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OCCUPATIONAL RISKS FOR RECENT ASTHMA EPISODES AMONG ADULTS

Molly Reese

University of Kentucky, molly.reese@uky.edu

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Molly Reese, Student

Wayne Sanderson, PhD, MS, Major Professor

Corrine Williams, ScD, MS, Director of Graduate Studies

**OCCUPATIONAL RISKS FOR RECENT ASTHMA EPISODES
AMONG ADULTS**

CAPSTONE PROJECT PAPER

**A paper submitted in partial fulfillment of the
requirements for the degree of
Master of Public Health
in the
University of Kentucky College of Public Health**

Molly Reese

Lexington, Kentucky

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Wayne T. Sanderson, Ph.D
Chair

Steven Browning, Ph.D

James Holsinger, M.D.

OCCUPATIONAL RISKS FOR RECENT ASTHMA

Objective

Asthma affects more than 37 million Americans at some point in their lives, making it one of the most common, but costly chronic conditions. There are many known risk factors for asthma, but additional research on environmental and occupational factors is needed to better understand the association between these variables and asthma. This study investigates the associations between occupational exposures and asthma episodes among adults.

Methods

Data was obtained from the 2011-2013 Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey for adults. There was a final study population of 11,408 participants after the exclusion criteria were applied. The primary outcome of interest was asthma attack status, which was defined as having an episode of asthma or having an asthma attack in the past 12 months. The primary exposure of interest was occupational exposure, which was determined by using responses for whether or not exposures in the workplace aggravated or caused the participant's asthma. Covariates used in the study included gender, age, education attainment, employment status, marital status, income, smoking status, air purifier in home, pets in home, mold in home, cockroaches in home, rodents in home, smoking indoors, and doctor diagnosed work asthma. Logistic regressions were used to determine associations between the covariates and asthma attack status.

Results

This study shows that of the 11,408 participants 4,373 (38.33%) individuals reported having an episode or asthma attack in the last 12 months. 4,996 (43.79%) participants reported that their asthma was aggravated by environmental exposures in the workplace. Significant predictors ($p < 0.05$) of an episode of asthma or asthma attack included in the final model were gender, age, marital status, income, smoking status, air purifier in home, dehumidifier in home, mold in home, cockroaches in home, doctor diagnosed work asthma and asthma aggravated by employment

Conclusions

The prevalence of an episode of asthma or asthma attack in the past 12 months is found to be higher among individuals who are exposed to things like chemicals, smoke, dust or mold in the workplace. Additional demographic and environment variables have found significant differences among asthma attack status. Further studies should examine the relationship between more specific occupational exposures and other environmental exposures to have a greater understanding of the association between asthma and these variables.

Introduction

Asthma is characterized by chronic airway inflammation and typically has symptoms including wheezing, shortness of breath, chest tightness and coughing.¹² The intensity of these symptoms are experienced differently throughout time and there can be periods when the symptoms are absent.¹² Asthma affects more than 37 million Americans at some point in their lives, making it one of the most common, but costly chronic conditions.⁴ Currently there are 24,009 people living with asthma in the United States or 7.7% of the population.⁴ 17,717 people living with asthma are 18 years of age or older.⁴ Additionally, it has been estimated that asthma costs more than \$30 billion dollars per year and it has been documented that asthma is responsible for more than 3,600 deaths per year.⁴

Although there are many different risk factors for asthma that include genetics, a variety of different exposures, and lifestyle factors this study is focused on environmental exposures and occupational risks for asthma. Exposure to indoor allergens is vital to understanding the control of asthma or any allergic disease.¹⁸ Dust mites, pets including dogs and cats, rodents, cockroaches and other pests, and molds are particularly important to understanding risk factors for asthma. It has been found that increased exposures to the cockroach allergen and the mouse allergen have increased asthma morbidity.¹⁸ Areas, mainly urban, that have prioritized the reduction of exposure to these allergens are hoping to see decreased rates of asthma.¹⁸ Furthermore, cases of asthma have been identified by sensitization to pet allergens. These findings are being said to have spread not only in homes with pets, but to other individuals through contact in public locations such as

schools and work.¹⁸ Additionally, mold exposure and its association with childhood asthma has long been researched. “Sharpe et al recently discovered that reporting mildew odor in the home was associated with an increased risk of childhood asthma.”¹⁸

Environmental factors for asthma have previously been focused on exposures in the home, but new research is finding that concentrating on shared public spaces including daycares and schools for children, and work places for adults is necessary to reduce asthma incidence and prevalence.

There are many different occupational exposures that are found to cause work-aggravated asthma (WAA).¹⁰ The exposures are typically categorized into two groups: Inhaled agents such as dusts, smoke, fumes, sprays, and common environmental allergens; or physical factors such as temperature, humidity and physical activity.¹⁰ Kim et al designed a study that investigated occupational contributions to asthma. These investigators had their participants complete a questionnaire about exposures, occupations and exacerbations of asthma. Two-thirds of their study population reported severe exacerbations associated with exposure to a variety of environmental conditions. These conditions included gas, smoke, organic dusts, dampness, mold and cold conditions. Furthermore, they found that 15% of asthma cases among adults could be contributed to occupation.¹⁴

A Morbidity and Mortality Weekly Report (MMWR) was released by the Centers for Disease Control on work-related asthma. This study used The Behavioral Risk Factor Surveillance System (BRFSS) Adult Asthma Call-back Survey data from 2006-2009, and

2012.¹⁵ The analysis found that 15.7% of the overall proportion of current asthma was work-related. This indicated that over the 22 states involved in the study, 1.9 million work-related asthma cases were documented. Therefore, 1.9 million cases of work-related asthma could have been prevented when utilizing the definition of work-related asthma as preventable.

Methods

Study Design

The Behavioral Risk Factor Surveillance System (BRFSS) is nationwide program aimed at evaluating behavioral risk factors among United States citizens 18 years of age or older. The BRFSS collects data by conducting telephone interviews.⁵ These telephone interviews include both landline telephones and cellular phones and occur monthly or every 1 to 3 months.⁵ The research for this study utilized data from the 2011-2013 Behavioral Risk Factor Surveillance System “Landline and Cell Phone Combined” Asthma Call-back Survey. The Asthma Call-back Survey is conducted for participants who reported having a diagnosis of Asthma in the initial BRFSS interview.

This study is cross sectional analysis of the data provided from the 2011-2013 BRFSS “Landline and Cell Phone Combined” Asthma Call-back Survey. Initially there were 11,456 participants included in the Asthma Call-back Survey. This study focused on asthma trends among adults therefore all individuals less than 18 years of age (n=46) were excluded from the study. Additionally individuals under the age of 18 have limited occupational exposures. Two more participants were excluded for failure to complete

survey questions associated with occupational related asthma. The final sample size for the cross sectional analysis was 11,408 participants (Figure 1).

Study Variables

Exposure to environmental conditions, including chemicals, smoke, dust or mold, at a previous or current job were analyzed to determine if an association occurred with individuals reporting having an episode of asthma or asthma attack during the last 12 months. The survey asked participants if they experienced a worsening in their asthma symptoms by things like chemicals, smoke, dust or mold in their current job. This same question was asked regarding previous employment for the participant. Additionally, the survey asked if the participant's asthma was first caused by exposure to things like chemicals, smoke, dust or mold at their current job. Again, this question was asked regarding previous employment. Participant's responses included "Yes", "No", or "Don't Know" while some refused to answer the question. An episode of asthma or asthma attack experienced in the last 12 months was the outcome of interest.

Respondents answered "Yes", "No", or "Don't Know" unless they refused to answer the question.

Participants that responded "Don't Know" or had refused to answer a question were included in the analysis, but were not included on the tables or focused on in the results because of the small percentage of the sample size represented in those categories.

Additionally, skip patterns within the survey questions were also included within the analysis, but were not exhaustive on the tables and results. When asked if asthma

symptoms were made worse by things like chemicals, smoke, dust or mold in your current job, participants would skip this question if they had never been employed.

Other Variables

Other covariates included in the model were gender, age in years, education attainment, employment status, marital status, income in U.S. dollars, smoking status, air purifier in home, dehumidifier in home, pets in home, mold in home, cockroaches in home, rodents in home, smoking indoors, and doctor diagnosis of work-related asthma. Gender was categorized as male or female. Age in years was reported continuously then categorized into four groups (18-29, 30-49, 50-69, 70-100) for improvement of the analysis.

Education attainment began with six categories that were minimized into three categories (less than high school, high school graduate, more than high school). Employment status remained the same with three categories (employed – full time, employed – part time, not employed). Marital status began with six categories that were minimized into four categories (married, divorced/widowed/separated, never married, member of unmarried couple). Income began with eight categories that were minimized into four categories (less than \$20,000, \$20,000-\$34,999, 35,000-74,999, More than 75,000). Smoking status remained the same with four categories (current: smokes everyday, current: smokes some days, former smoker, never smoked). Air purifier in home, dehumidifier in home, pets in home, mold in home, cockroaches in home, rodents in home, smoking indoors, and doctor diagnosis of work-related asthma all remained the same with two categories (yes or no).

Statistical Analysis

The initial exploratory analysis conducted focused on descriptive statistics of the study population. The descriptive statistics identified the numbers of individuals and the percentages of individuals for the population distribution stratified by each variable in association with the main outcome variable. A logistic regression analysis was then performed to determine the association between occupational exposures for asthma attack status. The variables being analyzed included doctor diagnosed work asthma, asthma aggravated by employment, and asthma caused by employment. Environmental exposure variables included in the logistic regression analysis were air purifier in home, dehumidifier in home, pets in home, mold in home, cockroaches in home, rodents in home and smoking indoors. Demographic variables included in the logistic regression model were gender, age, education attainment, employment status, marital status and income. An adjusted logistic regression analysis was then performed to determine the association estimate differences among occupational exposure variables when all of the covariates are included in the model. This logistic regression also helps assess effect modification and confounding among the variables. A final model was determined by using both forward selection and backward elimination to identify significant variables. Test results with a p value <0.05 were considered statistically significant and used in the final model. All analyses were conducted using SAS 9.3 (SAS Institute Inc).

Results

Demographics and Descriptive Statistics

Demographic information and descriptive statistics about the sample population of 11,408 are shown in Table 1. Table 1 includes the population distribution by the number of individuals and the percentage of individuals for all the included variables.

Furthermore, this information is stratified by asthma status (asthma in the last 12 months vs. no asthma in the last 12 months). 38.33% (n=4373) of the study population reported having an episode of asthma or asthma attack in the last 12 months. In the study population the highest proportion were female (68%), 50-69 years of age (47.71%), obtained more than a high school degree (65.53%), were not employed (56.35%), married (46.77%), had an income less than \$20,000 (25.56%), never smoked (51.73%), did not have an air purifier in their home (77.12%), did not have a dehumidifier in their home (77.12%), had pets in their home (55.62%), did not report having mold in their home (89.11%), did not report having cockroaches in their home (90.17%), did not report having rodents in their home (93.26%), did not smoke in their home (86.16%), did not have a doctor diagnosis of work asthma (83.51%), and did not report having their asthma aggravated (53.84%) or caused (71.23%) by their employment.

Bivariate Analysis and Multivariate Regression

The results of the bivariate logistic regression analysis (unadjusted) and multivariate logistic regression analysis (adjusted) are shown in Table 2 and Table 3 respectively. These models were used to determine significant predictors ($p < 0.05$) of an episode of asthma or asthma attack in the last 12 months. Covariates that were determined to be

significant ($p < 0.05$) in the unadjusted logistic regression model were gender, age, employment status, marital status, income, smoking status, air purifier in home, dehumidifier in home, pets in home, mold in home, cockroaches in home, rodents in home, smoking indoors, doctor diagnosed work asthma, asthma aggravated by employment and asthma caused by employment. Covariates that were determined to be significant ($p < 0.05$) in the adjusted logistic regression model were gender, age, marital status, smoking status, air purifier in home, dehumidifier in home, mold in home, cockroaches in home, rodents in home, doctor diagnosed work asthma, and asthma aggravated by employment.

Final Multivariate Regression Model

The final multivariate regression model is shown in Table 4. To select the best model, a forward selection analysis and backward elimination analysis were performed.

Significant covariates ($p < 0.05$) included in the final model were gender, age, marital status, income, smoking status, air purifier in home, dehumidifier in home, mold in home, cockroaches in home, doctor diagnosed work asthma, and asthma aggravated by employment. The analysis of effects found that each variable had a p-value of less than 0.05 when the variable was looked at as a whole. Table 4 shows each variable categorized into smaller groups where some of the p-values are greater than 0.05. The variables included in the model were each assessed as a whole to determine significance. Additionally, the Hosmer and Lemeshow Goodness-of-Fit found $p = 0.052$ which indicates there is no evidence of poor fit.

The main exposure variable of interest in the final model is asthma aggravated by employment. Participants that reported that their asthma was not aggravated by exposures (chemicals, smoke, dust or mold) in the workplace had an odds ratio of 0.47 (CI: 0.43 – 0.52) compared to those who reported that their asthma was aggravated by exposures in the workplace. This indicates that participants that reported that their asthma was aggravated in the workplace have higher odds of experiencing an episode or asthma attack in the past 12 months.

All variables included in the final model were considered significant predictors of asthma status. Females were 79% more likely to have had an episode of asthma or asthma attack in the last 12 months than males (OR: 1.79, CI: 1.63 – 1.96). Individuals 30-49 years of age and individuals 50-69 years of age had higher odds for an asthma episode than individuals 18-29 years of age. Individuals 70-100 years of age were not found to be significant. Participants that reported being married had higher odds for an asthma episode than a participant that was a member of an unmarried couple. There was no significant difference in asthma episodes between participants who were divorced/widowed/separated or never married compared to participants that were married. Individuals with an income of less than \$20,000 had higher odds for an asthma episode than individuals who had incomes greater than \$20,000. Participants that reported never smoked had lower odds of an asthma episode than individuals who smoke daily. There was no significant difference in asthma episodes between individuals who smoke some days or former smokers compared to individuals who smoke daily. Participants who reported not having an air purifier in their home, not having a dehumidifier in their home

and not having mold in their home had lower odds of an asthma episode than those reporting having one of the previous variables in their homes. If the participant had a diagnosis of work asthma, they had higher odds of an asthma episode than an individual with no work asthma diagnosis. Lastly, if a participant reported having no cockroaches in their homes, they had higher odds of an asthma episode than those reporting cockroaches in their homes.

Discussion

This study was designed to explore occupation risks for recent asthma episodes among adults. In addition, other environmental risks were analyzed. The study was looking to determine the association between exposure to things like chemicals, smoke, dust or mold in the workplace and recent asthma episodes. All individuals in the study reported having asthma, so this study specifically looked at whether a participant had reported an episode of asthma or asthma attack in the past 12 months.

Previous research found that exposure to the cockroach allergen and mouse allergen increased the risk for asthma. This study found that participants that reported having rodents in their homes were at higher odds of having an asthma episode (No rodents in home: OR: 0.83; CI: 0.71 – 0.98). However, having cockroaches in their homes was found to be protective of asthma episodes (No cockroaches in home: OR: 1.41; CI: 1.22 – 1.62). This suggests, like previous findings have mentioned, that focusing solely on exposure conditions in the home is not sufficient. The results in this study only focus on rodents and cockroaches within the home so we are unable to determine if there are

exposures to these allergens elsewhere. Additionally, this study found that individuals who reported having mold in their homes had increased odds of having an asthma episode (No mold in home: OR: 0.77; CI: 0.67 – 0.87). This conclusion is similar to other research that showed exposure to molds increased ones risk for asthma.

Asthma aggravated by employment was the main exposure of interest. The findings of this study showed that individuals reporting asthma aggravation in the workplace had a 53% increase in odds of having an asthma episode in the last 12 months than individuals who did not report asthma aggravation in the workplace. To better understand occupational asthma or work-aggravated asthma, it would be vital to go into further detail about what exposures in the workplace are responsible for the increased risks.

Limitations of this study go into further detail below.

Limitations

There are limitations to our study beginning with data collection. The Behavioral Risk Factor Surveillance System (BRFSS) Asthma Call-back Survey relies on telephone interviews to collect the data. It is found that telephone interviews have lower levels of coverage than face-to-face interviews because not all households in the United States have telephones.³ Additionally, it is found that there are demographic, economic, and health characteristic differences among populations with household phones and populations without household phones.³ BRFSS has made adjustments for age, race, and sex along with other variables to reduce the impact of differences.³ This study also used cell-phone interviewing, but again this is not exhaustive of then entire United States

population. Another limitation among data collection is that many of the variables in the survey are based off and defined by the participant's responses. Response bias could be introduced if participants did not answer truthfully or misunderstood the question being asked. Furthermore, specific occupational exposures would help determine what exactly is putting an individual at a higher risk of aggravating their asthma in the workplace.

There is no current data provided by BRFSS that indicates the current prevalence of work related asthma, which would need to be taken into consideration when looking at this studies findings. Finally, some of the smaller groups categorized under the variables had small sample sizes and would need additional data for more precise estimates.

Recommendations

Based on the findings in this study, further exploration of exposure in the workplace is necessary. Specific occupational exposures will determine the main risk factors in an occupational setting for asthma. Additionally, this study explored some factors associated with an episode of asthma or asthma attack in the past 12 months. These factors included gender, age, education attainment, employment status, marital status, income, smoking status, air purifier in home, dehumidifier in home, pets in home, mold in home, cockroaches in home, rodents in home, smoking indoors, doctor diagnosed work asthma and asthma aggravated or caused by employment. All of these variables should be examined in further detail to have a greater determination of the associations with asthma episodes. Comparing this data with data for asthma among children would be beneficial in seeing similarities between the information.

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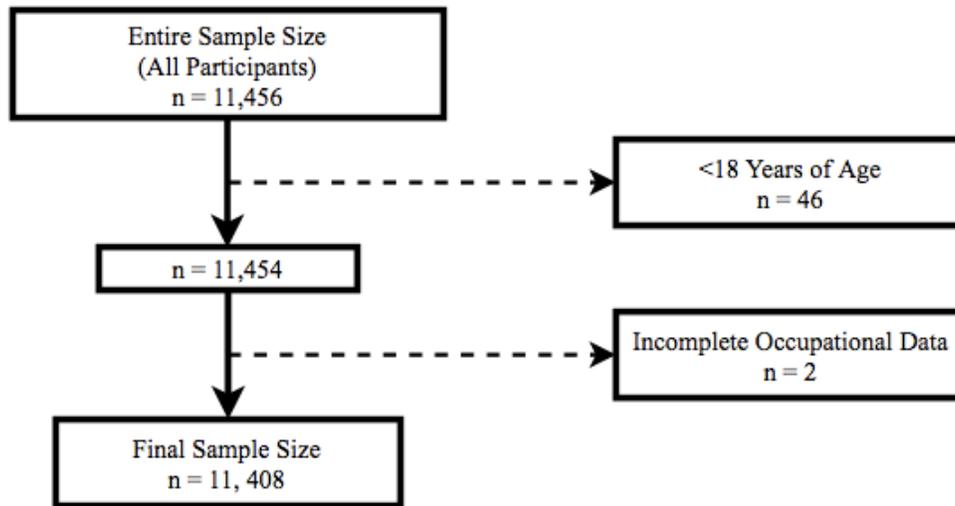
Figure 1. Exclusion Criteria and Selection of Final Sample Size

Table 1. Cross Sectional Distribution of Study Population in 2013

Variables	Population Distribution*	Asthma in Last 12 Months [†]	No Asthma in Last 12 Months [†]	P-Value
	n = 11408 (100.00%)	n = 4373 (38.33%)	n = 7035 (61.67%)	
Asthma Attack (Prev. 12 mths)				
Yes	4373 (38.33)			
No	7035 (61.67)			
Gender				
Male	3650 (32.00)	1061 (29.07)	2589 (70.93)	<.0001
Female	7758 (68.00)	3312 (42.69)	4446 (57.31)	
Age (Years)				
18-29	1054 (9.24)	277 (26.28)	777 (73.72)	<.0001
30-49	2560 (22.44)	1014 (39.61)	1546 (60.39)	
50-69	5443 (47.71)	2296 (42.18)	3147 (57.82)	
70-100	2351 (20.61)	786 (33.43)	1565 (66.57)	
Education Attainment				
Less than High School	1012 (8.88)	406 (40.12)	606 (59.88)	0.4199
High School Graduate	2915 (25.58)	1124 (38.56)	1791 (61.44)	
More than High School	7467 (65.53)	2839 (38.02)	4628 (61.98)	
Employment Status				
Employed Full-Time	3583 (31.41)	1225 (34.19)	2358 (65.81)	<.0001
Employed Part-Time	1360 (11.92)	486 (35.74)	874 (64.26)	
Not Employed	6428 (56.35)	2648 (41.19)	3780 (58.81)	
Marital Status				
Married	5336 (46.77)	2008 (37.63)	3328 (62.37)	<.0001
Divorced/Widowed/Separated	3918 (34.34)	1659 (42.34)	2259 (57.66)	
Member of Unmarried Couple	315 (2.76)	115 (36.51)	200 (63.49)	
Never Married	1815 (15.91)	587 (32.34)	1228 (67.66)	
Income (U.S. Dollars)				
Less than \$20,000	2916 (25.56)	1316 (45.13)	1600 (54.87)	<.0001
\$20,000 - \$34,999	2124 (18.62)	842 (39.64)	1282 (60.36)	
\$35,000 – \$74,999	2778 (24.35)	969 (34.88)	1809 (65.12)	
More than \$75,000	2383 (20.89)	785 (32.94)	1598 (67.06)	
Smoking Status				
Current: Smokes Everyday	1246 (10.92)	556 (44.62)	690 (55.38)	<.0001
Current: Smokes Some Days	527 (4.62)	235 (44.59)	292 (55.41)	
Former Smoker	3690 (32.35)	1485 (40.24)	2205 (59.76)	
Never Smoked	5901 (51.73)	2077 (35.20)	3824 (64.80)	
Air Purifier in Home				
Yes	2846 (24.95)	1288 (45.26)	1558 (54.74)	<.0001
No	8486 (74.39)	3066 (36.13)	5420 (63.87)	
Dehumidifier in Home				
Yes	2561 (22.45)	1082 (42.25)	1479 (57.75)	<.0001
No	8798 (77.12)	3273 (37.20)	5525 (62.80)	

Pets in Home					
Yes		6345 (55.62)	2528 (39.84)	3817 (60.16)	0.0001
No		5058 (44.34)	1845 (36.48)	3213 (63.52)	
Mold in Home					
Yes		1191 (10.44)	564 (47.36)	627 (52.64)	<.0001
No		10166 (89.11)	3779 (37.17)	6387 (62.83)	
Cockroaches in Home					
Yes		1107 (9.70)	366 (33.06)	741 (66.94)	0.0004
No		10287 (90.17)	4003 (38.91)	6284 (61.09)	
Rodents in Home					
Yes		751 (6.58)	331 (44.07)	420 (55.93)	0.0036
No		10639 (93.26)	4035 (37.93)	6604 (62.07)	
Smoked Indoors					
Yes		1573 (13.79)	714 (45.39)	859 (54.61)	<.0001
No		9830 (86.17)	3659 (37.22)	6171 (62.78)	
Doctor Diagnosed Work Asthma					
Yes		1501 (13.16)	833 (55.50)	668 (44.50)	<.0001
No		9527 (83.51)	3415 (35.85)	6112 (64.15)	
Asthma Aggravated By Employment					
Yes		4996 (43.79)	2529 (50.62)	2467 (49.38)	<.0001
No		6142 (53.84)	1768 (28.79)	4374 (71.21)	
Don't Know		7 (0.06)	1 (14.29)	6 (85.71)	
Asthma Caused By Employment					
Yes		2259 (19.8)	1103 (48.83)	1156 (51.17)	<.0001
No		8126 (71.23)	2844 (35.00)	5282 (65.00)	
Don't Know		760 (6.66)	351 (46.18)	409 (53.82)	

* Column percentage

† Row percentage

** Not all variables add up to total subject number due to skip patterns and missing values

Table 2. Unadjusted Bivariate Analysis for Asthma Attack Status (n=11,408)

Variables	OR (CI)	P Value
Gender		
Male	Reference	
Female	1.82 (1.67 – 1.98)	<.0001
Age (Years)		
18-29	Reference	
30-49	1.84 (1.57 – 2.15)	<.0001
50-69	2.04 (1.77 – 2.37)	<.0001
70-100	1.41 (1.20 – 1.66)	<.0001
Education Attainment		
Less than High School	Reference	
High School Graduate	0.94 (0.81 – 1.08)	1.08
More than High School	0.92 (0.80 – 1.05)	1.92
Employment Status		
Employed Full-Time	Reference	
Employed Part-Time	1.07 (0.94 – 1.22)	0.31
Not Employed	1.35 (1.24 – 1.47)	<.0001
Marital Status		
Married	Reference	
Divorced/Widowed/Separated	1.22 (1.12 – 1.32)	<.0001
Member of Unmarried Couple	0.95 (0.75 – 1.21)	0.69
Never Married	0.79 (0.71 – 0.89)	<.0001
Income (U.S. Dollars)		
Less than \$20,000	Reference	
\$20,000 - \$34,999	0.80 (0.71 – 0.89)	0.0001
\$35,000 – \$74,999	0.65 (0.59 – 0.73)	<.0001
More than \$75,000	0.60 (0.53 – 0.67)	<.0001
Smoking Status		
Current: Smokes Everyday	Reference	
Current: Smokes Some Days	0.99 (0.81 – 1.23)	0.99
Former Smoker	0.84 (0.73 – 0.95)	0.01
Never Smoked	0.67 (0.60 – 0.76)	<.0001
Air Purifier in Home		
Yes	Reference	
No	0.63 (0.63 – 0.75)	<.0001
Dehumidifier in Home		
Yes	Reference	
No	0.81 (0.74 – 0.89)	<.0001
Pets in Home		
Yes	Reference	
No	0.87 (0.80 – 0.94)	0.0002
Mold in Home		
Yes	Reference	
No	0.65 (0.58 – 0.74)	<.0001
Cockroaches in Home		
Yes	Reference	
No	1.29 (1.13 – 1.47)	0.0001

Rodents in Home		
Yes	Reference	
No	0.78 (0.67 – 0.90)	0.0008
Smoked Indoors		
Yes	Reference	
No	0.71 (0.64 – 0.79)	<.0001
Doctor Diagnosed Work Asthma		
Yes	Reference	
No	0.45 (0.40 – 0.50)	<.0001
Asthma Aggravated By Employment		
Yes	Reference	
No	0.39 (0.37 – 0.43)	<.0001
Don't Know	0.16 (0.02 – 1.35)	0.09
Asthma Caused By Employment		
Yes	Reference	
No	0.56 (0.51 – 0.62)	<.0001
Don't Know	.0.90 (0.76 – 1.06)	0.21

Table 3. Adjusted Multivariate Analysis for Asthma Attack Status (n=11,408)

Variables	OR (CI)	P Value
Gender		
Male	Reference	
Female	1.78 (1.63 – 1.95)	<.0001
Age (Years)		
18-29	Reference	
30-49	1.34 (1.12 – 1.61)	0.001
50-69	1.26 (1.06 – 1.50)	0.01
70-100	0.89 (0.73 – 1.09)	0.25
Education Attainment		
Less than High School	Reference	
High School Graduate	1.05 (0.90 – 1.23)	0.52
More than High School	1.14 (0.98 – 1.33)	0.09
Employment Status		
Employed Full-Time	Reference	
Employed Part-Time	0.97 (0.84 – 1.11)	0.65
Not Employed	1.11 (1.00 – 1.24)	0.05
Marital Status		
Married	Reference	
Divorced/Widowed/Separated	0.98 (0.88 – 1.08)	0.65
Member of Unmarried Couple	0.82 (0.72 – 0.94)	0.01
Never Married	0.90 (0.70 – 1.16)	0.41
Income (U.S. Dollars)		
Less than \$20,000	Reference	
\$20,000 - \$34,999	0.83 (0.73 – 0.94)	0.004
\$35,000 – \$74,999	0.70 (0.61 – 0.79)	<.0001
More than \$75,000	0.69 (0.60 – 0.80)	<.0001
Smoking Status		
Current: Smokes Everyday	Reference	
Current: Smokes Some Days	0.99 (0.80 – 1.24)	0.95
Former Smoker	1.04 (0.89 – 1.22)	0.62
Never Smoked	0.85 (0.72 – 0.99)	0.04
Air Purifier in Home		
Yes	Reference	
No	0.74 (0.68 – 0.82)	<.0001
Dehumidifier in Home		
Yes	Reference	
No	0.87 (0.79 – 0.96)	0.007
Pets in Home		
Yes	Reference	
No	0.96 (0.89 – 1.05)	0.36
Mold in Home		
Yes	Reference	
No	0.78 (0.69 – 0.89)	0.0002
Cockroaches in Home		
Yes	Reference	

No	1.42 (1.23 – 1.63)	<.0001
Rodents in Home		
Yes	Reference	
No	0.83 (0.71 – 0.98)	0.02
Smoked Indoors		
Yes	Reference	
No	0.89 (0.77 – 1.02)	0.09
Doctor Diagnosed Work Asthma		
Yes	Reference	
No	0.70 (0.61 – 0.79)	<.0001
Asthma Aggravated By Employment		
Yes	Reference	
No	0.48 (0.44 – 0.53)	<.0001
Don't Know		
Asthma Caused By Employment		
Yes	Reference	
No	0.99 (0.89 – 1.11)	0.91
Don't Know		

Table 4. Final Model Results for Asthma Attack Status (n=11,408)

Variables	OR (CI)	P Value
Gender		
Male	Reference	
Female	1.79 (1.63 – 1.96)	<.0001
Age (Years)		
18-29	Reference	
30-49	1.36 (1.14 – 1.62)	0.0008
50-69	1.31 (1.10 – 1.56)	0.0022
70-100	0.94 (0.77 – 1.14)	0.51
Marital Status		
Married	Reference	
Divorced/Widowed/Separated	0.97 (0.88 – 1.08)	0.60
Member of Unmarried Couple	0.82 (0.71 – 0.94)	0.0036
Never Married	0.90 (0.70 – 1.16)	0.42
Income (U.S. Dollars)		
Less than \$20,000	Reference	
\$20,000 - \$34,999	0.83 (0.73 – 0.93)	0.0019
\$35,000 – \$74,999	0.68 (0.61 – 0.77)	<.0001
More than \$75,000	0.67 (0.59 – 0.77)	<.0001
Smoking Status		
Current: Smokes Everyday	Reference	
Current: Smokes Some Days	0.98 (0.79 – 1.21)	0.85
Former Smoker	0.98 (0.85 – 1.13)	0.75
Never Smoked	0.79 (0.69 – 0.90)	0.0005
Air Purifier in Home		
Yes	Reference	
No	0.74 (0.68 – 0.82)	<.0001
Dehumidifier in Home		
Yes	Reference	
No	0.88 (0.80 – 0.97)	0.0096
Mold in Home		
Yes	Reference	
No	0.77 (0.67 – 0.87)	<.0001
Cockroaches in Home		
Yes	Reference	
No	1.41 (1.22 – 1.62)	<.0001
Doctor Diagnosed Work Asthma		
Yes	Reference	
No	0.70 (0.62 – 0.79)	<.0001
Asthma Aggravated By Employment		
Yes	Reference	
No	0.47 (0.43 – 0.52)	<.0001

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