

CONTROL

The ACT and the ATAQ Are Useful Surrogates for Asthma Control in Resource-Poor Countries with Inadequate Spirometric Facilities

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Objective. The objective of this study is to determine the utility of simple asthma control questionnaires in assessing the asthma control in our practice setting. **Methods.** The Asthma Control Test (ACT), Asthma Therapy Assessment Questionnaire (ATAQ), and mini Asthma Quality of Life Questionnaire (mini AQLQ) were administered to previously diagnosed asthma patients. Spirometry was performed to obtain the prebronchodilator forced expiratory volume in 1 second (FEV1). The relationship between test scores (ACT and ATAQ) and the FEV1 and mini AQLQ scores, respectively, was explored. **Results.** A total of 106 patients (mean age 41 ± 15.3 years, 61 (57.5%) females) participated in the study. The mean ACT score was 17 ± 5.3 and the mean ATAQ score was 1.46 ± 1.34 . There was a significant positive correlation between the ACT score and FEV1% predicted indicating the improvement in asthma control when FEV1% predicted increases (Pearson's correlation = 0.518, $R^2 = 0.268$, $p < .0001$) and a negative correlation between the ATAQ score and FEV1% predicted also indicating the improvement in asthma control when FEV1% predicted increases (Pearson's correlation = -0.516 , $R^2 = 0.266$, $p < .0001$). The ACT score was significantly and positively related to the mini AQLQ score signifying an improvement in quality of life with increasing ACT score (Pearson's correlation = 0.691, $R^2 = 0.461$, $p < .0001$). The ATAQ score was significantly and negatively related to the mini AQLQ score indicating an improvement in quality of life with decreasing ATAQ score (Pearson's correlation = -0.654 , $R^2 = 0.428$, $p \leq .0001$). The FEV1% predicted and the mini AQLQ score were the only significant determinants of both the ACT score and the ATAQ score. **Conclusion.** The ACT and ATAQ are the objective and reliable tools in determining asthma control due to their strong correlation with the FEV1 and the asthma-specific health-related quality of life. Use of either questionnaire routinely will identify more patients with poor asthma control even when spirometry services are not readily available.

Keywords FEV1, Nigeria, quality of life, sub-Saharan Africa

INTRODUCTION

The aim of asthma treatment is to improve symptoms and prevent lung function decline. Uncontrolled asthma significantly increases the risk of near-fatal attacks and asthma deaths (1). Poor asthma control also has negative effects on several health indices, including the health-related quality of life (HRQoL) and health care utilization (2, 3). The Global Burden of Disease estimates that asthma is responsible for a disability-adjusted life years (DALYs) of 15 million people per year accounting for about 1% of all DALYs lost from any disease (4). The quality-adjusted life years (QALYs) of a year with asthma are equivalent to 0.7 years without asthma symptoms (5).

According to the Global Initiative for Asthma (GINA), "asthma control" is achieved when there is suppression of asthma symptoms resulting in reduction in frequency of rescue β_2 -agonist use and prevention of exacerbations (4). Additional targets include preservation of lung function decline and avoidance of adverse effects of medications (4). Despite the availability of these guidelines that enumerate goals of asthma control and specific management

strategies, asthma remains relatively poorly controlled worldwide (6, 7).

The two main considerations in assessing asthma control are the evaluation of current impairment and the determination of future risk (8). Current impairment is measured by the frequency of daytime/nighttime symptoms and the use of short-acting β_2 -agonists for symptom relief, difficulty with normal activities, and lung function (8). Future risk is judged by the history of exacerbations and lung function decline over time (8).

Lack of recognition of symptoms of poorly controlled asthma contributes to the high prevalence of uncontrolled asthma (8). Assessment of lung function using spirometry and based on the forced expiratory volume in 1 second (FEV1) is an objective means of assessing asthma control; however, access to spirometry is limited in many clinical settings in the developing countries, thus hampering its wide application as a measure of asthma control (9). In contrast, questionnaire-based assessments have the potential for more extensive utilization irrespective of infrastructural capabilities.

To improve the detection, validated questionnaires for the evaluation of symptom control have been developed, including the Asthma Control Questionnaire (ACQ), the Asthma Control Test (ACT), and the Asthma Therapy Assessment Questionnaire (ATAQ) (10–12). Whereas the ACT and

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ATAQ are entirely questionnaire-based, the ACQ incorporates spirometry as a measure of control. The ACT and ATAQ therefore have the potential of serving as useful surrogates for assessing asthma control (without spirometry), if it is shown to correlate significantly with asthma control as determined objectively by spirometry. The utility of the ACT and the ATAQ in such settings has not been extensively described.

The objective of this study was thus to determine the correlation between the levels of asthma control based on the two questionnaire-based tools (ACT and ATAQ) and lung function measured by the FEV1 in persons with asthma in Nigeria. The study also explored the relationship between asthma control and the asthma-specific HRQoL based on the questionnaires, and helps to determine the utility of either questionnaire in routine assessment of asthma control in resource-limited practice setting like ours.

METHODS

This was a cross-sectional and observational study of consecutively consenting asthma patients attending the adult outpatient respiratory clinic of the Lagos University Teaching Hospital, Lagos, Nigeria. Ethical approval was obtained from the Health Research Ethics Committee of the Lagos University Teaching Hospital Lagos (No: ADM/DCST/HREC 450). Informed consent was obtained from all the participants.

Study participants included patients previously diagnosed to have asthma based on symptoms of wheeze, cough, and chest tightness in addition to a prebronchodilator FEV1/forced vital capacity (FVC) ratio of less than 75% with an improvement in the FEV1 of $\geq 12\%$ and ≥ 200 ml postbronchodilator (8). Minimum duration of clinic attendance was 1 month. All participants had been prescribed inhaled steroid plus a long-acting bronchodilator with variable adherence to therapy. Asthma patients with heart failure from cardiac causes, chronic respiratory infections such as tuberculosis, and patients with chronic obstructive pulmonary disease were excluded from the study.

Following recruitment, an interviewer obtained baseline demographic and clinical data [age, gender, weight (kg), height (m), and waist circumference (cm)]. The body mass index (BMI) was calculated using the Quetelet index (13), and recategorized as overweight/obese ($\text{BMI} \geq 25 \text{ kg/m}^2$) and not overweight/obese ($\text{BMI} < 25 \text{ kg/m}^2$). The standard current criteria were used to categorize participant's waist circumference as a reflection of the presence or absence of abdominal adiposity (based on gender-specific cutoffs) (14).

The ACT, ATAQ, and mini Asthma Quality of Life Questionnaire (mini AQLQ) were performed on all participants by an interviewer. The adult version of the ACT is a validated simple five-item questionnaire that assesses interference of asthma with activity, symptoms of shortness of breath, nocturnal symptoms, use of rescue medication, and patient's self-assessment of symptoms in the preceding 4 weeks (11, 15). A score of ≥ 20 defines "well-controlled" asthma, 16–19 "not controlled" asthma, and ≤ 14 "very poorly controlled" asthma (11).

The adult version of the control domain of the ATAQ is a validated four-item questionnaire, which highlights the potential management issues such as self-reported asthma symptoms control, missed daily activities, missed work/school, nocturnal awakening, and high use of quick reliever medications in the preceding 4 weeks (12). A score of 0 defines good asthma control, 1–2 poor asthma control, and 3–4 very poor asthma control (8).

The mini AQLQ is a validated 15-item questionnaire, which assesses the quality of life specifically in relation to asthma (16). The questionnaire assesses three domains of asthma interference with daily life (symptoms, environmental limitations, and emotions). The total score obtained in the different domains was divided by 15 to obtain the score for each patient, with higher scores being indicative of better quality of life (16).

Asthma control was objectively assessed by spirometric measurement of prebronchodilator FEV1 following the European Respiratory Society/American Thoracic Society 2005 guidelines (17). In each participant, a minimum of three and a maximum of eight acceptable and reproducible values were obtained (17). The per cent predicted was calculated using reference values for adult Nigerians (18). An FEV1 of $\geq 80\%$ predicted categorized the lung function as "normal," 60–79% as "mild airway obstruction," and $< 60\%$ as "moderate to severe airway obstruction" (8).

Data were analyzed using the Statistical Software for Social Sciences (SPSS, IBM Corporation, Somers, New York, USA)[®] statistical software version 20.0. The numerical demographic and clinical data (e.g., age, WC, and BMI) and the test scores were summarized as mean $\pm$ standard deviation (SD). Categorical variables (e.g., gender, BMI category, abdominal adiposity, and degree of asthma control) were summarized as frequencies (%). We explored the relationship between the test scores (the ACT and ATAQ) and the FEV1 and mini AQLQ scores, respectively, using Pearson's correlation test. Independent determinants of ACT and ATAQ scores were evaluated using multivariate linear regression analysis (imputing only variables found to be significantly associated with the score in univariate analysis). Level of significance was set at p -value $< .05$.

RESULTS

A total of 106 patients with asthma, aged between 17 and 79 years, participated in the study. Table 1 describes the baseline characteristics of the patients. The mean FEV1 $\pm$ SD was 2.08 ± 0.8 l, the mean FVC $\pm$ SD was 3.03 ± 1.19 l, and the mean FEV1/FVC $\pm$ SD was 69.68 ± 14.98 l. The mean FEV1% predicted $\pm$ SD was $95\% \pm 33.8$ and mean FVC% predicted was 108.36 ± 32.19 . Table 2 shows detailed spirometric parameters of the participants by age group and gender categories. Trend analysis showed significant inverse correlation between age on the one hand and FEV1% (Pearson's correlation coefficient = -0.378 , $R^2 = 0.143$, $p < .0001$), FVC% (Pearson's correlation coefficient = -0.218 , $R^2 = 0.048$, $p < .025$), and FEV1/FVC (Pearson's correlation coefficient = -0.402 , $R^2 = 0.162$, $p < .0001$), respectively.

TABLE 1.—Baseline characteristics of the 106 study participants.

Characteristic	Overall, N = 106	Male, N = 45	Female, N = 61	p-Value
Mean age $\pm$ SD (years)	40.9 $\pm$ 15.3	40.3 $\pm$ 15.8	41.4 $\pm$ 15.1	.71
<20 years	7 (6.6%)	4 (8.9%)	3 (4.9%)	.82
20–39 years	40 (37.7%)	23 (37.7%)	17 (37.7%)	
40–59 years	50 (47.2%)	21 (46.6%)	29 (47.5%)	
≥ 60 years	9 (8.5%)	6 (9.8%)	3 (9.8%)	
Mean BMI $\pm$ SD (kg/m ²)	25.9 $\pm$ 5.8	23.8 $\pm$ 3.7	27.5 $\pm$ 6.5	.001
Overweight/obese (N, %)	50 (47.1%)	16 (35.6%)	34 (55.7%)	.04
Mean WC $\pm$ SD (centimetres)	86.2 $\pm$ 12.7	83.0 $\pm$ 9.8	88.6 $\pm$ 14.2	.02
Abdominal adiposity (N, %)	28 (26.4%)	1 (2.2%)	27 (44.3%)	<.001
Mini AQLQ	4.47 $\pm$ 1.23	4.29 $\pm$ 1.25	4.60 $\pm$ 1.21	.19

Note: SD, standard deviation; WC, waist circumference; AQLQ, Asthma Quality of Life Questionnaire.

Based on the FEV1% predicted, lung function was normal ($\geq 80\%$ predicted) in 68 (64.2%) of the participants, mild airway obstruction in 18 (17%), and moderate to severe obstruction in 20 (18.9%).

Asthma Control Measured by the ACT and ATAQ Scores

The mean ACT score $\pm$ SD was 17 ± 5.3 . Based on the ACT score, 46 (43.4%) participants had ACT score ≥ 20 (good control), 34 (32.1%) had score of 15–19 (poor control), and 26 (24.5%) had score of ≤ 14 (very poor control). Table 3 shows the details of the mean ACT scores by age group and gender categories.

The mean ATAQ score $\pm$ SD was 1.46 ± 1.34 . Based on the ATAQ score, 37 (34.9%) participants had a score of 0 indicating good asthma control, 40 (37.7%) had a score of 1–2 indicating poor asthma control, and 29 (27.4%) had a score of 3–4 indicating very poor asthma control. Table 3 shows the details of the mean ATAQ scores by age group and gender categories. The ACT and ATAQ scores predicted asthma control as being good in 46 (43.4%) versus 37 (34.9%) participants, poor in 34 (32.1%) versus 40 (37.7%), and very poor in 26 (24.5%) versus 29 (27.4%) participants. There was a significant agreement between the levels of asthma control (good, poor, or very poor) as determined by the ACT and the ATAQ scores ($p < .001$).

TABLE 3.—Mean ACT and ATAQ scores by age and gender categories.

Age group (years)	Male, N = 45		Female, N = 61	
	ACT score	ATAQ score	ACT score	ATAQ score
<20	17.25 $\pm$ 2.21	2.25 $\pm$ 0.5	15.57 $\pm$ 5.57	1.67 $\pm$ 0.58
20–39	17.76 $\pm$ 4.88	1.53 $\pm$ 1.5	19.48 $\pm$ 4.86	1.04 $\pm$ 1.19
40–60	16.05 $\pm$ 6.2	1.76 $\pm$ 1.45	17.62 $\pm$ 4.89	1.07 $\pm$ 1.28
>60	11.67 $\pm$ 5.86	3.0 $\pm$ 1.0	16.5 $\pm$ 5.47	2.33 $\pm$ 1.21
All	16.51 $\pm$ 5.51	1.80 $\pm$ 1.41	18.08 $\pm$ 4.99	1.21 $\pm$ 1.25

Note: ATAQ scores overall differed significantly (ANOVA; $p = .03$) whereas ACT scores did not differ significantly overall by gender (ANOVA; $p = .13$).

Correlation of the ACT and ATAQ Scores with FEV1% Predicted and HRQoL

The correlation of the ACT and ATAQ scores with the FEV1% predicted was assessed using the Pearson's correlation. There was a significant positive correlation between the ACT score and FEV1% predicted indicating an improvement in asthma control based on the ACT score as the FEV1% increases (Pearson's correlation = 0.518, $R^2 = 0.268$, $p < .0001$) (Figure 1). The levels of asthma control (good, poor, or very poor) as determined by the ACT was significantly related to the lung function (normal, mild airway obstruction, and moderate to severe airway obstruction) as determined by the FEV1% predicted ($\chi^2 = 25.7$, $p < .001$).

There was a significant negative correlation between the ATAQ score and the FEV1% predicted indicating an improvement in asthma control based on the ATAQ scores as the FEV1% predicted increases (Pearson's correlation = -0.516 , $R^2 = 0.266$, $p < .0001$) (Figure 2). The levels of asthma control as determined by the ATAQ were also significantly related to the presence/degree of airway obstruction as determined by the FEV1% predicted ($\chi^2 = 22.65$, $p \leq .001$).

The ACT score was significantly and positively related to the mini AQLQ score indicating an improvement in the HRQoL as asthma control based on the ACT score improves (Pearson's correlation = 0.691, $R^2 = 0.461$, $p < .0001$). The ATAQ score was significantly and negatively related to the mini AQLQ score indicating an improvement in HRQoL as asthma control based on the ATAQ score improves (Pearson's correlation = -0.654 , $R^2 = 0.428$, $p \leq .0001$).

In multivariate regression (Table 4), the FEV1% predicted and the mini AQLQ score were the only significant

TABLE 2.—Mean spirometric parameters of the persons with asthma by age and gender categories.

Age range (years)	Male, N = 45					Female, N = 61				
	FEV1	FVC	FEV1%	FVC%	FEV1/FVC	FEV1	FVC	FEV1%	FVC%	FEV1/FVC
<20	3.4 $\pm$ 0.5	4.3 $\pm$ 1.0	114.7 $\pm$ 34.4	106.7 $\pm$ 15.3	80.2 $\pm$ 10.9	2.5 $\pm$ 0.3	3.2 $\pm$ 0.2	113.6 $\pm$ 18.3	117.8 $\pm$ 8.0	76.0 $\pm$ 7.2
20–39	2.8 $\pm$ 1.0	3.8 $\pm$ 1.1	96.0 $\pm$ 33.6	107.3 $\pm$ 28.4	74.2 $\pm$ 16.7	2.4 $\pm$ 0.7	3.1 $\pm$ 0.7	116.4 $\pm$ 34.2	118.4 $\pm$ 27.5	77.7 $\pm$ 12.8
40–60	2.1 $\pm$ 0.8	3.8 $\pm$ 1.4	90.1 $\pm$ 29.9	121.1 $\pm$ 42.4	62.3 $\pm$ 10.8	1.5 $\pm$ 0.5	2.2 $\pm$ 0.7	88.4 $\pm$ 29.1	101.0 $\pm$ 27.1	66.9 $\pm$ 14.5
>60	0.9 $\pm$ 0.5	1.6 $\pm$ 0.6	39.3 $\pm$ 16.4	54.1 $\pm$ 15.5	52.5 $\pm$ 18.3	1.1 $\pm$ 0.4	1.7 $\pm$ 0.4	71.2 $\pm$ 22.3	87.3 $\pm$ 21.3	63.9 $\pm$ 15.8
All	2.4 $\pm$ 1.0	3.7 $\pm$ 1.3	91.2 $\pm$ 33.9	110.2 $\pm$ 37.6	67.7 $\pm$ 15.5	1.8 $\pm$ 0.7	2.5 $\pm$ 0.8	98.5 $\pm$ 33.7	107.0 $\pm$ 22.8	71.1 $\pm$ 14.6

Note: Statistical comparison (ANOVA) of pulmonary function tests by gender yielded the following values: FEV1 ($p = .001$); FVC ($p < .0001$); FEV1% ($p = .27$); FVC% ($p = .62$); and FEV1/FVC ($p = .25$).

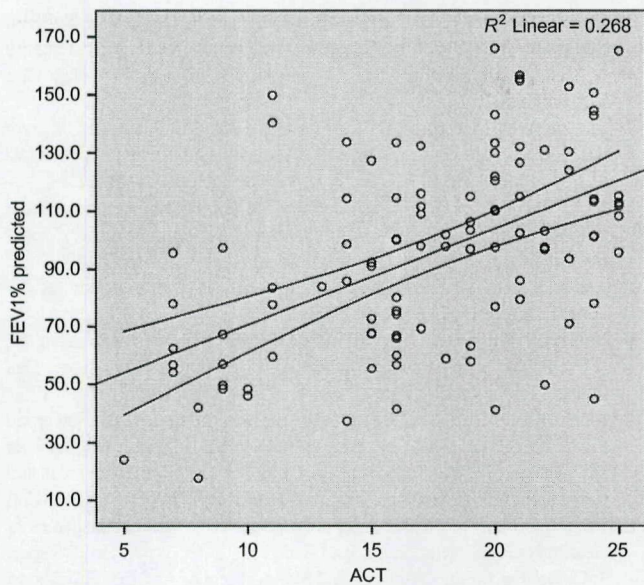


FIGURE 1.—Correlation of the Asthma Control Test (ACT) score with the FEV1% predicted.

Note: Diagram shows a trend of increasing FEV1% (improvement in lung function) with increasing ACT score (indicative of better asthma control).

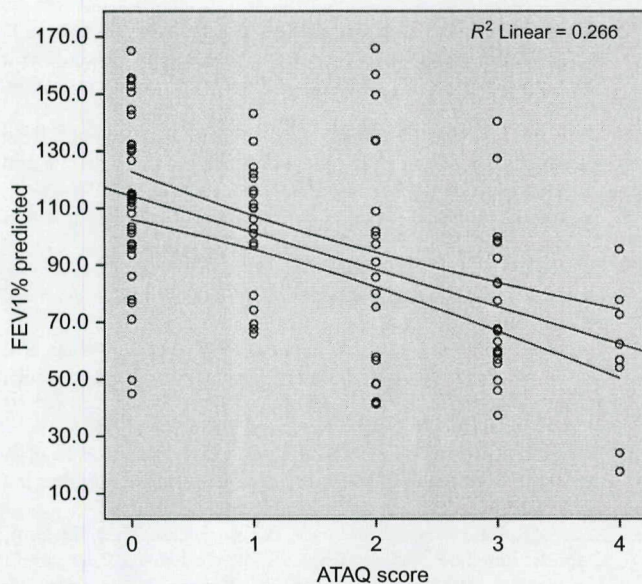


FIGURE 2.—Correlation of the Asthma Therapy Assessment Questionnaire (ATAQ) score to the FEV1% predicted.

Note: Diagram shows a trend of increasing FEV1% (improvement in lung function) with decreasing ATAQ score (indicative of better asthma control).

determinants of both the ACT and the ATAQ scores, respectively.

DISCUSSION

The emphasis of recent asthma guidelines is aimed at achieving asthma control (1). This study had set out to explore the utility of two simple validated questionnaires in determining asthma control by assessing their relationship with an objective means of assessing asthma control using the lung function and a subjective means of assessing asthma control using the quality of life. Since all the participants in this study were already on asthma treatment for a minimum duration of 1 month, we were clear in our objective of assessing asthma control and not disease severity (19).

We have demonstrated that the ACT and the ATAQ scores strongly correlate with the FEV1% predicted and the asthma-specific HRQoL. The FEV1% predicted and the mini AQLQ score remained as the only significant determinants of the ACT and the ATAQ scores even when the effect of cofounders such as the age, BMI, and waist circumference were considered. Based on the ACT score or the ATAQ score, treatment can be stepped up or down and patients with serious control problems can be referred for specialist care and regular spirometry to monitor lung function. These findings are consistent with that of the studies in other populations in which the ACT and ATAQ were shown to relate strongly with FEV1%, quality of life indices, and health care utilization (2, 3, 15, 20, 21).

Although spirometry provides an objective and reproducible means of assessment of asthma control, it is available only to about 25% of doctors practicing in Nigeria and even less in other parts of sub-Saharan Africa (9, 22–24). The ACT and ATAQ, therefore, provide alternative and valid means of assessing asthma control in such settings. Furthermore, since asthma is a variable disease, lung function assessment during a clinical visit may not represent the patient's control status and the patients with poor asthma control, especially in those with night symptoms, may be missed. Despite the subjectivity of the ACT and ATAQ, they examine the asthma control over 4 weeks and incorporate the various aspects of control problems such as limitations in activity, use of rescue medications, day and night symptoms, and patient's assessment of control and are more likely to be reliable in identifying patients with poor asthma control. This was demonstrated in this study where the proportion of patients with good asthma control

TABLE 4.—Multivariate linear regression analysis of the determinants of asthma control based on the ATAQ scores and ACT scores.

Variable	ATAQ scores				ACT scores			
	B	Standard error	95% CI	p-Values	B	Standard error	95% CI	p-Values
Age (years)	−0.01	0.8	−0.02 to 0.01	.47	−0.0	0.03	−0.06 to 0.06	.98
BMI (kg/m ²)	−0.00	0.03	−0.06 to 0.05	.09	−0.11	0.12	−0.33 to 0.10	.3
WC (cm)	−0.00	0.01	−0.06 to 0.05	.87	0.03	0.05	−0.07 to 0.13	.59
FEV1% predicted	−0.01	0.0	−0.02 to −0.00	.002	0.05	0.01	0.02 to 0.07	.002
Mini AQLQ score	−0.04	0.01	−0.05 to −0.03	<.001	0.156	0.02	0.11 to 0.20	<.001

as determined by the ACT and ATAQ scores were lower than those with good asthma control as determined by a normal FEV1% predicted. This indicates that many patients with normal lung function at the time of spirometry may actually have control problems. Repeated spirometry will be more useful in monitoring lung function decline over time and assessing future risks of poor asthma control.

The level of asthma control in our patients is quite low and corroborates the reports of poor asthma control worldwide (1, 24). In our setting, poor asthma control is related to inadequate lung function assessment and poor utilization of symptom-based questionnaires (22, 25). The utility of the ACQs in our practice setting has not been demonstrated before this time and may contribute to the low utilization. Physician's assessment of asthma control may be a reliable means of assessment but depends on the competence, knowledge, and patience of the attending physician. Use of the ACT and ATAQ obviates this and allows non-pulmonary specialists, especially in the primary care setting to accurately determine asthma control.

The utility of the ACT and ATAQ surpasses its relationship to the lung function as we demonstrated their strong correlation with the asthma-specific HRQoL. Patients with more control problems had lower quality of life indices. An asthma-specific quality of life tool such as the mini AQLQ is capable of identifying small differences in HRQoL and therefore a very sensitive instrument.

Certain limitations in this study were noted. The role of other confounders that determine asthma control such as compliance to medications, inhaler technique, control of triggers, and the presence of co-morbidities was not explored. Also, repeat assessment of the patients at a follow-up visit was not done and, therefore, the reproducibility of the questionnaires in determining asthma control was not assessed. It would be useful in the future to address this shortcoming.

In conclusion, we have demonstrated the utility of the ACT and ATAQ in determining asthma control and assessing the HRQoL in our practice setting. Both questionnaires are reliable tools and either can be used for this purpose. Due to the limited access to spirometry in our setting, using the ACT and the ATAQ could identify patients with inadequate asthma control in whom the treatment should be optimized and those with very poor asthma control over time can be referred for specialists care.

DECLARATION OF INTEREST

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

REFERENCES

1. Turner MO, Noertjojo K, Vedal S, Bai T, Crump S, Fitzgerald JM. Risk factors for near-fatal asthma. A case-control study in hospitalized patients with asthma. *Am J Respir Crit Care Med* 1998; 157:1804-1809.
2. Chen H, Gould MK, Blanc PD, Miller DP, Kamath TV, Lee JH, Sullivan SD, for the TENOR Study Group. Asthma control, severity and quality of life: quantifying the effect of uncontrolled disease. *J Allergy Clin Immunol* 2007; 120:396-402.
3. Vollmer WM, Markson LE, O'Connor E, Sanocki LL, Fitterman L, Berger M, Buist SA. Association of asthma control with health care utilization and quality of life. *Am J Respir Crit Care Med* 1999; 160:1647-1652.
4. Masoli M, Fabian D, Holt S, Beasley R. The global burden of asthma: executive summary of the GINA dissemination committee report. *Global Initiative for Asthma (GINA) programme. Allergy* 2004; 59:469-478.
5. Hubbel BJ. Implementing QALYs in the analysis of air pollution regulations. *Environ Res Econ* 2006; 34:365-348.
6. Boulet LP, Phillips R, O'Byrne P, Becker A. Evaluation of asthma control by physician and patients: comparison with current guidelines. *Can Respir J* 2002; 9:417-423.
7. Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald M, Gibson P, Ohta K, O'Byrne P, Pedersen SE, Pizzichini E, Sullivan SD, Wenzel SE, Zar HJ. Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J* 2008; 31:143-178.
8. US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma: Full Report 2007. NIH publication 07-4051. Available at: www.nhlbi.nih.gov/guidelines/asthma/index.htm. Accessed February 2012.
9. Desalu OO, Onyedum CC, Iseh KR, Salawu FK, Salami AK. Asthma in Nigeria: are the facilities and resources available to support internationally endorsed standards of care? *Health Pol* 2011; 99:250-254.
10. Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. *Eur Respir J* 1999; 14:902-907.
11. Nathan RA, Sorkness CA, Kosinski M, Schatz M, Li JT, Marcus P, Murray JJ, Pendergraft TB. Development of the Asthma Control Test: a survey for assessing asthma control. *J Allergy Clin Immunol* 2004; 113:59-65.
12. Vollmer WM, Markson LE, O'Connor E, Frazier EA, Berger M, Buist AS. Association of asthma control with health care utilization: a prospective evaluation. *Am J Respir Crit Care Med* 2002; 165:195-199.
13. Eknayan G, Adolphe Quetelet: the average man and the indices of obesity. *Nephrol Dial Transplant* 2001; 23:47-51.
14. The IDF consensus worldwide definition of the metabolic syndrome. Available at: http://www.idf.org/VAT_BE433.674.528. Accessed February 2012.
15. Schatz M, Sorkness CA, Li JT, Marcus P, Murray JJ, Nathan RA, Kosinski M, Pendergraft TB, Jhingran P. Asthma control test: reliability, validity, and responsiveness in patients not previously followed by asthma specialists. *J Allergy Clin Immunol* 2006; 117:549-556.
16. Juniper EF, Guyatt GH, Ferrie DJ, King DR. Development and validation of the Mini Asthma Quality of Life Questionnaire. *Eur Respir J* 1999; 5:35-46.
17. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, van der Grinten CPM, Gustafsson P, Jensen R, Johnson DC, MacIntyre N, McKay R, Navajas D, Pedersen OF, Pellegrino R, Viegi G, Wanger J. Standardisation of spirometry. *Eur Respir J* 2005; 26:319-338.
18. Patrick JM, Femi-Pearse D. Reference values for FEV1 and FVC in Nigerian men and women: a graphical summary. *Niger Med J* 1976; 6:380-385.
19. Taylor DR, Bateman ED, Boulet LP, Boushey HA, Busse WW, Casale TB, Chanec P, Enright PL, Gibson PG, de Jongste JC, Kerstjens HA, Lazarus SC, Levy ML, O'Byrne PM, Partridge MR, Pavord ID, Sears MR, Sterk PJ, Stolf SW, Szeffler SJ, Sullivan SD, Thomas MD, Wenzel SE, Reddel HK. A new perspective on the concepts of asthma severity and control. *Eur Respir J* 2008; 32:545-554.
20. Zhou X, Ding FM, Lin JT, Yin KS, Chen P, He QY, Shen HH, Wan HY, Liu CT, Li J, Wang CZ. Validity of asthma control test in Chinese patients. *Chin Med J* 2007; 120:1037-1041.
21. Schatz M, Mosen MD, Kosinski M, Vollmer WM, Magid DJ, O'Connor E, Zeiger RZ. The relationship between asthma-specific quality of life and asthma control. *Chest* 2007; 44:391-395.

22. Ayuk A, Iloh K, Obumneme-Anyim I, Ilechukwu G, Oguonu T. Practice of asthma management among doctors in south-east Nigeria. *Afr J Respir Med* 2010; 7:14–17.
23. Desalu OO, Busari OA, Onyedum CC, Salawu FK, Obateru OA, Nwogu KC, Salami AK. Evaluation of current knowledge, awareness and practice of spirometry among hospital-based Nigerian doctors. *BMC Pulm Med* 2009; 14:49–50.
24. Mehtrotra A, Akanbi MO, Gordon SB. The burden of COPD in Africa: a literature review and prospective survey of the availability of spirometry for COPD diagnosis in Africa. *Trop Med Int Health* 2009; 14:840–848.
25. Stempel DA, McLaughlin TP, Stanford RH, Fuhlbrigge AL. Pattern of asthma control: a 3 year analysis of patient claim. *J Allergy Clin Immunol* 2005; 115:935–939.

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