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Health-related quality of life among adults with work-related asthma in the United States

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Abstract

Purpose—The objective of this study was to examine health-related quality of life among adults with work-related asthma.

Methods—We analyzed 2006–2009 Behavioral Risk Factor Surveillance System Asthma Call-back Survey data for ever-employed adults with current asthma from 38 states and District of Columbia. Individuals with work-related asthma had been told by a doctor or other health professional that their asthma was related to any job they ever had. Health-related quality of life indicators included poor self-rated health, impaired physical health, impaired mental health, and activity limitation. We calculated prevalence ratios (PRs) adjusted for age, sex, race/ethnicity, education, income, employment, and health insurance.

Results—Of ever-employed adults with current asthma, an estimated 9.0 % had work-related asthma, 26.9 % had poor self-rated health, 20.6 % had impaired physical health, 18.2 % had impaired mental health, and 10.2 % had activity limitation. Individuals with work-related asthma were significantly more likely than those with non-work-related asthma to have poor self-rated health [PR, 1.45; 95 % confidence interval (CI), 1.31–1.60], impaired physical health (PR, 1.60; 95 % CI, 1.42–1.80), impaired mental health (PR, 1.55; 95 % CI, 1.34–1.80), and activity limitation (PR, 2.16; 95 % CI, 1.81–2.56).

Conclusions—Future research should examine opportunities to improve health-related quality of life among individuals with work-related asthma.

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Keywords

Occupational asthma; Quality of life; Occupational health; Behavioral Risk Factor Surveillance System; Asthma

Introduction

Asthma is a chronic inflammatory disease of the airways that affects over 17.5 million adults in the United States [1]. Work-related asthma includes both occupational asthma (asthma that is caused by workplace exposures) and work-exacerbated asthma (preexisting asthma that is made worse by workplace exposures) [2]. Based on a review of published studies, the American Thoracic Society estimated that 15 % of adult asthma (range 4–58 %) is attributable to workplace exposures [3]. Individuals with work-related asthma have increased likelihood for asthma attacks, more frequent doctor and emergency room visits for worsening asthma, and more frequent asthma-related hospitalizations than individuals with non-work-related asthma [4–6]. Goals of asthma management for both work-related asthma and non-work-related asthma include reducing the risk of asthma attacks, controlling asthma symptoms, and improving quality of life [7].

In recent years, the concept of health-related quality of life, which assesses the impact of disease on daily life from the patient's perspective, has gained attention when evaluating health outcomes [8]. This is partly because measures of disease morbidity and related health-care utilization do not always correlate with patients' perception of well-being and because patient well-being cannot be imputed from clinical outcomes [9, 10]. Additionally, it is important that patients present their own perceived health-related quality of life as this may differ from health-care providers' perception of the impact of disease [11] and because poor health-related quality of life indicators have been shown to be a powerful predictor of mortality, independent of other behavioral, medical, and psychosocial risk factors [12, 13].

Most individuals with asthma have mild to moderate disease and should be able to live a normal life with the appropriate treatment [14]. However, research by Ford et al. [15] that examined health-related quality of life among adults with asthma found that when compared with adults without asthma, adults with asthma have poorer self-rated health and increased number of physically unhealthy days, mentally unhealthy days, and days with activity limitation. Also, studies on health-related quality of life among individuals with asthma have shown that poor quality of life may be related to asthma severity [16–19]. Moreover, results of clinically based studies of adults with asthma have shown that both occupational and work-exacerbated asthma are associated with poor quality of life [20, 21].

Population-based information on health-related quality of life among adults with work-related asthma is limited. To address this gap, we analyzed cross-sectional data from the 2006–2009 Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-Back Survey for ever-employed adults with current asthma in select states and District of Columbia (DC).

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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 that annually collects information on health risk behaviors, preventive health practices, health-care access, and select disease status [22]. In 2006–2009, BRFSS respondents in 39 states, DC, and Puerto Rico, who indicated that they had ever been told by a doctor, nurse, or other health professional that they had asthma, were eligible to participate in the Asthma Call-back Survey. The Asthma Call-back Survey was administered within 2 weeks of the BRFSS interview and collected additional information on asthma including work-related asthma. The median response rates among the participating areas 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 Asthma Call-back Survey. The BRFSS has a surveillance exemption from Institutional Review Board review at CDC and required participants' informed consent. Participating states are subject to state-specific IRB requirements.

For this analysis, we examined ever-employed adults with current asthma. Asthma Call-back Survey participants were considered to be ever-employed if they indicated that they were currently "employed full-time" or "employed part-time" or that they have ever been employed outside the home. Participants with current asthma were those who responded "yes" to the question "Do you still have asthma?"

Of ever-employed adults with current asthma, those who responded "yes" to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?" were determined to have health professional-diagnosed work-related asthma. Four additional questions addressed the potential role of workplace exposures in the onset and exacerbation of asthma symptoms: (1) "Was your asthma caused by chemicals, smoke, fumes, or dust in your current job?"; (2) "Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had?"; (3) "Is your asthma made worse by chemicals, smoke, fumes, or dust in your current job?"; and (4) "Was your asthma made worse by chemicals, smoke, fumes, or dust in any previous job you ever had?" Respondents who answered "yes" to any of these four questions and "no" to the question on health professional-diagnosed work-related asthma were determined to have possible work-related asthma. Respondents who answered "no" to all five of the questions on work-related asthma were determined to have non-work-related asthma (referent group).

Four questions addressed health-related quality of life: (1) "Would you say that in general your health is excellent, very good, good, fair, or poor?" (i.e., self-rated health); (2) "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?" (i.e., physical health); (3) "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" (i.e., mental health); and (4) "During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?" (i.e., activity limitation). These four indicators of health-related quality of life have previously been evaluated for population-based public health

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surveillance [23–27]. Andresen et al. [24] reported that the retest reliability of BRFSS health-related quality of life indicators ranged from moderate to excellent. BRFSS health-related quality of life indicators are moderately to highly valid [23, 25–27] and have acceptable construct, criterion, and known-groups validity [25].

To examine associations between work-related asthma and health-related quality of life indicators, we dichotomized related responses. We categorized self-rated health as poor health versus fair, good, very good, and excellent health. In agreement with previous research, answers to questions on physical health, mental health, and activity limitation were categorized as ≥14 days (i.e., impaired) versus <14 days (i.e., not impaired) in the past 30 days [28].

Based on the Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma Full Report (EPR-3), we used survey participants' responses to questions on asthma symptoms, nighttime awakenings, and rescue medication use to categorize asthma control as well controlled, not well controlled, or very poorly controlled [4, 7].

Participants' race/ethnicity, smoking status, and adverse asthma outcomes have previously been defined and are summarized in Online Supplement Table 1 [4, 29].

Statistical analysis

During 2006–2009, 39 states, DC, and Puerto Rico administered the Asthma Call-back Survey. However, not all states conducted the Asthma Call-back Survey in each year. Information on states administering the Asthma Call-back Survey by year can be found at http://www.cdc.gov/brfss/acbs/2009/ACBS_06-09.rtf. For this cross-sectional study, we excluded the 2009 data from North Carolina, because the data were not considered representative, and Puerto Rico, because the data were incomplete at the time of analysis.

We used SAS® software version 9.2 (SAS Institute Inc., Cary, NC, USA) survey procedures and SUDAAN® Release 10.0.1 software (Research Triangle Institute, Research Triangle Park, NC, USA) for analyses. To increase precision of estimates, we combined data for 2006–2009. Data from each state/area were weighted to account for non-response differences in the sample and the unequal probability of sample selection. Weights were based on the number of adults in the household, the probability of selection of a telephone number, and the number of phones in a household and were adjusted to reflect the demographic distribution of the population in that state. For the 36 states and DC participating in the Asthma Call-back Survey during multiple years, new weights were established by multiplying the proportion of subjects in each survey year by the corresponding weight for that survey year. For the two states participating in the Asthma Call-back Survey during 1 year only, unaltered weights for that year were used. Respondents not included in the study population (i.e., did not have current asthma, were never employed, had missing data on asthma or employment status) were included in the standard error computations to fully account for the complex sample design.

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Additional information on BRFSS estimation methods including measurement, non-response, and sampling error is available at ftp://ftp.cdc.gov/pub/Data/BRFSS/userguide.pdf and http://www.cdc.gov/brfss/technical_infodata/quality.htm.

We estimated the proportion of individuals with health professional-diagnosed work-related asthma and possible work-related asthma, who had poor health-related quality of life. For comparison, we used BRFSS data collected during 2006–2009 from the same 38 states and DC in our study to estimate the prevalence of health-related quality of life indicators in the adult population.

We examined associations between health professional-diagnosed work-related asthma, possible work-related asthma, and health-related quality of life indicators. We used univariate logistic regression to calculate unadjusted prevalence ratios (PRs) and separate multivariate logistic regression models to calculate adjusted PRs [30]. Because race/ethnicity (four categories: non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic other), education (two categories: high school or less, more than a high school), annual household income (five categories: <$15,000, $15,000–$24,999, $25,000–$34,999, $35,000–$49,999, ≥$50,000), current employment status (two categories: employed, unemployed), and health insurance status (two categories: yes, no) were all significantly associated with work-related asthma and at least one of the health-related quality of life indicators; these independent variables were simultaneously included in the multivariate logistic regression models. Age (continuous) and sex were also included in the models regardless of statistical associations with the independent and dependent variables because findings from previous research have shown associations with either work-related asthma or health-related quality of life [31–33]. Poor quality of life among adults with asthma may be related to asthma severity [16–18, 34]. Therefore, we examined associations between work-related asthma and health-related quality of life indicators after stratifying for level of asthma control.

Results

Overall, 56,097 (10,802 in 2006, 15,245 in 2007, 15,007 in 2008, and 15,043 in 2009) adults participated in the Asthma Call-back Survey in 38 states and DC during 2006–2009. Of these, 38,306 respondents (representing an estimated 16 million) were ever-employed adults with current asthma. Select characteristics of the study population are shown in Table 1. The proportions of individuals with poor/impaired health-related quality of life indicators among groups with different demographic characteristics can be seen in Online Supplement Table 1.

During 2006–2009, an estimated 26.9 % of ever-employed adults with current asthma had poor self-rated health, 20.6 % had impaired physical health, 18.2 % had impaired mental health, and 10.2 % experienced activity limitation (Table 2). An estimated 9.0 % of ever-employed adults with current asthma had work-related asthma and 37.5 % had possible work-related asthma (Online Supplement Table 2).

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Among ever-employed adults with current asthma, the proportions of individuals with poor/impaired health-related quality of life were greatest among those with health professional-diagnosed work-related asthma (range 19.2–40.2 %) (Table 2). For comparison purposes, prevalences of health-related quality of life indicators among all BRFSS adult respondents in the same 38 states and DC that conducted the Asthma Call-back Survey in 2006–2009 are also shown in Table 2. Among all BRFSS adult respondents, the prevalence of poor/impaired health-related quality of life indicators ranged from 4.0 to 16.2 % and was lowest among individuals without asthma (range 3.3–14.8 %) and highest among those with current asthma (range 10.5–29.6 %).

Estimated proportions of individuals with health professional-diagnosed work-related asthma, possible work-related asthma, and non-work-related asthma, who have poor/impaired health-related quality of life, are shown in Table 3. Adjusting for covariates, individuals with health professional-diagnosed work-related asthma were significantly more likely than individuals with non-work-related asthma to have poor self-rated health (PR = 1.45), impaired physical health (PR = 1.60), impaired mental health (PR = 1.55), and activity limitation (PR = 2.16) in the past 30 days (Table 3). Similar, although weaker, associations were found between possible work-related asthma and poor/impaired health-related quality of life (Table 3).

When associations between health professional-diagnosed work-related asthma and health-related quality of life indicators among ever-employed adults with current asthma were examined by level of asthma control, health professional-diagnosed work-related asthma remained associated with health-related quality of life indicators in all levels of asthma control, and the stratum-specific adjusted PRs were similar between strata with overlapping 95 % CIs (Table 4). Similarly, when associations between possible work-related asthma and health-related quality of life were examined by level of asthma control, possible work-related asthma remained associated with health-related quality of life indicators in all levels of asthma control and the stratum-specific adjusted PRs were similar between strata with overlapping 95 % CIs (Table 4).

Discussion

In this cross-sectional, population-based study, we found that among ever-employed adults with current asthma, those with work-related asthma had worse health-related quality of life than individuals with non-work-related asthma. These findings are consistent with previous research that found that individuals with occupational and work-exacerbated asthma had poor health-related quality of life [20, 21]. To the best of our knowledge, this is the first population-based study to illustrate the associations of work-related asthma with health-related quality of life.

We have previously shown that among individuals who describe their asthma as being caused or made worse by workplace exposures (i.e., possible work-related asthma), those who do not have health professional-diagnosed work-related asthma have similar demographic characteristics as those who do have health professional-diagnosed work-related asthma, indicating that some of these individuals may have undiagnosed work-

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related asthma [35]. In this study, we found additional evidence that some individuals with possible work-related asthma may have undiagnosed work-related asthma because, similar to those with work-related asthma, individuals with possible work-related asthma have poorer health-related quality of life than individuals with non-work-related asthma.

Health-related quality of life among adults with either work-exacerbated asthma or occupational asthma has previously been examined [20, 21, 36]. Using the Marks Asthma Quality of Life Questionnaire, Lowery et al. [20] examined responses of 598 adults with asthma from a health maintenance organization in Massachusetts and found that work-exacerbated asthma was associated with worse asthma-related quality of life. In a Canadian study on quality of life and occupational asthma, Miedinger and colleagues found that high proportions of patients with occupational asthma continued to have moderate quality of life impairment 2 years after changing jobs because of their occupational asthma. The authors also found that increased asthma severity was the principal factor associated with poor quality of life [36]. In another Canadian study, using the Juniper Asthma Quality of Life Questionnaire, Malo et al. [21] found that among adults with similar asthma severity, those with occupational asthma had more impaired quality of life than subjects with asthma not related to work.

Multiple factors may contribute to decreased quality of life among adults with occupational asthma, including factors related to individuals leaving their jobs, retraining for new jobs, losing income, or taking early retirement or disability retirement as a result of occupational asthma [21]. Poor health-related quality of life among adults with work-related asthma might also be due to awareness about suffering from a chronic disease, fear and anxiety about it getting worse or losing control of asthma, or perceived lack of asthma control [14, 37]. Studies on asthma and health-related quality of life provide additional evidence on factors that may contribute to decreased quality of life. For example, a study by Hesselink et al. [38] suggested that health-related quality of life is related to psychosocial coping styles in adults with asthma. The authors found that individuals with asthma who are distressed by unpredictable situations such as asthma exacerbations and those who have decreased confidence in the ability to sufficiently react to unpredictable or stressful disease situations have poor health-related quality of life. In addition, decreased confidence may negatively affect self-care and disease management, which in turn causes more severe asthma symptoms [38]. Previous research has also shown that health-related quality of life is associated with disease characteristics such as functional incapacitation [39]. Future studies should examine whether factors related to continued work at a job related to asthma, job changes, psychosocial coping skills, disease characteristics, or other factors help explain the difference in health-related quality of life between adults with work-related asthma and non-work-related asthma.

Evidence indicates that the impact of asthma is greater on the physical health component of quality of life than on mental health [8, 40, 41]. We found, however, that all asthma, regardless of work-related asthma status, had only a slightly greater impact on physical functioning than mental health. This may be because we only examined individuals who had ever been employed while other studies included individuals regardless of employment status. For individuals with work-related asthma, this may be explained, in part, by the fact

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that the diagnosis of work-related asthma can result in job change or job loss [21, 36] and/or decreased income [42], and consequently, the diagnosis of work-related asthma may affect a person's mental health [29].

We found that, after stratifying for asthma control, the associations between work-related asthma and health-related quality of life were not stronger among those with very poorly controlled asthma. This was unexpected given previous research reporting the relationship between health-related quality of life and asthma severity [16–19]. We used a general measure of health-related quality of life, while many studies showing an association between health-related quality of life and asthma severity used asthma-specific health-related quality of life instruments such as the Asthma Quality of Life Questionnaire [16–19]. In addition, asthma severity and asthma control are distinct concepts. Asthma severity represents the intrinsic intensity of the disease and is a reasonably stable characteristic of the individual's asthma that includes current impairment and future risk of adverse events. Asthma control, on the other hand, reflects current functioning and whether the goals of asthma therapy have been met [7]. Asthma control may serve as an indicator of the adequacy of healthcare being provided to patients rather than severity of asthma [43]. However, because of data limitations, we could only assess asthma control.

Our findings on work-related asthma are consistent with the research by Malo et al. [21] that found that individuals with occupational asthma have poorer quality of life than those with non-work-related asthma even after controlling for asthma severity. More research is needed to better understand the current findings that asthma severity and/or asthma control play a lesser role in health-related quality of life among adults with work-related asthma.

The BRFSS has many strengths and limitations. BRFSS uniquely allows for state-level population-based estimates on a variety of health and behavior indicators including health-related quality of life and work-related asthma. BRFSS also includes information that is timely and annually collected. BRFSS limitations include self-reported measures that are not validated and may be subject to recall bias. It is not possible to determine causality due to the cross-sectional design of the survey. For example, it is not clear whether work-related asthma affects health-related quality of life or if poor health-related quality of life makes it more likely that a diagnosis of work-related asthma is made [44]. However, because the reference time period for the questions on health-related quality of life is 30 days prior to the interview and the reference time period for work-related asthma is the respondent's lifetime, it is likely that work-related asthma affects health-related quality of life. Lastly, BRFSS queried only those with telephone access and did not include people residing in households lacking telephones.

The findings of this report are subject to additional limitations. The levels of asthma control in this study were based on EPR-3 guidelines but do not include objective measures of lung function as recommended [7]. Therefore, the percentages with very poorly controlled asthma are likely underestimated. Moreover, generic measures of health-related quality of life such as what is used here may not be sensitive enough to detect changes specific to asthma [40]. However, such instruments allow broad comparisons of health-related quality of life for many different disease states and have been shown to be valid [15, 25, 41]. In addition, due

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to unreliable estimates, we were unable to examine whether poor health-related quality of life was associated with increased health-care utilization among individuals with work-related asthma. Findings from past research suggest that poor health-related quality of life is associated with increased health-care utilization among individuals with asthma but results are inconclusive [45–47]. Finally, estimates are limited to the 38 states and DC that conducted the Asthma Call-back Survey in 2006–2009 and do not represent non-participating states or the entire US population.

These results provide additional information on the burden of work-related asthma and show that individuals with work-related asthma have worse health-related quality of life than those with non-work-related asthma. Individuals with poor health-related quality of life may benefit from more intensive asthma management including counseling about risk of asthma exacerbations and individualized asthma action plans [14, 48]. Future research should examine opportunities to improve health-related quality of life among individuals with work-related asthma.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics of ever-employed adults with current asthma, Asthma Call-back Survey, 38 states and District of Columbia, 2006–2009 (*N* = 38,306)

Characteristics	Ever-employed adults with current asthma		
	n [a]	Weighted *N* (in thousands)[b]	%[c] (95 % CI)
Age (year)			
18–44	9,637	8,089	50.1 (48.8–51.3)
45–64	18,402	5,716	35.4 (34.3–36.4)
65+	10,113	2,353	14.6 (14.0–15.1)
Sex			
Male	10,199	6,018	37.2 (35.9–38.5)
Female	28,107	10,173	62.8 (61.5–64.1)
Race/Ethnicity			
White, non-Hispanic	31,660	12,254	76.1 (74.9–77.3)
Black, non-Hispanic	2,069	1,360	8.4 (7.8–9.1)
Hispanic	1,599	1,403	8.7 (7.8–9.6)
Other, non-Hispanic	2,694	1,091	6.8 (6.1–7.5)
Education level			
≤High school	13,485	5,538	34.2 (33.0–35.4)
>High school	24,788	10,645	65.8 (64.6–67.0)
Household income			
<$15,000	5,608	1,901	13.1 (12.3–14.0)
$15,000–$24,999	6,462	2,316	16.0 (15.0–16.9)
$25,000–$34,999	4,077	1,473	10.2 (9.4–10.9)
$35,000–$49,999	5,164	2,027	14.0 (13.1–14.9)
≥$50,000	13,385	6,792	46.8 (45.5–48.1)
Health insurance			
Yes	34,880	14,145	87.5 (86.5–88.5)
No	3,332	2,025	12.5 (11.5–13.5)
Current employment status			
Employed	18,602	9,325	57.6 (56.4–58.8)
Not employed	19,675	6,854	42.4 (41.2–43.6)
Smoking status			
Current	7,021	3,089	19.1 (18.1–20.1)
Former	12,920	4,417	27.4 (26.3–28.4)
Never	18,199	8,641	53.5 (52.3–54.8)
Health-related quality of life			
Poor self-rated health	12,753	4,343	26.9 (25.9–27.9)
Impaired physical health	9,861	3,288	20.6 (19.7–21.4)
Impaired mental health	6,820	2,908	18.2 (17.3–19.1)
Limited activity	4,540	1,639	10.2 (9.5–10.9)

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Characteristics	Ever-employed adults with current asthma		
	n [a]	Weighted *N* (in thousands)[b]	%[c] (95 % CI)
Asthma control			
Well controlled	17,869	8,104	50.1 (48.8–51.3)
Not well controlled	9,986	4,351	26.9 (25.8–28.0)
Very poorly controlled	10,436	3,734	23.1 (22.1–24.0)
Adverse asthma outcome events in past 12 months			
Asthma attack	19,597	8,285	51.5 (50.3–52.8)
Urgent treatment	9,092	3,651	23.0 (22.1–24.0)
Emergency room visit	4,455	1,880	11.7 (87.5–89.0)
Overnight hospital stay	1,554	546	3.4 (3.0–3.8)

CI confidence interval

[a] Unweighted sample size. The numbers may not add to total (38,306) because of missing values (154 for age, 284 for race/ethnicity, 33 for education, 3,610 for household income, 94 for health insurance, 29 for employment status, 166 for smoking status, 192 for poor self-rated health, 692 for impaired physical health, 581 for impaired mental health, 468 for activity limitation, 15 for asthma control, 432 for asthma attack, 569 for urgent treatment, 175 for emergency room visit, and 191 for overnight hospital stay)

[b] Weighted to the state population using the survey sample weights for each ACBS participant

[c] Results presented as weighted average annual estimate

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Table 2

Estimated proportion of individuals with poor health-related quality of life among select population groups, Behavioral Risk Factor Surveillance System and Asthma Call-back Survey, 38 states and District of Columbia, 2006–2009

Population (Survey, sample size)	Poor self-rated health	Impaired physical health	Impaired mental health	Limited activity
	%[a] (95 % CI)	% (95 % CI)	% (95 % CI)	% (95 % CI)
Adults (Behavioral Risk Factor Surveillance System, *N* = 1,082,135)	16.2 (16.0–16.3)	10.7 (10.6–10.8)	10.2 (10.1–10.3)	4.0 (3.9–4.1)
No asthma[b]	14.8 (14.7–15.0)	9.5 (9.4–9.7)	9.2 (9.1–9.3)	3.3 (3.3–3.4)
Former asthma[c]	15.7 (15.0–16.4)	11.1 (10.5–11.7)	12.3 (11.7–13.0)	4.4 (4.0–4.7)
Current asthma[d]	29.6 (29.0–30.2)	22.2 (21.6–22.7)	18.9 (18.3–19.5)	10.5 (10.1–10.9)
Ever-employed adults with current asthma[e] (Asthma Call-back Survey, *N* = 38,306)	26.9 (25.9–27.9)	20.6 (19.7–21.4)	18.2 (17.3–19.1)	10.2 (9.5–10.9)
Non-work-related asthma[f]	21.6 (20.4–22.8)	15.8 (14.8–16.8)	14.3 (13.1–15.4)	6.6 (5.9–7.2)
Possible work-related asthma[g]	31.3 (29.6–33.0)	24.5 (23.0–26.0)	21.9 (20.3–23.5)	13.3 (11.9–14.6)
HCP-diagnosed work-related asthma[h]	40.2 (36.9–43.6)	32.4 (29.2–35.6)	26.2 (23.0–29.4)	19.2 (16.5–21.9)

CI confidence interval, *HCP* health-care professional

[a] Results presented as weighted average annual estimate

[b] Behavioral Risk Factor Surveillance System participants who answered "No" to the question "Were you ever told by a doctor or other health professional that you had asthma?"

[c] Behavioral Risk Factor Surveillance System participants who answered "Yes" to the question "Were you ever told by a doctor or other health professional that you had asthma?" and "No" to the question "Do you still have asthma?"

[d] Behavioral Risk Factor Surveillance System participants who answered "Yes" to the questions "Were you ever told by a doctor or other health professional that you had asthma?" and "Do you still have asthma?"

[e] Asthma Call-back Survey participants who described current employment status as "employed full-time" or "employed part-time" or responded "yes" to the question "Have you ever been employed outside the home?"

[f] "No" to all of the following five questions: "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?", "Was your asthma caused by chemicals, smoke, fumes, or dust in your current job?", "Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had?", "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?"

[g] "No" response to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?" and "Yes" responses to any of the following four questions: "Was your asthma caused by chemicals, smoke, fumes, or dust in your current job?", "Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had?", "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?"

[h] "Yes" to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?"

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Table 3

Estimated proportion of individuals with poor health-related quality of life by work-related asthma status, Asthma Call-back Survey, 38 states and District of Columbia, 2006–2009, (*N* = 38,306)

Health-related quality of life indicator	HCP-diagnosed work-related asthma[a] versus non-work-related asthma PR[b] (95 % CI)	Possible work-related asthma[b] versus non-work-related asthma PR (95 % CI)
Poor self-rated health	1.45 (1.31–1.60)	1.28 (1.19–1.38)
Impaired physical health	1.60 (1.42–1.80)	1.42 (1.30–1.55)
Impaired mental health	1.55 (1.34–1.80)	1.37 (1.23–1.53)
Limited activity	2.16 (1.81–2.56)	1.79 (1.57–2.04)

CI confidence interval, *HCP* health-care professional, *PR* prevalence ratio

[a] "Yes" to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?"

[b] "No" response to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?" and "Yes" responses to any of the following four questions: "Was your asthma caused by chemicals, smoke, fumes, or dust in your current job?", "Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had?", "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?"

[c] Prevalence ratio adjusted for age, sex, race/ethnicity, education, income, health insurance status, and employment status

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Table 4

Multivariate associations of health professional-diagnosed work-related asthma and possible work-related asthma with health-related quality of life indicators among ever-employed adults with current asthma by asthma control level, Asthma Call-back Survey, 38 states and District of Columbia, 2006–2009, (*N* = 38,306)

Health-related quality of life indicator	Well-controlled asthma (*N* = 17,869)[c]	Not well controlled asthma (*N* = 9,986)	Very poorly controlled asthma (*N* = 10,436)
	PR[d] (95 % CI)	PR (95 % CI)	PR (95 % CI)
Poor self-rated health			
Non-work-related asthma	1.00 (ref)	1.00 (ref)	1.00 (ref)
Possible work-related asthma[b]	1.26 (1.09–1.46)	1.16 (1.00–1.34)	1.22 (1.11–1.34)
HCP-diagnosed work-related asthma[a]	1.37 (1.10–1.71)	1.20 (0.98–1.49)	1.32 (1.18–1.48)
Impaired physical health			
Non-work-related asthma	1.00 (ref)	1.00 (ref)	1.00 (ref)
Possible work-related asthma[b]	1.35 (1.14–1.59)	1.31 (1.10–1.57)	1.39 (1.24–1.55)
HCP-diagnosed work-related asthma[a]	1.58 (1.22–2.04)	1.33 (1.04–1.70)	1.43 (1.23–1.65)
Impaired mental health			
Non-work-related asthma	1.00 (ref)	1.00 (ref)	1.00 (ref)
Possible work-related asthma[b]	1.41 (1.17–1.70)	1.29 (1.05–1.58)	1.27 (1.09–1.49)
HCP-diagnosed work-related asthma[a]	1.47 (1.11–1.97)	1.37 (1.04–1.82)	1.42 (1.15–1.74)
Limited activity			
Non-work-related asthma	1.00 (ref)	1.00 (ref)	1.00 (ref)
Possible work-related asthma[b]	1.87 (1.45–2.42)	1.75 (1.35–2.27)	1.56 (1.31–1.85)
HCP-diagnosed work-related asthma[a]	2.80 (1.96–4.00)	1.67 (1.16–2.41)	1.67 (1.35–2.07)

CI confidence interval, *HCP* health-care professional, *PR* prevalence ratio

[a] "Yes" to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?"

[b] "No" response to the question "Were you ever told by a doctor or other health professional that your asthma was related to any job you ever had?" and "Yes" responses to any of the following four questions: "Was your asthma caused by chemicals, smoke, fumes, or dust in your current job?", "Was your asthma caused by chemicals, smoke, fumes, or dust in any previous job you ever had?", "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?"

[c] Unweighted sample size. The numbers may not add to total (38,306) because of missing values

[d] Prevalence ratio adjusted for age, sex, race/ethnicity, education, income, health insurance status, and employment status