

# BMJ Open Barriers and determinants of asthma control in children and adolescents in Africa: a systematic review

Reratilwe Ephenia Mphahlele <sup>1</sup>, Omolemo Kitchin,<sup>2</sup> R Masekela <sup>1</sup>

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<sup>1</sup>Department of Paediatrics and Child Health, University of KwaZulu-Natal Nelson R Mandela School of Medicine, Durban, South Africa

<sup>2</sup>Department of Paediatrics and Child Health, University of Pretoria, Pretoria, South Africa

## Correspondence to

Dr Reratilwe Ephenia Mphahlele; [mphahlele@ukzn.ac.za](mailto:mphahlele@ukzn.ac.za)

## ABSTRACT

**Objective** To identify reasons for poor asthma control in African children and adolescents.

**Design** Systematic review

**Data sources** PubMed, Scopus, CINHAL, PsycINFO, MEDLINE and Web of Science databases were systematically searched up to 31 May 2020. Hand searching was done on Sabinet, African Journal online and Google Scholar.

**Eligibility criteria** Studies identifying barriers to asthma control, where asthma control was assessed by the validated Asthma Control Test/Child Asthma Control Test and/or Asthma Control Questionnaire were included.

**Data extraction and synthesis** Two reviewers independently selected studies for inclusion with disagreements resolved by a research team discussion, including a third reviewer. Data were extracted using the Cochrane Effective Practice and Organization of Care data collection form. The quality of the included studies was assessed using the modified Newcastle-Ottawa quality assessment scale. Identified barriers were reported in a thematic narrative synthesis.

**Primary outcomes** Poorly controlled asthma and associated factors.

**Results** From 914 records, three studies conducted between 2014 and 2019 in Nigeria, Uganda and South Africa met the inclusion criteria. A total of 883 children aged 4–19 years were analysed. Older age, concurrent allergy and city-dwelling significantly impacted asthma control. Few children with asthma symptoms in the community had ever used inhaled corticosteroids (6.7%) and identified reasons included lack of asthma diagnosis (38.8%) and no prescribed treatment (47.6%).

**Conclusion** Asthma control in African children is impacted by age, allergy, urbanisation and lack of access to asthma diagnosis and treatment. More studies focusing on identifying barriers to asthma control in Africa are needed.

**PROSPERO** Registration no: CRD42020196755

## INTRODUCTION

Asthma is a chronic non-communicable respiratory disease. According to the 2018 Global Asthma Report, asthma affects over 340 million people worldwide, the majority of whom reside in low-income and middle-income countries (LMICs).<sup>1</sup> In contrast to many high-income countries (HICs), the prevalence of asthma is steadily increasing

## Strength and limitations of this study

- This systematic review highlights the paucity of studies on barriers and determinants of asthma control in Africa.
- The sufficiently validated Asthma Control Test/Child Asthma Control Test was used to assess asthma outcomes and identify barriers to asthma control.
- Barriers to asthma control reported in this study contribute to, and match those described in the literature on paediatric asthma.
- A limitation of this study is that the heterogeneity of the studies precluded a meta-analysis.

in LMICs, particularly in Africa.<sup>1</sup> The latest systematic review on asthma prevalence in Africa shows that compared with 74 million in 1990, by 2010, asthma affected 119 million of the total population. Of concern, nearly half of these asthma cases were children under 15 years.<sup>2</sup> Countries with the highest childhood asthma prevalence in Africa, South Africa (20.3%), Congo (19.9%) and Ivory Coast (19.3%), are also regions with increasing urbanisation rates.<sup>3–4</sup> Factors associated with urbanisation including poverty, poor air quality and lifestyle and dietary changes may drive the rising asthma rate and impact asthma control.<sup>5</sup> However, in this setting, access to asthma healthcare and diagnosis as well as asthma research and research infrastructure remains lacking.<sup>6–9</sup>

The most commonly used validated tools for asthma control assessment are the composite score instruments: Asthma Control Test (ACT), Child Asthma Control Test (cACT) and the Asthma Control Questionnaire (ACQ).<sup>10</sup> The ACT and ACQ provide a quantitative assessment of asthma control and have been designated as core measures by the National Institutes of Health (NIH) for clinical research and observational studies.<sup>10–11</sup> ACT and ACQ are simple methods that can help quantify the impact of barriers on asthma control,<sup>12</sup> which may not

be comparable between HICs and LMICs.<sup>13</sup> This review was conducted to collate data on reported barriers to asthma control in children and adolescents in Africa.

## METHODS

The systematic review is registered with PROSPERO (registration no: CRD42020196755). We used the Population, Exposure, Comparator and Outcomes (PECO) acronym to aid with the systematic search. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting standards were followed.<sup>14</sup> The Synthesis Without Meta-Analysis reporting items guideline was used in conjunction with the PRISMA.<sup>15</sup>

### Search strategy

The following databases were searched: PubMed, Scopus, CINHAL, PsycINFO, MEDLINE and Web of Science. The search methodology for all the databases is provided in the supplementary material (online supplemental table 1). Hand searching of the following databases was also conducted: Sabinet, African Journal online and Google Scholar. Only scientific articles written in English with date restrictions from 1 January 2000 to 31 May 2020 were included.

The search strategy was structured to include terms for 'Child', 'Asthma', 'Barriers', 'Asthma Control Test', 'Africa' and/or variations of these.

### Selection of studies

Studies identified from searching electronic databases were combined and duplicates were removed. Two reviewers (REM, OK) independently screened references using a three-stage review of title and abstract, followed by a full-text review of included studies. The full text of potentially eligible studies was screened against the review criteria and potential articles identified. At each stage, disagreements were resolved by a team discussion with a third reviewer (RM).

### Inclusion and exclusion criteria

The study's focus was to identify barriers associated with poor asthma control in African children and adolescents with doctor-diagnosed/suspected asthma, where the validated ACT/cACT or ACQ tool was used to assess asthma control. The population included children between the ages of 6 and 18 years. Studies were included with broader age ranges if children aged 6–18 years were reported separately, or if >50% of the population were children within this age range.

Studies published from January 2000 to May 2020 were included to ensure the encompassing of all data since validation of the ACT and ACQ. Clinical trials assessing pharmaceutical treatment and diagnostic accuracy of tools were excluded. Grey literature from experts in the field, conference abstracts or unpublished material were also excluded (table 1).

### Data extraction

The full texts of all studies found to be relevant and meeting the inclusion criteria were retained for data extraction and final synthesis. Data including study design, setting, population, authorship and statistical analysis was extracted using a standardised data extraction form modified from the Cochrane Effective Practice and Organization of Care data collection form.<sup>16</sup> The authors were contacted where clarification was required, and data were missing. The selection process was summarised using a PRISMA flow diagram (figure 1).

### Quality assessment

The included studies' quality was assessed using the modified Newcastle-Ottawa Scale for cohort, case studies and cross-sectional studies<sup>17</sup> (online supplemental table 2).

### Data analysis and synthesis

We anticipated that the population and statistical analysis heterogeneity of the studies would preclude a formal meta-analysis. We, therefore, grouped into themes asthma control barriers corresponding to literature; patient, environmental, healthcare/doctor-related factors and comorbidities.<sup>12 13</sup> (online supplemental table 3). Statistical analyses were performed using MedCalc-Software, Ostend, Belgium; <http://www.medcalc.org>; 2018.<sup>18</sup>

### Patient and public involvement

Patients and the public were not involved in the study design or conduction of the study.

## RESULTS

### Search results

There were 914 articles identified: 863 articles through electronic database searching (EBSCO host=27, PubMed=136, Web of Science=97, Scopus=603) and an additional 51 articles through hand searching (Google scholar=23, Sabinet=12, AJOL=16). The total number of articles found after duplicates were removed was 498. Of the 498 articles screened, 484 were excluded as they were not appropriate or did not relate to the study. The remaining 14 full articles were assessed for eligibility, and 11 articles were excluded for the following reasons: wrong age group=2, did not use ACT/ACQ=2, not original research=2, assessed impact rather than barriers of poor asthma control=5. Three studies met the inclusion criteria (figure 1).

### Characteristics of the studies

All three studies conducted in Nigeria, South Africa and Uganda<sup>19–21</sup> were cross-sectional; two hospital-based and one community-based. The sample size was smaller for hospital-based studies with 207 and 115 participants in Nigeria<sup>19</sup> and South Africa,<sup>20</sup> respectively, compared with the community-based study of 561 participants in Uganda.<sup>21</sup> Publication dates ranged from 2014 to 2019. The ages of participants ranged from 4 to 19 years. Asthma diagnosis was based on doctor diagnosis<sup>19 20</sup> guided by

**Table 1** Criteria for the search and rules devised to facilitate inclusion/exclusion criteria

Search strategy	Definition	Rules
Population	Children and adolescents between ages 6 and 18 years with a doctor diagnosis or a baseline prescription for asthma treatment or presumed diagnosis of asthma based on a history of recurrent wheeze.	<i>Included:</i> Studies with broader ranges of ages if children aged 6–18 were reported separately or if >50% of the population were children within this age range. <i>Excluded:</i> Studies in adults (>18 years).
Exposure	Environmental related factors Pollution (indoor and outdoor), environmental tobacco smoke, mould, biomass fuels, pets, physical exercise, sedentary lifestyle, antibiotic use, paracetamol use, industrial combustion, respiratory infections. Patient-related factors Attitudes, knowledge and perceptions, adherence, beliefs, inhaler technique, lifestyle, relationships, communication Healthcare and doctor-related factors Availability of treatment and healthcare facilities, doctor asthma knowledge, time spent on asthma education, availability of medications. Comorbidities Allergic rhinitis, obesity, obstructive sleep apnoea Gastro-oesophageal Reflux Disease	<i>Included:</i> Studies aiming to identify exposures that had a quantifiable impact on asthma control. <i>Excluded:</i> ▶ Clinical trials assessing pharmaceutical treatments. ▶ Studies assessing the diagnostic accuracy of tools. ▶ Studies assessing the validity of tools.
Comparison (if applicable)	Usual care in people of the same age with well-controlled asthma	
Outcome	Asthma control measured using ACT/cACT and/or ACQ	<i>Excluded:</i> Studies using tools for measuring asthma control other than ACT/cACT and/or ACQ
Timeframe	20 years between January 2000 and May 2020	<i>Excluded:</i> Studies conducted before January 2000 and after May 2020
Setting	Africa	<i>Excluded:</i> Studies not done in Africa
Study	Cohort, case–control, cross-sectional	<i>Included:</i> Studies identifying exposures that impact asthma control as measured by cACT/ACT and/or ACQ

ACQ, Asthma Control Questionnaire; ACT, Asthma Control Test; cACT, Child Asthma Control Test.

the Global Initiative on Asthma (GINA),<sup>19</sup> and symptom screening by the International Study of Asthma and Allergies in Childhood questionnaire.<sup>21</sup> One study adjusted for age, gender and concurrent allergy,<sup>21</sup> while the rest did not report adjusting for potential confounders, reducing their quality score<sup>19 20</sup> (online supplemental table 2). To recruit participants, two of the hospital-based studies used consecutive enrolment from a group of children attending asthma clinic.<sup>19 20</sup> The community-based study derived participants from a large case–control study investigating risk factors of asthma in school going children<sup>21 22</sup> (table 2).

### Assessment of asthma control

All the studies measured asthma control using ACT and cACT. Scores were based on the cut-off point of >19 for controlled asthma and ≤19 for uncontrolled asthma. The prevalence of uncontrolled asthma in the Nigeria,

South Africa and Uganda was 30.9%, 44.3% and 44.5% respectively.

### Thematic synthesis

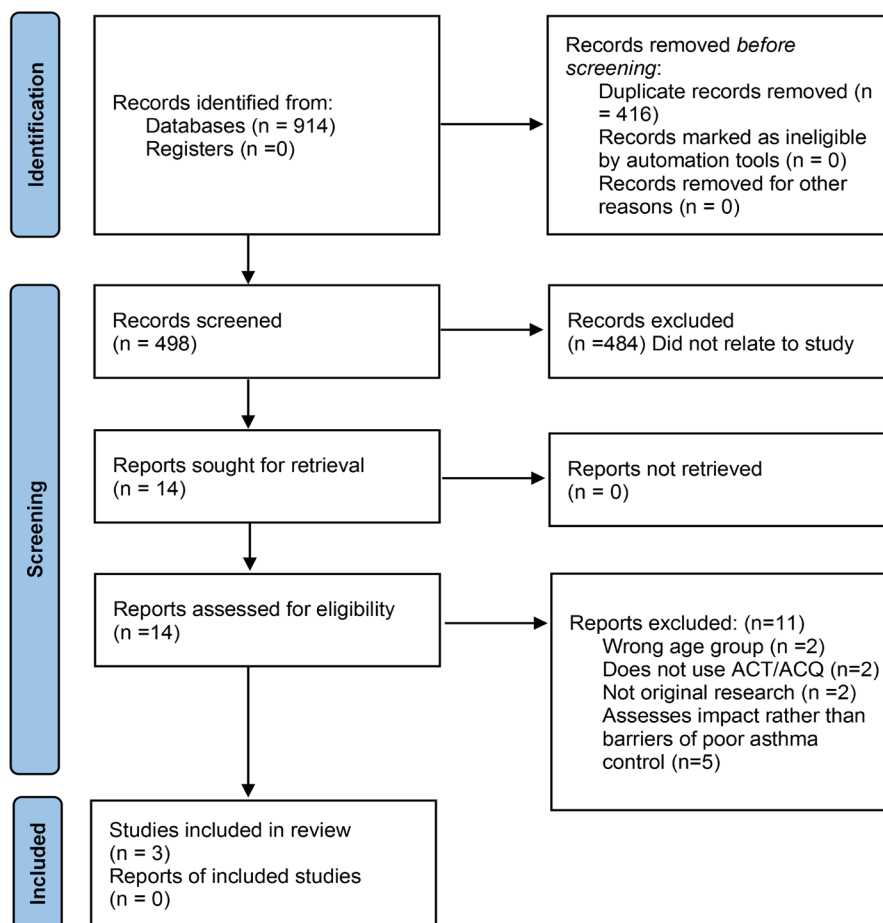
#### Patient-related factors

##### Age

Two studies assessed the impact of age on asthma control. The large community-based study showed that older age (13–17 years) was significantly associated with poorer asthma control (adjusted regression coefficient (95% confidence interval), p-value: (–1.07 (–1.20 to –0.94), p<0.0001).<sup>21</sup> The exception was a small clinic cohort of moderate quality, which showed no association.<sup>20</sup>

##### Gender

Two of the studies<sup>20 21</sup> that examined gender showed no significant association with asthma control.



**Figure 1** Study eligibility chart according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses criteria. ACQ, Asthma Control Questionnaire; ACT, Asthma Control Test.

### Asthma medication use

Two studies<sup>20 21</sup> examined the use and compliance of asthma medication. The study among school-going children<sup>21</sup> showed that the majority (73%) had never used inhaled asthma medications. Additionally, regular use of inhaled asthma medication in the last 12 months was inadequate for salbutamol (18.1%) and corticosteroid (6.7%) even though the majority (55.8%) had a doctor diagnosis of asthma. Although not significant, in the same cohort, children with poorly controlled asthma preferred regular use of (salbutamol and prednisone) tablets rather than inhaled salbutamol and corticosteroids.<sup>21</sup> Conversely, in the cohort of children attending asthma clinic,<sup>20</sup> good adherence to medications was seen in 82.6% of patients. In these doctor-diagnosed children, asthma control was significantly associated with good adherence to medication, where 37.9% and 62.1% of patients had uncontrolled asthma and controlled asthma, respectively ( $\chi^2=0.217$ ,  $p=0.002$ ).<sup>20</sup>

### Ethnicity

There was no significant association between asthma control and ethnicity ( $\chi^2=3.22$ ,  $p=0.359$ ) in Black-African, Caucasian, mixed-ethnicity and Indian participants in South Africa.<sup>20</sup>

### Environmental related factors

Two studies conducted in Uganda<sup>21</sup> and Nigeria<sup>19</sup> examined the effects of rural versus urban domicile on asthma control. The school-based Ugandan cohort showed that city residence in early life was associated with poor asthma control ( $-1.99$  ( $-3.69$  to  $-0.29$ ),  $p=0.02$ ).<sup>21</sup> In contrast the clinic-based cohort in Nigeria showed, although without significance, that within the rural community, more children with current allergies had better control of their asthma (85.7%) when compared with their urban counterparts (66.7%). Interestingly, the children who lived in rural areas *without* concurrent allergy had poorly controlled asthma (50.0%) compared with their urban counterparts (28.3%), Fisher's exact test=2.076,  $p=0.17$ , although this too was not significant.<sup>19</sup>

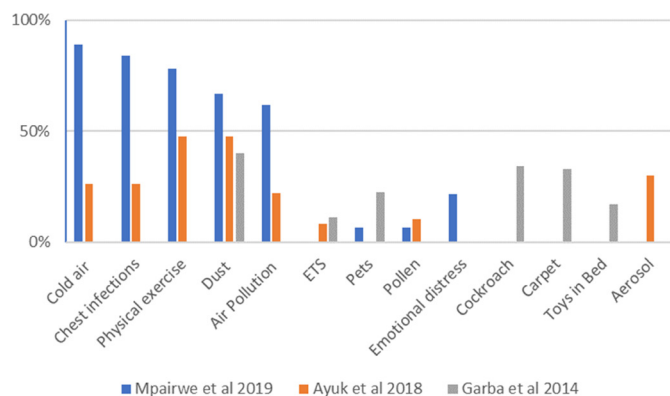
All three included studies considered the presence of asthma triggers in their participants' environments, but only the South African study examined these triggers in relation to asthma control. Common triggers included dust, cold air, physical exercise, fumes or air pollution, pollen, pets, smoking and biomass fuels (figure 2). In the South African cohort, home circumstances including dust, cockroach, carpet, pets, toys in bed and smoking were not found to be associated with asthma control.<sup>20</sup> The use of biomass fuel was uncommon in South Africa

**Table 2** Characteristics of included studies

Author ref	Study type	Setting	Year of publication	Country of origin	Sample size	Age ranges (years)	Asthma definition	Asthma control definition	Recruitment	Exposures	Quality score	Reviewers comment
Ayuk et al <sup>19</sup>	Cross-sectional	Hospital	2018	Nigeria	207	4–18	Doctor diagnosis, GINA	ACT/cACT >19 controlled <19 uncontrolled	Consecutive enrolment for 1 year from a group of children attending the asthma clinic	Family size, socioeconomic status, urban vs rural dwelling, allergy status (by ISAAC), Triggers (particulate and non-particulate)	7/10	Author contacted for further information on participant numbers.
Garba et al <sup>20</sup>	Cross-sectional	Hospital	2014	South Africa	115	5–18	Doctor diagnosis	ACT/cACT =25 (ACT)/27 (cACT) total control >19 well-controlled ≤19 uncontrolled 16–19 somewhat controlled <16 Poorly controlled	Consecutive enrolment for 4 months from a group of children attending the asthma clinic	Presence of a smoker at home, presence of pets, cockroaches and use of biomass fuel, the child's sleeping environment (dust, carpets and soft toys in the bedroom). Compliance with medications and inhaler technique. Allergy status (by clinical examination)	5/10	Author contacted for further information on recruitment strategy, data analysis and participant numbers.
Mpairwe et al <sup>21</sup>	Cross-sectional	Community School	2019	Uganda	561	5–17	Screening ISAAC questionnaire	ACT/cACT >19 Well controlled 15–19 partly controlled <15 Poorly controlled	Recruitment from children with self-reported breathing problems at schools in an urban area	Age, sex, regular physical exercise as recommended by WHO, area of residence in first 5 years of life (rural, town or city), concurrent allergy, antimalarials	10/10	Describes participants as derived from a large case-control* study to investigate risk factors of asthma.

\*Mpairwe et al.<sup>22</sup>

ACT, Asthma Control Test; cACT, Child Asthma Control Test; GINA, Global Initiative for Asthma; ISAAC, International Survey on Asthma and Atopy in Children; WHO, world health organisation.



**Figure 2** Prevalence of asthma triggers among study participants across African studies using the Asthma Control Test/Childhood Asthma Control Test to identify asthma control barriers. ETS, environmental tobacco smoke.

(6.1%) compared with Nigeria (22.1%) and was not found to be significantly associated with asthma control ( $\chi^2=6.202$ ,  $p=0.185$ ).<sup>19 20</sup>

### Healthcare and doctor-related factors

Only the field-based study in Uganda, reported the impact of healthcare-seeking behaviour on asthma control. In 553 children who reported treating their asthma in the last year, 26.8% reported having ever used inhaled asthma medications, and a similar proportion, 29.7% reported having ever used herbal remedies for asthma management. On enquiry about previous asthma assessments and follow-up, 73 (13.2%) visited a health facility to monitor their asthma, 45 (8.2%) children had ever had a lung function test; 2 (0.4%) had ever used a peak flow metre as an asthma monitoring tool at home, and only 3 (0.5%) had a personal written asthma action plan.<sup>21</sup> The reason for having never used inhaled asthma medication was investigated in 405 children and included inhaled asthma medications had never been prescribed for them (47.6%), never been diagnosed (38.8%), high cost of inhalers (4.5%), fear of side effects of inhalers (4.5%), alternative treatment with salbutamol or steroid tablets (1.4%) and non-medicinal treatment, that is, wrapping up in warm clothes and resting.<sup>21</sup>

### Comorbidities

All three studies assessed children for allergic rhinitis, but only two<sup>19 21</sup> in relation to asthma control. In the larger powered community-based study,<sup>21</sup> children with concurrent allergic rhinitis were more likely to have lower asthma control scores ( $-1.33$  ( $-2.28$  to  $-0.38$ ),  $p=0.006$ ), whereas no significant association was found between atopy and asthma control in the small cohort clinic-based study.<sup>19</sup> However, in the latter study, children with current allergy had more emergency hospital visits due to asthma exacerbations ( $\chi^2=10.09$  (df: 1)  $p=0.002$ ; Spearman's  $R=0.22$ ,  $p=0.001$ ).<sup>19</sup>

## DISCUSSION

Older age, concurrent allergic rhinitis and early life urban residence are barriers similar to HICs and significantly impact asthma control in African children. Access to healthcare and appropriate asthma medication remains limited, with a minority of children with asthma symptoms ever having used inhaled corticosteroids (ICS).

### Older age

Mpairwe *et al*<sup>22</sup> found adolescents in Uganda have inadequate asthma control and outcomes. Similarly, the age group 12–17 years was more predictive of exacerbations than other age groups in a European cohort study using the General Practice Research Database.<sup>23</sup> One reason for this can be explained by adolescent studies that show poor adherence compared with other age groups.<sup>24</sup> Social stigma, forgetfulness and poor understanding of medication play a significant role in adherence and warrant further exploration.<sup>25 26</sup>

### Concurrent allergic rhinitis

The Ugandan and Nigerian studies found that children with allergic rhinitis (AR) had less well-controlled asthma and were more likely to be hospitalised. Similarly, in a large UK retrospective cohort of 9522 children with asthma, the presence of AR significantly increased the likelihood of physician visits and more than doubled the likelihood of hospitalisation. Furthermore, drug use and costs were significantly higher among children with asthma and concurrent AR.<sup>27</sup> Active search and recognition of AR when assessing children remain critical in comprehensive asthma management.

### Rural versus urban residence

Studies in Africa show a decreasing gradient in asthma prevalence between urban and rural areas.<sup>28 29</sup> In this context, biomass fuel exposure remains a significant contributor to inflammatory lung diseases, including asthma and chronic obstructive pulmonary disease.<sup>30 31</sup> Few studies in Africa have compared asthma control between rural and urban areas.<sup>19 21 32 33</sup> Urban residence was significantly associated with poorly controlled asthma in Uganda, where asthma risk among schoolchildren<sup>21</sup> was three times higher in children who in early life resided in cities rather than rural areas.<sup>22</sup> Similarly, rural to urban migration appears to be an important determinant of the increasing prevalence of wheeze among schoolgoing children in Latin American cities.<sup>34 35</sup> Increasing asthma rates in urban settings could be related to over-crowding, reduction of exercise, poorer air quality and changes in lifestyle and diets.

### Access to diagnosis and healthcare

Six out of 10 children attending healthcare institutions have good asthma control, while a similar number of undiagnosed children in the community have poorly controlled asthma.<sup>19–21</sup> Even after a diagnosis of asthma, ICS use is limited in communities<sup>21 36</sup> compared with clinic patients<sup>20</sup> who once diagnosed, have significantly better

asthma control. The preference of tablets (salbutamol and corticosteroids) over ICS may largely be explained by their quick relief and ease of administration combined with underlying suboptimal knowledge and asthma medications cost.<sup>36</sup> Furthermore, traditional healers remain integral to medical care in communities due to local cultural practices and beliefs. There is a need to communicate asthma management strategies to communities in a culturally sensitive manner.<sup>32 37</sup> Triggers including dust, air pollution, pollen, pets and smoking common across the globe, indicate the feasibility of a global checklist and the necessity of avoidance education.<sup>38</sup>

### Strengths and limitations

We may not have identified all significant barriers that impact asthma control as other asthma control tools, that is, GINA and National Asthma Education Programme, were excluded because they are not as sufficiently validated as the ACT and ACQ.<sup>10</sup> Nevertheless, we identified variables in each group classification for poor asthma control in current literature.<sup>13</sup> Our wide-ranging search strategy found no non-English articles requiring exclusion. The studies' heterogeneity in terms of outcome analysis and population precluded a meta-analysis; therefore, we reported all the factors within the emerging themes.

### Implications for clinical practice, healthcare systems and policymakers

Strategies that improve medication access, including initiatives like the WHO Essential Medicines List, low-cost equipment like plastic spacers<sup>39</sup> and implementing culturally appropriate educational programmes for healthcare workers and the public, remain vital.<sup>40 41</sup>

### Implications for future research

Studies beyond healthcare institutions that include communities in identifying barriers and their impact on asthma control are needed in African children.

## CONCLUSION

Asthma control barriers requiring focus in Africa are lack of accurate diagnosis, limited access to inhaled therapy, lack of asthma knowledge and poor air quality. Better education and advocacy through community-based public interventions are needed to improve African children's asthma control and outcomes.

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**Contributors** REM, OK and RM designed the study and the search strategy. REM performed the literature search. REM, OK and RM performed the screening. REM performed the data extraction and analysis. REM, OK and RM interpreted the results. REM wrote the manuscript. All authors reviewed and approved the final version of the manuscript. RM is the study guarantor.

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### ORCID iDs

Reratlwe Ephenia Mphahlele <http://orcid.org/0000-0002-3348-9004>  
R Masekela <http://orcid.org/0000-0002-2006-1201>

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Table S1 SEARCH STRINGS Asthma control barriers in African children.

## PUBMED SEARCH STRING

pediatric* or paediatric* or child* or kindergarten* or kindergarden* or "elementary school*" or schoolchild* or boy or boys or girl* or "middle school*" or pubescen* or juvenile* or teen* or youth* or "high school*" or adolesc* or pre-pubesc* or prepubesc*) OR (child* or adolesc* or pediat* or paediat* [Journal]) OR child[MeSH Terms] OR infant[MeSH Terms] OR adolescent[MeSH Terms] OR pediatrics[MeSH Terms] OR minors[MeSH Terms]
AND
Asthma control test OR Asthma control questionnaire OR ACT OR ACQ OR asthma control surveys OR asthma control assessment tool OR ACQ composite score OR ACQ5 OR ACQ6 OR ACQ-FEV1 OR ACQ-PEF OR ACQ-wLF
AND
Challenges OR Challenge OR Problem OR Problems barriers or Difficulties or Issues or Limitations or Obstacles OR predisposing factors OR enabling factors OR factors or precipitating factors OR reinforcing factors OR risk factors OR predictor or contributing factors or key factors or cause or correlation OR Factor, Risk OR Factors, Risk OR Risk Factor OR Population at Risk OR Risk, Population at OR Populations at Risk OR Risk, Populations at OR Causalities OR Multifactorial Causality OR Causalities, Multifactorial OR Causality, Multifactorial OR Multifactorial Causalities OR Multiple Causation OR Causation, Multiple OR Causations, Multiple OR Multiple Causations OR Reinforcing Factors OR Factor, Reinforcing OR Factors, Reinforcing OR Reinforcing Factor OR Causation OR Causations OR Enabling Factors OR Enabling Factor OR Factor, Enabling OR Factors, Enabling OR Predisposing Factors OR Factor, Predisposing OR Factors, Predisposing OR Predisposing Factor
AND
"asthma"[MeSH Terms] OR asthma[Text Word]OR Wheeze [All Fields]))) AND (((("africa"[MeSH Terms] OR "africa"[All Fields]) OR ("africa south of the sahara"[MeSH Terms] OR ("africa"[All Fields] AND "south"[All Fields] AND "sahara"[All Fields]) OR "africa south of the sahara"[All Fields] OR ("sub"[All Fields] AND "saharan"[All Fields] AND "africa"[All Fields]) OR "sub saharan africa"[All Fields] OR ("angola"[MeSH Terms] OR "angola"[All Fields]) OR ("benin"[MeSH Terms] OR "benin"[All Fields]) OR ("botswana"[MeSH Terms] OR "botswana"[All Fields]) OR ("burkina faso"[MeSH Terms] OR ("burkina"[All Fields] AND "faso"[All Fields]) OR "burkina faso"[All Fields]) OR ("burundi"[MeSH Terms] OR "burundi"[All Fields]) OR ("cape verde"[MeSH Terms] OR ("cape"[All Fields] AND "verde"[All Fields]) OR "cape verde"[All Fields] OR ("cabo"[All Fields] AND "verde"[All Fields]) OR "cabo verde"[All Fields]) OR ("cameroon"[MeSH Terms] OR "cameroon"[All Fields]) OR ("central african republic"[MeSH Terms] OR ("central"[All Fields] AND "african"[All Fields] AND "republic"[All Fields]) OR "central african republic"[All Fields]) OR ("chad"[MeSH Terms] OR "chad"[All Fields]) OR ("comoros"[MeSH Terms] OR "comoros"[All Fields]) OR ("congo"[MeSH Terms] OR "congo"[All Fields]) OR ("cote d'ivoire"[MeSH Terms] OR ("cote"[All Fields] AND "d'ivoire"[All Fields]) OR "cote d'ivoire"[All Fields]) OR ("democratic republic of the congo"[MeSH Terms] OR ("democratic"[All Fields] AND "republic"[All Fields] AND "congo"[All Fields]) OR "democratic republic of the congo"[All Fields]) OR ("djibouti"[MeSH Terms] OR "djibouti"[All Fields]) OR ("egypt"[MeSH Terms] OR "egypt"[All Fields]) OR ("equatorial guinea"[MeSH Terms] OR ("equatorial"[All Fields] AND "guinea"[All Fields]) OR "equatorial guinea"[All Fields]) OR ("eritrea"[MeSH Terms] OR "eritrea"[All Fields]) OR ("ethiopia"[MeSH Terms] OR "ethiopia"[All Fields]) OR ("gabon"[MeSH Terms] OR "gabon"[All Fields]) OR ("gambia"[MeSH Terms] OR "gambia"[All Fields]) OR ("ghana"[MeSH Terms] OR "ghana"[All Fields]) OR ("guinea"[MeSH Terms] OR "guinea"[All Fields]) OR ("guinea-bissau"[MeSH Terms] OR "guinea-bissau"[All Fields] OR ("guinea"[All Fields] AND "bissau"[All Fields]) OR "guinea bissau"[All Fields]) OR ("kenya"[MeSH Terms] OR "kenya"[All Fields]) OR ("lesotho"[MeSH Terms] OR "lesotho"[All Fields]) OR ("liberia"[MeSH Terms] OR "liberia"[All Fields]) OR ("libya"[MeSH Terms]

OR "libya"[All Fields]) OR ("madagascar"[MeSH Terms] OR "madagascar"[All Fields]) OR ("malawi"[MeSH Terms] OR "malawi"[All Fields]) OR ("mali"[MeSH Terms] OR "mali"[All Fields]) OR ("mauritania"[MeSH Terms] OR "mauritania"[All Fields]) OR ("mauritius"[MeSH Terms] OR "mauritius"[All Fields]) OR ("comoros"[MeSH Terms] OR "comoros"[All Fields]) OR "mayotte"[All Fields]) OR ("morocco"[MeSH Terms] OR "morocco"[All Fields]) OR ("mozambique"[MeSH Terms] OR "mozambique"[All Fields]) OR ("namibia"[MeSH Terms] OR "namibia"[All Fields]) OR ("niger"[MeSH Terms] OR "niger"[All Fields]) OR ("nigeria"[MeSH Terms] OR "nigeria"[All Fields]) OR ("reunion"[MeSH Terms] OR "reunion"[All Fields]) OR ("rwanda"[MeSH Terms] OR "rwanda"[All Fields]) OR ("atlantic islands"[MeSH Terms] OR ("atlantic"[All Fields] AND "islands"[All Fields]) OR "atlantic islands"[All Fields] OR ("saint"[All Fields] AND "helena"[All Fields]) OR "saint helena"[All Fields]) OR ("atlantic islands"[MeSH Terms] OR ("atlantic"[All Fields] AND "islands"[All Fields]) OR "atlantic islands"[All Fields] OR ("sao"[All Fields] AND "tome"[All Fields] AND "principe"[All Fields]) OR "sao tome and principe"[All Fields]) OR ("senegal"[MeSH Terms] OR "senegal"[All Fields]) OR ("seychelles"[MeSH Terms] OR "seychelles"[All Fields]) OR ("sierra leone"[MeSH Terms] OR ("sierra"[All Fields] AND "leone"[All Fields]) OR "sierra leone"[All Fields]) OR ("somalia"[MeSH Terms] OR "somalia"[All Fields]) OR ("south africa"[MeSH Terms] OR ("south"[All Fields] AND "africa"[All Fields]) OR "south africa"[All Fields]) OR ("south sudan"[MeSH Terms] OR ("south"[All Fields] AND "sudan"[All Fields]) OR "south sudan"[All Fields]) OR ("sudan"[MeSH Terms] OR "sudan"[All Fields]) OR ("swaziland"[MeSH Terms] OR "swaziland"[All Fields]) OR ("tanzania"[MeSH Terms] OR "tanzania"[All Fields]) OR ("togo"[MeSH Terms] OR "togo"[All Fields]) OR ("tunisia"[MeSH Terms] OR "tunisia"[All Fields]) OR ("uganda"[MeSH Terms] OR "uganda"[All Fields]) OR ("zambia"[MeSH Terms] OR "zambia"[All Fields]) OR ("zimbabwe"[MeSH Terms] OR "zimbabwe"[All Fields])

## SCOPUS SEARCH STRING

pediatric* OR paediatric* OR child* OR kindergarten* OR kindergarden* OR "elementary school*" OR schoolchild* OR boy OR boys OR girl* OR "middle school*" OR pubescen* OR juvenile* OR teen* OR youth* OR "high school*" OR adolesc* OR pre-pubesc* OR prepubesc* OR child* OR adolesc* OR pediat* OR paediat* OR child OR adolescent OR pediatric* OR minor*
AND
"Asthma*" OR "Bronchial Asthma" OR "Bronchial" AND "Asthma" OR "Bronchial Asthma, Exercise Induced" OR "Exercise Induced Bronchial Asthma*" OR "Asthma*, Exercise-Induced" OR "Exercise Induced Asthma" OR "Exercise-Induced Asthma*" OR "Bronchospasm, Exercise-Induced" OR "Bronchospasm*, Exercise Induced" OR "Exercise-Induced Bronchospasm*" OR "Exercise Induced Bronchospasm" OR "Bronchial Spasm*" OR "Spasm*, Bronchial" OR "Bronchospasm*" OR "Wheez*" OR "Status Asthmaticus" OR "Bronchial Hyperreactivit*" OR "Respiratory Hypersensitivit*" OR "Bronchoconstrict*"
AND
"Asthma control test" OR "Asthma control questionnaire" OR ACT OR "Childhood asthma control test" OR C-ACT OR ACQ OR "asthma control survey*" OR "asthma control assessment tool" OR "ACQ composite score" OR ACQ5 OR ACQ6 OR ACQ-FEV1 OR ACQ-PEF OR ACQ-wLF
AND
Challenge* OR Problem* OR Barriers OR Difficult* OR Issue* or Limitation* OR Obstacle* OR "predisposing factor*" OR "enabling factor*" OR factors OR "precipitating factor*" OR "reinforcing factor*" OR "risk factor*" OR predictor OR "contributing factor*" OR "key factor*" OR caus* OR correlation* OR "Factor, Risk" OR "Factors, Risk" OR "Risk Factor" OR "Population at Risk" OR "Risk, Population" at OR "Populations at Risk" OR "Risk, Populations at" OR Causalities OR "Multifactorial Causality" OR "Causalities, Multifactorial" OR "Causality, Multifactorial" OR "Multifactorial Causalities" OR "Multiple Causation" OR "Causation, Multiple" OR "Causations, Multiple" OR "Multiple Causations" OR "Reinforcing Factors" OR "Factor, Reinforcing" OR "Factors, Reinforcing" OR "Reinforcing Factor" OR Causation* OR "Enabling Factor*" OR "Enabling Factor" OR "Factor, Enabling" OR "Factor*, Enabling" OR "Predisposing Factor*" OR "Factor, Predisposing" OR "Factor*, Predisposing"
AND
"africa" OR "africa" OR "africa south of the sahara" OR "Africa AND south" AND "sahara" OR "africa south of the sahara" OR "sub AND saharan AND africa" OR "sub Saharan africa" OR "angola" OR "angola" OR "benin" OR "benin" OR "botswana" OR "botswana" OR "burkinafaso" OR "burkina AND faso" OR "burkinafaso" OR "burundi" OR "burundi" OR "cape verde" OR "cape AND verde" OR "cape verde" OR "cabo AND verde" OR "cabo verde" OR "cameroon" OR "central african republic" OR "central AND african AND republic" OR "central african republic" OR "chad" OR "comoros" OR "congo" OR "cote d'ivoire" OR "cote AND d'ivoire" OR "democratic republic of the congo" OR "democratic AND republic AND congo" OR "democratic republic of the congo" OR "djibouti" OR "egypt" OR "equatorial guinea" OR "equatorial AND guinea" OR "eritrea" OR "ethiopia" OR "gabon" OR "gambia" OR "ghana" OR "guinea" OR "guinea-bissau" OR "guinea AND bissau" OR "guinea bissau" OR "kenya" OR "lesotho" OR "liberia" OR "libya" OR "madagascar" OR "malawi" OR "mali" OR "mauritania" OR "mauritus" OR "comoros" OR "mayotte" OR "morocco" OR "mozambique" OR "namibia" OR "niger" OR "nigeria" OR "reunion" OR "rwanda" OR "atlantic islands" OR "atlantic AND islands" OR "saint AND helena" OR "saint helena" OR "sao AND tome AND principe" OR "sao tome and principe" OR "senegal" OR "seychelles" OR "sierra leone" OR "sierra AND leone" OR "somalia" OR "south africa" OR "south AND africa" OR "south sudan" OR "south AND sudan" OR "Swaziland" OR "tanzania" OR "togo" OR "tunisia" OR "uganda" OR "zambia" OR "zimbabwe"

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pediatric* OR paediatric* OR child* OR kindergarten* OR kindergarden* OR "elementary school*" OR schoolchild* OR boy OR boys OR girl* OR "middle school*" OR pubescen* OR juvenile* OR teen* OR youth* OR "high school*" OR adolesc* OR pre-pubesc* OR prepubesc* OR child* OR adolesc* OR pediat* OR paediat*OR child OR adolescent OR pediatrics OR minors
AND
"asthma" OR asthma OR Asthmas OR Bronchial Asthma OR Asthma OR Bronchial Asthma, Exercise Induced OR Exercise-Induced Asthma OR Asthmas, Exercise-Induced OR Exercise Induced Asthma OR Exercise-Induced Asthmas OR Bronchospasm, Exercise-Induced OR Bronchospasm, Exercise Induced OR Bronchospasms, Exercise-Induced OR Exercise-Induced Bronchospasms OR Exercise-Induced Bronchospasm OR Exercise Induced Bronchospasm OR Bronchial Spasms OR Spasm, Bronchial OR Spasms, Bronchial OR Bronchospasm OR Bronchospasms OR Wheeze OR Status Asthmaticus OR Bronchial Hyperreactivity OR Respiratory Hypersensitivity OR Bronchoconstriction
AND
Asthma control test OR Asthma control questionnaire OR ACT OR Childhood asthma control test OR C-ACT OR ACQ OR asthma control surveys OR asthma control assessment tool OR ACQ composite score OR ACQ5 OR ACQ6 OR ACQ-FEV1 OR ACQ-PEF OR ACQ-wLF
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islands" OR "atlantic"AND "islands"OR "atlantic islands"OR "sao"AND "tome"AND "principe"OR "sao tome and principe"OR "senegal" OR "senegal"OR "seychelles" OR "seychelles"OR "sierra leone" OR "sierra"AND "leone"OR "sierra leone"OR "somalia" OR "somalia"OR "south africa" OR "south"AND "africa"OR "south africa"OR "south sudan" OR "south"AND "sudan"OR "south sudan"OR "sudan" OR "sudan"OR "swaziland" OR "swaziland"OR "tanzania" OR "tanzania"OR "togo" OR "togo"OR "tunisia" OR "tunisia"OR "uganda" OR "uganda"OR "zambia" OR "zambia"OR "zimbabwe" OR "zimbabwe"

EBSCO host: CINAHL Complete, Academic Search Complete, APA PsycInfo, CINAHL with Full Text, MEDLINE Complete, MEDLINE with Full Text) SEARCH STRING

<p>((pediatric* or paediatric* or child* or kindergarten* or kindergarden* or "elementary school*" or schoolchild* or boy or boys or girl* or "middle school*" or pubescen* or juvenile* or teen* or youth* or "high school*" or adolesc* or pre-pubesc* or prepubesc*) OR (child* or adolesc* or pediat* or paediat* [Journal]) OR child[MeSH Terms] OR infant[MeSH Terms] OR adolescent[MeSH Terms] OR pediatrics[MeSH Terms] OR minors[MeSH Terms])) Search modes - Boolean/Phrase</p>
<p>AND</p>
<p>( environmental factors OR environmental influences OR environmental exposure ) OR ( environmental factors.mp. OR environmental influences.mp OR environmental exposure.mp. OR environmental tobacco smoke.mp. OR maternal smoking.mp. OR parental smoking.mp. OR Nitrogen Dioxide/ OR gas fire*.mp. OR cooker*.mp. mp. OR Volatile Organic Compounds/ OR cleaning agents.mp. OR chemicals.mp. OR glue*.mp. OR floor covering*.mp. OR dry cleaning.mp. OR Chlorine/ oR swimming pool*.mp. resin*.mp. OR varnish.mp. OR Paint/ OR ethyl benzene.mp. OR air fresheners.mp. OR toluene.mp. OR caulk*.mp. / OR Vehicle Emissions/ae, pc, to [Adverse Effects, Prevention &amp; Control, Toxicity] OR plastic\$.mp. OR phthalate\$.mp. OR flame retardant\$.mp. OR plasticizer\$.mp. OR plasticiz\$ polyvinyl chloride.mp. OR floor covering\$.mp. OR adhesive\$.mp. OR synthetic leather.mp. OR toy\$.mp. OR cosmetic\$.mp. OR indoor dust.mp. OR di 2-ethylhexyl phthalate.mp. OR pvc.mp. outdoor source\$.mp. OR ozone.mp. OR sulphur dioxide.mp. OR traffic.mp. OR exhaust.mp OR coal fire\$.mp. OR diesel.mp. OR weather.mp OR particulate matter.mp. OR UFP\$.mp. OR transport.mp. OR industrial incineration.mp. OR firework\$.mp. OR bonfire.mp. OR solid fuel.mp. OR heating\$.mp. OR cooking.mp OR candle\$.mp. OR vacuum\$.mp. OR Hoover\$.mp. OR resuspension.mp. OR ingressio.mp. OR incineration.mp. OR NOX.mp. OR mp. OR carpet*.mp. OR tetraethyl lead.mp. OR cerium oxide*.mp. OR cold air.mp. OR meteorolog*.mp. OR. temperature.mp. OR climate.mp. OR air pollut*.mp. OR total suspended particulate*.mp. OR coal.mp.OR wood.mp. OR peat.mp. OR biomass.mp. OR oil.mp. OR diacetyl.mp. OR allergens.mp. OR aspergillus.mp. OR cladosporium.mp. OR dust mite*.mp. OR cat*.mp. OR dog*.mp. OR horse*.mp. OR animal*.mp. OR pet*.mp. OR mould.mp. OR mold.mp. OR alternaria.mp.OR cockroach*.mp. OR mice.mp. OR rats.mp. OR pollen.mp. OR grass.mp. OR aeroallergen*.mp. OR IgE.mp. OR fungal spore*.mp. OR food allerg*.mp. OR glucan*.mp. OR peanut*.mp. OR egg.mp. OR milk.mp. OR dairy.mp. OR exercise.mp. OR 197. lipopolysaccharide.mp. OR endotoxin.mp. OR. respiratory syncytial virus.mp. OR rhinovirus.mp. OR influenza virus.mp. OR corona virus.mp. OR diet.mp. OR sulphite*.mp. OR sulfite*.mp. OR sodium metabisul*.mp. OR monosodium glutamate.mp. OR MSG.mp. OR sodium benzoate.mp. OR vitamin D.mp. OR vitamin E.mp. OR antioxidant*.mp. OR lipid*.mp. OR. drug*.mp. OR aspirin.mp. OR paracetamol.mp. OR antibiotic*.mp. OR NSAID*.mp. ORobesity.mp. ) OR ( Challenges OR Challenge OR Problem OR Problems barriers or Difficulties or Issues or Limitations or Obstacles OR predisposing factors OR enabling factors OR factors or precipitating factors OR reinforcing factors OR risk factors OR predictor or contributing factors or key factors or cause or correlation OR Factor, Risk OR Factors, Risk OR Risk Factor OR Population at Risk OR Risk, Population at OR Populations at Risk OR Risk, Populations at OR Causalities OR Multifactorial Causality OR Causalities, Multifactorial OR Causality, Multifactorial OR Multifactorial Causalities OR Multiple Causation OR Causation, Multiple OR Causations, Multiple OR Multiple Causations OR Reinforcing Factors OR Factor, Reinforcing OR Factors, Reinforcing OR Reinforcing Factor OR Causation OR Causations OR Enabling Factors OR Enabling Factor OR Factor, Enabling OR Factors, Enabling OR Predisposing Factors OR Factor, Predisposing OR Factors, Predisposing OR Predisposing Factor )</p>
<p>AND</p>

Asthma control test OR Asthma control questionnaire OR ACT OR ACQ OR asthma control surveys OR asthma control assessment tool OR ACQ composite score OR ACQ5 OR ACQ6 OR ACQ-FEV1 OR ACQ-PEF OR ACQ-wLF

AND

(MH "Asthma") OR "asthma" OR (MH "Asthma, Occupational") OR (MH "Asthma, Exercise-Induced") OR (MH "Status Asthmaticus")

AND

(MM "Africa+") OR "africa" OR (MH "Africa South of the Sahara") OR (MH "Africa, Western") OR (MH "Democratic Nursing Organisation of South Africa") OR (MH "Africa, Southern") OR (MH "Africa, Eastern") OR (MH "Africa, Northern") OR (MH "South Africa") OR (MH "Africa, Central") OR (MH "South African Nursing Council") OR (MH "Namibia") OR (MH "Yohimbe") OR (MH "Medicine, African Traditional") OR (MH "Guinea") OR (MH "Ghana") OR (MH "Gabon") OR (MH "Ethiopia") OR (MH "Eritrea") OR (MH "Equatorial Guinea") OR (MH "Egypt") OR (MH "Djibouti") OR (MH "Democratic Republic of the Congo") OR (MH "Cote d'Ivoire") OR (MH "Botswana") OR (MH "Burkina Faso") OR (MH "Burundi") OR (MH "Cameroon") OR (MH "Cape Verde") OR (MH "Central African Republic") OR (MH "Algeria") OR (MH "Benin")

Table S2 NEWCASTLE OTTAWA QUALITY ASSESSMENT of included studies. Taken from: PA Modesti et al., (2016) .<sup>17</sup>

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE (adapted for cross sectional studies)	Ayuk et al. 2018	Garba et al. 2014	Mpairwe et al. 2019
<b>Selection: (Maximum 5 stars)</b>			
1) Representativeness of the sample:			
a) Truly representative of the average in the target population. * (all subjects or random sampling)	★	★	★
b) Somewhat representative of the average in the target population. * (non-random sampling)			
c) Selected group of users.			
d) No description of the sampling strategy.			
2) Sample size:			★
a) Justified and satisfactory. *	★		★
b) Not justified.		0	
3) Non-respondents:			
a) Comparability between respondents and non-respondents' characteristics is established, and the response rate is satisfactory. *			
b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.			
c) No description of the response rate or the characteristics of the responders and the non-responders.	0	0	
4) Ascertainment of the exposure (risk factor):			
a) Validated measurement tool. **	★ ★		★ ★
b) Non-validated measurement tool, but the tool is available or described. *		★	
c) No description of the measurement tool.			
<b>Comparability: (Maximum 2 stars)</b>			
1) The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled.			
a) The study controls for the most important factor (select one). *	0	0	★
b) The study control for any additional factor. *	0	0	★
<b>Outcome: (Maximum 3 stars)</b>			
1) Assessment of the outcome:			
a) Independent blind assessment. **	★ ★	★ ★	★ ★
b) Record linkage. **			
c) Self-report. *			
d) No description.			
2) Statistical test:			
a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value). *	★	★	★
b) The statistical test is not appropriate, not described or incomplete.			
<b>TOTAL</b>	★ 7	★ 5	★ 10

17. Modesti PA, Reboldi G, Cappuccio FP, et al. Panethnic differences in blood pressure in Europe: a systematic review and meta-analysis. PLoS one. 2016;11(1):e0147601. doi: 10.1371/journal.pone.0147601



Table S3 Barriers that impact asthma control in African children

Key:

Notes on this table:

- The study data has been grouped into thematic factors with multiple barriers; therefore, studies appear multiple times.
- Within each thematic factor, the studies are listed by the study design, quality score, size and the barriers they present.
- Barriers are colour coded according to the key below

Barriers associated with uncontrolled asthma	
Barriers that have null effect	
Complex or difficult to interpret	

## Abbreviations

y	years	SPT	skin prick test	n	number of children
F	female	FeNo	fractional exhaled nitric oxide	x	number with outcome
M	male			N	number of children in population
				OR	odds ratio
				AMD	adjusted Mean difference
				m	missing
ICS	inhaled bronchodilator	AR	allergic rhinitis	CS	cross-sectional
SABA	short-acting beta-agonist	ETS	environmental tobacco smoke		
CA	controlled asthma	ACT	asthma control test	%	percent
UA	uncontrolled asthma				

Patient-related factors									
Study ID, Design, Quality Score	Country, Sample Size, Ages	Effect measure	Barrier definition	Effect value	95%CI or significance	Reference group or comparator	Analysis used	Adjustments or variables	Comments
<b>Age</b>									
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] 5-12 y n=338 13-17 y n=214 Age 5-18 y	AMD	13 -17 y	-1.07	-1.20 to -0.94 P < 0.0001	5-12 y	Multivariate analysis	Sex, regular physical exercise as recommended by WHO, area of residence 1st 5 years of life (rural, town or city), concurrent allergy,	
Garba 2014 CS 6/10	South Africa N=115 15-18y n=23 10-14y n=54 Age 4-19 y	x/n (%)	15-18 y	15-18y 11(47.8%) UA vs 10-14y 25(46.3%) UA	NS	10-14 y	χ <sup>2</sup> test	None	
<b>Gender</b>									
Mpairwe H 2019 CS 10/10	Uganda N=561 [m=8] F n=292 M n=261 Age 5-18 y	OR	F	-0.54	NS	M	Multivariate analysis	Age, regular physical exercise as recommended by WHO, area of residence 1st 5 years of life (rural, town or city), concurrent allergy,	
Garba 2014 CS 6/10	South Africa N=115 F n=56 M n=59 Age 4-19 y	x/n (%)	F	F 26 (46.4%) UA vs M 25 (42.4%) UA	NS	M	χ <sup>2</sup> test	None	
<b>Asthma medication use</b>									
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] CA n=307 UA n=246 Age 5-18 y	x/n (%)	Inhaled SABA Yes 100 (18.1%)	51 (16.6%) CA vs 49 (19.9%) UA	NS		χ <sup>2</sup> test	No information	
			ICS Yes 37 (6.7%)	22 (7.2%) CA vs 15 (6.10%) UA	NS			No information	
			Steroid tablets Yes 149 (27.0%)	86 (28.1%) CA vs 63 (25.6%) UA	NS			No information	
			Neither salbutamol nor steroids Yes 225 (40.7%)	153 (49.8%) CA vs 72 (22.6%) UA	<0.0001		χ <sup>2</sup> test	No information	Mpairwe et al. noted that of 307 children with well-controlled asthma, 153 (49.8%) reported not using salbutamol or steroids in any formulation, they suggested that perhaps they had mild asthma.
<b>Ethnicity</b>									
Garba 2014 CS 6/10	South Africa N=115 CA n=64 UA n=51 Age 4-19	x/n (%)	Black n= 99 (86.1%) Coloured n= 7(6.1%) White n= 5 (4.3%) Asian n= 4 (3.5%)	Black race 53 (82.1%) CA vs Black race 46 (90.2%) UA	NS		χ <sup>2</sup> test	None	

Environmental related factors									
Study ID, Design, Quality Score	Country, Sample Size, Ages	Effect measure	Barrier definition	Effect value	95%CI or significance	Reference group or comparator	Analysis used	Adjustments or variables	Comments
<b>City residence</b>									
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] Rural n=71 Town n=433 City n=49 Ages 5-18y	OR	City dwelling in the first five years of life	-1.99	-3.69 to -0.29 p=0.02	Rural residence	Multivariate analysis	Age, sex, regular physical exercise as recommended by WHO, concurrent allergy	Mpairwe et al. notes that p-value = 0.06 was for town and city and p-value= 0.02 for city only.
Ayuk A 2018 CS 6/10	Nigeria N=207 Urban n=178 Rural n=28 Ages 4-18y	x/n (%)	Urban residence	Urban 56 (31.4%) UA vs Rural 9 (32.1%) UA	NS	Rural residence	Fisher's exact test	No information	
<b>Triggers (Home)</b>									
Garba B 2014 CS 6/10	South Africa N=115 CA n=64 UA n=51 Age 4-19	x/n (%)	Dust n= 46 (40%)	25 (54.3%) CA vs 21 (45.7%) UA	NS		χ <sup>2</sup> test	None	
			Cockroach n= 39 (33.9%)	19 (48.7%) CA vs 20 (51.3%) UA	NS		χ <sup>2</sup> test	None	
			Carpet n= 38 (33.0%)	17 (44.7%) CA vs 21 (55.3%) UA	NS		χ <sup>2</sup> test	None	
			Pets n=26 (22.6%)	15 (57.7%) CA vs 11 (42.3%) UA	NS		χ <sup>2</sup> test	None	
			Toys in bed n= 20 (17.4%)	9 (45.0%) CA vs 11 (55.0%) UA	NS		χ <sup>2</sup> test	None	
			ETS n= 13 (11.3%)	6 (46.2%) CA vs 7 (53.8%) UA	NS		χ <sup>2</sup> test	None	

Healthcare-related factors									
Study ID, Design, Quality Score	Country, Sample Size, Ages	Effect measure	Barrier definition	Effect value	95%CI or significance	Reference group or comparator	Analysis used	Adjustments or variables	Comments
<b>Access to medication</b>									
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] CA n=307 UA n=246 Age 5-18 y	x/n (%)	ICS Yes n=37 (6.7%)	22 (7.2%) CA vs 15 (6.10%) UA	NS	Well-controlled asthma	$\chi^2$ test	No information	
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] CA n=307 UA n=246 Age 5-18 y	x/n (%)	Inhaled SABA Yes n=100 (18.1%)	51 (16.6%) CA vs 49 (19.9%) UA	NS	Well-controlled asthma	$\chi^2$ test	No information	
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] CA n=307 UA n=246 Age 5-18 y	x/n (%)	Neither salbutamol nor steroids Yes n=225 (40.7%)	153 (49.8%) CA vs 72 (29.3%) UA	p < 0.0001	Well controlled asthma	$\chi^2$ test	No information	Mpairwe et al. noted that of 307 children with well-controlled asthma, 153 (49.8%) reported not using salbutamol or steroids in any formulation, they suggested that perhaps they had mild asthma.
<b>Skin prick test</b>									
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] ACT test scores N=553 [m=9] Negative n=244 Positive n=300 Ages 5-18y	OR	Positive SPT $\geq 3$ mm	-0.51	-1.31 to 0.29 NS	Negative SPT <3mm	multivariate analysis	Age, sex, regular physical exercise as recommended by WHO, area of residence 1st 5 years of life (rural, town or city), concurrent allergy	
<b>Fractional nitric oxide</b>									
Mpairwe H 2019 CS 10/13	Uganda N= 561 ACT test scores N=553 [m=13] Normal n=335 Elevated n=195 Ages 5-18y	OR	Elevated value FeNo $\geq 35$ ppb	0.42	-0.39 to 1.24 NS	Normal value FeNo <35ppb	multivariate analysis	Age, sex, regular physical exercise as recommended by WHO, area of residence 1st 5 years of life (rural, town or city), concurrent allergy	

Comorbidities									
Study ID, Design, Quality Score	Country, Sample Size, Ages	Effect measure	Barrier definition	Effect value	95%CI or significance	Reference group or comparator	Analysis used	Adjustments or variables	Comments
<b>Allergy</b>									
Mpairwe H 2019 CS 10/10	Uganda N= 561 [m=8] ACT test scores N=553 [m=1] No n=434 Yes n=118 Ages 5-18y	OR	Concurrent AR	-1.33	-2.28 to -0.38 p= 0.006	No concurrent allergy	multivariate analysis	Age, sex, regular physical exercise as recommended by WHO, area of residence 1st 5 years of life (rural, town or city)	
Ayuk A 2018 CS 6/10	Nigeria N=207 No n=121 Yes n=86 Ages 4-18y	x/n (%)	Current allergy	Current allergy 26 (30.2%) UA vs No Allergy 38 (31.4%) UA	NS	No current allergy	Fisher's exact test	No information	