stains	0	1	2	3	4

Please circle your "best estimate" of exposure for <u>each</u> item.

	Definitely not exposed	Exposed 1 to 3 times a month	Exposed 1 to 3 times a week	Exposed more than 3 times a week	Not sure about exposure
GLUES/RESINS/CAULKS					
Glues	0	1	2	3	4
Resins (epoxy, foam, acrylic, polyester,...)	0	1	2	3	4
Caulks (epoxy, silicone, latex,...)	0	1	2	3	4
METAL DUSTS OR FUMES					
Aluminum dusts or fumes	0	1	2	3	4
Cobalt dusts or fumes	0	1	2	3	4
Nickel dusts or fumes	0	1	2	3	4
Platinum dusts or fumes	0	1	2	3	4
Tungsten Carbide dusts or fumes	0	1	2	3	4
Stainless steel (Chromium dusts or fumes)	0	1	2	3	4
Vanadium dusts or fumes	0	1	2	3	4
PROCESSES USING METALS					
Metal Plating	0	1	2	3	4
Soldering or Brazing fumes	0	1	2	3	4
Welding or Cutting Fumes	0	1	2	3	4
OTHER EXPOSURES					
Acids (muriatic acid, sulfuric acid,...)	0	1	2	3	4
Alkali (caustics, lye, sodium hydroxide,...)	0	1	2	3	4
Ammonia	0	1	2	3	4
Chlorine (swimming pool maintenance, paper mill,...)	0	1	2	3	4
Concrete Form Oils	0	1	2	3	4
Cutting oils (coolant/oil mists from machining operations)	0	1	2	3	4
Drug/Pharmaceutical manufacturing	0	1	2	3	4
Dyes	0	1	2	3	4

Please circle your "best estimate" of exposure for <u>each</u> item.

	Definitely not exposed	Exposed 1 to 3 times a month	Exposed 1 to 3 times a week	Exposed more than 3 times a week	Not sure about exposure
OTHER EXPOSURES continued					
Enzymes (detergent, plastic, or pharmaceutical industry)	0	1	2	3	4
Formaldehyde or Glutaraldehyde vapor	0	1	2	3	4
Fumes from heated plastics	0	1	2	3	4
Glycols (antifreeze, paints)	0	1	2	3	4
Pesticides, Insecticides, Herbicides	0	1	2	3	4
Printing inks and oils	0	1	2	3	4
Styrene (Fiberglass boat building, fixtures)	0	1	2	3	4
Tar (coal or petroleum)	0	1	2	3	4
Urethane Foam Insulation	0	1	2	3	4
Wood Sealers (Thompson's water seal, Ducksback water seal)	0	1	2	3	4
MISCELLANEOUS EXPOSURES					
Animals (fur and wastes from dogs, cats, rats, mice...)	0	1	2	3	4
Seafood Processing	0	1	2	3	4
Cigarette smoke from co-workers in the work place	0	1	2	3	4
Gasoline (service station attendant, mechanic)	0	1	2	3	4
Exhaust from engines or automobiles at work (e.g. gasoline or diesel powered equipment)	0	1	2	3	4
Smoke from combustion (Firefighters, incinerators, clearing land with fires)	0	1	2	3	4
Mold	0	1	2	3	4

D. HOME ACTIVITIES/HOBBIES

If you are exposed to chemicals, dusts or fumes in your home or in pursuit of a hobby, please fill out the table below listing your hobbies (carpentry, metal working, photo development,...) or activities (construction, cleaning,...), materials used (wood, glue, spray paint,...), and length of time involved.

Hobby or Activity	Materials Used	Hours per Week	Number of Years
Example: *Automobile repair*	*WD40, motor oil, oil-based enamel paint*	*15*	*7*

SECTION II--MEDICAL HISTORY

THE NEXT SET OF QUESTIONS ARE ABOUT YOUR HEALTH. PLEASE MARK YOUR ANSWERS WITH AN [X].

1. Have you ever been diagnosed with:

a.	Bronchitis	[ ] YES [ ] NO
b.	Emphysema	[ ] YES [ ] NO
c.	Lung Cancer	[ ] YES [ ] NO
d.	Asbestosis	[ ] YES [ ] NO
e.	Silicosis	[ ] YES [ ] NO
f.	Chronic bronchitis	[ ] YES [ ] NO
g.	Asthma	[ ] YES [ ] NO

2. Have you had wheezing or whistling in your chest, at any time in the last 12 months? [ ] YES [ ] NO

3. Have you woken up with a feeling of tightness in your chest at any time in the last 12 months? [ ] YES [ ] NO

4. Have you at any time in the last 12 months had an attack of shortness of breath that came on during the day when you were not doing anything strenuous? [ ] YES [ ] NO

5. Have you had an attack of shortness of breath that came on after you stopped exercising at any time in the last 12 months? [ ] YES [ ] NO

6. Have you at any time in the last 12 months been woken at night by an attack of shortness of breath? [ ] YES [ ] NO

7. Have you at any time in the last 12 months been woken at night by an attack of coughing? [ ] YES [ ] NO

8. Do you usually cough first thing in the morning? [ ] YES [ ] NO

9. Which of the following statements best describes your breathing?

   a. I never or only rarely have trouble with my breathing. [ ]

   b. I have regular trouble with my breathing, but it always gets completely better. [ ]

   c. My breathing is never quite right. [ ]

10. When you are in a dusty part of the house or with animals (for instance dogs, cats or horses) or near feathers (including pillows, quilts and eiderdowns) do you ever:

   a. Get a feeling of tightness in your chest? [ ] YES [ ] NO

   b. Start to feel short of breath? [ ] YES [ ] NO

11. Have you ever had an attack of asthma? [ ] YES [ ] NO

   a. If **YES**, was the attack of asthma within the last 12 months? [ ] YES [ ] NO

THESE QUESTIONS ARE FOR **PEOPLE WHO HAVE HAD ASTHMA**. IF YOU HAVE NOT HAD ASTHMA, GO TO QUESTION 17 (PAGE 12).

12. How old were you when you had your first attack of asthma? _______________(years old)

13. Did a doctor ever tell you that you had asthma? [ ]YES [ ]NO

14. Have you ever had to seek medical treatment for your asthma? [ ]YES [ ]NO

    a. If **YES**, did you get care from an emergency room? [ ]YES [ ]NO

        1. Year first used emergency room for asthma care: _______________(year)

        2. Approximate number of visits to the emergency room for asthma care: _______________

    b. If **YES,** were you hospitalized? [ ]YES [ ]NO

        1. Year first hospitalized: _______________(year)

        2. Approximate number of hospitalizations for asthma: _______________

15. Have you ever filed a worker's compensation claim for your asthma? [ ]YES [ ]NO

    a. If **YES**, what is the status of your claim?
    [ ]AWARDED
    [ ]PENDING
    [ ]DENIED
    [ ]DON'T KNOW

b. If **YES,** what year did you file your compensation claim for asthma? _______________(year)

16. Have you ever taken **any** medicines, pills or inhalers for asthma? We are interested in **any medicines**, even if not prescribed by a doctor.

[ ]YES [ ]NO

If you have **not** taken any medicine(s) for asthma, please skip to question 17 (page 12).

If **YES**, please list the medicines and the year you started taking them:

a. First, list **"over-the-counter medicines"** that you have gotten **without** a prescription for asthma. Include any inhalers you use that do not require a prescription.

OVER-THE-COUNTER MEDICINE	**YEAR STARTED**
______________	____________
______________	____________
______________	____________

b. Next, list any **inhalers prescribed** by a doctor.

PRESCRIBED INHALERS	**YEAR STARTED**
______________	____________
______________	____________
______________	____________

c. List any pills or **other medicines** (other than an inhaler), **prescribed** by a doctor for your asthma.

OTHER PRESCRIBED MEDICATIONS FOR ASTHMA	**YEAR STARTED**
______________	____________
______________	____________
______________	____________

THE NEXT SET OF QUESTIONS ARE **ONLY FOR PEOPLE WHO HAVE HAD BREATHING PROBLEMS AT WORK**. IF YOU HAVE NOT HAD ANY PROBLEMS AT WORK, SKIP AHEAD TO QUESTION 23 (PAGE 14).

17. Have you ever been bothered **at work** by any of the following symptoms?

   a. Wheezing at work? [ ]YES [ ]NO

      1. If **YES**, year symptoms started ____________(year)

      2. If no longer present, year ended ____________(year)

   b. Cough at work? [ ]YES [ ]NO

      1. If **YES**, year symptoms started ____________(year)

      2. If no longer present, year ended ____________(year)

   c. Chest tightness at work? [ ]YES [ ]NO

      1. If **YES**, year symptoms started ____________(year)

      2. If no longer present, year ended ____________(year)

   d. Shortness of breath at work? [ ]YES [ ]NO

      1. If **YES**, year symptoms started ____________(year)

      2. If no longer present, year ended ____________(year)

18. If you have ever had wheezing, cough, chest tightness or shortness of breath, please answer the following:

a. Did the symptoms get worse during the day when you worked? [ ]YES [ ]NO

b. Were the symptoms worse on Mondays, or first day back to work (if you work weekends), than other days? [ ]YES [ ]NO

c. Did the symptoms get better when you were away from work on the weekends or vacations? [ ]YES [ ]NO

d. Did symptoms get worse when you went home after work? [ ]YES [ ]NO

e. Did the symptoms get worse throughout the work week? [ ]YES [ ]NO

19. Have you ever found that specific things seem to cause your breathing problems? [ ]YES [ ]NO

If **YES**, do you feel the breathing problems are caused by:

[ ]SEVERAL SPECIFIC SUBSTANCES
[ ]ONE SUBSTANCE
[ ]DON'T KNOW

20. If you believe your breathing problems were caused by a substance(s), what is/are the name(s) of the substance(s) causing the breathing problems?

____
____
____

21. Are you still exposed at work to the substance(s) causing breathing problems? [ ]YES [ ]NO

If **NO**, give year last exposed. ______________(year)

22. Are there specific duties or job tasks which you believe are causing the breathing problems? [ ]YES [ ]NO

If YES, please specify: ______________________

____

THE NEXT SET OF QUESTIONS ARE ABOUT TOBACCO.

23. Have you ever smoked cigarettes? (**NO** means less than 20 packs of cigarettes or 12 oz. of tobacco in a lifetime or less than 1 cigarette a day for 1 year). [ ]YES [ ]NO

IF **NO**, PLEASE GO TO **QUESTION 26** (PAGE 15)

IF **YES**, PLEASE ANSWER THESE QUESTIONS ABOUT SMOKING

a. Do you now smoke cigarettes (as of 1 month ago)? [ ]YES [ ]NO

b. How old were you when you first started regular cigarette smoking? __________ (years old)

c. If you have stopped smoking cigarettes completely, how old were you when you stopped? __________ (years old)

d. How many cigarettes do you smoke per day now? __________ (per day)

e. On the average, of the entire time you smoked, how many cigarettes did you smoke per day? __________ (per day)

f. Do or did you inhale the cigarette smoke? [ ]YES [ ]NO

24. Have you ever smoked a pipe regularly? (**YES** means more than 12 oz. or one can, of tobacco in a lifetime). [ ]YES [ ]NO

25. Have you ever smoked cigars regularly? (**YES** means more than 1 cigar a week for a year). [ ]YES [ ]NO

26. In the last 12 months:

   a. Not counting yourself, how many people in your household smoked regularly? ___________ (people)

   b. Did people smoke regularly in the room where you work? [ ]YES [ ]NO

   c. How many hours per day were you exposed to other people's tobacco smoke? ___________ (hours per day)

PLEASE TELL US A LITTLE BIT ABOUT YOUR HOME.

27. Do you live in a mobile home or trailer? [ ]YES [ ]NO

28. Has there ever been any water damage to your home or its contents, for example, from broken pipes, leaks or floods? [ ]YES [ ]NO

   If **YES,**

   a. Has there been any water damage in the last **12 months?** [ ]YES [ ]NO

      If **YES,**

      1. Has this happened in the last **12 months**? [ ]YES [ ]NO

29. Do you have a basement or cellar? [ ]YES [ ]NO

If YES,

a. Does water ever collect on the basement floor? [ ]YES [ ]NO

30. Has there ever been mold or mildew on any surface, other than food, inside the home? [ ]YES [ ]NO

31. Do you use a humidifier, including any humidifier system built into your home heating system? [ ]YES [ ]NO

32. Which of the following fuels do you use for heating? (Check all that apply)

a. fireplace/wood stove (coal, coke, or wood) [ ]
b. gas fireplace [ ]
c. electric heater [ ]
d. kerosene heater [ ]
e. gas-fired boiler or gas furnace [ ]
f. oil-fired boiler or oil furnace [ ]
g. solar [ ]
h. heat pump [ ]
i. other: ______________________ [ ]

33. What kind of stove do you **MOSTLY** use for cooking? (Check only one answer)

a. coal, coke or wood solid fuel [ ]
b. gas [ ]
c. electric [ ]
d. kerosene [ ]
e. other: _________________ [ ]

34. Does anyone with whom you live have asthma? [ ]YES [ ]NO

PLEASE GIVE US A LITTLE MORE INFORMATION ABOUT YOURSELF.

1. What is your sex?

   [ ] Male

   [ ] Female

2. What is your date of birth? ______/______/______

3. With what race or ethnic group do you identify?

   a. Alaskan/American Indian [ ]
   b. Asian/Pacific Islander [ ]
   c. Black [ ]
   d. White [ ]
   e. Hispanic [ ]
   f. Other [ ]
   please specify: ____________

4. What is the highest grade you completed in school?

   1 2 3 4 5 6 7 8 9 10 11 12 More than High School

Thank you for your help, If you do not mind, please give us a phone number where we can reach you if we have further questions.

Home ____________ ________-____________
area code phone number

Work ____________ ________-____________
area code phone number

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