Published in final edited form as:

Ann Allergy Asthma Immunol. 2015 September ; 115(3): 198–204. doi:10.1016/j.anai.2015.06.021.

Significant Predictors of Poor Quality Of Life In Older Asthmatics

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Introduction

The burden of asthma on adults age 65 years and older is significant and under recognized. The prevalence of asthma in this age group is as high as 10%, and continues to rise as the population ages.^{1,2} There are at least 2 million asthmatics over age 65 in the US, with an anticipated increase to at least 5 million by 2030.³ Older asthmatics have higher morbidity and mortality than younger asthmatics, accounting for a greater number of hospitalizations, longer hospital stays, and more than 50% of deaths from asthma.³⁻⁶ The direct economic cost of care for asthmatic seniors, including hospitalizations, visits to practitioners, and medications, is double that of younger adult asthmatics.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 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 asthmatics, studies involving the mAQLQ have included small numbers of asthmatics over age 65 years.^{8,18-20} In addition, few studies have administered the mAQLQ to stable, older asthmatics in an outpatient setting. Identifying factors that predict poor total mAQLQ scores and specific domain scores may lead to interventions that will significantly improve quality of life in this growing demographic. This study therefore sought to quantify the impact of asthma on quality of life in a large group of older asthmatics using the mAQLQ. To our knowledge, this is the largest study to date using the mAQLQ to evaluate quality of life specifically in asthmatics age 65 years and older, 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 asthmatics age 65 years and older recruited from 2010-2012 with a physician's diagnosis of asthma, objectively confirmed by spirometry or methacholine challenge testing.²² Exclusion criteria included a physician's diagnosis of chronic obstructive pulmonary disease (COPD) or class 3 or greater congestive heart failure. Former smokers were not excluded, unless they had a diagnosis of COPD, because the prevalence of former smoking in this age group is so high (at least 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 in order to increase the ability to identify risk factors for more severe asthma.²¹ Participants signed an informed consent approved by the University of Cincinnati institutional review board.

Data collection

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

Enrolled participants also completed a standardized, close-ended questionnaire between 2010-2012 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 (SPT) 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 address to estimate ECAT exposure.²¹ Thus, estimated ECAT exposure served as a marker of traffic-related air pollution exposure.

Mini-AQLQ

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 asthmatics.^{17,27,28} The survey queries subjects regarding four domains of asthma-related quality of life in the previous two weeks: symptoms, emotional function, environmental stimuli, and activity limitation. Responses are rated from one to seven (one= total limitation; seven=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 the 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 $p < 0.15$ are listed in Table 3. 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. ECAT was analyzed as a log-transformed, continuous variable. Atopy was defined as at least one positive skin prick test to a panel of 10 aeroallergens.²¹ Body mass index (BMI) was dichotomized at the cut-point for obesity at $< 30 \text{ kg/m}^2$. Income was dichotomized at the median income of \$40,000 annually. Age of 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 asthmatics ages 65 years and older are described in Table 1. The mean age of included subjects was 73 ± 6.3 years. There were slightly more females (54%) than males. Other demographic and racial characteristics were reflective of the population of greater Cincinnati. Eighty-two percent of subjects were Caucasian and 17% were African-American. The mean annual income was $\$41,097 \pm \$17,312$, and 46% of subjects had an income of less than \$40,000 per year. Forty-six percent were obese. Physician diagnosed gastroesophageal reflux disease (GERD) was also highly prevalent (60%), and 66% of subjects were atopic based on having at least one positive SPT. Nine percent of subjects had self-reported obstructive sleep apnea (OSA), 13% had current or previous self-reported eczema/atopic dermatitis, and 22% had a physician's diagnosis of nasal polypsis. Fifty-eight percent of subjects with nasal polypsis were atopic. Thirty-five percent of subjects reported a current or past diagnosis of depression. A slight majority (56%) reported asthma symptom onset prior to age 40 years. There were no current smokers, although 47% of subjects reported a past history of smoking cigarettes, cigars, or a pipe, with 25% having smoked 10 pack-years or more. Twenty-nine percent of subjects had high ($0.39 \mu\text{g}/\text{m}^3$) elemental carbon attributable to traffic (ECAT), a surrogate for diesel particulate exposure, based on a linear spline model.²¹

Mini-Asthma Quality of Life Questionnaire (mAQLQ) scores

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

Relationship between mAQLQ scores and asthma outcomes

The relationship between mAQLQ scores and the ACQ, ACT, and Emergency Department (ED) visits is displayed in Table 2. 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; $\beta = -0.7$ [-0.9 to -0.5]; $p < 0.0001$). This was also the case when using a validated cut-point for not well controlled asthma ($n=38$ subjects with ACQ ≥ 1.5 ; $\beta = -1.4$ [-1.8 to -1.1]; $p < 0.0001$).²⁹ Findings were similar for ACT scores ($n=60$

subjects with ACT <20, indicating not well-controlled asthma; $\beta = -1.3$ [-1.6 to -1.0]; $p < 0.0001$).³⁰ In addition, having one or more ED visits in the previous year ($n=15$) was significantly associated with poorer mAQLQ scores ($\beta = -1.3$ [-1.9 to -0.7]; $p < 0.0001$), as was the total number of ED visits in the previous year ($\beta = -0.2$ [-0.3 to -0.03]; $p = 0.02$).

Relationship 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 3. 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 $[a]\beta = -1.6$ [-3.0 to -0.3]; $p = 0.02$ after adjustment for other significant covariates listed in Table 3). This relationship was independent of income, and income was not significantly associated with mAQLQ scores in the univariate or multivariate analysis. Female gender was significantly associated with poorer mAQLQ scores ($a\beta = -0.4$ [95% CI=-0.7 to -0.1]; $p = 0.006$). Being obese (BMI ≥ 30 kg/m²) and having GERD were also significantly associated with poorer mAQLQ scores ($a\beta = -0.4$ [-0.7 to -0.1]; $p = 0.01$ and $a\beta = -0.4$ [-0.7 to -0.1]; $p = 0.01$, respectively). Atopic subjects had better mAQLQ scores ($a\beta = 0.5$ [0.2 to 0.9]; $p = 0.002$), while asthma onset at less than age 40 years was associated with poorer asthma-related quality of life ($a\beta = -0.5$ [-0.8 to -0.2]; $p = 0.004$). Factors that were not significantly associated with mAQLQ scores are listed in the footnotes of Table 3.

Predictors of mAQLQ domain scores

The relationship between subject characteristics and mAQLQ domains are presented in Table 4 for findings with $p < 0.15$.

Environmental Domain—Poorer environmental domain scores were significantly associated with higher ECAT levels (i.e., traffic pollutants) ($a\beta = -2.2$ [-4.3 to -0.09]; $p = 0.04$), female gender ($a\beta = -0.7$ [-4.3 to -0.2]; $p = 0.004$), asthma symptom onset before age 40 years ($a\beta = -0.8$ [-1.3 to -0.3]; $p = 0.001$), and GERD ($a\beta = -0.9$ [-1.4 to -0.4]; $p = 0.0005$). Atopy was significantly associated with better environmental domain scores ($a\beta = 0.6$ [0.04-1.1]; $p = 0.04$).

Emotional Domain—Poorer emotional domain scores were significantly associated with asthma symptom onset before age 40 years ($a\beta = -0.7$ [-1.2 to -0.1]; $p = 0.01$). Atopy was significantly associated with better emotional domain scores ($a\beta = 0.7$ [0.2 to 1.3]; $p = 0.007$).

Symptom Domain—Poorer symptom domain scores were significantly associated with female gender ($a\beta = -0.5$ [-0.9 to -0.1]; $p = 0.01$), and GERD ($a\beta = -0.4$ [-0.8 to -0.5]; $p = 0.03$). Atopy was significantly associated with better symptom domain scores ($a\beta = 0.4$ [0.02 to 0.8]; $p = 0.04$).

Activity Domain—Poorer activity domain scores were significantly associated with female gender ($a\beta = -0.5$ [-0.8 to -0.2]; $p = 0.001$), BMI ≥ 30 kg/m² ($a\beta = -0.3$ [-0.6 to 0.04];

p=0.03), asthma symptom onset before age 40 ($\alpha\beta = -0.3$ [-0.6 to -0.03]; p=0.03), GERD ($\alpha\beta = -0.3$ [-0.6 to -0.01]; p=0.04), and OSA ($\alpha\beta = -0.8$ [-1.3 to -0.3]; p=0.004). Atopy was significantly associated with higher activity domain scores ($\alpha\beta = 0.5$ [0.1 to 0.8]; p=0.004).

Discussion

Despite high morbidity and mortality from asthma in older adults, few studies have previously 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 impacting quality of life for this demographic. We have obtained data from older asthmatic subjects in part for the purpose of drawing comparisons between similar data obtained from the literature on AQLQ data from younger asthmatic subjects. While some predictors of poor asthma-related quality of life in younger populations appear to be important in older asthmatics, several novel findings also emerged.

As has been shown in younger asthmatics, asthma-related quality of life based on the mAQLQ correlated well with asthma control, based on ACQ, ACT, and ED visits for this population of ambulatory older adults. Total mAQLQ scores in this study were similar to those in stable asthmatics of various ages.^{10,17,18,31-33} For example, in a validation study performed by Juniper et al. on 39 symptomatic asthmatic subjects between ages 18-65 years, mean mAQLQ scores were 5.4 ± 0.9 , while the older adult population in this study had mean mAQLQ scores of 5.35 ± 1.13 .¹⁷ Individual domain scores were also similar to younger patients, except for the environmental domain (4.9 ± 1.4 for patients age 18-65 years in the Juniper study, versus 4.37 ± 1.71 in older adults).¹⁷ Differences in environmental domain scores may possibly be explained by increased susceptibility to traffic pollution among older asthmatics, as described below. Taken together, these findings suggest that the mAQLQ is an appropriate tool to assess quality of life in asthmatics over age 65, and should be considered, along with other validated tools, when assessing responses to medical treatments and other interventions for asthma in older adults.

To our knowledge, this is the largest study examining quality of life in older asthmatics and the first to examine traffic pollution as a predictor for quality of life specifically in asthmatics age 65 years and older. Although few studies have included asthmatics over age 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 asthmatics may 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 among older asthmatics with higher exposure to traffic exhaust.³⁶ In this 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 around dust, cigarette smoke, weather, and air pollution exposure. This relationship was independent of annual income. Residential proximity to traffic exhaust should therefore be considered as part of the history for asthmatic patients over age 65 years. This should especially be considered in older

asthmatics who are not responding to traditional therapies, as their decreased quality of life may be influenced by environmental exposures.

Female gender 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 age groups showing that female asthmatics have poorer asthma-related quality of life.²⁰ Women make more visits to providers, receive more tests, and are prescribed more medications than men.^{37,38} It has also been suggested that men may underreport their symptoms compared to 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 due to lower inspiratory muscle strength, lower respiratory reserve relative to men, and higher rates of anxiety and depression.⁴⁰⁻⁴⁴ A relationship between changes in sex hormones and asthma in older women has also been proposed, but has not been well defined.⁴⁵

As has been demonstrated in younger asthmatics, obesity was significantly associated with poorer asthma-related quality of life among older asthmatics.^{46,47} Another study in the same cohort found that obesity was a major predictor of poor asthma control based on ACQ scores.²¹ In addition, older asthmatics with an elevated BMI had poorer activity domain scores. OSA was also associated with poorer quality of life scores in the activity domain, possibly because of the association of OSA with obesity.⁴⁸ It is also possible that wearing a CPAP machine could trigger asthma symptoms if humidification is not properly adjusted.⁴⁹ Although in this study we do not know whether patients were obese prior to becoming asthmatic, or vice-versa, multiple other studies have suggested mechanisms for decreased asthma control due to obesity, including: alterations in lung volume and compliance; secretion of pro-inflammatory hormones due to excess adipose tissue; and increased dyspnea due to altered chest wall mechanics.^{50,51} In addition, obese asthmatics may be less responsive to asthma medications, and may require unique therapies to achieve optimal control.⁵² It has been shown in younger populations that weight reduction is associated with improved asthma control and quality of life.⁵³ Interventions targeting weight loss among obese older asthmatics should be strongly considered.

Having GERD was also 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 may affect quality of life even in well controlled asthmatics.⁵⁴ Treatment of GERD in studies that included some asthmatics over age 65 years has previously been shown to improve quality of life and to specifically improve the emotional domain.⁵⁵ Identifying and addressing concomitant GERD in older asthmatics should therefore be attempted.

Interestingly, being non-atopic was associated with poorer quality of life in this older asthmatic population. A previous study from this cohort also indicated that non-atopic asthmatics had poorer asthma control based on ACQ scores.²¹ This is in contrast to some previous studies showing that a high degree of atopy was associated with poorer quality of life in older asthmatics.^{12,21} Although some previous studies have indicated that nasal polyposis impacts asthma outcomes, no such association was found in this study, possibly because most subjects with nasal polyposis were also atopic.⁵⁶ Reasons for differences in

asthma-related quality of life based on atopic status have not been fully elucidated. One study found that older atopic asthmatics were less likely to miss doctor's appointments, require steroids, or have ER visits than non-atopic asthmatics, which they hypothesized could be due to being seen regularly for other atopic diseases.¹⁹ It is also possible that non-atopic asthmatics may be less responsive to treatments designed for atopic asthmatics. Our sample size was not adequate to determine whether non-atopic asthmatics 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 may be enlightening.

For reasons that are not entirely clear, onset of asthma after age 40 years 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 previously associated with higher quality of life in at least one other study.⁵⁷ In addition, another study found that older asthmatics with long-standing asthma had lower lung function and a lower quality of life.⁵⁸ Reduced lung function was not associated with a younger age of asthma onset in our cohort; however, the study was not specifically powered to analyze such differences. Another possible explanation is that asthmatics with long-standing disease may be less compliant with current standards of asthma care due to differences in asthma education and treatment strategies at the time of their diagnosis. Unpublished data from this cohort suggest that late onset asthmatics have better adherence to asthma medications (Tan, J., unpublished data 2015). If this finding is confirmed, then educational initiatives targeting improved adherence, particularly among long-standing older asthmatics, 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 asthmatics. For example, questions regarding "strenuous activity" may not be as pertinent to older adults with physical disabilities. In the future, it may be beneficial to modify questions involving the activity domain in order 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 should also be noted that findings from this study may not apply to more physically or cognitively impaired older adult asthmatics, given that participants in this study had high enough 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 may have better quality of life than patients who frequently visit emergency rooms or urgent care centers. Another possible limitation is that some individuals included in the cohort could have had a COPD 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 asthmatics, and that findings correlate well with other validated measures of asthma control. The impact of traffic pollution on poor quality of life in this population should be further examined, and clinicians should consider this when evaluating older asthmatics that are refractory to standard treatments. Initiatives to

combat other modifiable risk factors such as obesity should also be considered. Future prospective studies to confirm these results are needed, as well as studies to better define mechanisms for these findings.

Acknowledgments

We thank the clinical research staff at the Bernstein Clinical Research Center, the Cincinnati VA Clinical Research Unit, Abraham Research Center, and the University of Cincinnati Immunology Clinical Research Center. We are especially grateful to the patients who participated in the Cincinnati Asthma Severity in Older Adults Study from the Bernstein Allergy Group, the Cincinnati VA Medical Center, the Fraggie Allergy & Asthma Clinic, and the University of Cincinnati.

This study was supported by: NIH/NCRR 8 KL2 TR000078-05; NIEHS P30-ES006096; NIEHS RO1 ES11170; and USPHS UL1 RR02631

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Table 1
Demographics, health characteristics and exposures for 164 asthmatics age 65 and older

Characteristic/Exposure	N (% of 164) ^a
Females	88 (54%)
Males	76 (46%)
Race	
Caucasian	134 (82%)
African-American	27 (17%)
Hispanic	2 (1%)
Native American	1 (1%)
Annual income	
Mean $\pm$ SD	\$41,097 $\pm$ 17,312
\$40,000	75 (46%)
Body mass index (BMI), kg/m ²	
Mean $\pm$ SD	30.2 $\pm$ 6.5
BMI $\geq$ 30	75 (46%)
Gastroesophageal reflux (GERD)	99 (60%)
Obstructive sleep apnea (OSA)	14 (9%)
Atopic (SPT+)	107 (66%)
Eczema/Atopic dermatitis	22 (13%)
Nasal polyposis	36 (22%)
Age of asthma <u>symptom</u> onset < 40 years	91 (56%)
Ever smoked cigarettes, cigars, or a pipe	76 (47%)
Currently smoke	0
Depression	58 (35%)
Elemental carbon attributable to traffic (ECAT)	
High (0.39-0.81 μ g/m ³)	46 (29%)
Low (0.23-0.38 μ g/m ³)	113 (71%)

^aFor binary data, results are presented as the number and percent out of 164 subjects. The mean and standard deviation (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 2
Relationship between Mini-Asthma Quality of Life Questionnaire scores (mAQLQ), and the Asthma Control Questionnaire-6 (ACQ), Asthma Control Test (ACT), and Emergency Department (ED) visits in 164 Asthmatics age 65 and older

Asthma Outcome	Number of subjects (% of 164)	β -coefficient [95% CI] ^a	p-value
ACQ ^b			
Continuous		-0.7 [-0.9 to -0.5]	<0.0001
1.5 (categorical)	38 (23%)	-1.4 [-1.8 to -1.1]	<0.0001
ACT ^c			
Continuous		0.2 [0.02 to 0.3]	<0.0001
<20 (categorical)	60 (38%)	-1.3 [-1.6 to -1.0]	<0.0001
ED visits			
Number of ED visits		-0.2 [-0.3 to -0.03]	0.02
Any ED visits	15 (9%)	-1.3 [-1.9 to -0.7]	<0.0001

^aRepresents the relationship between continuous mAQLQ scores and other asthma outcomes in 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 ACQ continuous (where higher ACQ scores are worse) and mAQLQ 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 ACT <20 and mAQLQ scores indicates that poorer asthma control is associated with poorer mAQLQ scores.

Table 3
Demographic and health characteristics versus Mini-Asthma Quality of Life
Questionnaire scores (mAQLQ) in 164 Asthmatics age 65 and older^a

Characteristic	Unadjusted β [95% CI]	Adjusted β [95% CI]^b	p-value^b
Female gender	-0.6 [-0.9 to -0.2]	-0.4 [-0.7 to -0.1]	0.006
Body mass index (BMI), kg/m ² 30 kg/m ²	-0.6 [-0.9 to -0.2]	-0.4 [-0.7 to -0.1]	0.01
Gastroesophageal reflux (GERD)	-0.7 [-1.0 to -0.3]	-0.4 [-0.7 to -0.1]	0.01
Atopic (SPT+)	0.6 [0.2 to 1.0]	0.5 [0.2 to 0.9]	0.002
Age of asthma <u>symptom</u> onset < 40 years	-0.5 [-0.8 to -0.1]	-0.5 [-0.8 to -0.2]	0.004
Elemental carbon attributable to traffic (ECAT)	-2.3 [-3.9 to -0.8]	-1.6 [-3.0 to -0.3]	0.02
Composite Adherence Score	-0.1 [-0.2 to -0.03]	-0.1 [-0.1 to 0.003]	0.06

^a Complete data for the multivariate analysis were available for 153 subjects.

^b B-coefficients represent the relationship between continuous mAQLQ scores and characteristics in the left hand column. Adjusted β -coefficients and p-values are shown only for co-variables with $p < 0.15$ in the final regression model. Characteristics that were not significantly associated with mAQLQ scores in the final model included: Race (Caucasian: 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 \$40,000: -0.2 [-0.6 to 0.1]; OSA: -0.5 [-1.1 to 0.1]; Eczema/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]; Depression (physician-diagnosed): -0.4 [-0.8 to -0.1]).

Table 4
Adjusted β -coefficients and p-values representing the relationship between demographics, health characteristics and exposures and mini-Asthma Quality of Life Questionnaire (mAQLQ) domains for 164 asthmatics age 65 and older^a

<u>mAQLQ Domain</u>	<u>Female</u>	<u>ECAT</u> ($\mu\text{g}/\text{m}^3$)	<u>BMI</u> $\frac{30}{\text{kg}/\text{m}^2}$	<u>Symptom Onset</u> $\leq \frac{40}{\text{Age}}$	<u>Atopy</u>	<u>Nasal Polyps</u>	<u>GERD</u>	<u>Ever Smoked cigarettes, cigars, or a pipe</u>	<u>OSA</u>
<u>Environmental</u>	-0.7 [-4.3; -0.2]; p=0.004	-2.2 [-4.3; -0.09]; p=0.04	-0.4 [-0.9; 0.08]; p=0.1	-0.8 [-1.3; -0.3]; p=0.001	0.6 [0.04; 1.1]; p=0.04	--	-0.9 [-1.4; -0.4]; p=0.0005	--	--
<u>Emotional</u>	-0.4 [-0.9; 0.07]; p=0.10	-1.9 [-4.1; 0.3]; p=0.08	-0.4 [-0.9; 0.10]; p=0.10	-0.7 [-1.2; -0.1]; p=0.01	0.7 [0.2; 1.3]; p=0.007	--	--	--	--
<u>Symptoms</u>	-0.5 [-0.9; -0.1]; p=0.01	-1.4 [-3.1; 0.3]; p=0.10	-0.4 [-0.8; 0.009]; p=0.06	-0.4 [-0.8; 0.1]; p=0.06	0.4 [0.02; 0.8]; p=0.04	0.4 [-0.07; 0.8]; p=0.10	-0.4 [-0.8; -0.5]; p=0.03	-0.3 [-0.7; 0.06]; p=0.10	--
<u>Activity</u>	-0.5 [-0.8; -0.2]; p=0.001	--	-0.3 [-0.6; 0.04]; p=0.03	-0.3 [-0.6; -0.03]; p=0.03	0.5 [0.1; 0.8]; p=0.004	--	-0.3 [-0.6; -0.01]; p=0.04	-0.2 [-0.5; 0.05]; p=0.10	-0.8 [-1.3; -0.3]; p=0.004

^a Only findings with p<0.15 in the final regression model are presented. Adjusted for co-variables listed in Table 3.