Evaluation and determinants of asthma control among adult patients with asthma attending the Johannesburg academic respiratory clinics: A cross-sectional study

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Background. The prevalence of asthma in South Africa is among the highest in Africa, but little research has been done regarding levels of asthma control and associated determinants.
Objectives. To explore level of asthma control and perceived risk factors associated with poor control in adult patients with asthma attending respiratory clinics at three major hospitals in Johannesburg.
Methods. This was a quantitative, descriptive, cross-sectional study of all adult patients attending the clinics. Participants were given a three-section self-reporting survey, consisting of a demographic section, an Asthma Control Test (ACT) questionnaire, and an eight-item Morisky Medication Adherence Scale (MMAS-8) questionnaire.
Results. The prevalence of poor asthma control based on participants' ACT scores in this study was 71.3%. A significant linear regression was identified between the ACT and MMAS-8 scores in the uncontrolled asthma group. Significant associations between asthma control and the sociodemographic factors age, body mass index ≥25 and previous hospitalisation for exacerbation were found. No such associations existed for gender or level of education. In evaluating comorbidities, no significant association was found for hypertension, gastro-oesophageal reflux disease, sinusitis or diabetes mellitus. Of the patients, 89.3% used short-acting beta-agonists and 93.3% inhaled corticosteroids (ICSs); 58.7% were on combined long-acting beta-agonists and ICSs.
Conclusion. Asthma control in the study setting was poor. There was also an interesting inverse relationship between control and therapy adherence. Further research is needed to better understand the issues surrounding asthma control and to lay the groundwork for policies to benefit asthma patients in the future.
Keywords. Asthma, control, public sector, Johannesburg.

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Study synopsis
What the study adds. This study adds to the data on asthma control and associated determinants in the adult population in South Africa (SA). Data are scarce, despite the known high prevalence of asthma in this population.
Implications of the findings. The study outlines the fairly poor levels of asthma control in this population, even at a tertiary level. The outcomes reflected here provide motivation for further investigation into levels of asthma control in SA and in sub-Saharan Africa as a whole. This further investigation could ultimately impact on patient care and provide the basis of improved best practice for both patient and physician education.

The prevalence of asthma in South Africa (SA is among the highest in Africa, and fifth highest in the world in terms of case mortality.[1-3] Global research on asthma control shows high levels of uncontrolled symptoms in both developed and developing countries; however, little is known about the levels of control and their associated determinants in SA.[4-7] To the authors' knowledge, only two studies have been done to date on asthma prevalence in SA, both in the paediatric setting.[8,9]

The present study investigated adult patients with asthma attending the Charlotte Maxeke Johannesburg Academic Hospital respiratory clinic, the Helen Joseph Hospital respiratory clinic and the Chris Hani Baragwanath Academic Hospital respiratory clinic, hereafter referred to as the Johannesburg respiratory clinics (JRCs). The aim of the study was to explore levels of asthma control and the perceived risk factors associated with poor control in adult patients with asthma attending the JRCs.

Recent international studies using the Asthma Control Test (ACT) questionnaire show that asthma control is suboptimal in numerous countries in Europe, Africa and North America.[4-6,10] Factors associated with poor asthma control include sociodemographic factors, physiological and medical factors, and a lack of understanding of disease management.[5,11-13] This study aimed to add information about a population on which there is currently a paucity of data.

Methods

Study design

This was a quantitative, descriptive, cross-sectional study of all adult patients presenting to the JRCs, conducted between March 2022 and August 2022. Ethics approval was obtained from the University of the Witwatersrand Human Ethics Committee (ref. no. M210960), and the study was conducted according to the Declaration of Helsinki and South African Good Clinical Practice Guidelines. The researchers arranged with hospital and clinic management to visit the respective clinics on multiple occasions over the 6-month period.

Study population

Inclusion criteria were patients aged ≥18 years, with asthma clinically diagnosed and confirmed by lung function testing prior to the study, followed up for asthma at the JRCs, and prescribed asthma treatment for at least 6 months. Patients who were pregnant or diagnosed with other chronic lung diseases were excluded. Patients were approached in the clinics and invited to participate. After registering at hospital administration and collecting their patient files, eligible participants were identified from the daily consultation register and/or by clinic staff. Assigned researchers distributed the hard-copy information leaflet, informed consent form and questionnaires to eligible participants, who were asked to complete and return the questionnaire to the researchers on the same day. By signing consent, participants agreed to partake in the study and allowed the researchers to collect and verify demographic information from their files.

Variables and outcomes

Participants were given a three-section self-reporting survey, consisting of a demographic section, an ACT questionnaire, and an 8-item Morisky Medication Adherence Scale (MMAS-8) questionnaire.

The demographic section questions included sociodemographic information (gender, weight and height, which were used to calculate the body mass index (BMI), level of education, employment status); health information (hypertension, gastro-oesophageal reflux disease (GORD), COVID-19, pulmonary tuberculosis); and asthma history (duration of asthma disease, recent asthma hospitalisations, list of medications, family members with asthma, access to care and medication). To ensure precision of data, information on BMI, list of medications, asthma duration, forced expiratory volume in 1 second (FEV_1)/forced vital capacity ratio, and FEV_1 before and after administration of a bronchodilator was gathered and checked from patient files by the study team.

The ACT questionnaire is a multidimensional, standardised and validated assessment measure that has been widely used to assess asthma control in patients aged >12 years.[14] The ACT comprises five questions on the frequency of asthma symptoms and use of rescue medication during the preceding 4 weeks. These questions are scored on a 5-point Likert-type rating scale from 5 to 25, where a score of >19 indicates well-controlled asthma, 16 - 19 points not well-controlled asthma, and ≤15 points uncontrolled asthma.[11] For this study we classified controlled asthma as ACT ≥20 and uncontrolled asthma as ACT ≤19, as has become practice in numerous previous studies.[4-7,10] The ACT is reliable, valid and responsive to changes in asthma control over time, with a baseline internal consistency reliability of 0.85 and a test-retest reliability of 0.77.[14,15]

The MMAS-8 is an eight-question survey addressing medication adherence. An 8-point score shows high adherence, 6 - 7 medium adherence and <6 low adherence. While the MMAS-8 is typically used for patients with hypertension, it is valid and reliable to assess medication adherence broadly and to predict health outcomes in patients with asthma.[16]

Statistical analysis

Clinics in the JRC system were visited at regular twice-weekly intervals over the 6-month study period, and 150 patients were surveyed. The self-questionnaire was used in conjunction with the participants' hospital records to form the study database. Data were stored in Excel version 16.97 (Microsoft, USA) and statistical analysis was done using Python 3.10 (Python Software Foundation, USA) utilising statsmodels.api and scipy.stats. Statistical tests were Student's *t*-test, linear regression and logistic regression. Descriptive statistics for normally distributed data were documented as mean values with standard deviations (SDs), and non-normally distributed data were documented as median values with interquartile ranges.

Results

Patient demographics and lifestyle characteristics are presented in Table 1.

Table 2 shows health-related patient data and a final classification of asthma control according to the ACT questionnaire.

Table 3 shows the association between uncontrolled asthma and the study variables. Age was found to be a statistically significant factor that differed between the controlled and uncontrolled groups ($p<0.01$), as was BMI ≥25 ($p<0.01$). Lastly, previous hospitalisation for exacerbation was also found to be significant ($p<0.01$).

Of the study sample, 50% ($n=75$) reported low adherence (scores <6) and 12.7% ($n=19$) high adherence (score = 8) to medication on the MMAS-8 questionnaire. The mean (SD) MMAS-8 score for the participants was 5.27 (1.95). The most common reason for poor adherence was forgetfulness, followed by stopping medication when symptoms were under control (Table 4).

In this study, we found a negative correlation between the ACT score and the MMAS-8 score in the uncontrolled asthma group ($r=-0.25$; $p=0.01$). A relationship between higher participant medication adherence and lower ACT score was found (Fig. 1).

Discussion

Poor asthma control has been associated with an increase in exacerbations and hospital visits, financial strain on the individual and the healthcare sector, and even death.[17] To our knowledge, this study is the first to evaluate asthma control, the determinants associated with poor asthma control, and medication adherence, specifically among adults attending the JRCs.

The prevalence of poor asthma control based on participants' ACT scores in this study was 71.3%. These findings are in keeping with the higher end of results from previous studies conducted in similar low- to middle-income countries. Studies from the Democratic Republic of the Congo, Cameroon, Ethiopia and China reported frequencies of uncontrolled asthma from 41.3% to 71.88%.[5,10,13,18] This wide variation could be attributed to a number of factors, such as accessibilty of healthcare, the structure of the healthcare sector, and cultural differences. As our cohort was recruited at major hospitals, it must also be kept in mind that there would be a bias towards patients with more severe asthma and poorer control.

Significant associated factors

As summarised under 'Results', a significant association between uncontrolled asthma and age ($p<0.01$), BMI ≥25 ($p<0.01$) and previous hospitalisation for exacerbations ($p<0.01$) was identified in this study.

Age

Age was found to be a statistically significant factor that differed between the controlled and uncontrolled groups ($p<0.01$). The controlled population comprised more patients in the younger age categories, while the majority of patients in the uncontrolled group fell into the older age categories, with 64.5% of the patients aged ≥50 years. This trend has been reported in both Europe and the USA, where asthma control decreased with an increase in age.[19,20]

BMI

BMI ≥25 was also found to be a statistically significant factor, with an association between a high BMI and uncontrolled asthma ($p<0.01$). The BMI was ≥25 in 85.0% of the uncontrolled population, as opposed to 62.8% of the controlled population. There is a wealth of published literature on the link between BMI and asthma severity, but little research has been published examining the relationship between BMI and asthma control. One Canadian study reported similar findings to our own, where higher BMI was associated with worse asthma control and quality of life, independent of age, sex and asthma severity.[21]

Previous hospitalisation

Previous hospitalisation for asthma exacerbation was also identified as a significant factor ($p<0.01$), with 81.3% of the uncontrolled population having been hospitalised v. 55.8% of the controlled population.

Non-significant factors

Duration of asthma was not statistically significantly different between the controlled and uncontrolled populations ($p=0.25$). This finding supports the theory that the link between age and control is in fact due to age itself, and is not confounded by duration of asthma.

The prevalence of hypertension was higher in the uncontrolled population (48.6%) than in the controlled group (30.2%), but was not found to be statistically significantly associated with asthma control ($p=0.06$). Although it was not significant in this population, the increase in the uncontrolled group is in line with previous studies that have highlighted the increased prevalence of hypertension in patients

Table 1. Demographic information on the study sample (N=150)

Variable	Frequency, *n* (%)*
Age (years)	
<25	17 (11.3)
25 - 34	8 (5.3)
35 - 49	33 (22.0)
50 - 60	44 (29.3)
>60	48 (32.0)
Height (m), mean (SD)	1.63 (0.11)
Weight (kg), mean (SD)	77.68 (19.19)
Gender	
Male	42 (28.0)
Female	108 (72.0)
BMI (kg/m^2), mean (SD)	29.39 (7.17)
Underweight (<18.5)	3 (2.0)
Healthy (18.5 - 24.9)	42 (28.0)
Overweight (25 - 29.9)	49 (32.7)
Obese (≥30)	56 (37.3)
Level of education	
Primary school or less	13 (8.7)
Grade 9 completed	50 (33.3)
Grade 12 completed	55 (36.7)
Higher education (degree/diploma)	32 (21.3)
Employment status	
Employed	43 (28.7)
Unemployed	62 (41.3)
Retired	45 (30.0)

SD = standard deviation; BMI = body mass index.
*Except where otherwise indicated.

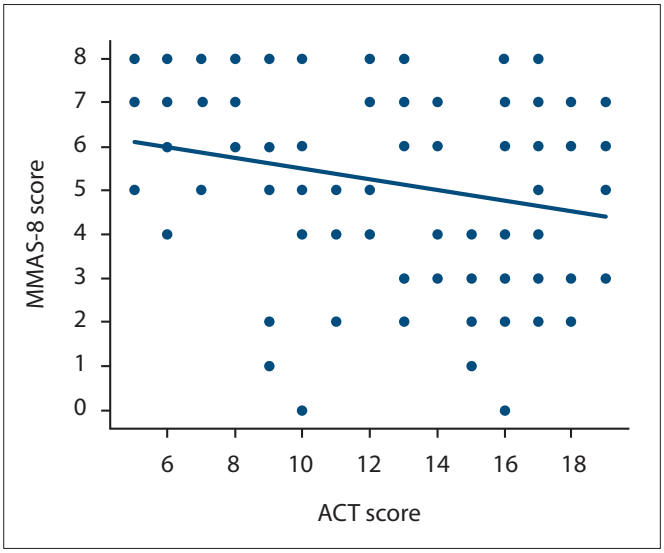

Fig. 1. ACT and MMAS-8 scores in the uncontrolled ACT group, with shown linear regression line. (ACT = Asthma Control Test; MMAS-8 = eight-item Morisky Medication Adherence Scale.)

Table 2. Health information on the sample, asthma history and asthma control based on the ACT questionnaire (*N*=150)

Variable	Frequency, *n* (%)*
Smoker	
Yes	9 (6.0)
No	141 (94.0)
Number of cigarettes per day (*n*=9), mean (SD)	10.22 (6.62)
Living with a smoker	
Yes	48 (32.0)
No	102 (68.0)
History of smoking	
Yes	35 (23.3)
No	115 (76.7)
Years since stopped smoking (*n*=35), mean (SD)	13.48 (13.33)
Comorbidities	
Hypertension	65 (43.3)
GORD	57 (38.0)
Sinusitis	48 (32.0)
Diabetes mellitus	29 (19.3)
Previous TB/COVID-19	53 (35.3)
Previous TB	8 (5.3)
Previous COVID-19	44 (29.3)
Previous TB and COVID-19	1 (0.7)
Years of asthma, mean (SD)	22.81 (16.11)
Family history of asthma	
Yes	84 (56.0)
No	66 (44.0)
Current pharmacological therapy	
SABA	134 (89.3)
ICS	140 (93.3)
LABA/ICS	88 (58.7)
Leukotriene receptor antagonist	34 (22.7)
Anticholinergics	15 (10.0)
Theophylline	10 (6.7)
Other (antihistamines, nasal corticosteroids)	24 (16.0)
Hospitalisation for asthma	
Ever	111 (74.0)
Within past 6 months	29 (19.3)
Never	39 (26.0)
ACT scores	
Uncontrolled (□19)	107 (71.3)
Well controlled (□20)	43 (28.7)

ACT = Asthma Control Test; GORD = gastro-oesophageal reflux disease; TB = tuberculosis; SABA = short-acting beta-agonist; LABA = long-acting beta-agonist; ICS = inhaled corticosteroid.
*Except where otherwise indicated.

with asthma, but also indicate increased odds of hospitalisation.[22] A recent meta-analysis showed a moderate association between asthma and hypertension (odds ratio (OR) 1.49; 95% confidence interval (CI) 1.39 - 1.59; $p<0.01$), and hypertensive cardiomyopathy was strongly associated with asthma (OR 4.24; 95% CI 2.06 - 8.90). The proposed pathogenesis of this relationship is based on elevated inflammatory cytokines from poorly controlled asthma resulting in cardiovascular disease.[23]

GORD and sinusitis have also traditionally been associated with asthma prevalence.[24] While we did find that the uncontrolled population in our study had higher levels of these comorbidities, the numbers were not statistically significantly different.

ACT and MMAS-8

Mean (SD) adherence to medication, based on self-reported MMAS-8 scores, was 5.27 (1.95). This finding is in keeping with studies conducted in similar low-income environments.[24,25]

A significant linear regression ($r=-0.25$; $p=0.01$) was identified between the ACT and the MMAS-8 score in the uncontrolled asthma group. The regression indicates an inverse relationship between ACT score (control) and MMAS-8 score (adherence); while control increases, adherence decreases.

An inverse association between treatment adherence and risk of exacerbation has been well established.[26] This 'paradoxical' or

Table 3. Association between controlled/uncontrolled asthma and variable factors (*N*=150)

Variable	Asthma control, *n* (%)		Overall *p*-value[§]
	Controlled[*] (*n*=43; 28.6%), *n* (%)[‡]	Uncontrolled[†] (*n*=107; 71.3%), *n* (%)[‡]	
Age (years)			<0.01
<25	11 (25.5)	6 (5.6)	
25 - 34	3 (6.9)	5 (4.6)	
35 - 49	6 (13.9)	27 (25.2)	
50 - 60	9 (20.9)	35 (32.7)	
>60	14 (32.6)	34 (31.7)	
Gender			0.16
Male	16 (37.2)	26 (24.3)	
Female	27 (62.7)	81 (75.7)	
Duration of asthma, mean (SD)	20.4 (14.2)	23.8 (16.8)	0.25
BMI (kg/m^2) ≥25	27 (62.8)	91 (85.0)	<0.01
Level of education			0.40
Primary school or less	4 (9.3)	9 (8.4)	
Grade 9 completed	11 (25.6)	39 (36.4)	
Grade 12 completed	20 (46.5)	35 (32.7)	
Higher education (degree/diploma)	8 (18.6)	24 (22.4)	
Comorbidities			
Hypertension	13 (30.2)	52 (48.6)	0.06
GORD	12 (27.9)	45 (42.1)	0.15
Sinusitis	10 (23.3)	38 (35.5)	0.21
Diabetes mellitus	5 (11.6)	24 (22.4)	0.19
Previous hospitalisation			<0.01
Yes	24 (55.8)	25 (81.3)	
No	19 (44.1)	82 (18.7)	

SD = standard deviation; BMI = body mass index; GORD = gastro-oesophageal reflux disease; ACT = Asthma Control Test.
[*]ACT score ≥20.
[†]ACT score ≤19.
[‡]Except where otherwise indicated.
[§]*p*-value based on *t*-test.

Table 4. Medication adherence factors in the sample (*N*=150)

MMAS-8 question	Participant responses, *n* (%)	
	Yes	No
Do you sometimes forget to take your medication?	51 (34.0)	99 (66.0)
People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past 2 weeks, were there any days when you did not take your medications?	51 (34.0)	99 (66.0)
Have you ever cut back or stopped taking your medication(s) without telling your doctor, because you felt worse when you took it?	23 (15.3)	127 (84.7)
When you travel or leave home, do you sometimes forget to bring along your medications?	30 (20.0)	120 (80.0)
Did you forget to take your medications yesterday?	75 (50.0)	75 (50.0)
When you feel like your symptoms are under control, do you sometimes stop taking your medication?	63 (42.0)	87 (58.0)
Taking medications every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your treatment plan?	44 (29.3)	106 (70.7)
Do you ever have difficulty remembering to take all your medications?	73 (48.7)	77 (51.3)

MMAS-8 = eight-item Morisky Medication Adherence Scale.

'reverse' phenomenon is one of the reasons behind the approach of prescribing inhaled corticosteroid (ICS)-fomoterol combination inhalers for reliever and maintenance therapy,[27] and may be explained by the self-titration of medication, where patients are more adherent during exacerbations, and then less adherent as asthma control improves.[26,27]

It can be postulated that the linear regression could be due to short-acting beta-agonist (SABA) monotherapy medication overuse,

which has been shown to elicit poorer control in the long term.[28] However, the majority of patients at the JRCs are on combination ICS-long-acting beta-agonist therapy, with the SABA used as a reliever, and while we cannot confirm daily adherence to their maintenance inhalers, it is unlikely that they are using SABA inhalers only. The MMAS-8 questionnaire is not designed to evaluate the choice of medication, as it only focuses on frequency and compliance.

Incorrect regimens or poor inhaler technique were not assessed in the present study, so require further research.

Study limitations

This research has a number of limitations. The sample population was from urban Johannesburg clinics, so data cannot be extrapolated to rural or primary-level settings, where most public healthcare sector patients are managed.

This was a cross-sectional study, so asthma control and adherence over a period of time could not be evaluated. It should be noted that the study duration coincided with the influenza season, which in 2023 was determined to start in late April and end in early July.[29] The 6-month data collection period of this study was reasonable for the scope of the project, which importantly adds to the paucity of published data in the field, but further research is needed for more robust findings to be determined.

Because the questionnaire was in layman's English, the researchers acknowledge that the participants' levels of English proficiency may have influenced the results. However, researchers with a variety of language proficiencies were present with participants throughout the study period to answer questions and attempt to avoid any misunderstandings.

Conclusion

The major finding of this study was the high proportion of individuals with poorly controlled asthma, as well as the low level of adherence to treatment in the JRC patient population. Additionally, there was an inverse relationship between control and adherence in the poorly controlled cohort. One postulated theory for this 'reverse phenomenon' is patient self-titrating, where people use their medication more during an exacerbation and less when they are asymptomatic, which is known to be very common in asthmatics. A significant relationship was found between asthma control and age, BMI ≥25, and previous hospitalisation for exacerbation. By identifying factors associated with poor asthma control in the SA urban public healthcare sector population, we hope that these findings provide motivation for further research to be done in this area. Ultimately, we hope that these findings can be utilised in the future to update patient education practices and improve asthma outcomes.

Data availability. The datasets generated and analysed during the present study are available from the corresponding author (GJT) on reasonable request. Any restrictions or additional information regarding data access can be discussed with the corresponding author.

Declaration. The research for this study was done in partial fulfilment of the requirements for JC-B, JC, YM, SM, VN, TSe, TSt and LW's MB ChB degrees at the University of the Witwatersrand.

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Conflicts of interest. None.

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