Work-related Asthma, Financial Barriers to Asthma Care, and Adverse Asthma Outcomes

Asthma Call-back Survey, 37 States and District of Columbia, 2006 to 2008

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Background: Proper asthma management and control depend on patients having affordable access to healthcare yet financial barriers to asthma care are common.

Objective: To examine associations of work-related asthma (WRA) with financial barriers to asthma care and adverse asthma outcomes.

Research Design: Cross-sectional, random-digit-dial survey conducted in 37 states and District of Columbia.

Subjects: A total of 27,927 ever-employed adults aged ≥ 18 years with current asthma.

Measures: Prevalence ratios (PR) for the associations of WRA with financial barriers to asthma care and of WRA with adverse asthma outcomes stratified by financial barriers.

Results: Persons with WRA were significantly more likely than those with non-WRA to have at least 1 financial barrier to asthma care [PR, 1.66; 95% confidence interval (CI), 1.43–1.92]. Individuals with WRA were more likely to experience adverse asthma outcomes such as asthma attack (PR, 1.31; 95% CI, 1.22–1.40), urgent treatment for worsening asthma (PR, 1.57; 95% CI, 1.39–1.78), asthma-related emergency room visit (PR, 1.69; 95% CI, 1.41–2.03), and very poorly controlled asthma (PR, 1.54; 95% CI: 1.36–1.75). After stratifying for financial barriers to asthma care, the associations did not change.

Conclusions: Financial barriers to asthma care should be considered in asthma management, and individuals with WRA are more likely to experience financial barriers. However, individuals with WRA are more likely to experience adverse asthma outcomes than individuals with non-WRA, regardless of financial barriers. Additional studies are needed to identify medical, behavioral, occupational, or environmental factors associated with adverse asthma outcomes among individuals with WRA.

Key Words: asthma, occupational health, emergency department, healthcare costs

(*Med Care* 2011;49: 1097–1104)

The prevalence of asthma has been increasing in recent years[1] with more than 17.5 million United States adults estimated to have current asthma in 2009.[2] The effect of the increase in asthma prevalence is a substantial burden to the healthcare system. In 2007, adult asthma resulted in an average annual 7.2 million physician visits, 1.1 million emergency department visits, 600,000 hospital outpatient department visits, 299,000 hospitalizations, and 3262 deaths.[3]

A distinct subgroup among persons with asthma is asthma that is caused or exacerbated by conditions at work. Work-related asthma (WRA) is asthma associated with the workplace environment and includes occupational asthma that is asthma caused by factors related to work or the workplace environment and work-exacerbated asthma that is preexisting or concurrent asthma worsened by factors related to work or the workplace environment.[4] On the basis of a review of published studies, the American Thoracic Society estimated that 15% of adult asthma (range, 4%–58%) is attributable to workplace exposures.[5] WRA shares many of the pathologic and clinical features with its nonoccupational counterpart, making it difficult to determine the work-relatedness of the disease.[6] However, individuals with WRA have more frequent doctor and emergency room visits for worsening asthma than individuals with non-WRA.[7,8] In addition, WRA is associated with increased mortality, disability, and adverse social and economic outcomes such as loss of income and employment.[9–15]

Proper asthma control depends on various factors, one of them being affordable access to healthcare.[16] However, difficulties in affording asthma care are common.[17] In 2007, it was estimated that approximately 10% (30 million persons) of the US civilian noninstitutionalized population was unable to receive or delayed in receiving needed medical care, dental care, or prescription medication.[18] A Healthy People 2020 objective, Access to Health Services-6, seeks to reduce this proportion.[19] Such difficulties in obtaining

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The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

The authors declare no conflict of interest.

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ISSN: 0025-7079/11/4912-1097

necessary medical care and prescription medication may be because of financial barriers. A recent study using the 2006 and 2007 Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey (ACBS) found that an estimated 12.7% of adults with asthma in New England experienced financial barriers to asthma care in the past 12 months.[20] Financial barriers to care have been shown to result in increased utilization of acute care services due to underuse of medications.[21–24] Individuals with asthma who have inadequate access to medical care may experience treatment delays and deterioration of their asthma leading to increased use of emergency departments.[25]

To date, there is limited information on financial barriers to asthma care and their impact on adverse asthma outcomes for individuals with WRA. The ACBS provided a unique opportunity to address this issue. Using data from the 2006 to 2008 ACBS for adults in 37 states and District of Columbia (DC), we examined associations of WRA with financial barriers to asthma care and adverse asthma outcomes in persons experiencing financial barriers.

METHODS

BRFSS is an ongoing, state-based, random-digit-dialed telephone survey of the noninstitutionalized US civilian population aged ≥ 18 years that collects information on health risk behaviors, preventive health practices, and healthcare access.[26] During 2006–2008, BRFSS respondents in 37 states and DC who responded "yes" to the question, "Have you ever been told by a doctor, nurse, or other health professional that you had asthma?" were eligible to participate in the ACBS. The ACBS collects information on asthma including disease history, healthcare utilization, financial barriers to asthma care, and disease work-relatedness.[27] The BRFSS has a surveillance exemption from Institutional Review Board review at the Centers for Disease Control and Prevention. Participating states are subject to state-specific Institutional Review Board requirements. Among the states and DC conducting the ACBS, the median Council of American Survey and Research Organizations response rate was 48.6%, 47.6%, and 50.3% in 2006, 2007, and 2008, respectively, for BRFSS and 53.1%, 54.3%, and 50.6% in 2006, 2007, and 2008, respectively, for ACBS.

We defined current asthma as a "yes" response to the question, "Do you still have asthma?". We defined ACBS respondents as being ever-employed if they responded "employed full-time" or "employed part-time" when describing their current employment status or 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 WRA.

Respondents who experienced financial barriers to asthma care were identified using positive responses to 3 questions: (1) "Was there a time in the past 12 months when you needed to see your primary care doctor for your asthma but could not because of the cost?"; (2) "Was there a time in the past 12 months when you were referred to a specialist for asthma care but could not go because of the cost?"; and (3) "Was there a time in the past 12 months when you needed to buy medication for your asthma, but could not because of the cost?" To determine whether respondents experienced adverse asthma outcomes, we used "yes" responses to the questions: "During the past 12 months, have you had an episode of asthma or an asthma attack?", "During the past 12 months, have you had to visit an emergency room or urgent care center because of your asthma?", and "During the past 12 months, have you had to stay overnight in a hospital because of your asthma?" We also used a response of ≥ 1 time for the question, "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?" to indicate an adverse asthma outcome.

The Expert Panel Report 3 (EPR-3): Guidelines for the Diagnosis and Management of Asthma Full Report defines asthma control level based on the most severe level of impairment.[28] Following these guidelines, we used ACBS participant responses to questions on asthma symptoms, night-time awakenings, and the use of rescue medication to categorize asthma control as very poorly controlled, not well controlled, or well controlled (Table 1).

During the ACBS interview, respondents reported prescription medications taken for asthma in the previous 3 months in various forms (pill, syrup, inhaler, and nebulizer). We used this information to assess the mean number of prescription medications taken for asthma.

Statistical Analyses

We used SAS software version 9.2 (SAS Institute Inc., Cary, NC) survey procedures and SUDAAN release 10.0.1

TABLE 1. Classification of Asthma Control in Adults Using the Asthma Call-back Survey

	Well Controlled	Not Well Controlled	Very Poorly Controlled
Symptoms*	≤ 8 d in the past 30 d	>8 d in the past 30 d but not throughout the day	Every day in the past 30 d and throughout the day
Night-time awakenings†	≤ 2 times in the past 30 d	≥ 3 and ≤ 12 times in the past 30 d	≥ 13 times in the past 30 d
Rescue medication‡	≤ 0.29 uses per day	>0.29 and <2.00 uses per day	≥ 2.00 uses per day

The asthma control level is based on the most severe impairment category.

*Symptoms were determined based on the response to the question "During the past 30 days, how many days did you have any symptoms of asthma?"

†Night-time awakenings were determined based on the response to the question, "During the past 30 days, how many days did symptoms of asthma make it difficult for you to stay asleep?"

‡Frequency of inhaler rescue medication (not nebulizer) uses per day or per week for all reported rescue medications taken in the last 3 months was converted to the number of uses per day and summed. Rescue medications used only for treatment before exercise were excluded.

software (Research Triangle Institute, Research Triangle Park, NC) for analyses. We weighted data to account for nonresponse differences in the sample and the unequal probability of sample selection. Data from 2006, 2007, and 2008 for each of the 32 states (Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, Ohio, Oklahoma, Oregon, Texas, Utah, Vermont, Washington, West Virginia, and Wisconsin) and DC participating in the ACBS during multiple years were combined to ensure sufficient sample sizes. For these states, weights were established by multiplying the proportion of subjects in each survey year by the corresponding survey year's weight. For 5 states (New Jersey, North Dakota, Pennsylvania, Rhode Island, and Virginia) participating in the ACBS during 1 year only, unaltered weights for that year were used. Sampled persons who did not have current asthma, were never employed, and had missing data on asthma or employment were included in the standard error computations. Estimates with a relative standard error >30% are not reported.

We used univariate logistic regression to calculate unadjusted prevalence ratios (PRs) for the associations between WRA and selected characteristics. We performed a *t* test to compare the mean number of prescription medications taken for asthma by individuals with WRA and non-WRA. We used multivariate logistic regression to calculate PRs adjusted a priori for age (continuous), sex, race/ethnicity, education, and health insurance status for the association between WRA and financial barriers to asthma care. We did not adjust for income because of the strong association of income with both financial barriers and health insurance status. In addition, income had a large proportion of missing values (9.1%). Next, we examined the association of WRA with adverse asthma outcomes and asthma control level (dependent variables) among all ever-employed adults with current asthma, those with at least 1 financial barrier to asthma care, and those with no financial barrier. All 3 analyses included WRA, age, sex, race/ethnicity, education, and health insurance status as the independent variables.

Some respondents indicated that their asthma may be associated with workplace exposures (ie, positively responded to any of the 4 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?"). Because of potential misclassification of WRA status, we performed separate analyses examining the associations of WRA with adverse asthma outcomes and asthma control level excluding these respondents.

RESULTS

A total of 41,054 adults were interviewed (10,802 in 2006, 15,245 in 2007, and 15,007 in 2008). Of these, 11,207 did not have current asthma, 800 were never employed, and 1120 had missing data on asthma or employment status. The remaining 27,927 respondents (representing an estimated 16 million in these 37 states and DC) were ever-employed adults with current asthma and were included in the analyses. Selected demographic and clinical characteristics of the study population are shown in Table 2.

An estimated 8.6% of ever-employed adults with current asthma have WRA. Ever-employed adults with WRA were significantly more likely than those with non-WRA to be aged 45–64 years, identify as non-Hispanic black, have a high school education or less, have annual household income <$25,000 or $25,000 to $49,999, to be uninsured, to be not currently employed, and have very poorly controlled asthma. Individuals with WRA were significantly more likely than those with non-WRA to experience adverse asthma outcomes (Table 2). Individuals with WRA also used significantly more prescription medications for asthma in the past 3 months than individuals with non-WRA (1.5 vs. 1.3; $P < 0.001$) (data not shown).

An estimated 18.7% [95% confidence interval (CI), 17.6%–19.8%] of ever-employed adults with current asthma had at least 1 financial barrier to asthma care: 9.1% (95% CI, 8.3%–9.8%) had only one financial barrier, 5.6% (95% CI, 4.9%–6.4%) had any 2 financial barriers, and 4.0% (95% CI, 3.4%–4.6%) had all 3 financial barriers (data not shown). Adults with at least 1 financial barrier to asthma care were significantly more likely than those without any financial barrier to be aged 18–64 years, to be female, to be non-Hispanic black or Hispanic, have a high school education or less, have annual household income <$25,000 or $25,000 to $49,999, to be uninsured, to be not currently employed, have very poorly controlled asthma, and have adverse asthma outcomes (Table 3).

Individuals with WRA were significantly more likely than those with non-WRA to be unable to see a primary care doctor for asthma, unable to see a specialist for asthma, and unable to buy asthma medication in the past 12 months because of the cost (Table 4).

Results from the multivariate analyses are shown in Table 5. Among ever-employed adults with current asthma, individuals with WRA were more likely than individuals with non-WRA to have adverse asthma outcomes and very poorly controlled asthma. When stratified for presence of at least 1 financial barrier to asthma care, associations between WRA and adverse asthma outcomes remained.

Approximately 37.9% of the ever-employed adults with current asthma did not have health professional-diagnosed WRA but indicated that their asthma may be associated with workplace exposures. After excluding these respondents, repeated multivariate analyses produced similar results with slightly stronger associations of WRA with adverse asthma outcomes and asthma control level (data not shown).

DISCUSSION

In the 37 states and DC participating in the ACBS, nearly 20% of ever-employed adults with current asthma had at least 1 financial barrier to asthma care in the past 12 months.

TABLE 2. Characteristics of Ever-employed Adults With Current Asthma by WRA Status

				WRA					
		Total		Yes		No		Univariate Model	
Characteristics	No. Sample*	%†	95% CI	%	95% CI	%	95% CI	PR‡	95% CI
Age group (y)									
18–44	7384	50.3	48.8–51.8	36.2	31.9–40.5	51.8	50.3–53.4	0.70	0.62–0.79
45–64	13,328	35.2	34.0–36.4	52.3	48.1–56.4	33.5	32.2–34.8	1.56	1.43–1.71
≥65	7103	14.5	13.8–15.2	11.5	9.7–13.4	14.7	13.9–15.4	0.79	0.66–0.93
Sex									
Male	7366	37.5	35.9–39.0	38.5	34.4–42.5	37.3	35.6–38.9	1.03	0.92–1.16
Female	20,561	62.5	61.0–64.1	61.5	57.5–65.6	62.7	61.1–64.4	0.98	0.91–1.06
Race/ethnicity									
White, non-Hispanic	23,113	75.9	74.5–77.4	69.9	65.7–74.2	76.4	74.9–78.0	0.92	0.86–0.98
Black, non-Hispanic	1456	8.0	7.2–8.8	10.9	8.2–13.6	7.8	6.9–8.6	1.41	1.06–1.86
Hispanic	1168	9.0	7.9–10.1	10.5	7.2–13.9	8.9	7.7–10.0	1.19	0.84–1.69
Other, non-Hispanic	1989	7.1	6.1–8.0	8.6	5.9–11.3	6.9	5.9–7.9	1.24	0.89–1.75
Education level									
≤High school	9836	34.0	32.6–35.5	40.0	35.9–44.1	33.3	31.8–34.9	1.20	1.07–1.34
>High school	18,069	66.0	64.5–67.4	60.0	55.9–64.1	66.7	65.1–68.2	0.90	0.84–0.97
Household income									
<$25,000	8741	28.2	26.8–29.6	37.0	32.8–41.2	27.3	25.8–28.8	1.36	1.20–1.54
$25,000–$49,999	6861	24.1	22.8–25.3	28.7	24.6–32.7	23.6	22.3–24.9	1.21	1.04–1.42
≥$50,000	9728	47.7	46.2–49.2	34.3	30.3–38.3	49.1	47.5–50.7	0.70	0.62–0.79
Health insurance									
Yes	25,383	86.9	85.6–88.1	83.3	79.4–87.1	87.2	85.9–88.5	0.96	0.91–1.00
No	2464	13.1	11.9–14.4	16.7	12.9–20.6	12.8	11.5–14.1	1.31	1.01–1.69
Employment status									
Currently employed	13,792	59.0	57.6–60.4	48.4	44.3–52.6	60.2	58.7–61.7	0.81	0.74–0.88
Not currently employed	14,114	41.0	39.6–42.4	51.6	47.4–55.7	39.8	38.3–41.3	1.30	1.18–1.42
Asthma control									
Well controlled	13,083	50.3	48.8–51.7	39.1	34.9–43.2	51.4	49.9–53.0	0.76	0.68–0.85
Not well controlled	7178	26.8	25.5–28.1	24.4	21.1–27.7	27.1	25.7–28.5	0.90	0.78–1.04
Very poorly controlled	7658	22.9	21.8–24.1	36.5	32.5–40.6	21.5	20.3–22.6	1.70	1.50–1.93
Adverse asthma outcomes									
Asthma attack in past 12 mo	14,346	51.2	49.7–52.7	65.2	61.2–69.2	49.8	48.2–51.4	1.31	1.22–1.40
Urgent treatment for worsening asthma	6667	23.4	22.3–24.6	36.1	32.0–40.1	22.2	21.0–23.4	1.62	1.43–1.84
Asthma-related emergency room visit	3234	11.6	10.8–12.5	19.6	16.4–22.8	10.8	9.9–11.7	1.81	1.51–2.17
Overnight stay in hospital because of asthma	1114	3.3	2.9–3.7	6.9	5.0–8.8	3.0	2.6–3.4	2.32	1.70–3.17
Total	27,927								

*Categories do not sum to total due to item nonresponse.
†Weighted average annual estimate.
‡For each model, the outcome variable was the individual characteristic and the predictor variable was WRA.
CI indicates confidence interval; PR, prevalence ratios; WRA, work-related asthma.

Higher proportions of individuals with at least 1 financial barrier to asthma care had not well controlled and very poorly controlled asthma compared with those without financial barriers. Canino et al[16] reported that asthma control depends on patients having affordable access to healthcare. The authors discussed that the presence of financial barriers may diminish access to medication and preventive management of asthma, particularly among disadvantaged groups.[16] Even with health insurance, the copayments for some insurance plans may be a financial burden for workers with lower incomes.[29,30] The inability of adults with asthma to afford healthcare and medication has been previously associated with increased emergency room visits and hospitalizations.[16,25,31–34]

In recent years, attention has been given to value-based health insurance designs where barriers to high-value treatments are reduced through lowered cost to patients. Research has shown that when barriers are decreased, patient adherence to recommended treatments increases and employers potentially experience cost-saving benefits. However, evidence on the benefits of decreasing costs of asthma treatment is conflicting and to our knowledge, there is no available research on value-based insurance benefits and WRA.[35–38]

There is evidence that asthma prevalence differs by race and ethnicity.[1,39,40] In addition, research shows that racial/ethnic minorities are more likely to have asthma-related urgent treatment, emergency room visits, and hospitalizations than non-Hispanic whites.[41,42] Everage et al[43] hypothesized that such racial/ethnic disparities in asthma-related healthcare utilization are unlikely to be affected by factors related to healthcare access alone. We found that individuals with WRA were less likely to be non-Hispanic whites than individuals with non-WRA. This may be due to a number of factors such as racial/ethnic differences in occupations and exposures that may lead to WRA. However, there is little in the literature that directly examines the impact of race/ethnicity on work-related outcomes of patients with asthma.[43]

TABLE 3. Characteristics of Ever-employed Adults With Current Asthma by Presence of Financial Barriers to Asthma Care

	At Least 1 Financial Barrier to Asthma Care*		No Financial Barriers to Asthma Care		Univariate Model	
Characteristics	**%**[†]	**95% CI**	**%**	**95% CI**	**PR**[‡]	**95% CI**
Age group (y)						
18–44	54.7	51.5–57.9	49.3	47.7–51.0	1.11	1.04–1.19
45–64	38.6	35.6–41.6	34.4	33.0–35.8	1.12	1.03–1.23
≥ 65	6.7	5.6–7.8	16.2	15.4–17.1	0.41	0.35–0.49
Sex						
Male	28.0	24.5–31.4	39.6	37.9–41.4	0.71	0.62–0.81
Female	72.0	68.6–75.5	60.4	58.6–62.1	1.19	1.13–1.26
Race/ethnicity						
White, non-Hispanic	65.4	61.9–69.0	78.3	76.7–79.9	0.84	0.79–0.89
Black, non-Hispanic	12.7	10.3–15.1	7.0	6.2–7.8	1.82	1.45–2.29
Hispanic	13.4	10.0–16.7	8.0	6.9–9.1	1.67	1.26–2.23
Other, non-Hispanic	8.5	6.9–10.0	6.7	5.6–7.9	1.26	0.98–1.61
Education level						
≤High school	48.5	45.1–51.8	30.8	29.2–32.4	1.58	1.44–1.72
>High school	51.5	48.2–54.9	69.2	67.6–70.8	0.74	0.69–0.80
Household income						
< $25,000	52.5	48.9–56.0	22.6	21.1–24.1	2.32	2.11–2.55
$25,000–$49,999	30.8	27.1–34.4	22.5	21.3–23.8	1.37	1.20–1.56
≥ $50,000	16.8	14.5–19.0	54.9	53.2–56.5	0.31	0.27–0.35
Health insurance						
Yes	60.5	57.1–63.8	92.9	91.7–94.2	0.65	0.61–0.69
No	39.5	36.2–42.9	7.1	5.8–8.3	5.58	4.57–6.81
Employment status						
Currently employed	52.2	48.9–55.5	60.6	59.0–62.1	0.86	0.81–0.92
Not currently employed	47.8	44.5–51.1	39.4	37.9–41.0	1.21	1.12–1.31
Asthma control§						
Well controlled	29.6	26.5–32.8	55.0	53.4–56.6	0.54	0.48–0.60
Not well controlled	33.1	29.7–36.4	25.4	24.0–26.7	1.30	1.16–1.46
Very poorly controlled	37.3	34.3–40.4	19.6	18.4–20.8	1.90	1.72–2.11
Adverse asthma outcomes						
Asthma attack in past 12 mo	70.2	67.2–73.2	46.8	45.2–48.5	1.50	1.42–1.59
Urgent treatment for worsening asthma	35.2	32.1–38.4	20.7	19.5–21.9	1.70	1.53–1.90
Asthma-related emergency room visit	23.0	20.3–25.7	9.0	8.2–9.8	2.56	2.20–2.97
Overnight stay in hospital because of asthma	7.2	5.8–8.7	2.4	2.1–2.8	2.95	2.29–3.80

*See Table 4 for criteria defining "At least 1 financial barrier to asthma care".
[†]Average annual estimate.
[‡]For each model, the outcome variable was the individual characteristic and the predictor variable was at least 1 financial barrier to asthma care.
[§]Asthma control based on definitions in Table 1.
CI indicates confidence interval; PR, prevalence ratios.

Age differences among individuals with WRA and non-WRA may be due to multiple factors[44] including duration of exposure and physiology.[45] Individuals with WRA are also more likely to have low annual household income, no health insurance, and to be currently unemployed. Because of the cross-sectional design of the ACBS, we were not able to determine whether individuals with WRA had low income occupations with potential workplace exposures before being diagnosed with WRA or they had lower incomes as a result of changing or losing their job after being diagnosed with WRA.[44]

When examining the differences in financial barriers to asthma care among individuals with WRA and non-WRA, individuals with WRA were more likely to have experienced at least 1 financial barrier to asthma care than individuals with non-WRA. In addition, results show that individuals with WRA are more likely to have an annual household income < $25,000 than individuals with non-WRA. This suggests that individuals with WRA may experience more financial barriers because of their lower income relative to those with non-WRA. In addition, individuals with low income are more likely to be uninsured than individuals with an income ≥ $50,000 (PR range, 3.6–6.5) (data not shown).

Over a quarter of adults with WRA were unable to buy asthma medication because of the cost. This may lead to adverse asthma outcomes because adults with asthma who cannot afford medication do not buy medication or take less than the recommended dose to prevent asthma symptoms.[46] Moreover, individuals with WRA use a greater number of prescription medications for asthma than individuals with non-WRA. Additional studies should examine prescription asthma medication use among individuals with and without WRA such as the frequency of use and cost of prescription medications.

In this analysis, individuals with WRA were more likely to have asthma attacks, urgent treatment for worsening asthma, asthma-related emergency room visits, and asthma-related hospitalizations than individuals with non-WRA. After

TABLE 4. Estimated Proportion of Individuals With Financial Barriers to Asthma Care by WRA Status

	WRA		Non-WRA			
Financial Barrier to Asthma Care	**%***	**95% CI**	**%**	**95% CI**	**PR†**	**95% CI**
Unable to see primary care doctor for asthma because of cost‡	20.0	16.5–23.4	9.8	8.8–10.8	1.77	1.43–2.19
Unable to see specialist for asthma because of cost§	15.2	11.8–18.5	5.1	4.4–5.8	2.49	1.93–3.20
Unable to buy medication for asthma because of cost‖	26.0	22.2–29.8	14.6	13.5–15.7	1.63	1.38–1.93
At least one financial barrier to asthma care¶	31.3	27.4–35.2	17.4	16.3–18.6	1.66	1.43–1.92
One financial barrier to asthma care#	12.3	10.0–14.5	8.7	7.9–9.5	1.41	1.13–1.76
Two financial barriers to asthma care**	8.4	5.7–11.1	5.3	4.6–6.1	1.41	1.00–1.99
Three financial barriers to asthma care††	10.6	7.8–13.4	3.3	2.8–3.9	2.65	1.93–3.65

*Average annual estimate.
†PR represents the probability of having a financial barrier to asthma care as compared with not having a financial barrier to asthma care. In the model, the outcome variable was financial barrier to asthma care and the predictor variables were WRA, age, sex, race/ethnicity, education, and health insurance status.
‡Responded "yes" to: "Was there a time in the past 12 months when you needed to see your primary care doctor for your asthma but could not because of the cost?"
§Responded "yes" to: "Was there a time in the past 12 months when you were referred to a specialist for asthma care but could not go because of the cost?"
‖Responded "yes" to: "Was there a time in the past 12 months when you needed to buy medication for your asthma, but could not because of the cost?"
¶Responded "yes" to at least 1 question in footnotes ‡, §, and ‖.
#Responded "yes" to only 1 question in footnotes ‡, §, and ‖.
**Responded "yes" to any 2 questions in footnotes ‡, §, and ‖.
††Responded "yes" to all 3 questions in footnotes ‡, §, and ‖.
CI indicates confidence interval; PR, prevalence ratios; WRA, work-related asthma.

stratifying for financial barriers to asthma care, the associations remained indicating that WRA is associated with increased adverse outcomes regardless of financial barriers to asthma care. These results are consistent with previous studies showing that individuals with WRA have higher healthcare utilization than individuals with non-WRA.[7,8] However, results indicate that financial barriers to asthma care modify the association of WRA with asthma-related hospitalization where individuals without financial barriers have a stronger association of WRA with hospitalization than those with at least 1

TABLE 5. Multivariate Association of WRA With Adverse Asthma Outcomes and Level of Asthma Control

	Total*		At Least 1 Financial Barrier†		No Financial Barrier‡	
Adverse Asthma Outcomes	**PR§**	**95% CI**	**PR**	**95% CI**	**PR**	**95% CI**
Asthma attack in past 12 mo						
Non-WRA (n = 24,630)	1.00	—	1.00	—	1.00	—
WRA (n = 2749)	1.31	1.22–1.40	1.11	1.01–1.22	1.32	1.21–1.44
Urgent treatment for worsening asthma						
Non-WRA (n = 24,601)	1.00	—	1.00	—	1.00	—
WRA (n = 2740)	1.57	1.39–1.78	1.43	1.18–1.75	1.49	1.27–1.74
Asthma-related emergency room visit						
Non-WRA (n = 24,428)	1.00	—	1.00	—	1.00	—
WRA (n = 2769)	1.69	1.41–2.03	1.41	1.10–1.82	1.59	1.24–2.03
Overnight stay in hospital because of asthma						
Non-WRA (n = 24,822)	1.00	—	1.00	—	1.00	—
WRA (n = 2270)	2.06	1.52–2.79	1.32	0.83–2.11	2.24	1.51–3.32
Asthma Control	**PR**	**95% CI**	**PR**	**95% CI**	**PR**	**95% CI**
Well controlled asthma						
Non-WRA (n = 24,909)	1.00	—	1.00	—	1.00	—
WRA (n = 2777)	0.81	0.73–0.90	0.68	0.51–0.91	0.91	0.82–1.00
Not well controlled asthma						
Non-WRA (n = 24,909)	1.00	—	1.00	—	1.00	—
WRA (n = 2777)	0.92	0.79–1.06	0.83	0.64–1.07	0.92	0.77–1.09
Very poorly controlled asthma						
Non-WRA (n = 24,909)	1.00	—	1.00	—	1.00	—
WRA (n = 2777)	1.54	1.36–1.75	1.46	1.23–1.73	1.39	1.19–1.62

*Consists of 5 models where the outcome variables were adverse asthma outcomes or asthma control and the predictor variables were WRA, age, sex, race/ethnicity, education, and health insurance status.
†Consists of 5 models where the outcome variables were adverse asthma outcomes or asthma control and the predictor variables were WRA, age, sex, race/ethnicity, education, and health insurance status among ever-employed adults with least 1 financial barrier to asthma care.
‡Consists of 5 models where the outcome variables were adverse asthma outcomes or asthma control and the predictor variables were WRA, age, sex, race/ethnicity, education, and health insurance status among ever-employed adults with no financial barrier to asthma care.
§PR represents the probability of having adverse asthma outcomes measures as compared with not having adverse asthma outcomes measures.
CI indicates confidence interval; PR, prevalence ratios; WRA, work-related asthma.

financial barrier. Because of the cross-sectional nature of this study, we were unable to determine whether the hospitalization or financial barrier occurred first.

The findings of this report are subject to some limitations. First, BRFSS and ACBS rely on self-reported measures of asthma and WRA that are not validated and thus estimates may be subject to recall bias. We previously reported that if those who indicate that their asthma may be work-related are considered WRA, the proportion of asthma that is work-related may be as high as 47.5%.[44] Therefore, associations presented here are likely biased toward the null value because of potential misclassification of WRA cases. When we excluded respondents who indicated that their asthma may be associated with workplace exposures, stronger associations between WRA and financial barriers to asthma care and adverse asthma outcomes were observed. In addition, the 2006–2008 ACBS 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. Moreover, because of the cross-sectional nature of this survey, causality cannot be determined. For example, it is not clear whether financial barriers to asthma care were a cause or a consequence of emergency room visits, which have high costs.[47] Furthermore, the levels of asthma control in this study were based on EPR-3 guidelines but do not include objective measures of lung function such as spirometry or peak flow measures or information on activity limitation as recommended in EPR-3.[28] Therefore, the percentages with very poorly controlled asthma are likely underestimated.

In addition, it is unclear whether or not respondents who answered "no" to any of the questions on financial barriers to asthma care did so because they did not experience financial barriers to asthma care in the last year, or because they did not need to see a primary care doctor, were not referred to a specialist, or did not need to buy medication. Therefore, the estimates for financial barriers to asthma care presented here are likely underestimates because they may include individuals who would not have seen a primary care doctor, seen a specialist, or bought medication, regardless of cost. In addition, answers to the financial barriers questions are subjective and not based on an objective financial standard. Thus, respondents' attitudes toward their asthma may have influenced their ability to see a physician or buy medication. These questions also do not provide information on the frequency that respondents restricted their asthma care due to cost. Moreover, factors like respondents' residence (rural versus urban) or travel time to a physician may be associated with a substantial cost.[48] It is possible that the respondents considered the cost of travel time in their responses. However, no such information was available in ACBS.

To the best of our knowledge, this is the only study to assess the proportion of financial barriers to asthma care and its association with WRA and adverse asthma outcomes. These results show that individuals with WRA are more likely to experience financial barriers to asthma care than individuals with non-WRA. Individuals with WRA are also more likely to have asthma attacks, urgent treatment for worsening asthma, and asthma-related emergency room visits than individuals with non-WRA, regardless of financial barriers to asthma care. These results suggest that medical, behavioral, or occupational and environmental factors other than financial barriers are associated with WRA that may increase adverse asthma outcomes. Physicians should consider these other factors when managing asthma in WRA patients, in particular among those who experience adverse asthma outcomes.

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