



Significant predictors of poor quality of life in older asthmatics

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ABSTRACT

Background: Morbidity and mortality from asthma are high in older adults and quality of life (QOL) might be lower, although standardized measurements of QOL have not been validated in this population.

Objective: To determine predictors of asthma-related QOL in older adults.

Methods: Allergy and pulmonary outpatients ($n = 164$) at least 65 years old with an objective diagnosis of asthma completed the Mini-Asthma Quality of Life Questionnaire (mAQLQ). Demographics, medical history, and mean value for daily elemental carbon attributable to traffic, a surrogate for diesel exposure, were obtained. Regression analysis was used to determine predictors of mAQLQ scores.

Results: Total mAQLQ (mean $\pm$ SD 5.4 ± 1.1) and symptom, emotional, and activity domain scores were similar to those of younger populations, whereas environmental domain scores (4.4 ± 1.7) appeared lower. Poorer mAQLQ scores were significantly associated with emergency department visits (adjusted β [$a\beta$] = -1.3 , where β values indicate the strength and direction of association, $P < .0001$) and with poorer scores on the Asthma Control Questionnaire ($a\beta = -0.7$, $P < .0001$). Greater ECAT exposure ($a\beta = -1.6$, $P < .02$), female sex ($a\beta = -0.4$, $P < .006$), body mass index of at least 30 kg/m^2 ($a\beta = -0.4$, $P < .01$), gastroesophageal reflux ($a\beta = -0.4$, $P < .01$), nonatopic status ($a\beta = -0.5$, $P < .002$), and asthma onset before 40 years of age ($a\beta = -0.5$, $P < .004$) were significantly associated with poorer mAQLQ scores.

Conclusion: The mAQLQ scores in older adults with stable asthma were similar to those in younger populations and were predictive of other measurements of asthma control, verifying that the mAQLQ is an appropriate tool in older adults with asthma. Traffic pollution exposure was the strongest predictor of poorer asthma-related QOL in older adults with asthma.

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Introduction

The burden of asthma on adults at least 65 years old is significant and under-recognized. The prevalence of asthma in this age group is as high as 10% and continues to increase as the population ages.^{1,2} There are at least 2 million adults older than 65 years with

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asthma in the United States, with an anticipated increase to at least 5 million by 2030.³ Older adults with asthma have higher morbidity and mortality than younger adults with asthma, accounting for a larger number of hospitalizations, longer hospital stays, and more than 50% of deaths from asthma.^{3–6} The direct economic cost of care for seniors with asthma, including hospitalizations, visits to practitioners, and medications, is double that of younger adults with asthma.⁷ Despite these sobering statistics, asthma in older adults is frequently underdiagnosed and undertreated, and a paucity of studies has been conducted on this population.^{1,3}

Improving health-related quality of life is a major emphasis in geriatric medicine and in the management of chronic diseases such as asthma.^{8–10} Despite this, few studies have quantified the impact of asthma on quality of life in older adults, and most have used non-asthma-specific tools or tools that have not been validated in geriatric

populations.^{8,10–16} The Mini-Asthma Quality of Life Questionnaire (mAQLQ) is a validated 15-item questionnaire designed to determine the impact of asthma on quality of life. It is ideally suited for large studies involving geriatric populations given its brevity and ease of interpretation.¹⁷ Despite speculation that asthma-related quality of life is lower in older adults with asthma, studies involving the mAQLQ have included small numbers of adults older than 65 years.^{18–20} In addition, few studies have administered the mAQLQ to older adults with stable asthma in an outpatient setting. Identifying factors that predict poor total mAQLQ scores and specific domain scores could lead to interventions that will significantly improve quality of life in this growing demographic. Therefore, this study sought to quantify the impact of asthma on quality of life in a large group of older adults with asthma using the mAQLQ. To the authors' knowledge, this is the largest study to date using the mAQLQ to evaluate quality of life specifically in adults at least 65 years old with asthma, and one of the first to identify factors that predict poorer asthma-related quality of life in this population.^{11,13,14,19}

Methods

Study Population

Data from participants in the Cincinnati Asthma Severity in Older Adults study were used for this study.²¹ The cohort includes 175 adults at least 65 years old with asthma recruited from 2010 through 2012 with a physician's diagnosis of asthma and objectively confirmed by spirometry or methacholine challenge testing.²² Exclusion criteria included a physician's diagnosis of chronic obstructive pulmonary disease or at least class 3 congestive heart failure. Former smokers were not excluded, unless they had a diagnosis of chronic obstructive pulmonary disease, because the prevalence of former smoking in this age group is so high ($\geq 50\%$) that exclusion of such individuals would have made the cohort unrepresentative of the general older asthmatic population.²³ The cohort was recruited from allergy and pulmonology subspecialty clinics to increase the ability to identify risk factors for more severe asthma.²¹ Participants signed an informed consent approved by the University of Cincinnati (Cincinnati, Ohio) institutional review board.

Data Collection

All subjects in the cohort were contacted by telephone to complete the mAQLQ during a telephone interview with a physician. Up to 5 attempts at various times of day were made to contact subjects. The mAQLQ could not be completed by 11 subjects because they were recently deceased (5), declined to participate (1), or were lost to follow-up (5). The remaining 164 subjects completed the mAQLQ from February to June 2013. Responses were saved onto an electronic database and de-identified for analysis.

Enrolled participants also completed a standardized, close-ended questionnaire from 2010 through 2012 that gathered previously published data on demographics, health characteristics, and exposures.²¹ A physical examination was performed and medical history, including exacerbations in the previous year, was obtained by a board-certified allergist and verified by medical records. Patients completed the 6-item Asthma Control Questionnaire (ACQ), Asthma Control Test (ACT), and spirometry according to American Thoracic Society guidelines.^{24,25} Skin prick testing to 10 common aeroallergens was performed, including cat, dog, timothy grass, white oak, maple mix, short ragweed, dust mite mix (50% *Dermatophagoides farinae* and 50% *Dermatophagoides pteronyssinus*), *Alternaria tenuis*, *Aspergillus fumigatus*, and German cockroach. Mean daily elemental carbon attributable to traffic (ECAT), a surrogate for chronic diesel ultrafine particulate exposure, was derived from a previously described land-use regression model that integrated traffic and local geographic land-use variations to estimate

air pollution exposure.^{21,26} Residential addresses from participants in this study were geocoded and the land-use regression model was applied to the subjects' current residential addresses to estimate ECAT exposure.²¹ Thus, estimated ECAT exposure served as a marker of traffic-related air pollution exposure.

Mini-Asthma Quality of Life Questionnaire

The mAQLQ is a validated 15-item survey modified from the original 32-item AQLQ to improve the ease of collecting information about functional impairments in patients with asthma.^{17,27,28} The survey queries patients regarding 4 domains of asthma-related quality of life in the previous 2 weeks: symptoms, emotional function, environmental stimuli, and activity limitation. Responses are rated from 1 (total limitation) to 7 (no limitation). The score for each domain is derived by taking the average of responses to domain-specific questions. The total mAQLQ score reflects the average for responses to all 15 questions. A higher mAQLQ score denotes better asthma-related quality of life.

Statistical Analysis

Total mAQLQ and specific domain scores were determined. General linear regression was used to evaluate the relationship between mAQLQ scores and other asthma outcomes (ACQ scores, ACT scores, and number of emergency department [ED] visits). Multivariate linear regression was used to evaluate the relationship between mAQLQ scores and demographic and health characteristics and exposures listed in Table 1. Variables included in the final model based on backward elimination with a *P* value less than .15 are listed in Table 2. Separate regression analyses were conducted to evaluate the relationship between specific domain scores (symptom, environment, emotional, and activity) and demographic and health characteristics and exposures. The ECAT was analyzed as a

Table 1

Demographics, health characteristics, and exposures for 164 participants at least 65 years old with asthma

Characteristic and exposure	n (% of 164) ^a
Women	88 (54%)
Men	76 (46%)
Race	
White	134 (82%)
African American	27 (17%)
Hispanic	2 (1%)
Native American	1 (1%)
Annual income	
Mean $\pm$ SD	\$41,097 $\pm$ 17,312
$\leq$ \$40,000	75 (46%)
BMI (kg/m ²)	
Mean $\pm$ SD	30.2 $\pm$ 6.5
BMI ≥ 30 kg/m ²	75 (46%)
GERD	99 (60%)
OSA	14 (9%)
Atopic (SPT ⁺)	107 (66%)
Eczema or atopic dermatitis	22 (13%)
Nasal polyposis	36 (22%)
Age at asthma symptom onset <40 y	91 (56%)
Ever smoked cigarettes, cigars, or a pipe	76 (47%)
Currently smoke	0
Depression	58 (35%)
ECAT	
High (0.39–0.81 μ g/m ³)	46 (29%)
Low (0.23–0.38 μ g/m ³)	113 (71%)

Abbreviations: BMI, body mass index; ECAT, elemental carbon attributable to traffic; GERD, gastroesophageal reflux; OSA, obstructive sleep apnea; SPT⁺, positive skin prick test reaction.

^aFor binary data, results are presented as number (percentage of 164 subjects). Mean and SD are presented for continuous data. Complete data were available for 161 subjects regarding nasal polyps, 160 subjects regarding OSA, 159 subjects regarding atopy, and 163 subjects regarding smoking history.

Table 2Demographic and health characteristics vs Mini-Asthma Quality of Life Questionnaire scores in 164 subjects at least 65 years old with asthma^a

Characteristic	Unadjusted β (95% CI)	Adjusted β (95% CI) ^b	P value ^b
Female sex	−0.6 (−0.9 to −0.2)	−0.4 (−0.7 to −0.1)	.006
BMI ≥ 30 kg/m ²	−0.6 (−0.9 to −0.2)	−0.4 (−0.7 to −0.1)	.01
GERD	−0.7 (−1.0 to −0.3)	−0.4 (−0.7 to −0.1)	.01
Atopic (SPT ⁺)	0.6 (0.2 to 1.0)	0.5 (0.2 to 0.9)	.002
Age at asthma symptom onset < 40 y	−0.5 (−0.8 to −0.1)	−0.5 (−0.8 to −0.2)	.004
ECAT	−2.3 (−3.9 to −0.8)	−1.6 (−3.0 to −0.3)	.02
Composite adherence score	−0.1 (−0.2 to −0.03)	−0.1 (−0.1 to 0.003)	.06

Abbreviations: BMI, body mass index; CI, confidence interval; ECAT, elemental carbon attributable to traffic; GERD, gastroesophageal reflux; SPT⁺, positive skin prick test reaction.

^aComplete data for multivariate analysis were available for 153 subjects.

^bThe β -coefficients represent the relation between continuous Mini-Asthma Quality of Life Questionnaire scores and characteristics in the left-hand column. Adjusted β -coefficients and P values are shown only for covariates with a P value less than .15 in the final regression model. Characteristics that were not significantly associated with Mini-Asthma Quality of Life Questionnaire scores in the final model included race (white 0.4 [−0.02 to 0.9], African American −0.3 [−0.8 to 0.2], Hispanic −1.8 [−3.4 to −0.2], Native American 0.03 [−2.2 to 2.3]), income no higher than \$40,000 (−0.2 [−0.6 to 0.1]), obstructive sleep apnea (−0.5 [−1.1 to 0.1]), eczema or atopic dermatitis (0.2 [−0.3 to 0.7]), nasal polyposis (0.2 [−0.3 to 0.6]), ever smoked cigarettes, cigars, or a pipe (−0.1 [−0.5 to 0.2]), and depression (physician diagnosed; −0.4 [−0.8 to −0.1]).

logarithmically transformed, continuous variable. Atopy was defined as at least 1 positive skin prick test reaction to a panel of 10 aero-allergens.²¹ Body mass index (BMI) was dichotomized at the cutoff point for obesity at less than vs greater than 30 kg/m². Income was dichotomized at the median income of \$40,000 annually. Age at asthma symptom onset was dichotomized at 40 years, which is generally considered the end of young adulthood.

Results

Demographic and Health Characteristics and Exposures

Characteristics of 164 participants at least 65 years old with asthma are listed in Table 1. The mean age of included subjects was 73 $\pm$ 6.3 years. There were slightly more women (54%) than men. Other demographic and racial characteristics were reflective of the population of greater Cincinnati. Eighty-two percent of subjects were white and 17% were African American. The mean annual income was \$41,097 $\pm$ \$17,312, and 46% of subjects had an income less than or equal to \$40,000 per year. Forty-six percent were obese. Physician-diagnosed gastroesophageal reflux disease (GERD) also was highly prevalent (60%), and 66% of subjects were atopic based on having at least 1 positive skin prick test reaction. Nine percent of subjects had self-reported obstructive sleep apnea (OSA), 13% had current or previous self-reported eczema or atopic dermatitis, and 22% had a physician's diagnosis of nasal polyposis. Fifty-eight percent of subjects with nasal polyposis were atopic. Thirty-five percent of subjects reported a current or previous diagnosis of depression. A slight majority (56%) reported asthma symptom onset before 40 years of age. There were no current smokers, although 47% of subjects reported a history of smoking cigarettes, cigars, or a pipe, with 25% having smoked at least 10 pack-years. Twenty-nine percent of subjects had high (≥ 0.39 $\mu\text{g}/\text{m}^3$) ECAT, a surrogate for diesel particulate exposure, based on a linear spline model.²¹

mAQLQ Scores

The mean $\pm$ SD of mAQLQ scores was 5.4 $\pm$ 1.1. The mean scores for the symptom, environment, emotional, and activity domains were 5.4 $\pm$ 1.3, 4.4 $\pm$ 1.7, 5.3 $\pm$ 1.7, and 6.1 $\pm$ 1.1, respectively.

Table 3

Relationship between mAQLQ scores and ACQ score, ACT score, and ED visits in 164 subjects at least 65 years old with asthma

Asthma outcome	Subjects, n (% of 164)	β -Coefficient (95% CI) ^a	P value
ACQ ^b	38 (23%)		
Continuous		−0.7 (−0.9 to −0.5)	<.0001
≥ 1.5 (categorical)		−1.4 (−1.8 to −1.1)	<.0001
ACT ^c	60 (38%)		
Continuous		0.2 (0.02–0.3)	<.0001
< 20 (categorical)		−1.3 (−1.6 to −1.0)	<.0001
ED visits	15 (9%)		
Number of ED visits		−0.2 (−0.3 to −0.03)	.02
Any ED visits		−1.3 (−1.9 to −0.7)	<.0001

Abbreviations: ACQ, Asthma Control Questionnaire–6; ACT, Asthma Control Test; CI, confidence interval; ED, emergency department; mAQLQ, Mini-Asthma Quality of Life Questionnaire.

^aRepresents the relationship between continuous mAQLQ scores and other asthma outcomes in the left-hand column. A more positive β -coefficient indicates a stronger positive association; a more negative β -coefficient indicates a stronger inverse (negative) association. Higher mAQLQ scores indicate better asthma-related quality of life.

^bAn inverse association between continuous ACQ scores (where higher ACQ scores are worse) and mAQLQ scores indicates that poorer asthma control is associated with poorer scores on the mAQLQ.

^cA positive association between continuous ACT scores (where higher scores indicate better asthma control) and mAQLQ scores indicates that better asthma control is associated with better scores on the mAQLQ. An inverse association between an ACT score lower than 20 and mAQLQ scores indicates that poorer asthma control is associated with poorer mAQLQ scores.

Relation between mAQLQ Scores and Asthma Outcomes

The relationship between mAQLQ scores and the ACQ, ACT, and ED visits is presented in Table 3. Poorer mAQLQ scores were significantly associated with poorer asthma control based on ACQ scores when ACQ was analyzed continuously (higher ACQ scores indicate poorer control; $\beta = -0.7$ [95% confidence interval −0.9 to −0.5], $P < .0001$). This also was the case when using a validated cutoff point for not well-controlled asthma ($n = 38$ subjects with ACQ score ≥ 1.5 ; $\beta = -1.4$ [−1.8 to −1.1], $P < .0001$).²⁹ Findings were similar for ACT scores ($n = 60$ subjects with ACT score < 20 , indicating not well-controlled asthma; $\beta = -1.3$ [−1.6 to −1.0], $P < .0001$).³⁰ In addition, having at least 1 ED visit in the previous year ($n = 15$) was significantly associated with poorer mAQLQ scores ($\beta = -1.3$ [−1.9 to −0.7], $P < .0001$), as was the total number of ED visits in the previous year ($\beta = -0.2$ [−0.3 to −0.03], $P = .02$).

Relation between Subject Characteristics and Total mAQLQ Scores

Findings from a multivariate regression analysis of the relationship between demographics, health characteristics and exposures, and mAQLQ scores are presented in Table 2. Note that a negative β -coefficient, which represents the “slope” of the regression line, indicates that a covariate is associated with poorer asthma-related quality of life, because higher mAQLQ scores indicate better quality of life. Higher ECAT levels were significantly associated with poorer mAQLQ scores (adjusted β [$a\beta$] = −1.6 [−3.0 to −0.3], $P = .02$, after adjustment for other significant covariates listed in Table 2). This relationship was independent of income, and income was not significantly associated with mAQLQ scores in the univariate or multivariate analysis. Female sex was significantly associated with poorer mAQLQ scores ($a\beta = -0.4$ [−0.7 to −0.1], $P = .006$). Being obese (BMI ≥ 30 kg/m²) and having GERD also were significantly associated with poorer mAQLQ scores ($a\beta = -0.4$ [−0.7 to −0.1], $P = .01$ and $a\beta = -0.4$ [−0.7 to −0.1], $P = .01$, respectively). Subjects with atopy had better mAQLQ scores ($a\beta = 0.5$ [0.2–0.9], $P = .002$), whereas asthma onset at younger than 40 years was associated with poorer asthma-related quality of life ($a\beta = -0.5$

Table 4
Adjusted β -coefficients and P values representing the relation between demographics, health characteristics and exposures, and mAQLQ domains for 164 subjects at least 65 years old with asthma^a

mAQLQ domain	Female sex		ECAT ($\mu\text{g}/\text{m}^3$)		BMI ≥ 30 kg/m ²		Symptom onset <40 y		Atopy		Nasal polyps		GERD		Ever smoked cigarettes, cigars, or a pipe		OSA	
	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value	β -Coefficients (95% CI)	P value
Environmental	−0.7 (−4.3 to −0.2)	.004	−2.2 (−4.3 to −0.09)	.04	−0.4 (−0.9 to 0.08)	.1	−0.8 (−1.3 to −0.3)	.001	0.6 (0.04 to 1.1)	.04	—	—	−0.9 (−1.4 to −0.4)	.0005	—	—	—	—
Emotional	−0.4 (−0.9 to 0.07)	.10	−1.9 (−4.1 to 0.3)	.08	−0.4 (−0.9 to 0.10)	.10	−0.7 (−1.2 to −0.1)	.01	0.7 (0.2 to 1.3)	.007	—	—	—	—	—	—	—	—
Symptoms	−0.5 (−0.9 to −0.1)	.01	−1.4 (−3.1 to 0.3)	.10	−0.4 (−0.8 to 0.009)	.06	−0.4 (−0.8 to 0.1)	.06	0.4 (0.02 to 0.8)	.04	0.4 (−0.07 to 0.8)	.10	−0.4 (−0.8 to −0.5)	.03	−0.3 (−0.7 to 0.06)	.10	—	—
Activity	−0.5 (−0.8 to −0.2)	.001	—	—	−0.3 (−0.6 to 0.04)	.03	−0.3 (−0.6 to −0.03)	.03	0.5 (0.1 to 0.8)	.004	—	—	−0.3 (−0.6 to −0.01)	.04	−0.2 (−0.5 to 0.05)	.10	−0.8 (−1.3 to −0.3)	.004

Abbreviations: BMI, body mass index; CI, confidence interval; ECAT, elemental carbon attributable to traffic; GERD, gastroesophageal reflux; OSA, obstructive sleep apnea; mAQLQ, Mini-Asthma Quality of Life Questionnaire.

^aOnly findings with a P value less than .15 in the final regression model are presented. Adjustments for covariates are listed in Table 3.

[−0.8 to −0.2], $P = .004$). Factors that were not significantly associated with mAQLQ scores are listed in the notes to Table 2.

Predictors of mAQLQ Domain Scores

The relationship between subject characteristics and mAQLQ domains is presented in Table 4 for findings with a P value less than .15.

Environmental domain

Poorer environmental domain scores were significantly associated with higher ECAT levels (ie, traffic pollutants; $a\beta = -2.2$ [−4.3 to −0.09], $P = .04$), female sex ($a\beta = -0.7$ [−4.3 to −0.2], $P = .004$), asthma symptom onset before 40 years of age ($a\beta = -0.8$ [−1.3 to −0.3], $P = .001$), and GERD ($a\beta = -0.9$ [−1.4 to −0.4], $P = .0005$). Atopy was significantly associated with better environmental domain scores ($a\beta = 0.6$ [0.04–1.1], $P = .04$).

Emotional domain

Poorer emotional domain scores were significantly associated with asthma symptom onset before 40 years of age ($a\beta = -0.7$ [−1.2 to −0.1], $P = .01$). Atopy was significantly associated with better emotional domain scores ($a\beta = 0.7$ [0.2–1.3], $P = .007$).

Symptom domain

Poorer symptom domain scores were significantly associated with female sex ($a\beta = -0.5$ [−0.9 to −0.1], $P = .01$) and GERD ($a\beta = -0.4$ [−0.8 to −0.5], $P = .03$). Atopy was significantly associated with better symptom domain scores ($a\beta = 0.4$ [0.02–0.8], $P = .04$).

Activity domain

Poorer activity domain scores were significantly associated with female sex ($a\beta = -0.5$ [−0.8 to −0.2], $P = .001$), BMI of at least 30 kg/m² ($a\beta = -0.3$ [−0.6 to 0.04], $P = .03$), asthma symptom onset before 40 years of age ($a\beta = -0.3$ [−0.6 to −0.03], $P = .03$), GERD ($a\beta = -0.3$ [−0.6 to −0.01], $P = .04$), and OSA ($a\beta = -0.8$ [−1.3 to −0.3], $P = .004$). Atopy was significantly associated with higher activity domain scores ($a\beta = 0.5$ [0.1–0.8], $P = .004$).

Discussion

Despite high morbidity and mortality from asthma in older adults, few studies have evaluated the impact of poorly controlled asthma on quality of life in this population.^{10,12,13,19} This is one of the first studies using a survey instrument that has been validated in younger populations to quantitatively assess asthma-related quality of life in older adults. In addition, this is the largest study to date using the validated mAQLQ to define characteristics and exposures affecting quality of life for this demographic. Data from older subjects with asthma were obtained in part for the purpose of drawing comparisons between similar data obtained from the literature from younger subjects with asthma. Although some predictors of poor asthma-related quality of life in younger populations appear to be important in older populations, several novel findings emerged.

As has been shown in younger adults with asthma, asthma-related quality of life based on the mAQLQ correlated well with asthma control, based on ACQ score, ACT score, and ED visits for this population of ambulatory older adults. Total mAQLQ scores in this study were similar to those in subjects with stable asthma of various ages.^{10,17,18,31–33} For example, in a validation study performed by Juniper et al¹⁷ on 39 subjects with symptomatic asthma 18 to 65 years old, mean mAQLQ scores were 5.4 ± 0.9 , whereas the older adult population in this study had mean mAQLQ scores of 5.35 ± 1.13 . Individual domain scores also were similar to those of younger patients, except for the environmental domain (4.9 ± 1.4 for patients 18–65 years old in the study by Juniper et al vs

4.37 $\pm$ 1.71 in older adults).¹⁷ Differences in environmental domain scores might be explained by increased susceptibility to traffic pollution in older adults with asthma, as described below. Taken together, these findings suggest that the mAQLQ is an appropriate tool to assess quality of life in adults older than 65 years with asthma and should be considered, along with other validated tools, when assessing responses to medical treatments and other interventions for asthma in older adults.

To the authors' knowledge, this is the largest study examining quality of life in older adults with asthma and the first to examine traffic pollution as a predictor for quality of life specifically in adults at least 65 years old with asthma. Although few studies have included adults older than 65 years, an association between traffic-related air pollution and poorly controlled asthma in older adults has been reported.^{21,34} It has been speculated that older adults with asthma might be more susceptible to traffic pollution-related effects because of increased susceptibility to oxidative stress.³⁵ A previous study using this cohort also showed increased lung inflammation in older adults with asthma and greater exposure to traffic exhaust.³⁶ In the present study, higher levels of exposure to ECAT, a surrogate for diesel particulate exposure, were associated with poorer quality of life in the total mAQLQ score and in the environmental domain, which is comprised of questions related to symptoms associated with dust, cigarette smoke, weather, and air pollution exposure. This relationship was independent of annual income. Therefore, residential proximity to traffic exhaust should be considered as part of the history for patients older than 65 years with asthma. This should especially be considered in older adults with asthma who are not responding to traditional therapies, because their decreased quality of life could be influenced by environmental exposures.

Female sex was associated with poorer quality of life in the total AQLQ score and in the environmental, symptom, and activity domains. This is consistent with findings from studies in younger groups showing that women with asthma have poorer asthma-related quality of life.²⁰ Women make more visits to providers, undergo more tests, and are prescribed more medications than men.^{37,38} It also has been suggested that men might under-report their symptoms compared with women.^{20,39} Proposed mechanisms for poorer asthma control in women include increased susceptibility to environmental triggers, increased bronchial hyperresponsiveness, increased awareness of dyspnea possibly owing to less inspiratory muscle strength, a smaller respiratory reserve compared with men, and higher rates of anxiety and depression.^{40–44} A relationship between changes in sex hormones and asthma in older women also has been proposed but has not been well defined.⁴⁵

As has been demonstrated in younger adults with asthma, obesity was significantly associated with poorer asthma-related quality of life in older adults with asthma.^{46,47} Another study of the same cohort found that obesity was a major predictor of poor asthma control based on ACQ scores.²¹ In addition, older subjects with asthma and an elevated BMI had poorer activity domain scores. OSA also was associated with poorer quality of life scores in the activity domain, possibly because of the association of OSA with obesity.⁴⁸ Wearing a continuous positive airway pressure machine could trigger asthma symptoms if humidification is not properly adjusted.⁴⁹ Although it is unknown whether the subjects in the present study were obese before developing asthma or vice versa, multiple other studies have suggested mechanisms for decreased asthma control owing to obesity, including alterations in lung volume and compliance, secretion of proinflammatory hormones owing to excess adipose tissue, and increased dyspnea owing to altered chest wall mechanics.^{50,51} In addition, obese adults with asthma could be less responsive to asthma medications and might require unique therapies to achieve optimal control.⁵² Weight

reduction has been associated with improved asthma control and quality of life in younger populations.⁵³ Interventions targeting weight loss in obese older patients with asthma should be strongly considered.

Having GERD also was a predictor for poorer asthma-related quality of life in the total mAQLQ score and in the environmental, symptom, and activity domains. Cough related to GERD can affect quality of life even in patients with well-controlled asthma.⁵⁴ Treatment of GERD in studies that included some subjects older than 65 years with asthma has been shown to improve quality of life and to specifically improve the emotional domain.⁵⁵ Therefore, identifying and addressing concomitant GERD in older patients with asthma should be attempted.

Interestingly, being nonatopic was associated with poorer quality of life in this older asthmatic population. A previous study of this cohort also indicated that asthmatic subjects without atopy had poorer asthma control based on ACQ scores.²¹ This is in contrast to some previous studies associating a high degree of atopy with poorer quality of life in older patients with asthma.^{12,21} Although some previous studies have indicated that nasal polyposis affects asthma outcomes,⁵⁶ no such association was found in this study, possibly because most subjects with nasal polyposis also had atopy. Reasons for differences in asthma-related quality of life based on atopic status have not been fully elucidated. One study found that older patients with asthma and atopy were less likely to miss physician appointments, require steroids, or have ED visits than those without atopy, which they hypothesized could be due to being seen regularly for other atopic diseases.¹⁹ Moreover, patients without atopy and with asthma might be less responsive to treatments designed for those with atopy. The present sample size was not adequate to determine whether subjects without atopy and with asthma might be more susceptible to the impact of air pollution on asthma-related quality of life. Future studies that are designed to investigate the susceptibility of specific older asthmatic phenotypes to air pollutants might be enlightening.

For reasons that are not entirely clear, onset of asthma after 40 years of age was associated with improved quality of life based on total mAQLQ scores and for each of the quality of life domains. Late-onset asthma has been associated with higher quality of life in at least 1 other study.⁵⁷ In addition, another study found that older patients with long-standing asthma had lower lung function and a lower quality of life.⁵⁸ Decreased lung function was not associated with a younger age of asthma onset in the present cohort; however, the study was not specifically powered to analyze such differences. Another possible explanation is that patients with long-standing asthma might be less compliant with current standards of asthma care owing to differences in asthma education and treatment strategies at the time of their diagnosis. Unpublished data from this cohort suggest that patients with late-onset asthma have better adherence to asthma medications (J. Tan, unpublished data, 2015). If this finding is confirmed, then educational initiatives targeting improved adherence, particularly in patients with long-standing asthma, should be considered.

Limitations of this study include the cross-sectional study design and the possible lack of applicability of certain questions on the mAQLQ to some older patients with asthma. For example, questions regarding "strenuous activity" might not be as pertinent to older adults with physical disabilities. In the future, it might be beneficial to modify questions involving the activity domain to better suit the daily routine of older adults. In addition, some questions related to sleep and shortness of breath could be complicated by other comorbidities experienced by this population. It also should be noted that findings from this study might not apply to more physically or cognitively impaired older adults with asthma, because participants in this study had adequate physical and cognitive functioning to come to an outpatient office for study

visits, complete spirometry, and answer survey questions. In addition, outpatient populations are generally more stable in terms of asthma control and might have better quality of life than patients who frequently visit EDs or urgent care centers. Another possible limitation is that some individuals included in the cohort could have had a chronic obstructive pulmonary disease overlap syndrome; however, no differences in mAQLQ or other asthma outcomes were identified based on smoking history.

Little is known regarding the impact of asthma on quality of life in older adults, despite the growing prevalence of the disease in this population. This study shows that the mAQLQ can be used to assess quality of life in older patients with asthma, and that findings correlate well with other validated measurements of asthma control. The impact of traffic pollution on poor quality of life in this population should be examined further, and clinicians should consider this when evaluating older patients with asthma that is refractory to standard treatments. Initiatives to combat other modifiable risk factors such as obesity also should be considered. Future prospective studies to confirm these results are needed, as are studies to better define the mechanisms for these findings.

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