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Preliminary communication

Effect of current depression on the association of work-related asthma with adverse asthma outcomes: A cross-sectional study using the Behavioral Risk Factor Surveillance System

Jacek M. Mazurek [a,*], Gretchen E. Knoeller [a], Jeanne E. Moorman [b]

[a] National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA
[b] National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA, USA

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ABSTRACT

Background: Depression has been associated with a decreased level of asthma control. The aim of our study was to examine associations between health-professional diagnosed work-related asthma (WRA) and current depression and the effect of current depression on the associations of WRA with adverse asthma outcomes.
Method: We analyzed data from the 2006 and 2008 Behavioral Risk Factor Surveillance System Asthma Call-Back Survey and the Anxiety and Depression Module conducted in 25 states and District of Columbia for ever-employed adults with current asthma. We computed weighted proportions and prevalence ratios adjusted for age, sex, race/ethnicity, education, current employment status, and smoking status. Survey participants who were ever told by a doctor or other health professional that their asthma was related to any job they ever had were determined to have WRA. Participants with current depression were identified using self-report of depressive symptoms.
Results: Of ever-employed adults with current asthma, an estimated 9.1% had WRA and 17.0% had current depression. Persons with WRA were significantly more likely than those with non-WRA to have current depression. Persons with either WRA, current depression, or both WRA and current depression were significantly more likely to have adverse asthma outcomes than persons with asthma and neither condition. The associations with adverse asthma outcomes were stronger when both current depression and WRA were present.
Limitations: This is a cross-sectional and hypothesis-generating study.
Conclusions: Depression may play an important role in asthma management and should be considered when assessing patients with asthma and, in particular, those with WRA.
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1. Introduction

In 2009, 13% (29.7 million) of U.S. adults ≥18 years of age had ever been told they had asthma and 8% (17.5 million) still had asthma (National Center for Health Statistics, 2009). Based on a review of published studies, the American Thoracic Society reported that 4%–58% (median 15%) of adults with asthma have work-related asthma (WRA), which includes asthma caused by factors related to work or the workplace environment (occupational asthma) and pre-existing or concurrent asthma worsened by factors related to work or the workplace environment (work-exacerbated asthma) (Balmes et al., 2003; Tarlo et al., 2008). WRA has been associated with acute morbidity, long-term disability, death, and adverse socioeconomic outcomes (Tarlo et al., 2008; Vandenplas et al., 2003).

Data from the 2006–2008 U.S. Behavioral Risk Factor Surveillance System (BRFSS) survey showed that an estimated 9.0% of the U.S. adult population has current depressive

* Corresponding author at: Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Respiratory Disease Studies, Surveillance Branch, Mailstop HG 900.2, 1095 Willowdale Rd. Morgantown, WV 26505, USA. Tel.: +1 304 285 5983; fax: +1 304 285 6111.
E-mail address: JMazurek1@cdc.gov (J.M. Mazurek).

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symptoms, including 3.4% with major depression (CDC, 2010). Studies have documented an association between depression and the onset and course of asthma (Goodwin et al., 2003; Hurwitz and Morgenstern, 1999; Katon et al., 2004; Kessler et al., 2003; Oraka et al., 2010; Scott et al., 2007; Solis et al., 2006; Strine et al., 2008b; Van Lieshout and Macqueen, 2008). Solis et al. (2006) reported that asthma preceded major depression in 62% of cases, asthma and major depression had a concurrent onset in 14% of cases, and depression preceded asthma in 24% of cases. Several hypotheses have been proposed to explain the association between mental health disorders and asthma, and evidence suggests that this association is related to alteration of the hypothalamic-pituitary-adrenocortical axis regulation (Di Marco et al., 2011; Van Lieshout et al., 2009).

Persons with a lifetime diagnosis of asthma have 1.7 times higher odds of having current depressive symptoms than those with no history of asthma (CDC, 2010; Strine et al., 2008b). Similar results were reported from the World Mental Health Survey conducted in 17 countries (Scott et al., 2007). In that study, persons with lifetime asthma compared to those with no asthma had 1.6 higher odds for depressive disorders.

Current depression in persons with asthma is associated with increased number of emergency room visits for asthma, asthma-related doctor visits, days with asthma symptoms (Strine et al., 2008a), increased risk for premature mortality (Aromaa et al., 1994; Zheng et al., 1997), co-morbidity (Katon et al., 2007), decreased work performance, and increased costs to employers, in particular the cost of lost work days (Druss et al., 2000; Kessler et al., 2003, 2008; Stein et al., 2006). Moreover, higher prevalence of depression, functional impairment, and decreased work productivity are associated with poorly controlled asthma (Gonzales Barcala et al., 2011; Wertz et al., 2010; Williams et al., 2009).

To date there is limited information on current depression among persons with WRA and its impact on adverse WRA outcomes. Using data from the 2006 and 2008 BRFSS Anxiety and Depression Module and the Asthma Call-Back Survey for ever-employed adults with current asthma in 25 states and DC, we examined associations of self reported health-professional diagnosed WRA with current depression. In addition, we examined the effect of current depression on the association of WRA with adverse asthma outcomes.

2. Methods

2.1. Data source

The BRFSS is an ongoing, state-based, telephone survey conducted by random-digit-dialing of the non-institutionalized U.S. civilian population aged ≥18 years. The survey collects information on health risk behaviors, preventive health practices, health care access, and disease status (see http://www.cdc.gov/brfss/). The BRFSS questionnaire has three parts: the core component administered in all 50 states, the District of Columbia (DC), Puerto Rico, the U.S. Virgin Islands, and Guam; optional modules which are sets of questions on specific topics; and state-added questions. We used demographic information from the core component and health data collected using the optional Anxiety and Depression Module and the optional Asthma Call-Back Survey. The Anxiety and Depression Module was administered as part of BRFSS to all participants and the Asthma Call-Back Survey was administered within two weeks of the BRFSS telephone interview to a subset of BRFSS respondents. The BRFSS respondents were eligible to participate in the Asthma Call-Back Survey if they answered "yes" to the question "Have you ever been told by a doctor, nurse, or other health professional that you had asthma?" The Anxiety and Depression Module and the Asthma Call-Back Survey were administered together in 20 states and DC in 2006 and in 11 states in 2008 (six states administered both in 2006 and in 2008). We combined 2006 and 2008 data to increase reliability and precision of the estimates. The Council of American Survey and Research Organizations (CASRO) median response rates among the 20 participating states and DC in 2006 were 49.2% (range, 36.9%–66.0%) for BRFSS/Anxiety and Depression Module and 53.7% (range, 37.0%–70.8%) for Asthma Call-Back Survey and among the 11 participating states in 2008 were 50.3% (range, 40.0%–65.5%) for BRFSS/Anxiety and Depression Module and 55.0% (range, 35.1%–61.5%) for Asthma Call-Back Survey.

For this study we used 2006 and 2008 BRFSS data without personal identifiers available at http://www.cdc.gov/brfss/technical_infodata/surveydata.htm. The BRFSS has a surveillance exemption from Institutional Review Board review at the Centers for Disease Control and Prevention (protocol #2988). Participating states are subject to state-specific IRB requirements.

2.2. Definitions

Respondents with current asthma were those who answered "yes" to both questions: "Have you ever been told by a doctor, nurse, or other health professional that you had asthma?" and "Do you still have asthma?" Respondents were ever-employed if they described their current employment status as "employed full-time" or "employed part-time" or, if not currently employed, answered "yes" to the question "Have you ever been employed outside the home?" Of ever-employed participants 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 WRA.

Participants with current depression were identified using the standardized and previously validated eight-item Patient Health Questionnaire (PHQ-8) from the Anxiety and Depression Module (Kroenke et al., 2001, 2009). These eight questions were designed to collect information on the number of days in the past two weeks that the respondent experienced depressive symptoms. Following a previously used algorithm, we assigned a score from 0 to 3 to the number of days for each of the eight items as follows: 0–1 days = 0; 2–6 days = 1, 7–11 days = 2, and 12–14 days = 3. Individuals with a summed score over the eight items ≥10 were defined as having current depression.

We based asthma control definitions on the "Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma" (NHLBI, 2007) criteria using participant responses to questions on asthma symptoms, nighttime

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awakenings, and the use of rescue medication (well controlled, not-well-controlled, or very poorly controlled).

Adverse asthma outcomes were assessed using responses to the following questions: "During the past 12 months, have you had an episode of asthma or asthma attack?" (yes, no); "During the past 12 months, have you had to visit an emergency room or urgent care center because of your asthma?" (yes, no); "During the past 12 months, have you had to stay overnight in a hospital because of your asthma?" (yes, no); "During the past 12 months, how many times did you see a doctor or other health professional for urgent treatment of worsening asthma symptoms or for an asthma episode or attack?" (0 times, ≥1 times); "During the past 12 months, how many days were you unable to work or carry out your usual activities because of your asthma?" (0 days, 1–13 days, ≥14 days).

Participants were asked whether they were of Hispanic or Latino ethnicity. Next they were asked to identify their race: White, Black or African American, Asian, Native Hawaiian or other Pacific Islander, American Indian or Alaskan Native, or Other. We used responses to these two items to categorize race/ethnicity into one of the four categories: non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic other (i.e., 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).

Respondent cigarette smoking status was categorized into three groups: current smokers were those who had smoked at least 100 cigarettes during their lifetime and who smoked "every day" or "some days" at the time of the interview; former smokers were those who had smoked at least 100 cigarettes in their lifetime but did not smoke at the time of the interview; never smokers were those who never smoked or those who had smoked fewer than 100 cigarettes during their lifetime.

Some respondents indicated that their asthma may be associated with workplace exposures (i.e., responded "yes" to any of the 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?", or "Was your asthma made worse by chemicals, smoke, fumes or dust in any previous job you ever had?"). These respondents were asked if they changed or quit a job because exposures in the workplace caused or made their asthma worse ("Did you ever change or quit a job because chemicals, smoke, fumes, or dust caused your asthma or made your asthma worse?"). Respondents who did not indicate that their asthma may be associated with workplace exposures (i.e., negatively responded to all four questions) were assumed to have never changed a job because of the exposures in their job.

2.3. Statistical analyses

We used SAS® software version 9.2 (SAS Institute Inc., Cary, NC) survey procedures and SUDAAN® release 10.0.1 software (Research Triangle Institute, Research Triangle Park, NC) for analyses. We weighted the data to account for non-response differences in the sample and the unequal probability of sample selection. Data from 2006 for each of the 20 states (Alaska, California, Connecticut, Georgia, Hawaii, Indiana, Iowa, Kansas, Maine, Maryland, Michigan, Missouri, Montana, Nebraska, New Hampshire, Oregon, Texas, Vermont, Washington, and Wisconsin) and DC and from 2008 for each of the 11 states (Arizona, Hawaii, Illinois, Kansas, Maine, Nebraska, New York, North Dakota, Ohio, Vermont, and Washington) administering the Anxiety and Depression Module and the Asthma Call-Back Survey were used. In eight states (Connecticut, Kansas, Maine, Maryland, Nebraska, New York, Ohio, and Washington), the Anxiety and Depression Module was administered to a subset of the state sample in one version of the questionnaire. For these states, the Asthma Call-Back Survey final weight was proportionately adjusted based on the value of the BRFSS version final weight relative to the value of the BRFSS core final weight. For states with two years of data (Hawaii, Kansas, Maine, Nebraska, Vermont, and Washington), weights based on the proportionate distribution of the sample completing the Anxiety and Depression Module and the Asthma Call-Back Survey between the two years were calculated. Sampled persons who did not have current asthma, were never employed, and had missing data on asthma, employment, or PHQ-8 were included in the standard error computations to account for the complex sample design.

We examined associations between WRA, current depression, and adverse asthma outcomes using univariate logistic regression to calculate unadjusted prevalence ratios (PRs) and multivariate logistic regression to calculate adjusted PRs (Thompson et al., 1998). All multivariate associations were simultaneously adjusted for age (continuous), sex, 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), employment status (two categories: currently employed, not currently employed), annual household income (five categories: <$15,000, $15,000–$24,999, $25,000–$34,999, $35,000–$49,999, ≥$50,000), and smoking status (three categories: current, former, never smoker). Age, education, employment status, annual household income, and smoking status were selected as covariates because of their significant association either with WRA or current depression in the univariate analyses. Sex and race/ethnicity were included in the adjustment because of reported disparities in adverse asthma outcomes (i.e., emergency department visits, hospitalizations, and death) associated with these factors (Moorman et al., 2007). Although variables such as health insurance status, financial barriers to asthma care, and body mass index were associated either with WRA or current depression, they did not substantially change findings when adjusted for and were not included in the final analyses.

To examine whether current depression modified the association between WRA and adverse asthma outcomes among adults with current asthma, we repeated the analyses by depression status. Finally, we examined whether there was an interaction between WRA and current depression and its impact on the association with adverse asthma outcomes using multivariate logistic regression analysis. For this analysis we created a new variable with four distinct categories of WRA and current depression, i.e., WRA alone, current depression alone, WRA and current depression, and no WRA or current depression (referent group).

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To account for sampling effect, we reported the 95% confidence intervals (CIs) around the estimates and PRs. PRs with CIs that did not include 1.0 were considered statistically significant.

3. Results

A total of 7494 adults in the 25 states and DC that administered the Anxiety and Depression Module and the Asthma Call-Back Survey in 2006 and 2008 were ever-employed and had current asthma. Characteristics of the study population are shown in Table 1.

Of ever-employed adults with current asthma, an estimated 9.1% (CI: 7.5–10.7) had WRA and 17.0% (CI: 14.8–19.2) had current depression. Persons with WRA were significantly more likely than those with non-WRA to have current depression (27.6% versus 16.0%, PR: 1.73; CI: 1.19–2.51). In addition, persons with WRA were significantly more likely to be aged 45–64 years, to identify as other non-Hispanic, to have an annual household income <$15,000, to be currently unemployed, and to have adverse asthma outcomes (Table 1).

Among ever-employed adults with current asthma those with current depression were significantly more likely than those with no current depression to be 45–64, to identify as other non-Hispanic, to have low annual household income,

Table 1
Characteristics of ever-employed adults with current asthma by work-related asthma (WRA) status.

Characteristics	Sample[a]	Total		WRA		No WRA		PR[c]	95% CI
		%[b]	95% CI	%[b]	95% CI	%[b]	95% CI		
Age group (years)									
18–44	2118	49.8	46.8–52.8	32.3	23.1–41.6	51.5	48.5–54.6	0.63	0.47–0.85
45–64	3597	36.1	33.5–38.8	57.8	48.4–67.1	34.0	31.4–36.7	1.70	1.42–2.04
≥65	1754	14.1	12.7–15.5	9.9	6.5–13.3	14.5	12.9–16.0	0.68	0.48–0.98
Sex									
Male	2020	36.6	33.5–39.7	37.7	28.1–47.3	36.4	33.1–39.6	1.04	0.79–1.36
Female	5474	63.4	60.3–66.5	62.3	52.7–71.9	63.6	60.4–66.9	0.98	0.83–1.15
Race/ethnicity									
White, non-Hispanic	6200	76.5	73.7–79.3	66.0	55.4–76.6	77.5	74.6–80.3	0.85	0.72–1.01
Black, non-Hispanic	322	8.0	6.4–9.5	9.5	5.1–14.0	7.8	6.2–9.5	1.21	0.68–2.16
Hispanic	258	9.1	6.8–11.4	–	–	9.0	6.6–11.4	1.16	0.50–2.66
Other, non-Hispanic	664	6.4	5.0–7.9	–	–	5.7	4.4–6.9	2.47	1.19–5.12
Education									
≤High school	2637	31.5	28.9–34.2	31.4	23.7–39.0	31.3	28.5–34.1	1.00	0.77–1.30
>High school	4852	68.5	65.8–71.1	68.6	61.0–76.3	68.7	65.9–71.5	1.00	0.89–1.13
Household income									
<$15,000	1106	14.3	11.9–16.6	24.1	15.2–32.9	13.2	10.8–15.6	1.82	1.21–2.75
$15,000–$24,999	1252	15.2	13.1–17.3	15.4	10.7–20.1	15.2	13.0–17.4	1.01	0.72–1.42
$25,000–$34,999	843	11.0	9.0–13.0	–	–	10.6	8.7–12.5	1.25	0.59–2.65
$35,000–$49,999	1084	13.9	11.9–15.9	14.9	9.1–20.7	13.8	11.7–15.9	1.08	0.71–1.65
≥$50,000	2502	45.6	42.6–48.7	32.4	23.7–41.1	47.2	43.9–50.4	0.69	0.52–0.91
Health insurance									
Yes	6805	86.7	84.3–89.1	81.8	73.3–90.2	87.2	84.7–89.7	0.94	0.84–1.04
No	660	13.3	10.9–15.7	18.2	9.8–26.7	12.8	10.3–15.3	1.42	0.86–2.35
Current employment									
Employed	3871	58.3	55.4–61.2	49.7	40.1–59.2	59.2	56.1–62.2	0.84	0.69–1.03
Not employed	3616	41.7	38.8–44.6	50.3	40.8–59.9	40.8	37.8–43.9	1.23	1.00–1.51
Smoking status									
Current	1418	20.1	17.8–22.5	24.4	15.0–33.8	19.8	17.3–22.2	1.24	0.82–1.86
Former	2478	26.7	24.2–29.1	24.7	18.4–30.9	26.6	24.0–29.2	0.93	0.70–1.22
Never	3530	53.2	50.3–56.2	50.9	41.5–60.4	53.6	50.5–56.7	0.95	0.78–1.16
Depression status									
Current depression	1270	17.0	14.8–19.2	27.6	18.1–37.1	16.0	13.7–18.2	1.73	1.19–2.51
No current depression	6169	83.0	80.8–85.2	72.4	62.9–81.9	84.0	81.8–86.3	0.86	0.75–0.99
Adverse asthma outcome									
Very poorly controlled	2092	24.0	21.6–26.5	38.4	28.8–48.0	22.6	20.1–25.1	1.70	1.29–2.23
Asthma attack[d]	3794	52.8	49.8–55.8	68.4	59.8–77.0	51.2	48.1–54.4	1.33	1.16–1.54
Urgent treatment for worsening asthma[d]	1746	24.1	21.6–26.6	38.7	29.4–48.0	22.6	20.1–25.2	1.71	1.31–2.23
Asthma-related emergency room visit[d]	826	11.5	9.7–13.2	19.4	12.6–26.3	10.7	8.8–12.5	1.83	1.23–2.71
Overnight stay in hospital because of asthma[d]	265	3.8	2.9–4.7	9.2	5.0–13.4	3.2	2.3–4.1	2.87	1.68–4.92
Unable to work or carry out usual activities 1–13 days[d]	1481	22.6	20.0–25.1	29.1	20.8–37.4	21.9	19.3–24.6	1.33	0.97–1.82
Unable to work or carry out usual activities ≥14 days[d]	729	9.4	7.9–10.9	21.5	14.3–28.8	8.2	6.8–9.7	2.62	1.79–3.85
Change/quit job due to asthma	745	10.1	8.4–11.7	35.6	27.2–44.0	7.4	5.9–8.9	4.79	3.49–6.58
Total	7494	100.0		9.1	7.5–10.7				

"–" indicates that relative standard error for the estimate >30%; estimate not reported.
[a] Categories do not sum to total due to item nonresponse.
[b] Based on an average annual estimate.
[c] Prevalence ratio represents the probability of a person with work-related asthma (WRA) having the individual characteristic as compared with a person with non-WRA. For each model, the dependent variable was the individual characteristic and the independent variable was WRA.
[d] During the past 12 months.

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to not have health insurance, to be not currently employed, to be a current smoker, to have WRA, and to have adverse asthma outcomes (Table 2).

After adjusting for age, sex, race/ethnicity, education, employment status, annual household income, and smoking status, individuals with WRA were more likely than those with non-WRA to have current depression (PR: 1.44; CI: 1.08–1.92) (data not shown). When associations between WRA and adverse asthma outcomes among ever-employed adults with current asthma were examined by current depression status, WRA remained associated with adverse asthma outcomes in both groups and the stratum-specific adjusted PRs were similar with 95% CIs overlapping between categories (Table 3).

Multivariate associations between WRA, current depression and adverse asthma outcomes among ever-employed adults with current asthma are shown in Table 4. The magnitude of associations of current depression alone with the adverse asthma outcomes was similar to associations of WRA alone with the adverse asthma outcomes. A notable exception was whether one changed or quit their job because of workplace exposures — the association for WRA alone was much greater than that for current depression alone. In general, associations between the presence of both WRA and current depression with the adverse asthma outcomes were greater compared with associations for current depression alone or WRA alone.

4. Discussion

Our study analyzed the data from the 2006 and 2008 BRFSS Anxiety and Depression Module and Asthma Callback Survey for ever-employed adults with current asthma

Table 2
Characteristics of ever-employed adults with current asthma by presence of current depression.

Characteristics	Current depression		No current depression		PR[b]	95% CI
	%[a]	95% CI	%[a]	95% CI		
Age group (years)						
18–44	45.3	38.1–52.5	50.7	47.5–53.9	0.89	0.75–1.06
45–64	48.4	41.3–55.5	33.7	30.9–36.4	1.44	1.22–1.70
≥ 65	6.3	4.3–8.3	15.6	14.0–17.3	0.40	0.29–0.57
Sex						
Male	30.4	23.2–37.7	37.9	34.5–41.3	0.80	0.62–1.04
Female	69.6	62.3–76.8	62.1	58.7–65.5	1.12	1.00–1.26
Race/ethnicity						
White, non-Hispanic	66.6	59.2–74.0	78.5	75.6–81.5	0.85	0.75–0.95
Black, non-Hispanic	10.3	6.0–14.6	7.5	5.8–9.1	1.40	0.86–2.21
Hispanic	10.4	4.9–16.0	8.9	6.4–11.3	1.18	0.64–2.15
Other, non-Hispanic	12.7	6.8–18.6	5.2	3.9–6.4	2.45	1.45–4.16
Education level						
≤High school	46.4	39.2–53.5	28.5	25.7–31.2	1.63	1.36–1.96
>High school	53.6	46.5–60.8	71.5	68.8–74.3	0.75	0.65–0.86
Household income						
<$15,000	29.3	23.4–35.3	11.3	8.7–13.9	2.60	1.91–3.53
$15,000–$24,999	29.4	22.5–36.2	12.3	10.4–14.3	2.38	1.80–3.15
$25,000–$34,999	15.3	7.9–22.6	10.2	8.3–12.0	1.50	0.90–2.51
$35,000–$49,999	9.0	5.5–12.5	14.8	12.5–17.1	0.61	0.40–0.92
≥$50,000	17.0	11.3–22.7	51.4	48.0–54.8	0.33	0.24–0.47
Health insurance						
Yes	76.3	69.7–82.9	88.8	86.3–91.4	0.86	0.78–0.94
No	23.7	17.1–30.3	11.2	8.6–13.7	2.12	1.48–3.04
Current employment						
Employed	35.1	28.2–42.0	63.0	59.9–66.1	0.56	0.46–0.68
Not employed	64.9	58.0–71.8	37.0	33.9–40.1	1.76	1.54–2.01
Smoking status						
Current	34.3	27.6–41.0	17.2	14.7–19.7	1.99	1.56–2.54
Former	30.8	24.1–37.5	25.8	23.2–28.4	1.19	0.94–1.52
Never	34.9	28.2–41.6	57.0	53.8–60.2	0.61	0.50–0.75
Asthma work-relatedness						
Work-related	14.8	9.1–20.5	7.9	6.4–9.5	1.86	1.20–2.88
Non-work related	85.2	79.5–90.9	92.1	90.5–93.6	0.93	0.86–0.99
Adverse asthma outcome						
Very poorly controlled	45.1	37.9–52.3	19.7	17.4–22.1	2.28	1.87–2.79
Asthma attack[c]	71.0	65.2–76.7	49.0	45.7–52.3	1.45	1.30–1.61
Urgent treatment for worsening asthma[c]	31.4	25.2–37.7	22.6	19.9–25.4	1.39	1.10–1.76
Asthma-related emergency room visit[c]	19.6	14.5–24.6	9.8	8.0–11.7	1.99	1.45–2.74
Overnight stay in hospital because of asthma[c]	10.4	6.6–14.2	2.4	1.6–3.2	4.30	2.63–7.02
Unable to work or carry out usual activities 1–13 days[c]	24.3	19.1–29.5	22.2	19.4–25.1	1.09	0.85–1.40
Unable to work or carry out usual activities ≥14 days[c]	28.4	22.1–34.6	5.9	4.7–7.0	4.84	3.59–6.53
Change/quit job due to asthma	22.2	16.2–28.2	7.6	6.1–9.0	2.94	2.11–4.09

[a] Based on an average annual estimate.
[b] Prevalence ratio represents the probability of a person with current depression having the individual characteristic as compared with a person with no depression. For each model, the dependent variable was the individual characteristic and the independent variable was current depression.
[c] During the past 12 months.

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Table 3
Logistic regression. Independent variable work-related asthma (yes/no).

Dependent variable	Current depression	No current depression
Very poorly controlled asthma	1.30; 0.38–1.32	1.32; 0.96–1.81
Asthma attack[a]	1.21; 1.07–1.37	1.30; 1.08–1.55
Urgent treatment for worsening asthma[a]	1.31; 0.89–1.91	1.65; 1.21–2.24
Asthma-related emergency room visit[a]	1.79; 1.09–2.93	1.39; 0.77–2.49
Asthma-related hospitalization[a]	1.40; 0.58–3.35	2.81; 1.37–5.74
Unable to work or carry out usual activities 1–13 days[a]	1.55; 1.01–2.39	1.19; 0.86–1.66
Unable to work or carry out usual activities ≥14 days[a]	1.27; 0.82–1.98	2.85; 1.67–4.86
Changed/quit job due to asthma	2.90; 1.92–4.38	6.03; 4.13–8.80

Results: Prevalence ratios (PRs) adjusted for age, sex, race/ethnicity, education, employment, annual household income, and smoking status; 95% CI.
PR represents the probability of a person with work-related asthma having an adverse asthma outcome as compared with a person with non-work-related asthma.
[a] During the past 12 months.

to determine the association of WRA with current depression and the effect of current depression on the association of WRA with adverse asthma outcomes. Overall, the estimated proportion of current depression in ever-employed adults with current asthma was 17.0%; nearly twice the prevalence of current depression reported for the general U.S. adult population (9.0%) (CDC, 2010). The proportion of current depression in adults with WRA (27.6%) was over three times that in the general U.S. adult population. Compared to those with non-WRA, persons with WRA were 1.6 times more likely to have current depression. Furthermore, we found that WRA is associated with adverse asthma outcomes regardless of the depression status which suggests that other factors such as medical (e.g., increased severity of WRA), behavioral (e.g., non-compliance with treatment), or environmental (e.g., persistence of the workplace exposure) factors may be associated with adverse asthma outcomes and decrease asthma control. Finally, the associations with adverse asthma outcomes were stronger when both WRA and current depression were present.

Results of our study are consistent with previous research on the presence of depression among persons with asthma and the effect of depression on asthma outcomes (Lavoie et al., 2005; Miedinger et al., 2011; Strine et al., 2008a; ten Brinke et al., 2005; Yacoub et al., 2007). Based on a structured psychiatric interview of asthma patients presenting to an asthma clinic, Lavoie et al. (2005) found that 15% of patients had major depression and 5% had minor depression. Strine et al. (2008a) demonstrated that among persons with asthma, current depression is associated with more severe disease, more frequent visits to the emergency room and health care providers, increased inability to work or carry out usual activities, and decreased asthma control. Similarly, ten Brinke et al. (2005) reported that frequent exacerbations in difficult-to-treat asthma patients were associated with psychological dysfunctioning. Yacoub et al. (2007) assessed psychological distress among 40 occupational asthma claimants who applied to the Workers' Compensation Agency of Quebec for assessment of occupational asthma. The authors found that 47.5% of participants had a clinically significant level of depression including 7.5% with major depression.

WRA has been associated with reduction in income, increased healthcare utilization, adverse emotional and social functioning, and impaired quality of life that persists after removal from the workplace (Miedinger et al., 2011; Tarlo et al., 2008; Vandenplas et al., 2003; Yacoub et al., 2007). Workers who develop WRA may need to change jobs or the activities conducted in the same job, may become unemployed, may develop functional limitations at work, or may require the use of assistive devices while remaining in the same job (Harber, 2009; Toren et al., 2009). These factors can explain, in part, the fact that persons with WRA are more likely to develop depression.

The findings of this report are subject to some limitations. Information on asthma and depression are self-reported and are not validated by medical records or follow up with health care providers, thus estimates may be subject to misclassification bias. Adverse asthma outcomes may be under- or overestimated due to recall bias. Also, the levels of asthma control in this study do not include objective measures of

Table 4
Logistic regression. Models with independent variables WRA alone, current depression alone, or WRA and current depression.

Dependent variable	Current depression alone	WRA alone	Current depression and WRA
Very poorly controlled asthma	1.59; 1.25–2.02	1.31; 0.96–1.78	2.22; 1.54–3.21
Asthma attack[a]	1.42; 1.25–1.62	1.30; 1.09–1.55	1.79; 1.56–2.05
Urgent treatment for worsening asthma[a]	1.28; 0.96–1.70	1.68; 1.22–2.30	1.88; 1.25–2.82
Asthma-related emergency room visit[a]	1.38; 0.96–1.98	1.46; 0.83–2.57	2.29; 1.29–4.07
Asthma-related hospitalization[a]	2.98; 1.70–5.20	–	–
Unable to work or carry out usual activities 1–13 days[a]	0.99; 0.72–1.35	1.20; 0.86–1.68	1.71; 1.11–2.63
Unable to work or carry out usual activities ≥14 days[a]	2.95; 2.10–4.13	2.78; 1.64–4.68	4.20; 2.43–7.25
Change/quit job due to asthma	2.42; 1.50–3.91	6.04; 4.10–8.91	6.28; 3.70–10.67

Results: Prevalence ratios adjusted for age, sex, race/ethnicity, education, employment, annual household income and smoking status; 95% CI.
Prevalence ratios from the multivariable logistic regression model examining four disjoint categories of WRA and current depression (i.e., WRA alone, current depression alone, WRA and current depression, and no WRA or depression as a referent category).
"–" indicates that relative standard error for the estimate >30%; estimate not reported.
[a] During the past 12 months.

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lung function such as spirometry or peak flow measures or information on activity limitation as recommended in the EPR-3 (NHLBI, 2007). Therefore, the proportion of very poorly controlled asthma is likely to be underestimated. Moreover, in 2006 and 2008 the surveys queried only persons with landline telephone access and did not include persons who resided in households that lacked a landline telephone and persons who only used cellular telephones. A recent study showed that adults using cellular telephones only were more likely to have an unmet need for medical care and were less likely to have any kind of health-care coverage and to use preventive health care services (Hu et al., 2011) suggesting that current depression is likely to be underestimated. Finally, persons with severe depression may be less likely to participate in the surveys, thus the results might underestimate the actual prevalence of current depression.

To the best of our knowledge, this is the first study examining the relationship between WRA and current depression in the United States. Clinicians should be aware of the potential risk for poorer asthma control and increased utilization of emergency health services among persons with WRA and current depression. These results indicate that a large proportion of ever-employed adults with WRA could benefit from mental health screening and implementation of optimized treatment similar to models developed for patients with depression and other chronic illnesses (Ford, 2008).

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Conflict of interest

Jacek M. Mazurek, Gretchen E. Knoeller, and Jeanne E. Moorman have no financial relationships with commercial interests.

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References

Aromaa, A., Raitasalo, R., Reunanen, A., Impivaara, O., Heliovaara, M., Knekt, P., Lehtinen, V., Joukamaa, M., Maatela, J., 1994. Depression and cardiovascular diseases. Acta Psychiatrica Scandinavica. Supplementum 377, 77–82.

Balmes, J., Becklake, M., Blanc, P., Henneberger, P., Kreiss, K., Mapp, C., Milton, D., Schwartz, D., Toren, K., Viegi, G., 2003. American Thoracic Society statement: occupational contribution to the burden of airway disease. American Journal of Respiratory and Critical Care Medicine 167 (5), 787–797.

Centers for Disease Control and Prevention (CDC), 2010. Current depression among adults—United States, 2006 and 2008. MMWR. Morbidity and Mortality Weekly Report 59 (38), 1229–1235.

Di Marco, F., Santus, P., Centanni, S., 2011. Anxiety and depression in asthma. Current Opinion in Pulmonary Medicine 17 (1), 39–44.

Druss, B.G., Rosenheck, R.A., Sledge, W.H., 2000. Health and disability costs of depressive illness in a major U.S. corporation. The American Journal of Psychiatry 157 (8), 1274–1278.

Ford, D.E., 2008. Optimizing outcomes for patients with depression and chronic medical illnesses. American Journal of Medicine 121 (11 Suppl. 2), S38–S44.

Gonzales Barcala, F.J., La Fuente-Cid, R.D., varez-Gil, R., Tafalla, M., Nuevo, J., Caamano-Isorna, F., 2011. Factors associated with a higher prevalence of work disability among asthmatic patients. The Journal of Asthma 48 (2), 194–199.

Goodwin, R.D., Jacobi, F., Thefeld, W., 2003. Mental disorders and asthma in the community. Archives of General Psychiatry 60 (11), 1125–1130.

Harber, P., 2009. Respiratory disability: what is it, how can we measure it, what causes it and is it important? Thorax 64 (4), 280–282.

Hu, S.S., Balluz, L., Battaglia, M.P., Frankel, M.R., 2011. Improving public health surveillance using a dual-frame survey of landline and cell phone numbers. American Journal of Epidemiology 173 (6), 703–711.

Hurwitz, E.L., Morgenstern, H., 1999. Cross-sectional associations of asthma, hay fever, and other allergies with major depression and low-back pain among adults aged 20–39 years in the United States. American Journal of Epidemiology 150 (10), 1107–1116.

Katon, W.J., Richardson, L., Lozano, P., McCauley, E., 2004. The relationship of asthma and anxiety disorders. Psychosomatic Medicine 66 (3), 349–355.

Katon, W., Lin, E.H., Kroenke, K., 2007. The association of depression and anxiety with medical symptom burden in patients with chronic medical illness. General Hospital Psychiatry 29 (2), 147–155.

Kessler, R.C., Ormel, J., Demler, O., Stang, P.E., 2003. Comorbid mental disorders account for the role impairment of commonly occurring chronic physical disorders: results from the National Comorbidity Survey. Journal of Occupational and Environmental Medicine 45 (12), 1257–1266.

Kessler, R., White, L.A., Birnbaum, H., Qiu, Y., Kidolezi, Y., Mallett, D., Swindle, R., 2008. Comparative and interactive effects of depression relative to other health problems on work performance in the workforce of a large employer. Journal of Occupational and Environmental Medicine 50 (7), 809–816.

Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. Journal of General Internal Medicine 16 (9), 606–613.

Kroenke, K., Strine, T.W., Spitzer, R.L., Williams, J.B., Berry, J.T., Mokdad, A.H., 2009. The PHQ-8 as a measure of current depression in the general population. Journal of Affective Disorders 114 (1–3), 163–173.

Lavoie, K.L., Cartier, A., Labrecque, M., Bacon, S.L., Lemiere, C., Malo, J.L., Lacoste, G., Barone, S., Verrier, P., Ditto, B., 2005. Are psychiatric disorders associated with worse asthma control and quality of life in asthma patients? Respiratory Medicine 99 (10), 1249–1257.

Miedinger, D., Lavoie, K.L., L'archeveque, J., Ghezzo, H., Zunzunuegui, M.V., Malo, J.L., 2011. Quality-of-life, psychological, and cost outcomes 2 years after diagnosis of occupational asthma. Journal of Occupational and Environmental Medicine 53 (3), 231–238.

Moorman, J.E., Rudd, R.A., Johnson, C.A., King, M., Minor, P., Bailey, C., Scalia, M.R., Akinbami, L.J., 2007. National surveillance for asthma—United States, 1980–2004. MMWR. Surveillance Summaries 56 (8), 1–54.

National Center for Health Statistics, 2009. Summary Health Statistics for U.S. Adults: National Health Interview Survey, 2009. Series 10: Data from the National Health Interview Survey, No. 249. DHHS Publication No. (PHS) 2011–1577.

National Heart, Lung, and Blood Institute (NHLBI), 2007. National Asthma Education and Prevention Program Expert Panel Report 3 (EPR3): Guidelines for the Diagnosis and Management of Asthma. . Bethesda, MD: NHLBI; 2007. Available at: http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm. Accessed August 22, 2011.

Oraka, E., King, M.E., Callahan, D.B., 2010. Asthma and serious psychological distress: prevalence and risk factors among US adults, 2001–2007. Chest 137 (3), 609–616.

Scott, K.M., Von Korff, M., Ormel, J., Zhang, M.Y., Bruffaerts, R., Alonso, J., Kessler, R.C., Tachimori, H., Karam, E., Levinson, D., Bromet, E.J., Posada-Villa, J., Gasquet, I., Angermeyer, M.C., Borges, G., de Girolamo, G., Herman, A., Haro, J.M., 2007. Mental disorders among adults with asthma: results from the World Mental Health Survey. General Hospital Psychiatry 29 (2), 123–133.

Solis, O.L., Khan, D.A., Brown, E.S., 2006. Age at onset of major depression in inner-city adults with asthma. Psychosomatics 47 (4), 330–332.

Stein, M.B., Cox, B.J., Afifi, T.O., Belik, S.L., Sareen, J., 2006. Does co-morbid depressive illness magnify the impact of chronic physical illness? A population-based perspective. Psychological Medicine 36 (5), 587–596.

Strine, T.W., Mokdad, A.H., Balluz, L.S., Gonzalez, O., Crider, R., Berry, J.T., Kroenke, K., 2008a. Depression and anxiety in the United States: findings from the 2006 Behavioral Risk Factor Surveillance System. Psychiatric Services 59 (12), 1383–1390.

Strine, T.W., Mokdad, A.H., Balluz, L.S., Berry, J.T., Gonzalez, O., 2008b. Impact of depression and anxiety on quality of life, health behaviors, and asthma control among adults in the United States with asthma, 2006. The Journal of Asthma 45 (2), 123–133.

Tarlo, S.M., Balmes, J., Balkissoon, R., Beach, J., Beckett, W., Bernstein, D., Blanc, P.D., Brooks, S.M., Cowl, C.T., Daroowalla, F., Harber, P., Lemiere, C., Liss, G.M., Pacheco, K.A., Redlich, C.A., Rowe, B., Heitzer, J., 2008. Diagnosis and management of work-related asthma: American College Of Chest Physicians Consensus Statement. Chest 134 (3 Suppl.), 1S–41S.

ten Brinke, A., Sterk, P.J., Masclee, A.A.M., Spinhoven, P., Schmidt, J.T., Zwinderman, A.H., Rabe, K.F., Bel, E.H., 2005. Risk factors of frequent exacerbations in difficult-to-treat asthma. European Respiratory Journal 26 (5), 812–818.

Thompson, M.L., Myers, J.E., Kriebel, D., 1998. Prevalence odds ratio or prevalence ratio in the analysis of cross sectional data: what is to be done? Occupational and Environmental Medicine 55 (4), 272–277.

Toren, K., Zock, J.P., Kogevinas, M., Plana, E., Sunyer, J., Radon, K., Jarvis, D., Kromhout, H., d'Errico, A., Payo, F., Anto, J.M., Blanc, P.D., 2009. An international prospective general population-based study of respiratory work disability. Thorax 64 (4), 339–344.

Van Lieshout, R.J., Macqueen, G., 2008. Psychological factors in asthma. Allergy, Asthma and Clinical Immunology 4 (1), 12–28.

Van Lieshout, R.J., Bienenstock, J., MacQueen, G.M., 2009. A review of candidate pathways underlying the association between asthma and major depressive disorder. Psychosomatic Medicine 71 (2), 187–195.

Vandenplas, O., Toren, K., Blanc, P.D., 2003. Health and socioeconomic impact of work-related asthma. European Respiratory Journal 22 (4), 689–697.

Wertz, D.A., Pollack, M., Rodgers, K., Bohn, R.L., Sacco, P., Sullivan, S.D., 2010. Impact of asthma control on sleep, attendance at work, normal activities, and disease burden. Annals of Allergy, Asthma & Immunology 105 (2), 118–123.

Williams, S.A., Wagner, S., Kannan, H., Bolge, S.C., 2009. The association between asthma control and health care utilization, work productivity loss and health-related quality of life. Journal of Occupational and Environmental Medicine 51 (7), 780–785.

Yacoub, M.R., Lavoie, K., Lacoste, G., Daigle, S., L'Archeveque, J., Ghezzo, H., Lemiere, C., Malo, J.L., 2007. Assessment of impairment/disability due to occupational asthma through a multidimensional approach. European Respiratory Journal 29 (5), 889–896.

Zheng, D., Macera, C.A., Croft, J.B., Giles, W.H., Davis, D., Scott, W.K., 1997. Major depression and all-cause mortality among white adults in the United States. Annals of Epidemiology 7 (3), 213–218.

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