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## A population-based study of asthma, quality of life, and occupation among elderly Hispanic and non-Hispanic whites: a cross-sectional investigation

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### Abstract

**Background:** The U.S. population is aging and is expected to double by the year 2030. The current study evaluated the prevalence of asthma and its correlates in the elderly Hispanic and non-Hispanic white population.

**Methods:** Data from a sample of 3021 Hispanics and non-Hispanic White subjects, 65 years and older, interviewed as part of an ongoing cross-sectional study of the elderly in west Texas, were analyzed. The outcome variable was categorized into: no asthma (reference category), current asthma, and probable asthma. Polytomous logistic regression analysis was used to assess the relationship between the outcome variable and various socio-demographic measures, self-rated health, asthma symptoms, quality of life measures (SF-12), and various occupations.

**Results:** The estimated prevalence of current asthma and probable asthma were 6.3% (95%CI: 5.3–7.2) and 9.0% (95%CI: 7.8–10.1) respectively. The majority of subjects with current asthma (Mean SF-12 score 35.8, 95%CI: 34.2–37.4) or probable asthma (35.3, 34.0–36.6) had significantly worse physical health-related quality of life as compared to subjects without asthma (42.6, 42.1–43.1). In multiple logistic regression analyses, women had a 1.64 times greater odds of current asthma (95%CI: 1.12–2.38) as compared to men. Hay fever was a strong predictor of both current and probable asthma. The odds of current asthma were 1.78 times (95%CI: 1.24–2.55) greater among past smokers; whereas the odds of probable asthma were 2.73 times (95%CI: 1.77–4.21) greater among current smokers as compared to non-smokers. Similarly fair/poor self rated health and complaints of severe pain were independently associated with current and probable asthma. The odds of current and probable asthma were almost two fold greater for obesity. When stratified by gender, the odds were significantly greater among females (*p*-value for interaction term = 0.038). The odds of current asthma were significantly greater for farm-related occupations (adjusted OR = 2.09, 95%CI: 1.00–4.39); whereas the odds were significantly lower among those who reported teaching as their longest held occupation (adjusted OR = 0.36, 95%CI = 0.18–0.74).

**Conclusion:** This study found that asthma is a common medical condition in the elderly and it significantly impacts quality of life and general health status. Results support adopting an integrated approach in identifying and controlling asthma in this population.

## Background

The U.S. population is aging and is expected to double by the year 2030, with the elderly comprising up to 20 percent of the total population. The population age 85 years and older will reach 21 million by the year 2050 [1]. Additionally, baby boomers will also reach 65 years of age in less than a decade. Therefore, epidemiologic studies of aging and age-associated diseases have national relevance.

Despite the worsening national trends for asthma for the past 25 years, bronchial asthma in the elderly has not received as much attention as asthma among children and adults. Many national and international studies exclude elderly when studying asthma, partly because asthma is difficult to distinguish from chronic obstructive pulmonary disease and congestive heart failure in older age [2,3]. However, recent studies have indicated that asthma is not an uncommon condition among the elderly. In the U.S., prevalence of asthma among the elderly range between 4% and 10% [4-7]. According to the Centers for Disease Control and Prevention (CDC) self-reported asthma rates in the elderly U.S. population increased sharply from 31 per 1000 in 1980 to 45 per 1000 in 1994 [8].

Long-term exposure to occupational agents at the workplace may result in poor quality of life later in life; however, the precise relationship between different occupations and asthma has not been studied previously in the elderly. According to state projections, by the year 2025 Texas will have the third largest population of individuals aged 65 and older after California and Florida [9]. Since morbidity due to asthma is on the rise, understanding factors associated with asthma and its association with the quality of life of older individuals is important. In this study the prevalence of asthma and asthma symptoms and their relationship with occupation and health related quality of life were estimated among older individuals in a largely sparsely settled region of west Texas.

## Methods

The study data were collected as part of a large ongoing telephone-based cross-sectional study of individuals 65 years and older residing in 108 counties that comprise west Texas. A detailed description of the survey methods has been previously described [10]. Three waves of the surveys have been completed. The original sample comprised of 5006 subjects. The focus of wave-3 of the survey was respiratory conditions and symptoms and their effects on the older population. The cooperation rate for the wave-3 survey (completed interviews/ (completed interviews+ refusals)) was 90.4%; the response rate (completed interviews/ (completed interviews + refusals + eligible non contact)) was 86.7% [11,12]. The analysis for the present study was limited to the third wave of the survey, conducted from October 2001 through December

2001. Of the 3392 subjects interviewed during this third wave, 237 reported a prior history of emphysema, as determined by an affirmative response to the question, "Have you ever been diagnosed by a physician to have emphysema?" and were excluded from the analysis, leaving a sample of size 3155. Of these, 3021 were non-Hispanic whites or Hispanics and were included in the final analysis. During wave 3 of the survey, subjects were asked questions on general demographics, presence of asthma, asthma symptoms, allergies, smoking habits, housing characteristics, family history of asthma and allergies, chronic bronchitis and emphysema (collectively referred to as "COPD"), health-related quality of life (SF-12), and asthma-specific quality of life (mini Asthma QoL).

Asthma-related questionnaire items in this study were derived mainly from the International Union Against Tuberculosis and Lung Disease (IUATLD) bronchial symptom questionnaire [13] which has been previously validated in several countries. In addition, a cluster of five previously validated questions on asthma symptoms, collectively referred to as the Discriminative Function Predictor (DFP) were included in the final questionnaire.

## Dependent variable

Our main outcome was a three category asthma variable coded as no asthma (reference category), current asthma, and probable asthma. Current asthma was defined as those responded in affirmative to questions, "have you ever been diagnosed by a physician to have asthma?" and "Do you still have asthma?" Diagnosis of asthma made by a health care provider still remains the most common approach used to define asthma in epidemiological studies [14]. The approach used in defining current asthma is similar to that used regularly in the U.S. National Health Interview Survey (NHIS) [15]. It is on this basis that the NHIS establishes its national prevalence estimates for current asthma. Probable Asthma was defined using the weighted 5-item asthma symptoms questions, collectively referred to as *Discriminant function predictor* (DFP) [13]. The items included in DFP were weighted using the following logit equation:  $\text{Logit } P(X) = (-2.92) + 1.42(W) + 1.39(\text{SOB}) + 1.00(\text{TRB\_C}) + 1.51(\text{TRB\_N}) + 2.37(\text{CT\_D})$  where  $W$  = wheezing in the past 12 months; SOB = nocturnal shortness of breath in the past 12 months; TRB\_C = continuous trouble with breathing; TRB\_N = breathing is never quite right; CT\_D = chest tightness around dust, animals, or feathers. To construct the variable "probable asthma" we used logit coefficients to generate logit scores. The default cut-off value of  $p > 0.5$  was used to classify subjects as having probable asthma. Based on these criteria a total of 207 subjects were classified as having current asthma and a total of 265 subjects were classified as having probable asthma; these two groups did not overlap. A total of 2,549

subjects were classified as having neither current nor probable asthma.

### Occupations

Each study subject was asked about their longest held occupation. This question was derived from the National Health and Nutrition Examination Survey III (item HAS17R) and asked from each study participant: "Thinking of all the paid jobs or businesses you ever had, what kind of work were you doing the longest?" [16]. Occupations were coded using the 1980 U.S. Bureau of Census Occupational Classification Codes [17]. Those who reported never having worked (n = 312) and those who employed in the Armed Forces (n = 61) were excluded from the analysis. Based on prior studies by the authors [18], together with a review of literature, the coded occupations were grouped into seven categories: administrative/secretarial, health-related, teaching, service-related, farm-related, precision production, and other occupations.

### Health-related Quality of Life (QoL)

The Medical Outcomes Study Short Form-12 (SF-12) health-related quality of life instrument was administered to all study participants. The SF-12, an abbreviated version of the SF-36, is commonly included in population-based studies to assess perceived health status [19], and its use has been validated in studies of older persons [20] and in clinical and community settings [21]. Scores on the 12 items were used to create two separate summary scores: a physical component score (PCS) and a mental component score (MCS). Scores ranged from 0 (the worst possible health) to 100 (the best possible health). In addition, the mini Asthma Quality of Life (mini-Asthma QoL) questionnaire was administered to those study participants who met the case definition for current asthma (n = 207). Mini-Asthma QoL measures functional impairments that are most troublesome to subjects with asthma during the 2 weeks prior to responding to the survey, and has four domains: 1) symptoms (5 items); 2) activity limitation (4 items); 3) emotional function (3 items); and 4) environmental stimuli (3 items). All responses were recorded on a 7-point Likert scale (from 1 = maximum impairment to 7 = no impairment). Responses to both the SF-12 scale and mini-Asthma QoL were scored according to published guidelines [21,22].

### Other measures

The following covariates were also included in the analysis: 1) age (four categories); 2) sex (male, female); 3) education level (four categories); 4) income level (four categories); 5) geographic location (urban, rural); 6) history of hay fever; 7) pet ownership (three categories); 8) smoking status (non-smoker, current smoker, and past smoker): this variable was defined using the two questions: *have you smoked at least 100 cigarettes during your*

*entire life?* Those who replied "yes" were asked *Do you smoke cigarettes now?*; those who responded in affirmative to both questions were classified as current smoker, those who smoked cigarettes in the past but no longer smoke cigarettes were classified as past smoker, and those who stated that they never smoke at least 100 cigarettes in their entire life were classified as non-smoker; 9) environmental tobacco smoke was defined based on responses to the question "other than the [respondent] how many people in home smoke?" 10) self-rated health was assessed using the question: "in general, would you say your health is excellent, very good, good, fair, or poor?" The responses were dichotomized into excellent/good and fair/poor; 11) complaint of pain: respondents were asked how often they were troubled with pain and how bad was their pain most of the time. The responses were grouped into three categories: no pain, mild pain, and severe pain; 12) body mass index (BMI): The BMI was defined as the weight in kilograms divided by the height in metres squared (kg/m<sup>2</sup>). This variable was computed based on self-reported weight and height and categorized into: normal weight (BMI <25), overweight (BMI 25–29.9), and obese (BMI = 30). Missing values were coded as a separate category; and 13) health insurance status. Nocturnal symptoms of asthma were defined using the question (asked separately for each symptom): "At any time in the last 12 months, have you been awakened at night by an attack of: 1) wheezing, 2) chest tightness, 3) shortness of breath, 4) cough."

To compare our study results with the prior published studies of asthma in the elderly, we performed a comprehensive MEDLINE search for English language articles published between 1966 and April 2005, using keyword terms "asthma", "elderly", "Health surveys or prevalence", and "Epidemiology". A total of 13 population or community-based studies were identified and data on type of the study, sample size, response rate, definition of asthma, and prevalence estimates of asthma were abstracted and summarized (Table 6). Only those studies which enrolled subjects aged 65 years and older, with clearly defined asthma as one of the outcome variables, and published prevalence estimates of asthma, were included in the summary table.

### Statistical analysis

Comparison of the sample data to the U.S. Census 2000 data for west Texas suggested that the sample slightly underestimated the proportion of Hispanics and overestimated women. Therefore, data were weighted using post-stratification. The post-stratification adjustment cells were made up of age (65–69, 70–74, 75–79, and 80+), sex (Male, Female) and ethnicity (Hispanics, non-Hispanic White) categories. First, the census data (for 108 west Texas counties) and the wave-3 sample were stratified by age, sex, and ethnicity; then, an adjustment factor was

**Table 1: Demographic, social, and health characteristics of the study sample**

Characteristics	Unweighted n (n = 3021) <sup>a</sup>	Weighted %
<b>Age-</b>		
65–69	700	29.0
70–74	938	25.8
75–79	656	19.7
80 and over	727	25.9
<b>Sex</b>		
Male	878	40.5
Female	2143	59.5
<b>Race/Ethnicity</b>		
NH-White	2671	73.6
Hispanic	350	26.4
<b>Education</b>		
< HS	732	33.5
HS/GED	1001	29.1
Some College	698	19.8
College	581	17.7
<b>Household Annual Income</b>		
≤ 20 k	1091	38.5
20–40 k	820	24.6
≥ 40 k	530	16.8
Missing	580	20.1
<b>Geographic Location</b>		
Urban	1643	57.8
Rural	1378	42.2
<b>Hay Fever</b>		
No	2283	77.8
Yes	718	22.2
<b>Pet Ownership</b>		
Don't Have a Pet	1945	64.5
Dog/Cat	954	30.8
Other pets	120	4.6
<b>Smoking Status</b>		
Non-Smoker	1657	54.1
Current Smokers	267	8.2
Past Smokers	1082	37.7
<b>Environmental tobacco smoke</b>		
No	2704	88.3
Yes	314	11.7
<b>Self-rated Health</b>		
Excellent/Good	2060	63.6
Fair/Poor	950	36.4
<b>Complaint of Pain</b>		
No Pain	1747	59.1
Mild Pain	518	16.7
Severe Pain	747	24.1
<b>Body Mass Index (BMI)<sup>c</sup></b>		

**Table 1: Demographic, social, and health characteristics of the study sample (Continued)**

Normal Weight	1225	36.3
Overweight	1100	37.5
Obese	547	18.8
<b>Health Insurance</b>		
No	81	3.8
Yes	2937	96.2
<b>Occupations</b>		
Administrative	279	10.0
Health Related	170	5.3
Teaching	275	9.3
Secretarial	602	18.5
Service Related	321	13.2
Farm Related	157	7.8
Precision Production	237	11.8
Other Occupations	574	24.1

<sup>a</sup> n may not total to 3021 in some variables due to missing values.

computed by dividing the census cell proportion by the sample cell proportion. Finally, sampling weights were computed using the following formula [23]: Final Weight = (Total Number in Census Population/Total # in Sample) \* Adjustment Factor

Weighted prevalence estimates and their corresponding 95% confidence intervals were computed. Since the outcome variable was categorical, polytomous logistic regression analyses were used to compute the odds ratios and their corresponding 95% confidence intervals. In polytomous logistic regression, the odds of current and probable asthma were simultaneously compared to no asthma, the common reference category. Odds ratios were adjusted for age, sex, race/ethnicity, smoking status, and history of hay fever. STATA statistical software version 9.0 (Stata Corp, College Station, TX), which incorporated sampling weights, was used for all the analyses.

## Results

The socio-demographic sample characteristics of the study are presented in Table 1. The mean age of the study participant was 75.5 years (SD = 6.4). Of the 3021 participants, 878 were male and 2143 were female. Approximately 19% were obese (BMI = 30). The prevalence patterns of current and probable asthma by selected characteristics are presented in Table 2. The overall weighted prevalence of current asthma was 6.3% (95%CI: 5.3–7.2), whereas an additional 9.0% (95%CI: 7.8–10.1) of the respondents had probable asthma. Hispanic Americans reported a lower prevalence of current asthma (4.0%, 95%CI: 1.9–6.1) as compared to non-Hispanic whites (7.1%, 95%CI: 6.1–8.1). No significant race/ethnic differences were

**Table 2: Weighted prevalence estimates (95% confidence interval) of current and probable asthma by selected characteristics.**

Characteristics	Current Asthma <sup>a</sup> % (95%CI)	Probable Asthma <sup>a</sup> % (95%CI)
<b>Overall</b>	6.3 (5.3–7.2)	9.0 (7.8–10.1)
<b>Age-</b>		
65–69	7.4 (5.3–9.5)	9.8 (7.3–12.3)
70–74	5.5 (4.0–6.9)	7.8 (5.8–9.8)
75–79	6.6 (4.5–8.7)	9.3 (6.6–12.0)
80 and over	5.6 (3.8–7.3)	8.9 (6.6–11.1)
<b>Sex</b>		
Male	5.2 (3.6–6.7)	7.8 (5.8–9.8)
Female	7.0 (5.9–8.2)	9.7 (8.3–11.2)
<b>Race/Ethnicity</b>		
NH-White	7.1 (6.1–8.1)	8.4 (7.3–9.5)
Hispanic	4.0 (1.9–6.1)	10.5 (7.2–13.8)
<b>Education</b>		
< HS	5.1 (3.3–6.9)	11.6 (9.0–14.3)
HS/GED	7.5 (5.8–9.1)	6.7 (5.1–8.4)
Some College	7.9 (5.9–10.0)	8.8 (6.4–11.2)
College	4.8 (2.9–6.6)	7.7 (5.3–10.1)
<b>Household Annual Income</b>		
≤ 20 k	7.3 (5.6–8.9)	11.2 (8.9–13.3)
20–40 k	6.6 (4.9–8.3)	5.9 (4.2–7.6)
≥ 40 k	4.8 (2.8–6.8)	6.8 (4.4–9.1)
Missing	5.2 (3.2–7.2)	11.1 (8.0–14.2)
<b>Geographic Location</b>		
Urban	6.2 (5.0–7.4)	8.7 (7.0–10.3)
Rural	6.3 (4.9–7.7)	9.3 (7.6–11.0)
<b>Hay Fever</b>		
No	4.3 (3.4–5.2)	7.5 (6.2–8.7)
Yes	13.3 (10.7–15.8)	13.9 (11.0–16.9)
<b>Pet Ownership</b>		
Don't Have a Pet	6.3 (5.1–7.6)	9.1 (7.6–10.6)
Dog/Cat	6.4 (4.9–8.0)	8.4 (6.4–10.4)
Other pets	3.8 (1.1–6.5)	10.6 (4.8–16.4)
<b>Smoking Status</b>		
Non-Smoker	5.5 (4.4–6.6)	7.9 (6.4–9.5)
Current Smokers	3.4 (1.5–5.3)	16.8 (11.8–21.8)
Past Smokers	8.0 (6.2–9.8)	8.6 (6.7–10.6)
<b>Environmental tobacco smoke</b>		
No	6.3 (5.4–7.3)	8.6 (7.3–9.8)
Yes	5.8 (2.8–8.7)	11.4 (7.5–15.3)
<b>Self-rated Health</b>		
Excellent/Good	4.9 (3.9–5.9)	5.7 (4.6–6.8)
Fair/Poor	8.7 (6.8–10.6)	14.7 (12.1–17.3)
<b>Complaint of Pain</b>		

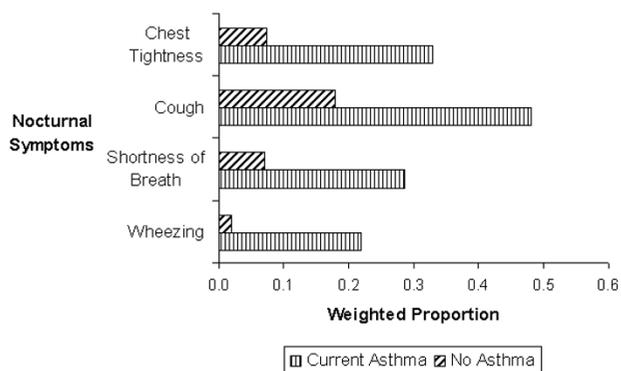
**Table 2: Weighted prevalence estimates (95% confidence interval) of current and probable asthma by selected characteristics. (Continued)**

No Pain	4.6 (3.6–5.7)	5.3 (4.1–6.5)
Mild Pain	7.2 (4.5–9.8)	8.8 (6.2–11.4)
Severe Pain	9.7 (7.4–11.9)	18.0 (14.6–21.3)
<b>Body Mass Index (BMI)</b>		
Normal Weight (BMI <25)	5.0 (3.8–6.2)	7.2 (5.6–8.9)
Overweight (BMI 25–29.9)	6.5 (4.9–8.1)	8.4 (6.6–10.2)
Obese (BMI ≥ 30)	8.6 (6.2–11.0)	12.9 (9.7–16.2)
<b>Health Insurance</b>		
No	8.5 (1.4–15.7)	12.8 (4.0–21.7)
Yes	6.2 (5.3–7.1)	8.8 (7.6–10.0)
<b>Occupations</b>		
Administrative	8.3 (6.4–10.2)	9.3 (7.2–11.5)
Health Related	7.6 (3.5–11.7)	8.4 (3.0–13.8)
Teaching	3.1 (1.0–5.1)	9.7 (5.5–13.9)
Secretarial	8.7 (6.3–11.1)	10.3 (7.5–13.2)
Service Related	4.7 (2.2–7.1)	12.8 (8.4–17.1)
Farm Related	9.5 (3.6–15.4)	6.8 (2.1–11.5)
Precision Production	5.5 (2.5–8.5)	10.1 (5.5–14.6)
Other Occupations	6.3 (4.3–8.2)	6.8 (4.6–9.0)

The outcome is a three category variable: no asthma (reference), current asthma, probable asthma.

<sup>a</sup> The prevalence estimates were obtained by cross tabulating individual characteristics with the three category outcome variable (No Asthma, Current Asthma, and Probable asthma).

observed for probable asthma (Table 2). The prevalence estimates of current and probable asthma were slightly higher among females as compared to males. More than half of the sample were non-smokers (Table 1); only 8.2% reported currently smoking cigarettes and the prevalence of probable asthma was significantly higher in this group (16.8%, 95%CI: 11.8–21.8) as compared to non-smokers and ex-smokers (Table 2). Current smokers (33.7%, 95%CI: 27.3–40.1) and ex-smokers (24.2%, 95%CI: 21.2–27.2) also had significantly higher prevalence of wheezing as compared to non-smokers (15.1%, 95%CI: 13.1–17.1). The prevalence of nocturnal symptoms was significantly higher among those with current asthma, as compared to those with no asthma, and ranged from as low as 21.9% (95%CI: 15.2–28.6) for nocturnal wheezing to as high as 48.0% (95%CI: 40.4–55.6) for nocturnal cough (Figure 1). The prevalence of current asthma was highest among those who reported farm-related occupations as their longest held job (9.5%, 95%CI: 3.6–15.4), whereas the prevalence of probable asthma was highest among those who reported service-related occupations (12.8%, 95%CI: 8.4–17.1) as their longest held occupation (Table 2). When data was separated by gender, the prevalence of probable asthma was slightly higher among women (13.0%, 95%CI: 8.1–17.8) as compared to men



**Figure 1**  
Prevalence of nocturnal symptoms among subjects with current asthma compared to no asthma.

**Table 3: SF-12 scores among subjects with and without Asthma**

Asthma Status	Mean <sup>b</sup> (95%CI)
<i>Physical Component Score (PCS12)<sup>a</sup></i>	
No Asthma	42.6 (42.1, 43.1)
Current Asthma	35.8 (34.2, 37.4)
Probable Asthma	35.3 (34.0, 36.6)
<i>Mental Component Score (MCS12)<sup>a</sup></i>	
No Asthma	53.4 (52.9, 53.8)
Current Asthma	52.9 (51.5, 54.3)
Probable Asthma	49.7 (48.2, 51.5)

<sup>a</sup> A lower score reflects a poorer quality of life.  
<sup>b</sup> Weighted mean and 95% Confidence Interval.

(11.8%, 95%CI: 1.6–22.0) in this occupation category. Approximately 25% of Hispanics (95%CI: 19.4–29.6), as compared to 9.5% (95%CI: 8.3–10.7) of non-Hispanic whites, reported service-related occupation as their longest held occupation.

The majority of subjects with current or probable asthma rated their health as fair or poor (Table 2) and had significantly worse physical health-related quality of life, as determined by lower scores on physical component part of SF-12 scale, compared to subjects without asthma (Table 3). Among the subsample of 207 subjects with current asthma who were administered the mini-Asthma QoL, significant impairment (Mean Score 4.6, 95%CI: 4.4–4.9) was observed only for the environmental stimuli domain (Table 4).

The estimated crude and adjusted odds ratios of association for current and probable asthma with selected varia-

**Table 4: Mini-Asthma Quality of Life scores among subjects with Current Asthma**

Mini-Asthma quality of life score <sup>a</sup>	Mean <sup>b</sup> (95%CI)
Overall	5.4 (5.2, 5.6)
Symptoms domain	5.4 (5.3, 5.6)
Activity limitation	5.6 (5.4, 5.9)
Emotional function	5.7 (5.4, 5.9)
Environmental stimuli	4.6 (4.4, 4.9)

<sup>a</sup> A lower score reflects a poorer quality of life.  
<sup>b</sup> Weighted mean and 95% Confidence Interval.

bles are presented in table 5. In the polytomous multiple logistic regression analysis, the adjusted odds of current asthma and probable asthma among women were 1.64 times (95%CI: 1.12–2.38) and 1.41 (95%CI: 1.00–2.01) times greater, respectively, as compared to men. Hispanics had significantly lower odds of current asthma as compared to non-Hispanic whites in the univariate analysis only (OR = 0.57, 95%CI 0.32–0.99). Hay fever was a strong predictor for both current and probable asthma. A past history of smoking was associated with 1.78 times greater odds of current asthma (95%CI: 1.24–2.55); however, for probable asthma, an increased odds of association was observed among current smokers only (adjusted OR 2.73, 95%CI: 1.77–4.21). Approximately one-fourth of respondents reported severe pain that prevented them from performing every day activities (Table 1). The self-reported severe pain was associated with more than twice the odds of having current asthma (adjusted OR = 2.35, 95%CI: 1.64–3.36) and more than four times the odds of probable asthma (adjusted OR = 4.23, 95%CI: 2.99–5.99) when compared to those without pain. Those who reported being in fair or poor health also had more than twice the odds of current and probable asthma as compared to those who reported their health as excellent or good. Similarly, the adjusted odds of current and probable asthma were 1.98 times and 2.12 times greater among obese individuals, respectively, as compared to normal weight individuals (Table 5). A significant interaction was found between female gender and obesity (BMI = 30) for current asthma only (adjusted OR = 2.85, 95%CI: 1.06–7.66).

A significant positive association between current asthma and farm-related occupation was found in this study (adjusted OR = 2.09, 95%CI: 1.00–4.39). The odds of current asthma were significantly lower among those who reported teaching as their longest held occupation (adjusted OR = 0.36, 95%CI = 0.18–0.74) (Table 5). Those in the service-related occupations had 1.47 times greater odds of probable asthma but the results were only

**Table 5: Polytomous multiple logistic regression analysis of factors associated with current and probable asthma.**

Characteristics	Current Asthma		Probable Asthma	
	Crude OR (95%CI)	Adjusted OR <sup>a</sup> (95%CI)	Crude OR (95%CI)	Adjusted OR <sup>a</sup> (95%CI)
<b>Age</b>				
65–69	1.00	1.00	1.00	1.00
70–74	0.70 (0.46–1.01)	0.68 (0.45–1.05)	0.76 (0.51–1.13)	0.80 (0.53–1.20)
75–79	0.88 (0.56–1.38)	0.86 (0.54–1.38)	0.93 (0.61–1.43)	1.05 (0.67–1.64)
80+	0.73 (0.47–1.14)	0.70 (0.44–1.11)	0.87 (0.58–1.30)	1.07 (0.71–1.61)
<b>Sex</b>				
Male	1.00	1.00	1.00	1.00
Female	1.43 (1.00–2.04)	1.64 (1.12–2.38)	1.30 (0.94–1.80)	1.41 (1.00–2.01)
<b>Race/Ethnicity</b>				
Non-Hispanic White	1.00	1.00	1.00	1.00
Hispanics	0.57 (0.32–0.99)	0.69 (0.39–1.24)	1.23 (0.84–1.81)	1.48 (0.99–2.21)
<b>Education Level</b>				
College Graduate	1.00	1.00	1.00	1.00
< HS	1.12 (0.65–1.94)	1.86 (1.05–3.30)	1.58 (1.04–2.42)	1.64 (1.02–2.64)
HS/GED	1.60 (0.99–2.56)	1.68 (1.03–2.73)	0.88 (0.58–1.36)	0.84 (0.54–1.29)
Some College	1.75 (1.07–2.87)	1.76 (1.06–2.93)	1.20 (0.77–1.88)	1.07 (0.68–1.68)
<b>Household Annual Income<sup>b</sup></b>				
≥ 40 k	1.00	1.00	1.00	1.00
≤ 20 k	1.64 (0.99–2.71)	2.43 (1.38–4.28)	1.77 (1.14–2.76)	1.85 (1.17–2.92)
20–40 k	1.38 (0.82–2.32)	1.42 (0.83–2.43)	0.88 (0.54–1.43)	0.90 (0.55–1.48)
<b>Geographic Location</b>				
Rural	1.00	1.00	1.00	1.00
Urban	0.97 (0.71–1.34)	1.02 (0.72–1.43)	0.92 (0.69–1.23)	0.84 (0.63–1.13)
<b>Hay Fever</b>				
No	1.00	1.00	1.00	1.00
Yes	3.74 (2.71–5.16)	3.62 (2.65–4.95)	2.26 (1.66–3.08)	2.46 (1.80–3.37)
<b>Pet Ownership</b>				
Do not own a pet	1.00	1.00	1.00	1.00
Own a Dog or a Cat	1.01 (0.72–1.40)	0.92 (0.65–1.30)	0.92 (0.67–1.27)	0.84 (0.61–1.17)
Own some other Pet	0.59 (0.27–1.28)	0.53 (0.23–1.25)	1.16 (0.61–2.19)	0.99 (0.49–1.98)
<b>Smoking Status</b>				
Non-Smoker	1.00	1.00	1.00	1.00
Current Smoker	0.67 (0.36–1.24)	0.73 (0.39–1.35)	2.30 (1.51–3.50)	2.73 (1.77–4.21)
Past Smoker	1.51 (1.08–2.10)	1.78 (1.24–2.55)	1.13 (0.82–1.57)	1.36 (0.95–1.96)

**Table 5: Polytomous multiple logistic regression analysis of factors associated with current and probable asthma. (Continued)**

<b>Environmental tobacco smoke</b>				
No	1.00	1.00	1.00	1.00
Yes	0.94 (0.53–1.65)	1.03 (0.58–1.85)	1.37 (0.90–2.08)	1.21 (0.77–1.89)
<b>Self-rated Health</b>				
Excellent/Good	1.00	1.00	1.00	1.00
Fair/Poor	2.08 (1.51–2.86)	2.71 (1.96–3.76)	3.03 (2.25–4.06)	3.41 (2.48–4.68)
<b>Complaint of Pain</b>				
No Pain	1.00	1.00	1.00	1.00
Mild Pain	1.65 (1.04–2.62)	1.61 (1.00–2.62)	1.77 (1.18–2.65)	1.83 (1.22–2.75)
Severe Pain	2.60 (1.84–3.68)	2.35 (1.64–3.36)	4.20 (3.01–5.87)	4.23 (2.99–5.99)
<b>Body Mass Index (BMI)</b>				
Normal Weight (BMI <25)	1.00	1.00	1.00	1.00
Overweight (BMI 25–29.9)	1.34 (0.92–1.94)	1.34 (0.91–1.95)	1.20 (0.84–1.69)	1.28 (0.89–1.86)
Obese (BMI ≥ 30)	1.94 (1.29–2.88)	1.98 (1.30–3.01)	2.00 (1.36–2.94)	2.12 (1.41–3.12)
<b>Health Insurance</b>				
No insurance	1.00	1.00	1.00	1.00
Have insurance	0.67 (0.26–1.71)	0.48 (0.17–1.33)	0.64 (0.28–1.43)	0.64 (0.28–1.47)
<b>Occupation<sup>c</sup></b>				
Administrative/Secretarial	1.46 (1.04–2.03)	1.18 (0.84–1.65)	1.08 (0.79–1.49)	1.01 (0.73–1.40)
Health Related	1.17 (0.63–2.17)	1.01 (0.53–1.93)	0.93 (0.45–1.91)	0.91 (0.44–1.89)
Teaching	0.43 (0.21–0.87)	0.36 (0.18–0.74)	1.04 (0.63–1.73)	1.14 (0.68–1.88)
Service Related	0.70 (0.39–1.25)	0.78 (0.42–1.44)	1.54 (1.00–2.37)	1.47 (0.93–2.30)
Farm Related	1.51 (0.74–3.08)	2.09 (1.00–4.39)	0.74 (0.34–1.59)	0.84 (0.39–1.77)
Precision Production	0.83 (0.45–1.51)	1.11 (0.56–2.17)	1.13 (0.66–1.93)	1.28 (0.73–2.22)
Other Occupations	0.91 (0.62–1.33)	0.94 (0.63–1.41)	0.67 (0.45–0.99)	0.65 (0.43–0.99)

The outcome is a three category variable: no asthma (reference), current asthma, probable asthma.

<sup>a</sup> Adjusted for age, sex, race/ethnicity, smoking status, and history of hay fever.

<sup>b</sup> Missing information was coded as a separate category.

<sup>c</sup> Occupations were coded using dummy variable approach and each occupation was regressed separately.

significant in the univariate analysis (unadjusted OR = 1.54, 95%CI: 1.00–2.37).

### Discussion

Asthma is a frequently overlooked and misdiagnosed medical condition in older patients. Morbidity due to asthma, if not properly diagnosed and managed, can have serious debilitating effects for older individuals. This large population based survey was an attempt to estimate the

prevalence of asthma and its correlates in this population in the west Texas region.

This study found the prevalence of current asthma of 6.3% (95%CI: 5.3–7.2) and an additional 9.0% (95%CI: 7.8–10.1) had probable asthma (symptoms based definition-DFP). In our earlier analysis of NHANES III data, using a similar case definition as reported in this study, we reported a prevalence of current asthma of 3.6%

**Table 6: Summary table of asthma studies in the elderly**

Reference (Year)	Country	Type of Study	Age Group	Final Sample Size (Response Rate-%)	Outcome	Prevalence (95%CI)
Hardie et al [25] (2005)	Norway	Cross-Sectional Survey	70 years and older	1649 (56%)	Current Asthma Wheezing	All: 8.0% (6.5–9.5) Men: 8.1% (6.0–10.2) Women: 8.0% (5.9–10.0) All: 7.7 (6.3–9.1) Men: 10.3 (8.0–12.5) Women: 6.2 (4.4–8.0)
Malik et al [7] (2004)	USA	Community-based Cross-Sectional Survey	> 60 years	380	Doctor Diagnosed Asthma	10% (9.0–16.0)
Mishra [31] (2003)	India	Interview administered Cross-sectional survey	60 years and older	38,582 (98% overall)	[Self-reported] Asthma	Range: 8.5%–12.4% (various age groups) Men: 9.5%–14.0% Women: 7.5%–10.5%
Choy et al. [32] (2002)	China	Cross-sectional survey	70 yrs and older	179 (72%)	[Clinical] Asthma [Symptom-based] Asthma	3.9% (1.6–7.9) 5.0% (2.3–9.3)
Saks et al. [33] (2001)	Estonia	Interview administered survey	≥ 65 years of age	811 (81.1%)	Doctor Diagnosed Asthma	5.5% (3.9%–7.2%)
Romero et al. [4] (2001)	USA	community-based cross-sectional survey	≥ 65 years of age	883 (53%)	[Self reported] Asthma	NHWM*: 9.3% NHWF*: 7.6% HM*: 4.2% HF*: 6.3%
Enright et al. [6] (1999)	USA	Prospective study- Cardiovascular Health Study	≥ 65 years of age	4581	Definite Asthma	3.9%
Parameswaran et al. [26] (1998)	U.K.	Cross-Sectional Survey	> 65 years of age	1362 (68%)	Probable Asthma	4.1%
Nejjari et al. [27] (1996)	France	Cross-sectional based on PAQUID Cohort	≥ 65 years of age	2355 (97.9%)	Asthma Current Asthma	7.0% Overall: 6.1% Men: 7.4% (5.7–9.0) Women: 5.2% (4.1–6.4) Overall: 2.5% Men: 2.9% Women: 2.2%
Isoaho et al. [28] (1994)	Finland	Cross-sectional survey	≥ 65 years of age	1196 (93%)	Self reported Asthma Current Asthma	Men: 7.0% Women: 8.6% Men: 2.9% Women: 3.8%
Burrows et al. [5] (1991)	USA	Cross-sectional as part of a longitudinal study	≥ 65 years of age	804	[Self reported] Asthma Active Asthma	Men: 3.8% Women: 7.1% Overall: 7.5% Men: 7.9% Women: 7.1%
Horsley et al. [29] (1991)	U.K.	Postal Cross Sectional Survey	≥ 65 years of age	1803 (96.2%)	Asthma Current Asthma Wheezing	Overall: 8.4% Men: 9.6% Women: 7.2% Overall: 4.2% Men: 4.9% Women: 3.6% Overall: 24.2% Men: 29.2% Women: 19.7%
Burr et al. [30] (1979)	U.K.	Random Cross-sectional survey	70 yrs and older	418 (86.2%)	Current Asthma [Ever] Asthma	Overall: 2.9% Men: 5.1% Women: 1.8% 6.5%

\* NHWM = non-Hispanic white male, NHWF = non-Hispanic white female, HM = Hispanic male, HF = Hispanic female.

(95%CI 2.9–4.2) in the U.S. population aged 60 and above [24]. The review of previously published population-based studies in the elderly suggests a wide variation in the prevalence of asthma (Table 6). The U.S. studies, on average, have reported a lower prevalence of asthma [4-7] as compared to European studies [25-30]. The four previous studies from the U.S., included in the summary table, found a median prevalence of asthma of 4.7% (range 3.9% to 10%); whereas the median prevalence from the six European studies was 7% (range 6% to 8.4%) (Table 6). The three studies from the Asia-Pacific region [31-33] reported a median prevalence of asthma of 5.5% (range 3.9–10.5). The wide variation in reported prevalence estimates could in part be due to use of different case definitions of asthma or different geographical region which complicates comparison among studies.

Some of the previously well recognized correlates of asthma, such as female gender, low socioeconomic status (as measured by education and income) and hay fever were also identified in this study [24,34]. In addition, smoking, poor health-related QoL, obesity, and certain occupational groups were associated with current or probable asthma.

Associations between smoking and asthma remain a subject of debate. In this study the prevalence of probable asthma was approximately 17% among current smokers; ex-smokers had a higher odds of current asthma (adjusted OR = 1.78, 95%CI: 1.24–2.55) whereas current smokers were more likely to have probable asthma (adjusted OR = 2.73, 95%CI: 1.77–4.21). In a recent study, Hardie et al., [25] reported a greater than two-fold increased odds of current asthma among ex-smokers age 70 years and older. Similarly, a recent incident case-control study reported an increase risk of asthma among ex-smokers [35]. Prior population-based surveys, focusing on younger adults, have largely failed to find such an association. In the NHANES III analysis, a positive association of current smoking was found with the presence of wheezing, but not with current asthma, suggesting possible confounding or misclassification with non-asthma causes of wheezing, such as emphysema or chronic bronchitis [24]. Similarly, results from the European Community Respiratory Health Survey (ECRHS) also found no association of asthma with either a current or past history of smoking [34]. Since ECRHS is a study of young adults, it is possible that, being of lesser duration, exposure to tobacco smoke has not yet had time to cause serious damage to airways that may contribute to the appearance of asthma. An alternative explanation could be that the general decline in prevalence of smoking in most developed countries partly explains the lack of association observed in the younger population. The results of this study suggest that despite quitting smoking, the airway damage is not completely

reversible. However, further studies are needed in older populations to assess the long term impact of smoking on asthma.

Self-rated health is considered a valid measure of person's health [36,37] and has been shown to relate directly to quality of life [38]. The SF-12 has been used previously to measure health outcomes for persons suffering from asthma [39] and COPD [40]. Use of both generic and asthma specific QoL measures are recommended to assess the impact of asthma on patient's daily life [41]. In a large community survey of elderly, Enright and colleagues [6] reported that subjects with asthma had significantly lower QoL and higher degree of impairment of activities of daily living. They were more likely to report symptoms of depression and poor general health. Similarly, Nejjari and colleagues [42] in a population based case-control study reported that older subjects with asthma were more likely to report lower QoL than controls. Breathlessness was reported as a major cause of lower QoL. In this study more than one-third of participants rated their health as fair or poor. Among those with current and probable asthma this percentage increased to approximately 50% and 60%, respectively. Since such a large proportion of subjects with probable asthma (i.e., without a clinical diagnosis of asthma) complained of poor health, it is possible they represent a group with as yet undiagnosed (and, hence, untreated) asthma. In addition, both current and probable asthma were associated with severe pain, poor physical health related quality of life and poor performance on the mini-Asthma QoL environmental domain subscale, all of which add consistency to this impression.

Although several recent studies are finding an association, the relationship between asthma and obesity remains controversial or, at best, unexplained. This association has been observed in children and adults, [24,43] as well as among nurses [44] and other health care workers (author's unpublished data). In this study we report a positive association between current asthma and obesity in the elderly, which was only significant among females (adjusted OR = 2.74, 95%CI 1.74–4.33; *p* value for interaction term = 0.038). The interaction term was not statistically significant for probable asthma. These findings are consistent with those of other population-based studies [44-47]. Beckett et al., [46] in a prospective study of 4547 African-American and White men and women, found a significant association between incident asthma and body mass index in females only. Camargo and colleagues, in a prospective study of registered nurses, found an association between body mass index and incident cases of asthma [44]. Chen et al., [47] in a large longitudinal study of the Canadian population reported a significant association between obesity and development of asthma among women. However, these and our results contrast some-

what to recently reported results from an incident case-control study on Swedish adults which reported an odds ratio of 3.0 and 3.3 in both females and males respectively [35]. The authors included 309 cases of incident asthma of which 202 (65%) were women. Although the authors enrolled an equal number of controls, they did not provide information on the gender distribution of this comparison group. Moreover, they did not adjust their results for known confounders including smoking and hay fever, which in part could explain the discrepant findings. Although a biological mechanism to explain such an association remains elusive, the strong evidence observed across all age groups, among different occupational groups, and from studies of all types (cross-sectional surveys, case-control studies and prospective studies) suggests a possible causal relationship between obesity and asthma.

In this study two occupational groups were significantly associated with current asthma. Those who reported teaching as their longest held occupation were 0.36 times less likely to have current asthma. This is in contrast to other reports that found higher rates of asthma among teachers including our own studies in other populations [18,48]. Kraut et al., [48] reported elevated odds ratios for "other teaching and related occupations" (OR 2.54, 95% CI 1.18–5.44); Whelan et al., [49] reported higher prevalences of work-related upper respiratory symptoms and wheezing among teachers, but not asthma. Differences in the study population could in part explain the discrepant findings. Alternately, the lower odds observed among teachers in this study could reflect a cohort effect. Following the energy crisis of the 1970s, schools were made more airtight. This resulted in school buildings with poor ventilation and excess moisture, and the subsequent risk of exposure to multiple antigens, including mold and other indoor air contaminants [50,51]. It is plausible that teachers in this group may have worked in this profession before changes were made to school building codes, and may not have been exposed to the poor indoor air quality and other environmental conditions that are being reported by the younger working population.

Farm-related occupations have previously been reported to be associated with asthma among adults, as is in this study. In the present study, subjects with farm-related occupations had twice the odds of current asthma. When the data were stratified by gender, the association was primarily seen in males (adjusted OR = 2.51, 95%CI: 1.02–6.21). There was no difference in the prevalence of hay fever among those with or without farming occupations, raising the possibility that the increased prevalence of current asthma in this population is of non-allergic origin. This is consistent with recently reported findings in Norwegian farmers with current asthma that was of non-

atopic origin [52]. In our earlier analyses of NHANES III data, [18] a greater than four-fold odds of work-related asthma (OR = 4.22, 95%CI: 1.76–10.10) was observed among those with farm-related occupations. In the French PAQUID cohort, retired farm workers (aged 65 and older) had more than five times the odds (OR = 5.35, 95%CI: 1.33–21.50) of current asthma [27]. Similarly, Kogevinas et al., [53] reported an odds ratio of 2.62 (95% CI 1.29–5.35) among farmers who participated in the ECRHS.

The service-related occupation group had significantly higher odds of probable asthma in the unadjusted analyses only. The three major groups that made up this occupational category were: food-related, housekeepers/janitors, and hairdressers. All of these occupations, which involve use of chemicals and substances that are respiratory irritants, have previously been associated with increase risk of asthma [18,54].

There were some limitations of this study. Since the study was cross-sectional in nature, cause and effect relationship cannot be established. There were 41 subjects who reported having both current asthma and chronic bronchitis; inclusion of these subjects caused a slight overestimation of current asthma prevalence. Respondents with chronic bronchitis were not excluded from the analysis because symptoms of asthma and chronic bronchitis can overlap, especially in the old age. Smoking confounds asthma and subjects with asthma tend to become incomparable with regard to smoking habits than those without asthma. It was difficult to separate these associations in a cross-sectional survey. Another limitation of the study is possible misclassification of current asthma status. Study respondents whose asthma was in control or in remission at the time of study may have responded as not having asthma and hence been classified as being non-asthmatic; however, if their asthma was not under control, they may have responded affirmatively to questions on asthma diagnosis, being thus classified as having current asthma. The survey sample attrition over time is also a potential concern. However, no evidence for differential survival was found in the study. With advancing age, quality of life in asthmatics can be compromised due to the concurrent presence of other chronic medical conditions, which could also partly explain the poor physical QoL observed in this study. However, our results are consistent with earlier findings where both the moderate or severe persistent asthma was associated with poor QoL among the elderly [55]. Finally, no reference values are available for mini Asthma QoL in the general elderly population; this fact, in addition to absence of indoor monitoring data, makes the interpretation of low scores on the environmental domain subscale of the Asthma QoL (reflecting poor QoL) difficult.

## Conclusion

This study found that asthma is a common medical condition among the elderly. Several factors including female gender, low socio-economic status, hay fever, obesity, and smoking status were associated with current or probable asthma. The majority of subjects with current or probable asthma rated their health as fair or poor and their quality of life was compromised. Male farmers had higher odds of current asthma; whereas lower odds of current asthma, possibly due to a cohort effect, were observed among those who were in a teaching occupation.

## Competing interests

The author(s) declare that they have no competing interests.

## Authors' contributions

AA carried out the study as part of funding from the National Institute of Aging, performed statistical analyses and drafted the manuscript. JER participated in the design of the study and draft of the manuscript. GD participated in the analysis and interpretation of occupational section of the manuscript. All authors read and approved the final manuscript.

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