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Asthma That Is Not Well-Controlled Is Associated with Increased Healthcare Utilization and Decreased Quality of Life

THERESA W. GUILBERT, M.D.,^{1,*} CINDY GARRIS, M.S.,² PRITI JHINGRAN, PH.D.,² MACHAON BONAFEDE, PH.D., M.P.H.,³ KENNETH J. TOMASZEWSKI, PH.D., M.S.,⁴ TIFFANY BONUS, M.S.,⁴ REBECCA M. HAHN, M.P.H.,⁵ AND MICHAEL SCHATZ, M.D., M.S.⁶

¹*The Department of Pediatrics, University of Wisconsin, Madison, WI, USA.*

²*GlaxoSmithKline.*

³*Albany College of Pharmacy and Health Sciences.*

⁴*KJT Group.*

⁵*Harris Interactive.*

⁶*Kaiser Permanente, San Diego, CA.*

Background. Relationships of asthma control to other asthma outcomes have been incompletely documented. **Objective.** This study examined the relationship between asthma control and health-related quality of life (HRQL) and subsequent healthcare resource utilization. **Methods.** A 1-year online prospective longitudinal survey was conducted in 497 adults and 170 children with asthma treated in the past year. Control was measured by Asthma Control TestTM (ACT) and Childhood ACTTM (C-ACT)TM scores dichotomized into “well-controlled” (scores > 19) or “not well-controlled” (scores ≤ 19), and HRQL was measured using the PedsQLTM 3.0 Asthma Module (children) and the SF-12 Health Survey (adults). Multivariate models were used for analysis. **Results.** HRQL scores were significantly lower for adults (mean decrease 3.4) and children (mean decrease 12.8) whose asthma was not well-controlled compared to patients with well-controlled asthma. Adults with asthma that was not well-controlled at baseline had a threefold greater risk of an asthma-related doctor visit and a 10-fold greater risk of an emergency department (ED) visit for asthma in the subsequent 9 months (odds ratio (OR) = 3.3 and OR = 11.3, respectively). Children with asthma that was not well-controlled had a nearly fivefold increased risk for subsequent asthma-related doctors’ and ED visits (OR = 4.8 and OR = 4.9, respectively). **Conclusion.** Both adults and children with not well-controlled asthma had significantly lower quality of life and were more likely to require an office or ED visit for asthma compared to patients with higher ACT scores. Therefore, it is important to continually assess asthma control and adjust controller therapy accordingly.

Keywords asthma, healthcare utilization, quality of life

INTRODUCTION

An estimated 22 million Americans suffer from asthma (1). Asthma prevalence remains at historically high levels across all age, sex, and racial groups (2). Asthma is currently the most common chronic condition among children in the United States. The economic burden of asthma is substantial. The annual cost is estimated to be nearly \$18 billion, with direct costs accounting for nearly \$10 billion and indirect costs for \$8 billion (lost earnings due to illness or death) (3). In 2004, asthma resulted in approximately 2 million emergency department (ED) visits, more than 10 million outpatient visits, and approximately 500,000 hospitalizations (1).

The 2007 National Asthma Education and Prevention Program (NAEPP) Asthma Guidelines (4) emphasize the importance of assessing asthma control to effectively manage asthma. Level of asthma control is then used to initiate or alter asthma management, including pharmacotherapy. The Asthma Control TestTM (ACT) and Childhood ACT (C-ACT)TM are validated survey tools

developed to help patients with asthma and their clinicians monitor the level of asthma control (5, 6). Although it may seem apparent that poor control as measured by the ACT/C-ACT would predict poorer quality of life and increased healthcare utilization, it has not been prospectively demonstrated in all age groups. Providers might question the effectiveness of a short questionnaire on predicting these future outcomes. One study has demonstrated that inadequately controlled asthma, as measured by the ACT, has a significant impact on asthma-specific health-related quality of life (HRQL) and school productivity and attendance of children aged 12–18 years as well as the work productivity of their caregivers (7). Previous studies have demonstrated that overall health and physical HRQL can be used to predict future asthma-related utilization and cost (8–11), and a few studies have described the relationship of asthma control to asthma-specific HRQL (12), generic HRQL (12), or subsequent healthcare utilization (13–15) in adults. However, only one retrospective study has demonstrated that uncontrolled asthma is associated with increased healthcare utilization and lower HRQL in children (7). The objective of this study was to determine if asthma control as measured by the ACT/C-ACT is associated with HRQL

*Corresponding author: Theresa W. Guilbert, M.D., The Department of Pediatrics, University of Wisconsin-Madison, 600 Highland Avenue, K4/944, CSC-4108, Madison, WI 53716, USA; Tel: 608-265-7959; Fax: 608-265-0510; E-mail: tguilbert@wisc.edu

and/or subsequent healthcare resource utilization in both adults and children.

METHODS

Sample

A prospective cohort online survey (GSK study number ADA107147) was conducted in the United States among adults and children with asthma treated in the past year. E-mails were sent to 17,033 of Harris Interactive's HarrisPollOnlineSM Panel members inviting them to participate in the baseline phase of the research in December 2006. The HarrisPollOnlineSM Panel consists of individuals who have double opted in and voluntarily agreed to participate in various online research studies. Selection bias is minimized by recruiting HarrisPollOnline members from hundreds of sources using diverse recruitment methods (e.g., partner websites, refer-a-friend program). Patient-reported outcomes data have been previously collected for various therapeutic areas using Harris Interactive's online panel (16–18). Adult patients were recruited from a general population panel, the majority of which are 18–65 year olds previously identified as having asthma. Parents of asthmatic children were recruited from a general population panel of parents of children aged 4–17. Respondents meeting the screening criteria at baseline and agreeing to participate received e-mail invitations for future phases of the study by October 2007. The response rate at baseline was 24%, similar to that observed in other online polls (19).

To qualify for the study at baseline, it was required that patients be US residents and citizens, be between 18 and 65 years of age, have a self-reported physician diagnosis of asthma or have a child who has physician diagnosis of asthma, and have been prescribed a controller or rescue medication within the past year to treat their asthma. Patients did not need to be actively taking medication to qualify. After the initial baseline measure, repeated measures (phases) were performed every 3 months over 1 year time period. Respondents received points in a Harris Interactive incentive program as encouragement for participating in this study and were also offered a \$10 incentive for each of the four phases in which they fully participated.

Surveys

The patient survey contained questions regarding demographics, health conditions, level of asthma control, quality of life, healthcare utilization due to asthma (i.e., hospitalizations, ED visits, and physician visits), asthma medication and other treatment history, self-reported adherence, and work or school absence and productivity. Self-reported/parent-reported asthma severity was defined as mild, moderate, or severe using the NAEPP asthma definitions of mild, moderate, and severe persistent asthma (20). Level of asthma control was measured by the ACT or C-ACT (QualityMetric Health Outcomes Solutions, Lincoln, RI, USA) as appropriate for age of

the patient with asthma. The ACT is a validated five-item, self-administered tool to monitor asthma control in adults and adolescents ≥ 12 years of age (5). The C-ACT is a validated seven-item tool to monitor asthma control in children 4–11 years of age in which the parent assists the child in answering the first four questions and the parent answers the remaining three questions (6). Scores range from 5 to 25 for the ACT and from 0 to 27 for the C-ACT with lower scores corresponding to poorer asthma control. ACT/C-ACT scores were dichotomized into “well-controlled” (scores > 19) or “not well-controlled” (scores ≤ 19) as defined in previous studies (5, 6).

For children (4–11 years of age) and adolescents (12–17 years of age), quality of life was measured using the PedsQLTM 3.0 Asthma Module (Mapi Research Trust, Lyon, France), an instrument designed to measure asthma-specific HRQL in children and adolescents using the dimensions of asthma, treatment, worry, and communication (9, 21, 22). The PedsQL 3.0 Asthma module parent report for toddlers (aged 2–4) is composed of 26 items; child and parent reports (aged 5–17) have 28 items. Quality of life of adults was assessed with the SF-12 Health Survey (QualityMetric Health Outcomes Solutions). The SF-12 is a validated subset of the SF-36 health assessment tool (QualityMetric Health Outcomes Solutions) measuring eight domains of health which are aggregated to provide component scores for physical (PCS) and mental (MCS) quality of life (23). For all HRQL assessments, scores were calculated based on each questionnaire's methodology, with higher scores indicating better HRQL. Self-reported adherence was assessed by asking respondents questions regarding how they/their children were taking their medications (i.e., as prescribed or differently than prescribed), using the Stages of Change model (24).

Statistical Analyses

The analytic models are based on the Andersen health utilization model. The Andersen model portrays the relationship between multiple influences on healthcare utilization taking into consideration the following three categories (factors) (25): (1) predisposing factors (demographics, social factors, and patient health beliefs), (2) enabling factors (personal and community factors), and (3) need factors (perceptions of illness and evaluated need inclusive of professional judgment about patient health status) (Table S1 available online at [http://informahealthcare.com/doi/suppl/\[10.3109/02770903.2010.535879\]](http://informahealthcare.com/doi/suppl/[10.3109/02770903.2010.535879])). This framework was used to ensure comprehensive models for measuring impact of various factors on healthcare utilization and associated quality of life. Once the full Andersen model was developed, a stepwise removal approach was used to refine the model with a cutoff *p* value of .50, allowing for a balance between statistical and theoretical support for variable inclusion. Models were developed separately for children and adults. All analyses were weighted according to the survey sample weights. Statistical analyses were

conducted using Stata v9.2 (StataCorp, College Station, TX, USA) and SPSS (SPSS for Windows, Rel. 17.0.2008, SPSS Inc., Chicago, IL, USA).

Participants were compared based on their dichotomous ACT control status in bivariate analyses using *t*-tests and chi-square tests, where appropriate, with an alpha of 0.05. Univariate and multivariate models were estimated to determine the impact of ACT status on quality of life and healthcare utilization. The covariates used in the models include predisposing characteristics (demographics, social structure, attitudinal beliefs), enabling characteristics (current prescription use and family resources), and need variables (perceived illness, compliance, and evaluated illness).

Quality of life models were estimated using ordinary least squares (OLS) regression to examine the impact of ACT status on quality of life. Both quality of life and ACT status were assessed at baseline. Self-reported PedsQL scores were used as the dependent variable for models involving participants under age 18. In the adult models, the physical component of the SF-12 was used as the dependent variable. An additional quality of life analysis was conducted exploring the MCS component in adults. Subgroup analysis was conducted dividing children into two age groups: 4–11 and 12–17 years.

Utilization models were estimated using logistic regression. ACT status was assessed at baseline and used to predict utilization over the subsequent 9 months, controlling for numerous covariates. Separate utilization models were constructed to examine the impact of ACT control status on emergency room use and doctor visits for asthma.

RESULTS

Cohort Demographics

The baseline sample consisted of 700 adults (aged 18–65) with asthma and 250 parents of children with asthma (aged 4–17 years). In this baseline cohort, children and adolescents were more likely to be male compared to adult respondents (Table 1). Younger children (aged 4–11 years) were also more likely to report seasonal asthma than year-round asthma and have more traditional insurance compared to the adults or adolescents (aged 12–17 years) surveyed (Table 1).

A total of 497 (71%) adults and 170 (68%) parents and their children with asthma completed all four phases. Although the demographic characteristics of the cohort completing all four phases (data not shown) were generally not substantially different than that of the baseline cohort, there were some significant differences. Compared to the baseline cohort, the subset of adults and children aged 4–11 years completing all four phases of the study were significantly more likely to have mild asthma. Adults completing all phases were also more likely to have seasonal asthma and have insurance with a PPO compared to the baseline cohort, and adolescents

aged 12–17 years were significantly more likely to be Caucasian.

Mean ACT/C-ACT scores were 18.5 (range 7–25) for adults 18 years of age and older, 18.2 for children aged 4–11 years (range 4–26), and 19.5 (range 5–25) for adolescents aged 12–17 years (Table 2). Adults had a mean SF-12 PCS of 47.3 and SF-12 MCS of 43.7 (below previously reported average scores for US population (26)). The children and adolescents had mean PedsQL scores of 57.16 and 61.43, respectively, both of which are below previous average scores for healthy children (27).

Asthma Control and HRQL

ACT/C-ACT scores of 19 or less, indicating not well-controlled asthma, were a significant predictor of lower HRQL for adults ($p < .01$), and for children and adolescents aged 4–17 years ($p < .01$) (Table 3). Not well-controlled asthma in adults was associated with significantly lower SF-12 HRQL scores (mean difference -3.4 (95% CI $[-1.8, -5.0]$) when compared to those with well-controlled asthma. In children and adolescents, not well-controlled asthma was also associated with significantly lower PedsQL scores (mean difference -12.8 $[-8.0, -17.6]$) compared to children and adolescents with well-controlled asthma (Table 3). Models using parent-reported PedsQL as the outcome demonstrated results nearly identical to the child-reported models (data not shown).

The additional quality of life analysis results of the MCS component in adults were not substantively different from the PCS component; the relationships found in the PCS analysis were also present in the MCS analysis (data not shown). Stratified results of the PedsQL into two age groups (4–11 years and 12–17 years) were not substantively different from the analyses containing children and adolescents aged 4–17 years (data not shown).

Asthma Control and Healthcare Utilization

ACT/C-ACT scores of 19 or less (not well-controlled asthma) were associated with a higher risk of an asthma-related event in the subsequent 9 months compared to higher ACT/C-ACT scores (well-controlled asthma). In bivariate analysis, 60.4% of adults with asthma that was not well-controlled had an asthma-related doctor visit in the subsequent 9 months compared to 26.1% of adults with well-controlled asthma (OR = 4.3). Similarly, 10.6% of adults with asthma that was not well-controlled had an asthma-related ER visit in the subsequent 9 months compared to 1.3% of adults with well-controlled asthma (OR = 8.9) (Figure 1). Among children with asthma that was not well-controlled, 81.4% had an asthma-related doctor visit in the subsequent 9 months (vs. 48.8% of children with well-controlled asthma, OR = 4.6) and 19.4% had an ER visit (vs. 12.4% of children with well-controlled asthma, OR = 1.7) (Figure 2). In multivariate analysis, adults with asthma that was not well-controlled

TABLE 1.—Baseline demographics.

	Adults ≥18 years (<i>n</i> = 700)	Children 4–11 years (<i>n</i> = 117)	Adolescents 12–17 years (<i>n</i> = 133)
Mean age (years)	42.1		10.7
Gender			
Male	34%	64%	59%
Female	66%	36%	41%
Typically experience asthma			
Year-round	78%	69%	75%
Seasonally	22%	31%	25%
Self-reported/parent- reported asthma severity			
Mild	45%	22%	48%
Moderate	51%	74%	46%
Severe	5%	4%	6%
Health insurance (Top 5)			
PPO	45%	52%	53%
HMO	20%	17%	23%
Traditional insurance	11%	17%	10%
Medicare/Medicaid	18%	6%	9%
None	7%	7%	10%
Race/ethnicity			
Caucasian	83%	88%	97%
African American	6%	6%	0%
Hispanic	6%	4%	1%
Other	3%	2%	2%
Household income			
Less than \$15,000	11%	9%	3%
\$15,000 to \$34,999	21%	19%	16%
\$35,000 to \$74,999	36%	41%	32%
\$75,000 to \$99,999	19%	15%	20%
\$100,000 or more	12%	16%	29%
Education/parent's education			
High school or less	27%	53%	52%
Some college, but no degree	30%	23%	19%
College (e.g., BA, BS)	16%	9%	12%
Associates degree	13%	10%	5%
Some graduate school, but no degree	6%	2%	3%
Graduate school (e.g., MS, MD, PhD)	8%	4%	10%

TABLE 2.—Mean asthma control and HRQL scores by respondent group.

Means	ACT/C-ACT	SF-12 PCS	SF-12 MCS	PedsQL
Adults ≥18 years (<i>n</i> = 700)	Mean: 18.5 ± 0.3 Median: 20 IQR: (16, 22)	Mean: 47.3 ± 0.6 Median: 50.9 IQR: (42.7, 55.3)	Mean: 43.7 ± 0.5 Median: 46.1 IQR: (37.8, 52.0)	—
Children age 4–11 (<i>n</i> = 117)	Mean: 18.2 ± 0.6 Median: 19 IQR: (16, 23)	—	—	Mean: 57.2 ± 1.8 Median: 62.5 IQR: (50.0, 70.5)
Adolescents age 12–17 (<i>n</i> = 133)	Mean: 19.5 ± 0.5 Median: 20 IQR: (16, 22)	—	—	Mean: 61.4 ± 2.2 Median: 63.6 IQR: (53.4, 72.7)

had a 3.3-fold greater risk of having asthma-related doctor visits (95% CI [1.9, 5.5], $p < .0001$) and a 11.3-fold greater risk of having ED visits for asthma ([2.4, 52.4], $p = .002$) compared to adults with well-controlled asthma (Figure 1). Children with asthma that was not well-controlled had a 4.8-fold greater risk of having asthma-related doctor visits ([1.4, 16.4], $p = .012$) and a 4.9-fold greater risk of having ED visits for asthma ([1.1, 21.4], $p = .036$) than children with well-controlled asthma (Figure 2).

DISCUSSION

Both the NAEPP (4) and the Global Initiative for Asthma (GINA) (28) guidelines state that assessment of asthma control is essential to effectively manage asthma. The results of the current study demonstrate that asthma that is not well controlled, as measured by the ACT/C-ACT, is associated with concurrent lower HRQL in both adults and children. Additionally, these relationships were the same for the physical and mental quality of life scores

TABLE 3.—Difference in HRQOL scores by asthma control status.

	Difference in HRQOL score for respondents with not well-controlled asthma (ACT/C-ACT ≤ 19) versus well-controlled asthma (ACT/C-ACT > 19)		
	Mean difference using OLS	95% Confidence interval	P value
Adults ≥ 18 years ($n = 700$)	SF-12 PCS		
Bivariate	−7.0	−9.0, −5.0	<.0001
Multivariate ^a	−3.4	−5.0, −1.8	<.0001
Children/adolescents 4–17 years ($n = 250$)	PedsQL		
Bivariate	−14.6	−19.7, −9.4	<.0001
Multivariate ^a	−12.8	−17.6, −8.0	<.0001

^aMultivariate models adjusted for age, gender, race/ethnicity, education, region, comorbidities, income, health insurance, employment, asthma treatment, current asthma medication, non-prescription strategies, type of doctor seen, topics discussed with a doctor, type of asthma, self-reported health.

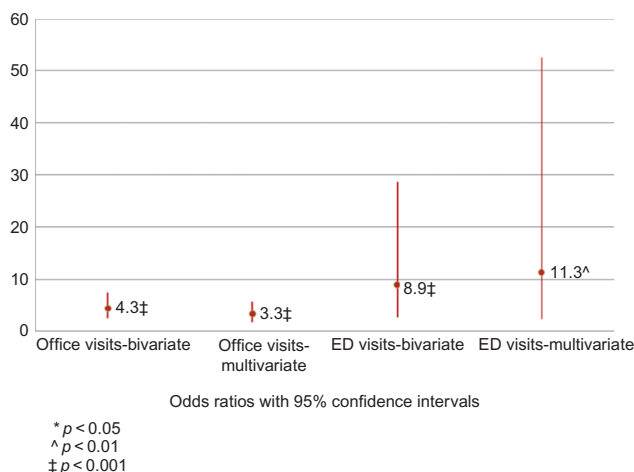


FIGURE 1.—Increased risk of healthcare utilization in the subsequent 9 months among adults whose asthma is not well controlled at baseline compared to those who have well-controlled asthma.

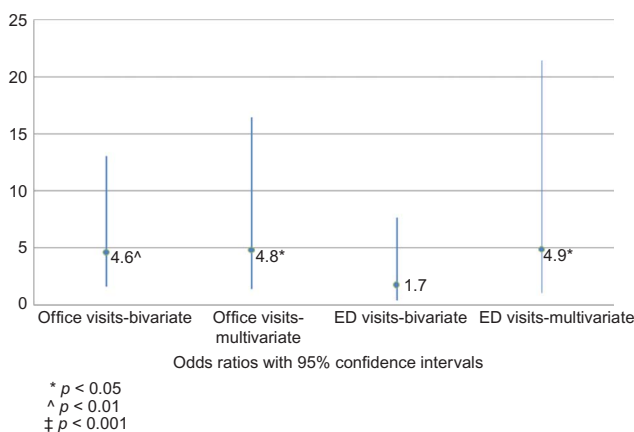


FIGURE 2.—Increased risk of healthcare utilization in the subsequent 9 months among children and adolescents whose asthma is not well controlled at baseline compared to those who have well-controlled asthma.

for adults, adolescents, and younger children. Although most practitioners would assume that poor control as measured by the ACT/C-ACT would be associated with lower HRQL and increased healthcare utilization, this has not been demonstrated sufficiently, particularly in the pediatric population. Indeed, only a few studies have described the relationship of asthma control to HRQL and healthcare utilization. In adults, asthma control as measured by home-administered ACT and the Asthma Therapy Assessment Questionnaire (ATAQ) has been found to

correlate with HRQL using the mini-AQLQ tool (12), and ACT scores in combination with lung function can predict future asthma exacerbations (29). Another retrospective study of school-aged children demonstrated that not well-controlled asthma as measured by the C-ACT is associated with lower HRQL in the preceding year (7).

Our results also demonstrate that adults, adolescents, and young children with asthma that is not well-controlled as measured by ACT/C-ACT have a higher risk of asthma-related doctor visits or ED visits in the subsequent

9 months compared to patients with well-controlled asthma. This finding is supported by adult studies demonstrating a relationship of asthma control as measured by the ATAQ or ACT to previous or subsequent healthcare utilization (13–15). A retrospective study in school-aged children also described an association between uncontrolled asthma as measured by the C-ACT and healthcare utilization in the previous year (7).

These findings suggest that asthma control assessment using the ACT/C-ACT may help clinicians identify patients at risk who have a need for intervention to reduce asthma-related healthcare utilization and improve HRQL. Both the ACT and C-ACT tests are simple self-administered questionnaires that have been validated and are able to discriminate among various levels of asthma control based on clinical variables, including spirometry and a specialist's recommendation of a change in therapy (5, 6). In addition, there is little overlap between the questions on the ACT and C-ACT and those on the SF-12 and PedsQL questionnaires.

The current study included a sample of respondents that was less ethnically diverse than the US population, which may limit the generalizability of these findings to other cohorts. However, an established weighting methodology was employed to correct for potential biases and all analyses were weighted according to these survey sample weights. The response rate to the survey at baseline was 24% and thus may represent a select population; however, this is similar to that observed in other online polls (19). It is possible that a more ethnically diverse or impoverished population may have demonstrated a higher risk of healthcare utilization and lower ACT/C-ACT scores, given the higher burden of disease observed in these patients (2, 30). It is also important to note that the patient's recall of asthma-related and ED visits was not independently validated through medical record review. However, studies have demonstrated that most subjects are able to accurately report their physician and ED visits up to 3–6 months after the event (31, 32). Furthermore, a recent study suggests that patient-reported exacerbations and patient-reported asthma control appear to reflect separate domains, but our findings confirm that they are still related to each other (33).

In conclusion, assessing asthma control using ACT/C-ACT helps clinicians and patients monitor asthma control, and may indicate that intervention is needed to decrease the risk of future healthcare resource utilization, and improve patient's quality of life. Additional studies to determine if monitoring asthma control and initiating interventions based on the results could lead to reduced healthcare resource utilization and healthcare costs in other populations would be valuable.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and the writing of the paper.

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APPENDIX

ACT	Asthma Control Test
ATAQ	Asthma Therapy Assessment Questionnaire
C-ACT	Childhood Asthma Control Test
ED	Emergency department
GINA	Global Initiative for Asthma
HRQL	Health-related quality of life
MCS	Mental component score
PCS	Physical component score
NAEPP	National Asthma Education and Prevention Program
OLS	Ordinary least squares regression
OR	Odds ratio

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