SHORT REPORT

Prevalence of airflow obstruction among ever-employed US adults aged 18–79 years by longest held occupation group: National Health and Nutrition Examination Survey 2007–2010

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ABSTRACT

Objectives To estimate the prevalence of spirometry-defined airflow obstruction among ever-employed US adults.

Methods Data from the 2007 to 2010 National Health and Nutrition Examination Survey (NHANES) for adults 18–79 years with valid spirometry and longest held occupation were analysed. The age-standardised prevalence of spirometry-defined airflow obstruction was estimated overall and by smoking status.

Results Age-standardised prevalence of airflow obstruction was 13.7% (95% CI 12.4% to 15.0%) and was highest in participants aged 60–79 years (17.4%, 95% CI 15.2% to 19.6%), males (14.8%, 95% CI 12.0% to 17.6%), non-Hispanic whites (15.4%, 95% CI 13.8% to 16.7%) and ever smokers (19.1%, 95% CI 16.6% to 21.5%). Age-standardised prevalence of airflow obstruction was >20% for installation, maintenance and repair occupations (p=22.1%, 95% CI 16.5% to 27.8%), and for construction and extraction occupations (20.7%, 95% CI 13.5% to 27.9%).

Conclusions Prevalence of airflow obstruction varied by demographic characteristics and occupational factors with a higher prevalence among ever smokers for most demographic characteristics and occupational factors. Study findings emphasise the importance of monitoring the lung function of workers in occupations with a high prevalence of airflow obstruction.

What this paper adds

- Occupational exposures to vapours, gases, dust and fumes are associated with obstructive lung disease.
- Previous research suggests workers in specific occupations are more likely to have spirometry-defined chronic obstructive pulmonary disease, but the prevalence of spirometry-defined airflow obstruction among the 2007–2010 National Health and Nutrition Examination Survey ever-employed adult population is unknown.
- Prevalence of airflow obstruction varied by demographic characteristics and occupational factors and was higher among ever smokers than in never smokers.
- These findings support prior research on airflow obstruction and smoking, and emphasise the importance of monitoring the lung function of workers in occupations with a high prevalence of airflow obstruction.

INTRODUCTION

The overall age-adjusted prevalence of spirometry-defined airflow obstruction among US adults aged 40–79 years from 2007 to 2010 was 14.5% (airflow obstruction was defined per American Thoracic Society/European Respiratory Society (ATS/ERS) criterion as forced expiratory volume in the 1 s (FEV_1)/forced vital capacity (FVC)<lower limit of normal (LLN)).[1] Airflow obstruction is a key feature of chronic obstructive pulmonary disease (COPD), asthma and other obstructive lung diseases.[2] Smoking is a principal risk factor for airflow obstruction as it damages lung airways.[3] Workplace exposures to vapours, gases, dust and fumes also increase the risk of obstructive lung disease.[4] Results from the 1988 to 1994 National Health and Nutrition Examination Survey (NHANES) indicated that workers aged 30–75 years reporting a longest held job in the freight, stock and material handlers or armed forces occupation groups had higher odds of spirometry-defined COPD (FEV_1/FVC<70% and FEV_1<80% predicted) compared with office workers when analysing 14 occupation groups.[5] Furthermore, an estimated 19.2% of COPD cases overall and 31.1% of COPD cases among never smokers were attributed to work.[5] The purpose of this study was to estimate the prevalence of spirometry-defined airflow obstruction among the ever-employed US adult population, using 2007–2010 NHANES data.

METHODS

The US population, 18–79 years, was studied using NHANES data from the combined cross-sectional 2007–2008 and 2009–2010 survey cycles. These were the most current NHANES cycles available with longest held occupation and spirometry data. The National Center for Health Statistics (NCHS) conducted NHANES, using a multistage probability sampling design to survey a representative sample of the civilian non-institutionalised US population.[6 7] We used publicly available data from the

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household interview survey and the standardised physical examinations conducted in mobile examination centres (MEC).[1 6 7] In the 2007–2010 NHANES, 11 891 persons aged 18–79 years who provided interview data were eligible for the spirometry component of the physical examination. Of those, 1867 were excluded from spirometry for safety reasons, health reasons, or other reasons, and 501 had poor quality spirometry data. Spirometry details including eligibility criteria, spirometry procedures and spirometry quality are available elsewhere.[7]

NHANES demographic and risk factor variables analysed included age, gender, race/ethnicity (including non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic and other), occupational exposure, longest held occupation and cigarette use. Prior studies have examined obstructive lung diseases, including asthma and chronic bronchitis, attributed to occupation, in a range of populations including workers aged 18 years.[4] Cigarette smoking status categories included never smokers and ever smokers. Never smokers were those 18–19 years who used neither tobacco nor nicotine products in the last 5 days and did not report using cigarettes in the past 5 days; and those 20–79 years who smoked <100 cigarettes during their entire life. Ever smokers were those aged 18–19 years who used cigarettes in the past 5 days and those aged 20–79 years who smoked at least 100 cigarettes during their entire life. Pack-years were estimated for ever smokers aged 20–79 years by multiplying the number of packs of cigarettes smoked by the number of years reported smoking.

Participants reporting 'yes' to questions about ever having work exposure to mineral dust (ie, dust from rock, sand, concrete, coal, asbestos, silica, or soil), organic dust (ie, dust from flours, grains, wood, cotton, plants or animals), exhaust fumes (ie, fumes from trucks, buses, heavy machinery, or diesel engines), or other fumes (ie, vapours from paints, cleaning products, glues, solvents and acids; or welding/soldering fumes) in any job were considered to have 'occupational exposure'.

Longest held occupation was determined for ever-employed participants from the question, 'Thinking of all the paid jobs or businesses you ever had, what kind of work were you doing the longest?', or from the question related to current occupation ('what kind of work were you doing' in the past week) among participants reporting that their longest held occupation was also their current occupation. Participants not reporting a longest held occupation, such as participants who never worked, were excluded from the analysis. Longest held occupation was used since airflow obstruction often has a latency period. NCHS classified longest held occupation into 23 occupation groups based on 2002 Census Bureau Occupation Codes.[7]

The ATS/ERS criterion was used to define airflow obstruction ($FEV_1/FVC<LLN$) using lung function values from prebronchodilator spirometry.[8] Normative reference equations developed from NHANES III data were used to determine the predicted and LLN pulmonary function values accounting for age, height, sex and race/ethnicity.[9]

Data analysis
Statistical analyses were performed using SAS V.9.3 (SAS Institute Inc, Cary, North Carolina, USA). Age-standardised prevalence of airflow obstruction with corresponding 95% CIs was calculated using the standard age distribution of the 2000 US Census Population age structure for age groups 18–39, 40–59, 60–79 years.[6] NCHS MEC weights accounted for the sampling strategy (the year and sampling unit) to obtain unbiased, nationally representative prevalence estimates.[6] SEs for prevalence estimates were calculated using Taylor series linearisation; and prevalence estimates with a relative SE (RSE) considered potentially unreliable (RSE>30%) were not presented.[6] Never and ever smokers were compared using two-tailed t tests and differences were considered statistically significant at p<0.05.

RESULTS
During 2007–2010, 4172 NHANES participants had valid spirometry, height and longest held occupation data, and were included in the study. The estimated age-standardised prevalence of airflow obstruction among ever-employed US adults aged 18–79 years was 13.7% (95% CI 12.4% to 15.0%) (table 1). The prevalence of airflow obstruction by demographic characteristic was highest in participants aged 60–79 years, males and non-Hispanic whites. Among ever-employed adults reporting any dust/fumes occupational exposure, the prevalence of airflow obstruction was 14.3% (95% CI 12.1% to 16.5%). The occupation groups with a prevalence of airflow obstruction >20% were installation, maintenance and repair occupations (p=22.1%, 95% CI 16.5% to 27.8%), and construction and extraction occupations (p=20.7%, 95% CI 13.5% to 27.9%). In contrast, office and administrative support occupations (p=10.3%, 95% CI 6.2% to 14.5%) had the lowest prevalence. The age-standardised prevalence of airflow obstruction by duration of occupational exposure to mineral dust, organic dust, exhaust fumes and other fumes was analysed but found not significantly different by duration of occupational exposure (quartiles) (results not shown).

Ever smokers had a significantly higher prevalence of airflow obstruction (19.1%, 95% CI 16.6% to 21.5%) compared with never smokers (8.6%, 95% CI 7.0% to 10.1%) (p<0.0001). The difference between prevalence estimates for never smokers and ever smokers remained significant for all demographic characteristics and occupational exposures analysed, with the exception of non-Hispanic black and Mexican American race/ethnicities. We estimated the prevalence of airflow obstruction by quartiles of pack-years for those aged 20–79 years (information on pack-years was not available for those <20 years) and found an increase in prevalence for ever smokers with 11 or more pack-years. The prevalence estimates of airflow obstruction were significantly higher among ever smokers compared with never smokers for construction and extraction occupations; food preparation and serving occupations; sales and related occupations; and office and administrative support occupations (p<0.05). However, prevalence estimates by cigarette smoking status were not comparable for all occupation groups due to potentially unreliable prevalence estimates.

DISCUSSION
We analysed NHANES data from 2007 to 2010 and estimated that the prevalence of spirometry-defined airflow obstruction among ever-employed US adults aged 18–79 years was 13.7%. The prevalence was significantly higher among ever smokers (19.1%) compared with never smokers (8.6%). Among adults aged 60–79 years, the prevalence of airflow obstruction was 27.8% among ever smokers and 5.9% among never smokers. The prevalence of airflow obstruction for each occupational exposure was significantly higher among ever smokers compared with never smokers (p<0.05). This suggests an additive effect on airflow obstruction between smoking and occupational exposure, and is consistent with previous studies.[10]

Table 1 Age-specific and age-standardised prevalence of airflow obstruction among ever-employed US adults aged 18–79 years by smoking status for selected demographic characteristics and occupational factors—NHANES 2007–2010

| Characteristics | Ever-employed adults* | | | Never smokers*† | | | Ever smokers*† | | |
| | Number in Sample | Prevalence of airflow obstruction | | Number in Sample | Prevalence of airflow obstruction | | Number in Sample | Prevalence of airflow obstruction | |
		Per cent	95% CI		Per cent	95% CI		Per cent	95% CI
Total	4172	13.7	12.4 to 15.0	2188	8.6	7.0 to 10.1	1972	19.1	16.6 to 21.5‡
Age group (years)									
18–39	1642	10.8	9.3 to 12.3	974	7.9	6.2 to 9.6	657	15.1	12.3 to 17.8‡
40–59	1416	13.7	11.9 to 15.5	688	10.2	7.9 to 12.4	728	17.0	14.3 to 19.8‡
60–79	1114	17.4	15.2 to 19.6	526	5.9	3.9 to 7.9	587	27.8	24.1 to 31.4‡
Gender									
Male	2158	14.8	12.0 to 17.6	969	8.8	6.2 to 11.5	1149	19.5	15.2 to 23.8‡
Female	2014	12.5	10.4 to 14.7	1219	8.3	5.7 to 10.9	774	18.4	14.1 to 22.8‡
Race/ethnicity§									
Non-Hispanic white	1965	15.4	13.8 to 16.7	880	9.1	7.5 to 10.8	1056	21.2	18.0 to 24.3‡
Non-Hispanic black	835	11.5	8.5 to 14.4	466	9.5	5.8 to 13.3	362	13.6	9.1 to 18.2
Mexican American	739	8.4	7.0 to 9.8	452	7.7	5.4 to 10.0	273	9.6	6.2 to 13.1
Occupational exposures									
No exposure	1890	13.0	10.8 to 15.2	1200	8.6	6.4 to 10.9	683	19.9	14.9 to 24.8‡
Any dust/fumes exposure	2276	14.3	12.1 to 16.5	987	8.5	6.6 to 10.4	1284	18.5	15.1 to 21.9‡
Mineral dust	1380	15.3	12.1 to 18.6	540	8.4	5.6 to 11.2	838	19.7	15.2 to 24.3‡
Organic dust	953	15.6	13.0 to 18.2	407	10.6	7.6 to 13.5	544	18.9	15.4 to 22.5‡
Exhaust fumes	1087	17.7	14.5 to 21.0	392	10.5	7.2 to 13.8	694	21.3	17.0 to 25.6‡
Other fumes	1338	15.4	12.5 to 18.3	535	7.3	5.0 to 9.5	800	20.8	16.6 to 25.0‡
Occupation group¶									
Installation, maintenance, repair occupations	149	22.1	16.5 to 27.8	50			99	26.9	19.5 to 34.4
Construction, extraction occupations	358	20.7	13.5 to 27.9	126	11.7	4.1 to 19.2	231	24.6	15.9 to 33.4‡
Food preparation, serving occupations	324	16.7	12.9 to 20.5	164	10.5	4.4 to 16.5	158	20.2	14.3 to 26.2‡
Business, financial operations occupations	107	16.1	8.0 to 24.2	73	11.3	3.3 to 19.3	34	23.2	3.7 to 42.7
Production occupations	466	16.0	10.4 to 21.7	201			264	21.7	12.0 to 31.4
Healthcare support occupations	127	15.9	9.4 to 22.4	63			64	20.2	9.7 to 30.7
Computer, mathematical occupations	63	14.1	5.2 to 23.1	35	17.2	2.8 to 31.6	28	¶	
Architecture, engineering occupations	75	13.8	5.1 to 22.5	38			37	20.7	5.0 to 36.4
Education, training, library occupations	188	12.3	7.2 to 17.4	128	13.0	5.9 to 20.1	60	¶	
Sales and related occupations	398	12.0	5.9 to 15.1	230	8.3	2.9 to 13.7	165	16.6	12.8 to 20.3‡
Management occupations	295	11.0	5.7 to 16.2	148			147	15.5	4.2 to 26.7
Transportation, material moving occupations	299	10.6	6.7 to 14.4	142			156	15.4	9.4 to 21.4
Office, administrative support occupations	531	10.3	6.2 to 14.5	330	5.7	2.0 to 9.5	200	16.0	11.1 to 20.9‡
Farming, fishing, forestry occupations	46			18	17.5	0.4 to 34.6	28	25.9	11.1 to 40.6
Legal occupations	33			20	26.0	17.3 to 34.6	13	¶	
Healthcare practitioner, technical occupations	146			102	10.3	2.2 to 18.5	44	¶	
Personal care, service occupations	112			69			41	30.5	14.4 to 46.6

Continued

Table 1 Continued

Characteristics	Ever-employed adults*			Never smokers*†			Ever smokers*†		
	Number in Sample	Prevalence of airflow obstruction Per cent	95% CI	Number in Sample	Prevalence of airflow obstruction Per cent	95% CI	Number in Sample	Prevalence of airflow obstruction Per cent	95% CI
Community, social services occupations	40			26			14	27.3	6.7 to 47.9
Building and grounds cleaning, maintenance occupations	213			114			99	22.3	4.6 to 40.0
Arts, design, entertainment, sports, media occupations	75			43			31	21.4	3.8 to 39.0
Cigarette pack-years**									
0–<3							479	14.7	10.1 to 19.3
3–<11							445	13.1	10.6 to 15.5
11–<28							457	21.9	17.1 to 26.8
≥28							462	36.0	25.6 to 46.3

*Samples with valid spirometry, height and longest held occupation data were evaluated for airflow obstruction.
†Smoking status data were missing for 12 participants.
‡Two-tailed t tests were used to determine statistically significant differences between point estimates for never and ever smokers at p<0.05.
§Other Hispanic (n=468) and other (n=165) participants are included in overall estimates but separate results were not reported for these groups.
¶Results not shown when the relative SE for the estimated prevalence with airflow obstruction is >30% and potentially unreliable. Results for the occupation groups Armed forces (n=22); life, physical, social science occupations (n=38); and protective service occupations (n=65), were unreliable for ever-employed adults, never smokers and ever smokers.
**Pack-years were estimated for ever smokers aged 20–79 years. Pack-years were missing for 82 ever smokers.

The burden of airflow obstruction appeared to be disproportionally affecting workers in installation, maintenance and repair occupations and construction and extraction occupations. These occupation groups have known, sometimes complex, occupational exposures that include mixtures of gases, vapours, dust, fumes, sensitisers and other exposures. For example, workers in installation, maintenance and repair occupations can be exposed to fumes and sensitisers when soldering.[11] Mechanics and service technicians repairing or replacing engines, or working on aircraft and vehicles, encounter fumes from diesel engines, as well as gases, vapours, sensitizers and metal dust exposures.[11] Construction and extraction workers may be exposed to diesel from machinery combustion and also to organic and inorganic dusts, gases and fumes.[11] Earth moving and extraction tasks performed by workers may result in exposure to coal mine dust, silica and other mineral dusts.[11]

A strength of our study is the use of population-based NHANES data on occupational exposure and longest held occupation. While this cross-sectional study has limitations for determining causality, longest held occupation data did provide information about the job that potentially contributed to the development of airflow obstruction. Industry group was available for longest held occupation, but we limited our analysis to occupation only for purposes of this short report. A limitation of this study is that no data were available to validate information on self-reported occupational exposure. Furthermore, use of reference equations developed from NHANES III data may lead to overestimation of the prevalence of airflow obstruction.[1] Even by combining data from the NHANES 2007–2008 and 2009–2010 survey cycles to improve the reliability of prevalence estimates, the prevalence estimates for some occupation groups were unreliable. The inclusion of NHANES occupation data from the 2011 to 2012 survey cycle, once it is released, may help us compute reliable prevalence estimates for additional occupation groups.

CONCLUSION

The prevalence of spirometry-defined airflow obstruction among ever-employed US adults from 2007 to 2010 varied by demographic characteristics and occupational factors, and was generally higher among ever smokers regardless of demographic characteristics or occupational factors. Study findings emphasise the importance of monitoring the lung function of workers in occupations with a high prevalence of airflow obstruction, to help prevent or identify lung function decline. We recommend that future research be conducted and include NHANES occupation data from additional survey cycles. In addition, future industry-specific and occupation-specific studies are needed to identify specific occupations at an increased risk for airflow obstruction and to identify methods to reduce risk.

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Workplace

Competing interests None declared.

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