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OCCUPATIONAL ASTHMA

Occupational Asthma Incidence: Findings from the Behavioral Risk Factor Surveillance System Asthma Call-Back Survey—United States, 2006–2009

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Background. Occupational asthma (OA) is new-onset asthma or the recurrence of previously quiescent asthma caused by workplace exposures. *Objective.* To estimate the incidence of population-based new-onset OA and the proportion of incident asthma that is work-related. *Methods.* Behavioral Risk Factor Surveillance System and Asthma Call-back Survey data collected from persons aged ≥18 years during 2006–2009 in 38 states and the District of Columbia were analyzed. Incident health professional-diagnosed new-onset OA cases were persons whose asthma was diagnosed for the first time within the past 12 months whose health professional indicated their asthma was related to their work. Incident potential new-onset OA cases were persons with asthma diagnosed within the past 12 months who did not have health professional-diagnosed work-related asthma but described their asthma as caused by workplace exposures. The proportion of incident asthma that is work-related was calculated using the 2006–2008 estimate of adult asthma incidence (3800 per million). *Results.* The estimated annual incidence of health professional-diagnosed new-onset OA was 179 (95% CI: 113–245) per million population. For combined health professional-diagnosed and potential new-onset OA the incidence was 692 (95% CI: 532–853) per million population. The proportion of incident asthma among adults that is work-related was 4.7% for health professional-diagnosed new-onset OA and 18.2% for combined health professional-diagnosed and potential new-onset OA. *Conclusions.* New-onset asthma in as many as one of six adult patients might be associated with work. Clinicians should consider the role of occupational exposures when evaluating adults with incident asthma which may uncover opportunities for early intervention and reversal of an otherwise chronic disease.

Keywords epidemiology, surveillance, work-related asthma

INTRODUCTION

Information on asthma incidence is important to quantify disease onset rates and to understand whether the number of new cases is changing. The estimated annual asthma incidence among adults from the 2006–2008 Behavioral Risk Factor Surveillance System (BRFSS) data is 3800 per million (1). Work-related asthma includes (a) occupational asthma (OA) that is new-onset asthma or the recurrence of previously quiescent asthma caused by factors related to the workplace environment and (b) work-exacerbated asthma that is preexisting or concurrent asthma worsened by factors related to the workplace environment (2, 3). Published estimates of work-related asthma incidence rely on case ascertainment within clinical practices or public health reporting of diagnosed cases (4–6). This report provides the first population-based estimate of incident OA in the United States. Using data from the BRFSS and Asthma Call-back Survey from 38 states and the District of Columbia (DC), we estimated the incidence of new-onset OA and the proportion of incident asthma that is work-related.

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METHODS

BRFSS is an ongoing, state-based, random-digit-dialed telephone survey of the non-institutionalized US civilian population aged ≥18 years. The BRFSS questionnaire has three parts: (1) the core component, (2) optional modules designed to address specific topics, and (3) state-added questions. The Asthma Call-back Survey, designed to collect additional information on asthma, was administered in select states within two weeks of the BRFSS interview to the BRFSS respondents aged ≥18 years who indicated that they had ever been told by a doctor, nurse, or other health professional that they had asthma and who agreed to be called back for the Asthma Call-back Survey (Centers for Disease Control and Prevention (CDC) Institutional Review Board review protocol #2988). Additional information on BRFSS and Asthma Call-back Survey is available at http://www.cdc.gov/brfss/. We used data from the 2006–2009 Asthma Call-back Survey for the 38 states and DC that provided comparable data at the time of this analysis.

Respondents with incident health professional-diagnosed new-onset OA (a subset of OA) were persons who were first diagnosed with asthma within the 12 months prior to the interview and who had ever been told by a doctor or other health professional that their asthma was related to any job they ever had (Figure 1). In addition, because OA is

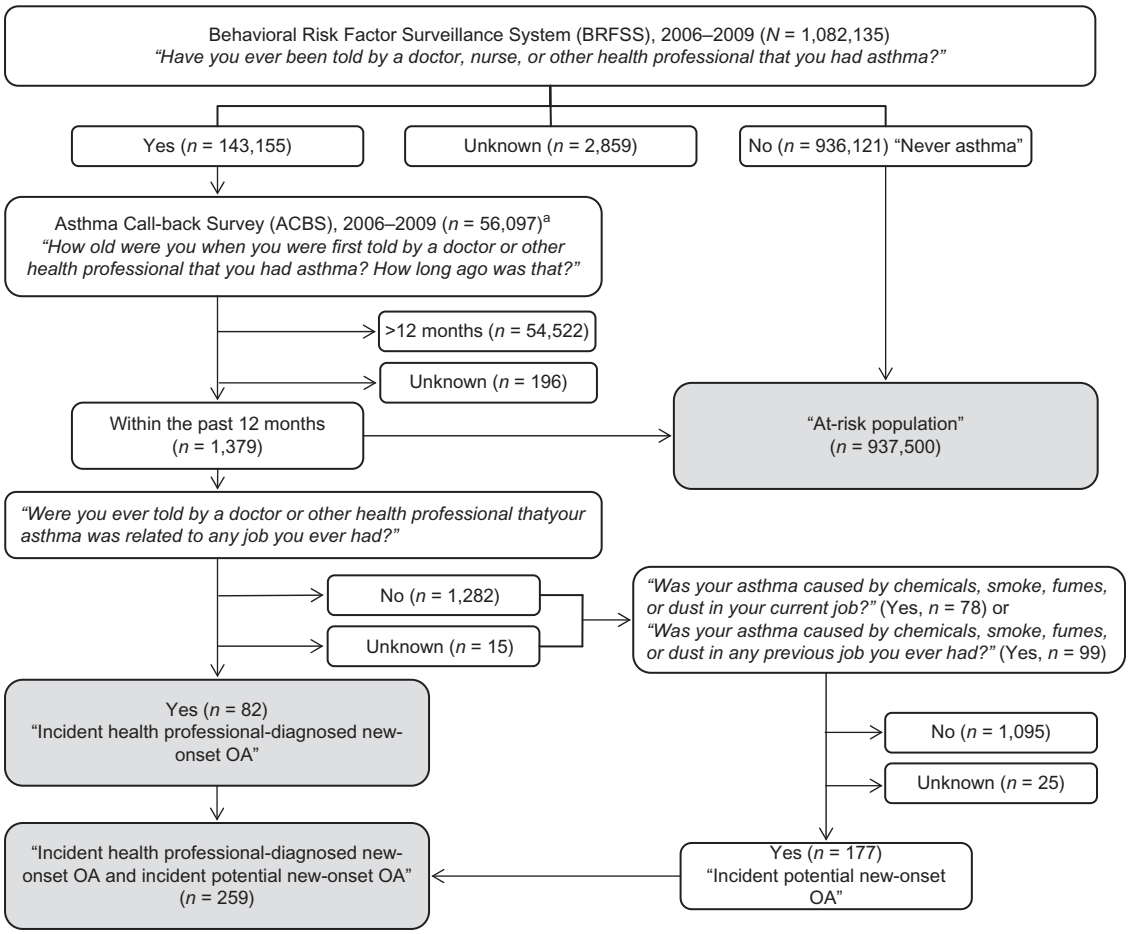

FIGURE 1.—Determination of at-risk adult population—Behavioral Risk Factor Surveillance System (BRFSS) and Asthma Call-back Survey (ACBS), 2006–2009.
Note: [a]Subset of BRFSS respondents who were invited and agreed to participate in ACBS.

underdiagnosed by health care professionals (4, 7–10), we defined those with incident potential new-onset OA as respondents who were diagnosed with asthma within the previous 12 months, had not been told by a doctor or other health professional that their asthma was related to any job they ever had, but who described their asthma as caused by chemicals, smoke, fumes, or dust in a current or previous job. We generated estimates of incident health-professional new-onset OA and the combination of incident potential new-onset OA and health-professional new-onset OA (Figure 1).

The at-risk population included respondents with no history of an asthma diagnosis at the beginning of the specified 12 month time period and those who were first diagnosed with asthma within the past 12 months (Figure 1). To calculate the proportion of incident asthma that might be related to work, we used our new-onset OA incidence rate estimates and the recently published estimates of adult asthma incidence rates from 2006–2008 BRFSS (3800 per million) (1).

Analyses were done using SAS® software version 9.3 (SAS Institute Inc., Cary, NC) to calculate estimates accounting for the complex survey design. We used Microsoft Excel® 2010 to combine elements from BRFSS and Asthma Call-back Survey and to calculate 95% confidence intervals (CIs). Annual data were weighted to account for the unequal probability of sample selection and non-response differences in the sample and to allow for generalization of findings to the whole population. Weights for the combined year analysis were determined by multiplying the proportion of subjects in each survey year by the corresponding weight for that survey year (additional information on survey methodology and data weighing is available at ftp://ftp.cdc.gov/pub/Data/Brfss/userguide.pdf). Standard error and relative standard error (i.e., standard error divided by the estimate) were calculated for each estimate. Standard errors for incidence rates were calculated using the "variance of ratios" formula assuming zero covariance (11). Estimates with a relative standard error greater than 30% were considered unreliable and were not reported.

RESULTS

A total of 1,082,135 adults participated in BRFSS and 56,097 in the Asthma Call-back Survey during 2006–2009 in 38 states and DC. Based on responses from 82 participants, on average, each year, an estimated 31,000 adults had incident health professional-diagnosed new-

TABLE 1.—Characteristics of the study population.

Characteristics	Incident health professional-diagnosed new-onset occupational asthma[a]		Combined incident potential new-onset occupational asthma and incident health professional-diagnosed new-onset occupational asthma[a]		All adults[b]	
	No. in sample	%[c] (95% CI)	No. in sample	%[c] (95% CI)	No. in sample	%[c] (95% CI)
Total	82	100.0	259	100.0	1,082,135	100.0
Age (years)						
18–44	18	33.8 (15.0–52.7)	62	48.5 (36.7–60.3)	310 293	50.0 (49.8–50.2)
45–64	50	56.7 (37.7–75.6)	150	39.5 (29.0–49.9)	446 365	33.1 (32.9–33.6)
65+	13	NR	46	12.0 (5.8–18.3)	315 814	16.9 (16.8–17.0)
Gender						
Male	33	45.8 (27.5–64.1)	85	42.5 (30.5–54.5)	412 560	48.7 (48.5–48.9)
Female	49	54.2 (35.9–72.5)	174	57.5 (45.5–69.5)	669 575	51.3 (51.1–51.5)
Race/Ethnicity[d]						
White, non-Hispanic	60	67.3 (49.9–84.7)	175	56.8 (44.6–69.0)	859 837	66.9 (66.7–67.1)
Other	20	32.7 (15.3–50.1)	80	43.2 (31.0–55.4)	211 478	33.1 (32.9–33.3)
Education						
≤ High school	33	48.6 (30.2–67.1)	127	59.6 (49.0–70.2)	414 994	39.4 (39.2–39.6)
>High school	49	51.4 (32.9–69.8)	132	40.4 (29.8–51.0)	663 450	60.6 (60.4–60.8)
Household income						
≤ $24,999	30	36.9 (19.2–54.5)	109	51.9 (39.9–64.0)	257 733	25.6 (25.4–25.8)
$25,000–$49,999	19	NR	50	12.3 (6.6–18.0)	266 424	25.8 (25.6–26.0)
≥ $50,000	24	41.0 (47.6–49.8)	73	35.8 (25.0–46.6)	417 855	48.6 (48.4–48.8)
Health insurance						
Yes	71	87.1 (76.8–97.5)	220	73.4 (60.9–86.0)	966 623	84.8 (84.6–84.9)
No	11	NR	38	26.6 (14.0–39.1)	112 871	15.2 (15.1–15.4)
Employment						
Currently employed	45	54.2 (35.8–72.7)	141	55.3 (43.8–66.7)	605 157	63.3 (63.1–63.5)
Not employed	37	45.8 (27.3–64.2)	118	59.6 (58.6–60.7)	476 978	36.7 (36.5–36.9)
Smoking status						
Current	17	NR	63	15.4 (9.4–21.4)	181 831	18.2 (18.0–18.4)
Former	25	42.1 (23.7–60.5)	79	35.7 (23.7–47.6)	322 974	24.4 (24.2–24.5)
Never	40	42.6 (24.2–61.1)	116	49.0 (37.3–60.6)	571 740	57.5 (57.3–57.7)

Notes: CI = confidence interval; NR = not reportable (relative standard error for the estimate >30%); Numbers may not add to total because of missing data.
[a]Adult respondents from the 38 states (Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin) and the District of Columbia participating in Asthma Call-back Survey during 2006–2009.
[b]Adult Behavioral Risk Factor Surveillance System respondents from the same 38 states and the District of Columbia that also conducted the Asthma Call-back Survey during 2006–2009.
[c]Estimated annual average.
[d]Race category "White, non-Hispanic" comprises people who indicated only this single race group. "Other" includes people reporting non-Hispanic black, Hispanic, Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, those who classified themselves as "other", and those who identified themselves as belonging to multiple racial groups. Race categorized according to the 1997 standards for Federal Data. Unknown race was excluded.

onset OA (data not shown). Most respondents with incident health professional-diagnosed new-onset OA were aged 45–64 years (56.7%, mean: 46.8 years): female (54.2%), non-Hispanic white (67.3%), and had health insurance (87.1%) (Table 1). When incident potential new-onset OA was combined with incident health professional-diagnosed new-onset OA (259 respondents), the estimated number of adults who might have incident new-onset OA was 119,000 and less than half were aged 18–44 years (48.5%, mean: 45.6 years): most were female (57.5%), non-Hispanic white (56.8%), and had health insurance (73.4%) (Table 1). For comparison, characteristics of all adults who participated in the 2006–2009 BRFSS in the same 38 states and DC are shown in the last column of Table 1.

For health professional-diagnosed new-onset OA the estimated average annual incidence was 178 (95% CI, 113–244) per million population. For combined incident potential new-onset OA and incident health professional-diagnosed new-onset OA, the estimate was 690 (95% CI: 530–850) per million population. The proportion of incident asthma that may be work-related ranged from 4.7% for health professional-diagnosed new-onset OA to 18.2% for combined incident potential new-onset OA and incident health professional-diagnosed new-onset OA.

DISCUSSION

Analysis of 2006–2009 BRFSS and Asthma Call-back Survey data showed that the incidence of new, adult-onset asthma that may be related to occupational exposure to asthma-causing agents ranges between 178 (health professional-diagnosed new-onset OA) and 690 (combined incident potential new-onset OA and incident health professional-diagnosed new-onset OA) per million population. The estimates of new-onset OA incidence are consistent with a previous study by Milton et al. that examined 1995 data for over 79,000 health maintenance organization members aged 15–55 years (9). In that study, of the 66 interviewed patients with asthma onset within the previous 12 months (including new-onset or reactivated asthma), 14 (21%) had evidence of pertinent occupational exposure

which corresponded with an estimated annual OA incidence of 710 per million (95% CI: 430–1110). Of these 14 patients, six (43%) were classified as new-onset asthma cases. When we combined incident potential new-onset OA and incident health professional-diagnosed new-onset OA, the estimated new-onset OA incidence was similar to that reported by Milton et al. with overlapping CIs. Likewise, based on a review of 67 medical charts, Milton et al. identified three (4.5%) cases that had evidence of a provider finding a positive association with work (9). Those results are similar to our estimates (4.7%) that are based on a history of health professional-diagnosis of work-related asthma.

From this study, the estimated proportion of incident asthma that might be work-related (18.2%) (for combined incident potential new-onset OA and incident health professional-diagnosed new-onset OA) is consistent with the recently reported median population-attributable fraction for occupational exposures and adult-onset asthma of 16.9% (range 8.6–44.0%) (12).

From this study, the broad range of estimates might be explained, in part, by the fact that work-related asthma is underdiagnosed and that clinicians rarely discuss whether asthma is work-related with their patients (9, 10, 13, 14). Previous studies have reviewed factors associated with limited communication about asthma and work between patients and clinicians (4, 7–9,13,15,16). To assist clinicians, employers, and others, CDC's National Institute for Occupational Safety and Health (NIOSH) published surveillance data that includes information on industry, occupation, and exposures associated with work-related asthma from four states—California, Massachusetts, Michigan, and New Jersey, for 1993–2006, at http://www2a.cdc.gov/drds/WorldReportData/SubsectionDetails.asp?ArchiveID=1&SubsectionTitleID=23. In addition, the American College of Chest Physicians and the American Thoracic Society provide guidelines for the clinicians evaluating adults with new-onset asthma (3).

The strengths of our study are the use of large population-based survey data for adults of all ages and the use of recent asthma incidence estimates (1) that were based on data collected using the same methodology. However, this cross-sectional study has limitations. Some respondents might incorrectly recall the timing of asthma diagnosis. Also, no information was available on the date of work-related asthma diagnosis. We considered incident asthma to be incident health professional-diagnosed new-onset OA in persons whose asthma was diagnosed in the past year and who were ever told that their asthma is work-related. Although it is likely that some persons with incident asthma were diagnosed with work-related asthma at the same time, some may have work-exacerbated asthma (i.e., coincident asthma exacerbated by workplace-related factors) in the 12 months following the asthma diagnosis (3). Thus, our results may be overestimated. To assess the extent of this bias, we conducted additional analyses of responses from adults with current asthma that was diagnosed in the past 12 months and who were ever told that their asthma is work-related. We examined responses to the questions "Is your asthma made worse by chemicals, smoke, fumes, or dust in your current job?" and "Was your asthma made worse by chemicals, smoke, fumes, or dust in any previous job you ever had?" and identified only 12 respondents with incident health professional-diagnosed new-onset OA who reported that their asthma was made worse but not caused by job exposures, i.e., might have work-exacerbated asthma. After excluding these respondents, our estimates did not change substantially. The estimated number of adults with an incident health professional-diagnosed new-onset OA was 26,600 (154 per million; 95% CI, 93–216) and the estimated number of adults who might have incident new-onset OA was 114,800 (666 per million; 95% CI, 507–824). No data were available to validate the diagnosis of work-related asthma or to classify work-related asthma as new-onset OA or work-exacerbated asthma. In addition, no data were available to estimate the proportion of respondents who might have experienced the recurrence of previously quiescent asthma (i.e., those who have asthma diagnosed in their childhood and experienced recurrence of asthma symptoms caused by factors in the workplace in the 12 months prior to the interview). Thus, the incidence of OA (i.e., including reactivated asthma) could not be calculated. Moreover, the small number of participants with incident new-onset OA precluded examination of trends over time and differences between subgroups. Future studies with more years of data may address this limitation. In addition, for 2006–2009, the median response rates among the 38 states and DC examined in this report ranged from 47.5% in 2007 to 51.4% in 2009 for BRFSS and from 47.2% in 2009 to 54.3% in 2007 for the Asthma Call-back Survey. Although the low response rates might affect the results, weights were post-stratified to adjust for non-response. Finally, the data used in this analysis are limited to adults living in select states and participating in Asthma Call-back Survey each year; therefore, the results are not nationally representative or representative of non-participating states.

Conclusions

The results suggest that new-onset asthma in as many as one of the six adult patients might be associated with work. The American College of Chest Physicians recommends that occupational factors should be considered in all adults with new-onset asthma (3). Timely recognition and diagnosis are important because early reduction or cessation of exposure and effective treatment improves the long term prognosis of occupational asthma. In addition, recognition of occupational asthma enables clinicians and employers to prevent new-onset asthma in co-workers (3, 17).

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Declaration of Interest

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