



REVIEW

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Prevalence of medication adherence among adult asthmatic patients in four African countries: A systematic review and meta-analysis

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ABSTRACT

Non-adherence to medications has many deleterious effects including poor treatment outcomes, increased economic burden, increased morbidity, hospitalization rate, health care utilization, productivity loss, and mortality. Therefore, this review aimed to estimate the pooled prevalence of medication adherence among asthmatic adults in 4 African countries.

Primary studies were extensively searched from databases such as PubMed, HINARI, Cochrane Library, CINHALand, Google Scholar, and Google search engines. After screening and assessing the quality of studies, data were extracted using a checklist. Heterogeneity was assessed using forest plot, Chocran's Q Test and I^2 . The random effects meta-analysis model was employed to pool the prevalence of medication adherence among adult asthmatic patients in Africa. Sub-group analysis and meta-regression were performed to identify the sources of heterogeneity. Publication bias was assessed using funnel plots with Egger's test. A sensitivity analysis was performed to assess the influence of individual studies on the overall estimate.

The review was performed among 16 studies of which 14 were cross-sectional with a total of 4019 participants. The pooled random effects prevalence of adherence to medications among adult patients with asthma in Africa was 39% (95% CI: 32, 47; $p < 0.001$) with a heterogeneity ($I^2 = 94.82$, $p < 0.001$). The pooled prevalence of medication adherence among adult asthmatic patients in Africa is low. Researchers should conduct further multicenter longitudinal studies by using objective methods of adherence measurement.

Keywords: Adherence, Medication, Adult, Asthma, Africa

INTRODUCTION

Asthma is a chronic inflammatory disorder of the respiratory system in which many cells are involved and characterized by recurrent attacks of

breathlessness, coughing, and wheezing.¹ Asthma is one of the major non-communicable diseases that affect a large number of people in the world. It is a major global public health problem with an increase in the economic burden, morbidity, and

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mortality of the disease.² Asthma ranked 28th among disease-leading causes of burden worldwide and 27th in low- and middle-income countries.³ According to the World Health Organization (WHO) report, globally, it affected 339 million people in 2018 with the magnitude expected to exceed 400 million by 2025. In 2019, more than 461 000 people died from asthma worldwide.⁴⁻⁶ Poor and middle-income nations account for more than 80% of asthma mortality.⁷

WHO defines medication adherence as “the extent to which a person’s behavior taking medication, corresponds with agreed recommendations from a health care provider.”⁸ The major global challenge in asthma treatment and control is non-adherence to prescribed medications.⁹ Non-adherence to medications in asthmatic patients can be affected by different factors. These factors are classified by WHO into 5 categories: socioeconomic factors, factors associated with the health care team and system in place, disease-related factors, therapy-related factors, and patient-related factors.⁸

Adherence to asthma medication is very low, with the prevalence of nonadherence ranging from 30 to 70%.¹⁰ Non-adherence to medications has many deleterious effects on the patient, community, and the country. It results in poor treatment outcome,¹¹⁻¹³ increased cost, increased morbidity and hospitalization rate, health care utilization, productivity loss, and mortality.^{2,9,14} In developing countries in which most African nations are categorized, the annual economic burden of asthma was over \$20 billion. Poor asthma control accounts for three-quarters of this annual economic burden, which is a result of medication non-adherence.¹⁵

Figuring out the pooled prevalence of adherence to anti-asthmatic medications can be quite helpful in highlighting the severity of the problem and making it a top priority. In addition, it helps combat the negative consequences of non-adherence such as uncontrolled asthma, morbidity, and mortality. In Africa, there are many primary studies conducted on adherence to medications among adult asthmatic patients but provided inconsistent findings ranging from 13.9 to 62%.^{16,17} According to the investigator’s search, there is no previous systematic review and meta-

analysis done regarding medication adherence among adults with asthma in Africa. Therefore, this review aimed to estimate the pooled prevalence of adherence medications among asthmatic adults in 4 African countries. “What is the prevalence of medication adherence among adult patients with asthma?” was the research question of this review.

MATERIAL AND METHODS

Study design and search strategy

A systematic review and meta-analysis of published and unpublished studies were used to determine the pooled prevalence of medication adherence among adult asthmatic patients in Africa. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was applied to report this review.¹⁸ Primary studies were extensively searched from databases such as PubMed, HINARI, Cochrane Library, and CINAHL. Grey kinds of literature were retrieved from Google and Google Scholar search engines and their advanced form. The key terms used in searching studies were adherence, medication, drug, treatment, asthma, bronchial asthma, Ethiopia, Eritrea, Kenya, North Sudan, South Sudan, Djibouti, Somalia, Senegal, Burundi, Benin, Sierra Leone, Mauritania, Lesotho, Guinea-Bissau, Rwanda, Uganda, Tanzania, Tunisia, Egypt, Libya, Morocco, Algeria, Angola, Namibia, Zambia, Botswana, Central African Republic, Nigeria, Niger, Democratic Republic of Congo, Zimbabwe, South Africa, Liberia, Cameroon, Cote d’Ivoire, Mali, Malawi, Chad, Guinea, Gabon, Gambia, Ghana, Mozambique, Madagascar, Congo Brazzaville, Burkina Faso, Togo, Eswatini, Comoros, Cabo Verde, Sao Tome & Principe, Equatorial Guinea, and Mauritius by a combination of Boolean operators “AND” or “OR” as applicable and the search was made by 2 authors independently (SZ and AA). To decrease the number of irrelevant studies, the search was restricted to only “human studies”, “published in the past 13 years”, and “English language” in the advanced search. The search was conducted from May 1, 2023 to June 30, 2023.

Eligibility criteria

The inclusion criteria of this review were:

Design: observational studies including cross-sectional, case-control, and cohort studies.

Population: Asthmatic patients who are 18 and above years old.

Condition: Prevalence of adherence to anti-asthmatic medications. The patient is said to be highly adherent if he/she scores 8 on Morisky Medication Adherence Scale (MMAS-8),¹⁹ 50 on the Test of Adherence to Inhalers (TAIs),²⁰ ≥ 4.5 for the Medication Adherence Rate Scale (MARS-A),²¹ and >23 in Adherence Starts with knowledge.

Context: Africa.

Publication status: Both published and unpublished.

Language: studies published in the English language.

Time frame: from January 1, 2010 to June 30, 2023.

Region: Articles from Africa region.

The exclusion criteria of this review were:

1. Studies conducted among asthmatic patient less than 18 years old.²²
2. Studies with different outcome measurement.²³
3. Studies scored <50 (low quality) when critically appraised using the standardized Joanna Briggs Institute (JBI) critical appraisal tool.^{24,25}

Study selection, quality appraisal, and data extraction

The article searches and screening activity were done by SZ and EMB. Articles searched from different sources were exported to EndNote V.20, and duplicates were identified and dropped. The titles of the remaining articles were evaluated. Studies with irrelevant titles were rejected and the abstracts and full texts of the remaining studies were reviewed. Two independent reviewers (SZ and BKA) perform the quality assessment appraisal. The quality of each article was assessed using the standardized Joanna Briggs Institute (JBI) critical appraisal tool prepared for cross-sectional, cohort, and case-control studies.²⁴ The tool has "Yes", "No", "unclear", or "not applicable" types of questions, and scores were given 1 for "Yes", and 0 for "No" and "unclear" responses, respectively. Scores were summed and transfor

med into a percentage. Those studies that scored $\geq 50\%$ were taken for both systematic review and meta-analysis of adherence to anti-asthmatic medications. When there were any scoring disagreements between the assessors, the sources of discrepancy were investigated by a thorough discussion. For persistent disagreements despite the detailed review, a third independent reviewer (BM) was assigned as arbitrator.

We developed a data extraction sheet using a Microsoft Excel worksheet, pre-tested on 5 randomly selected included studies and modified the checklist accordingly. Information such as the name of the first author, year of publication, study design, the country the study was conducted, sample size, response rate, adherence rate, the primary outcome of the study, type of medication the study focused, and study quality score were included in the data extraction tool. One reviewer author (SZ) extracted the data from included studies and the last author (AA) checked the extracted data.

Statistical methods and analysis

The extracted data was exported to STATA/SE V.17 for further analysis. Forest plots were used to present the prevalence of adherence to medications among adults with asthma in Africa. They provide a visual inspection of the confidence intervals of effect sizes of individual studies. The existence of heterogeneity among studies was assessed using the forest plot, the Cochran's Q statistics and the I^2 . The presence of non-overlapping intervals suggests heterogeneity. Significance of heterogeneity was declared using Q statistics at p -value <0.1 . Heterogeneity test (I^2) of $\geq 50\%$ and a p -value of <0.05 was declared as the presence of heterogeneity.²⁶ The confidence intervals were computed using the exact method. The DerSimonian and Laird (D-L) method for the random effects model was applied in the meta-analysis of the prevalence of adherence to medications. A funnel plot was used to detect and examine publication and small study biases. The funnel plot asymmetry was statistically checked using Egger's test.²⁷ Accordingly, asymmetry of the funnel plot and/or statistical significance of Egger's regression test ($p < 0.05$) were suggestive of publication or small study bias.

Subgroup analysis was performed by using response rate, sample size, study quality score and type of medication as grouping variables and sources of variation. Meta-regression was also conducted for the prevalence of medication adherence using sample size and mean age as covariates. To check the influence of a single study on the effect size, a sensitivity analysis was performed using the random effects model.

RESULTS

Study selection

A total of 774 studies were found through electronic searches. About 32 full-text articles were

assessed for eligibility. Sixteen met the inclusion criteria and were included in the review (Fig. 1).

Study characteristics

About 14 studies included in this review were cross-sectional^{3,11,16,17,28-37} and the remaining 2 were case-control and prospective cohort.^{12,38} Of the included studies 9 were from Ethiopia,^{11,12,16,17,28-30,34} 3 from Egypt,^{3,33,38} 3 from Nigeria,^{31,32,36} and the remaining 1 was from Tanzania.³⁵ The sample size of the included studies ranged from 110³ to 474³³ with a total sample size of 4019 adults living with asthma. Regarding sex of the participants, 2029 participants were females. All of the

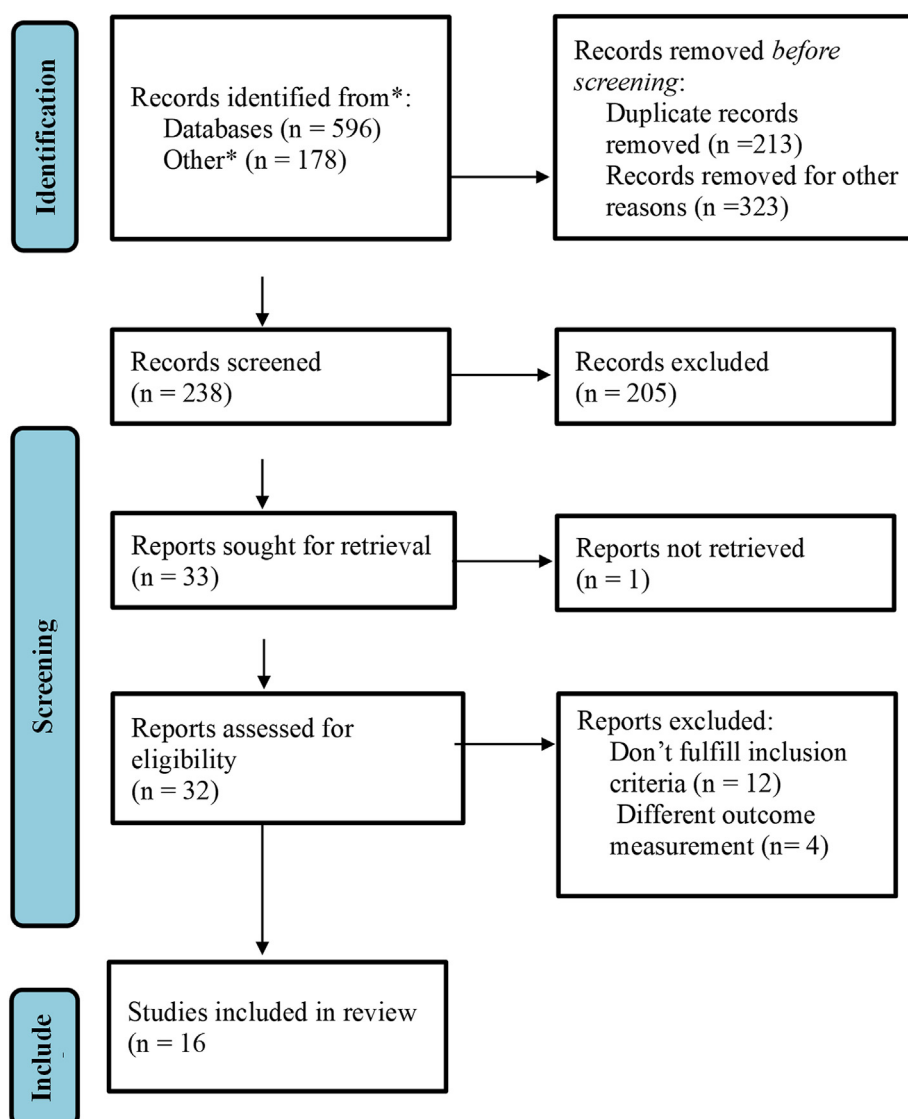


Fig. 1 PRISMA flow diagram of included studies in the systematic review and meta-analysis of the prevalence of medication adherence among adult patients with asthma in 4 African countries from 2010 to 2023.

Study Id	Author, Publication year	Country	Study Design	Sample Size	Response rate	Adherence%	Primary outcome/ Prevalence of	Quality Score
1	Demelash et al, 2023	Ethiopia	Cross-sectional	400	94.8	44.5	adherence	89%
2	Heluf et al, 2022	Ethiopia	Cross-sectional	257	100	42.8	uncontrolled asthma	78%
3	Kebede and Mamo, 2019	Ethiopia	Cross-sectional	140	98	62.1	adherence	78%
4	Ayele et al, 2017	Ethiopia	Cross-sectional	164	100	49.4	non-adherence	89%
5	Heluf et al, 2022	Ethiopia	Cross-sectional	320	93.2	34.1	adherence	78%
6	Belachew et al, 2022	Ethiopia	Cross-sectional	409	96.7	13.9	adherence	89%
7	Tesfaye et al, 2018	Ethiopia	Cross-sectional	150	92.6	22.7	adherence	78%
8	Zewudie et al, 2019	Ethiopia	Case-Control	242	100	56.3	uncontrolled asthma	78%
9	Ali et al, 2020	Egypt	Cross-sectional	110	100	42.2	adherence	78%
10	N. Rifaat et al, 2013	Egypt	Prospective cohort	143	100	49	adherence	56%
11	Galal et al, 2018	Egypt	Cross-sectional	474	100	28.2	adherence	89%
12	Azeez et al, 2016	Nigeria	Cross-sectional	355	100	51	adherence	78%
13	Desalu et al, 2016	Nigeria	Cross-sectional	121	100	39.7	non-adherence	56%
14	Amaka et al, 2022	Nigeria	Cross-sectional	113	100	29	adherence	56%
15	Shayo et al, 2022	Tanzania	Cross-sectional	385	92.1	39.7	non-adherence	66%
16	Degarege, 2022	Ethiopia	Cross-sectional	236	94.8	29.2	non-adherence	89%

Table 1. Characteristics of studies included in the systematic review and meta-analysis of the prevalence of medication adherence among adults with asthma in 4 African countries from 2010 to 2023

studies were institution-based and 14 were published.^{11,12,16,17,28-30,32-35,38} All the included studies measured adherence to medications by using self-report medication adherence measurement tools. Of the included studies, 6 used the Morisky Medication Adherence Scale,^{3,12,30,33,37,38} 3 studies used Medication Adherence Rating Scale-Asthma,^{11,16,34} 3 used Test of the Adherence to Inhalers,^{17,29,35} and 1 study used Adherence Starts with Knowledge.²⁸ But the remaining 3 studies^{31,32,36} did not use a validated tool to determine the prevalence of medication adherence (Table 1).

Risk of bias within studies

The JBI checklist²⁴ of cross-sectional, case-control and cohort studies was used to assess the quality of individual studies. Some of the criteria of the JBI checklist include: the appropriateness of the sampling frame; appropriateness of sampling procedure; adequacy of the sample size; the description of the study participants and the

setting; response rate; appropriateness of the statistical analysis and identification and handling strategies of confounding factors; and validity of the tool used to measure adherence. The scoring was performed by assigning 1 for “yes”, and 0 for “no” and “uncertain”. Except for 1 study,²⁵ the rest selected studies fulfilled the 50% quality assessment score for the review.

Prevalence of medication adherence

Of the included studies, 7 focused on adherence to specifically inhaled medications among adult asthmatic patients^{3,16,17,29,31,35,38} but the remaining 9 studies focused on any type of anti-asthmatic medications.^{11,12,28,30,32-34,36,37} The lowest prevalence of adherence to anti-asthmatic medications (13.9%) was reported in Ethiopia¹⁶ and the highest (62.1%) was reported by another study conducted in Ethiopia.¹⁷ The pooled random effects prevalence of adherence to medications among adult patients with asthma in Africa was 39% (95% CI: 32, 47; $p < 0.001$). There was high heterogeneity between studies as evidenced by a significant heterogeneity chi-

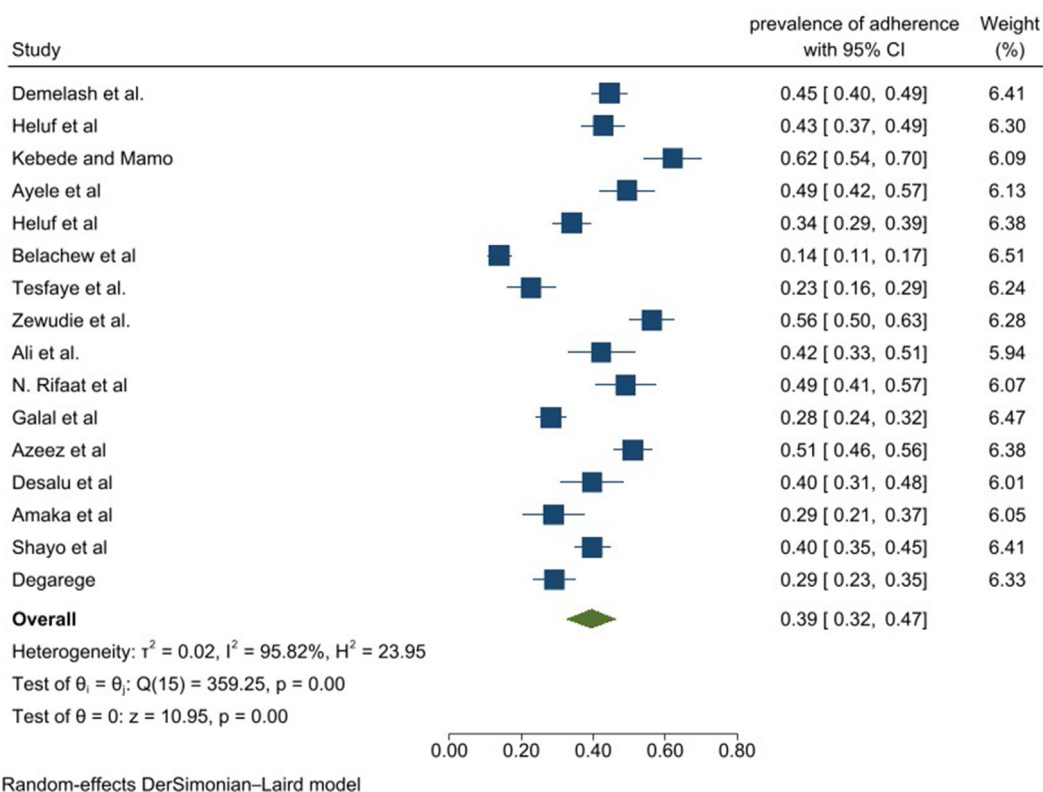


Fig. 2 Forest plot of the pooled prevalence of medication adherence among adults with asthma in 4 African countries from 2010 to 2023. CI, Confidence Interval.

squared statistic ($Q = 359.25$ (d.f. = 15), $p < 0.001$) and $I^2 = 95.82\%$ with $p < 0.001$ (Fig. 2).

Sub-group analysis

Subgroup analyses were done by sample size, response rate, and study quality score to detect the source of heterogeneity. But, still, there is high heterogeneity. Therefore, the heterogeneity may be explained by other factors not considered in this review. The prevalence of medication adherence among studies with small and large sample sizes was 42% (95% CI: 33, 51) and 36% (95% CI: 26, 47), respectively (Table 2).

Meta-regression

Further, we investigated the heterogeneity using different statistical techniques to identify the source of heterogeneity. A meta-regression was performed using sample size and mean age as covariates and by specifying the DerSimonian-Laird method for estimating the between-study variance. The sample size was statistically significant ($p = 0.037$) and explains heterogeneity (Table 3).

Sensitivity analysis

To check the influence of a single study on the effect size, a sensitivity analysis was performed using the random effects model and none of the studies had significant influence (Fig. 3).

Risk of bias across studies

The presence of publication bias was assessed using a funnel plot and Egger's statistical test at a 5% level of significance. The funnel plot was performed by labeling the prevalence of medication adherence (the effect size) on the x-axis and the standard error of prevalence of medication adherence on the y-axis. Observation of the funnel plot indicated the presence of some publication bias. But there was no significant publication or small study effect as evidenced by insignificant Egger's test ($p = 0.0848$) (Fig. 4).

DISCUSSION

Our systematic review and meta-analysis were conducted to estimate the pooled prevalence of medication adherence among adult asthmatic

Subgroup	Number of Studies	Total sample size	Prevalence (95% CI)	Heterogeneity	
				$I^2\%$	P value
Sample Size					
Small	9	1419	0.42 (0.33, 0.51)	92.75	<0.001
Large	7	2600	0.36 (0.26, 0.47)	97.20	<0.001
Response Rate					
Low	5	1491	0.34 (0.27, 0.41)	88.49	<0.001
High	11	2528	0.42 (0.32, 0.52)	96.92	<0.001
Quality Score					
Low	4	762	0.39 (0.32, 0.47)	73.27	=0.01
High	12	3257	0.40 (0.31, 0.48)	96.77	<0.001
Type of Medication					
Inhalation	7	1362	0.43 (0.29, 0.58)	97.70	<0.001
All type	9	2657	0.37 (0.30, 0.43)	91.72	<0.001
Total	16	4019	0.39 (0.32, 0.47)	95.82	<0.001

Table 2. Sub-group analysis of the prevalence of medication adherence among adult patients with asthma in 4 African countries from 2010 to 2023 CI, Confidence Interval.

Variables	Coefficients (95% CI)	P value
Sample size	-0.0007175 (-0.001393, -0.000042)	0.037
Mean age	-0.0132456 (-0.0301598, 0.0036687)	0.125

Table 3. Meta-regression of heterogeneity test for prevalence medication adherence among adult patients with asthma in 4 African countries from 2010 to 2023 *CI, Confidence Interval.*

patients in 4 African countries using the available published and unpublished studies. Non-adherence to medications is a risk factor for uncontrolled asthma, high rate of hospitalization, asthma exacerbation, productivity loss, morbidity and mortality.^{2,14}

The pooled estimate of medication adherence among adult asthmatic patients in 4 African countries was found to be 39% (95% CI: 32, 47; $p < 0.001$). According to this review, only less than one-half of the participants were adherent to medications. Fragmented and fragile health care systems, inaccessibility, unavailability and unaffordability of drugs,^{39,40} low socio-economic status of the African population,⁴¹ and food insecurity and housing instability may be the reasons for the low prevalence of medication adherence among African adult asthmatic patients.^{14,42,43} Evidence also showed that the prevalence of medication adherence is low in communities with inadequate health literacy.^{44,45} This implies that the evolution

of health systems in Africa must occur to adequately improve adherence through the use of effective health interventions.

The result of this review is comparable with previous systematic reviews and meta-analysis conducted globally among 15-30 years old young adults (28%).⁴⁶ This finding is also in line with another systematic review and meta-analysis conducted in 2018 globally among adults with asthma (49%).⁴⁷ However, the current systematic review and meta-analysis were much lesser than a systematic review and meta-analysis conducted in Ethiopia (70.05%).⁴⁸ The possible justification for this difference may be a review conducted in Ethiopia specifically in a single country, only includes studies that investigate adherence to inhaled medications and was conducted only on 6 studies with a total sample size of 921 adults.

The result of this systematic review and meta-analysis indicated that 3 out of 5 adult asthmatic

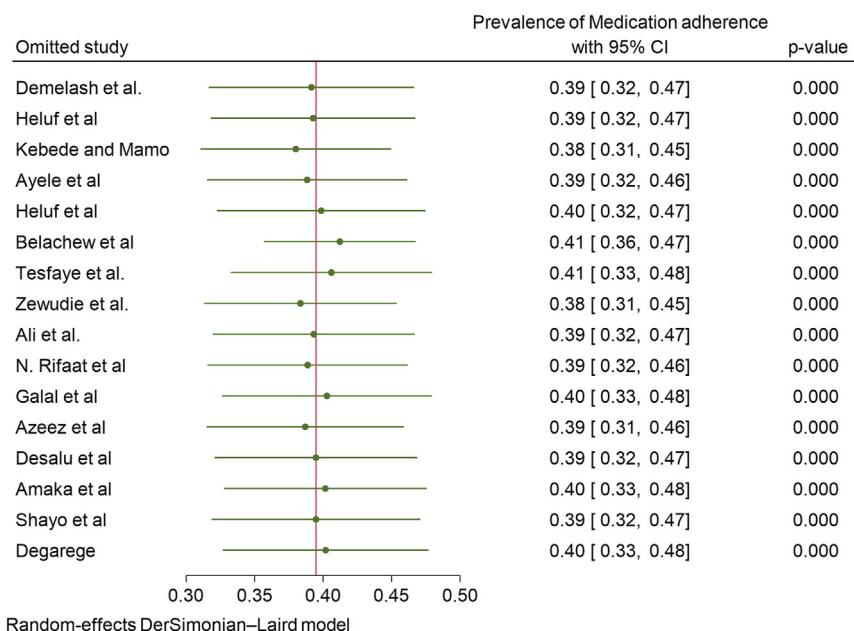


Fig. 3 Sensitivity analysis for the prevalence of medication adherence among adult patients with asthma in 4 African countries from 2010 to 2023. *CI, Confidence Interval.*

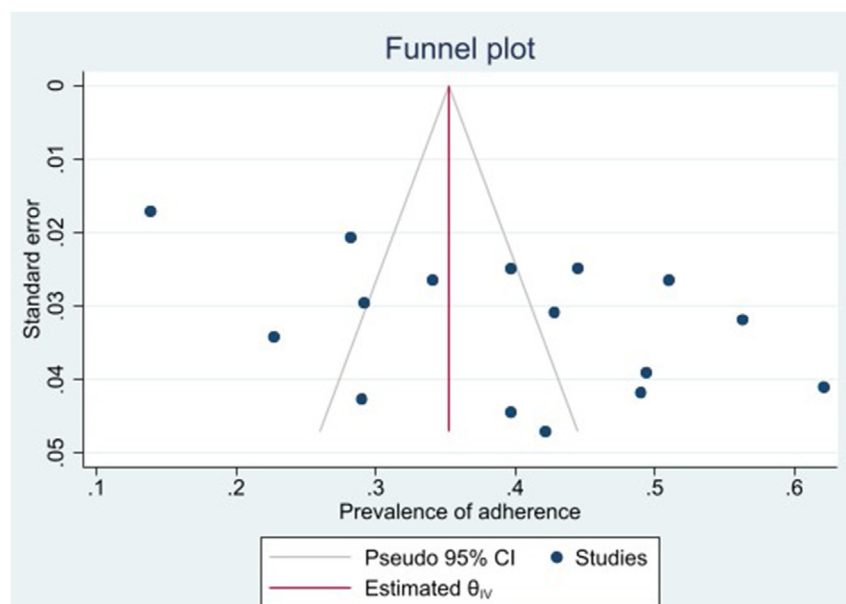


Fig. 4 A funnel plot for publication bias of prevalence of medication adherence among adult patients with asthma in 4 African countries from 2010 to 2023. CI, Confidence Interval.

patients are non-adherent to medications in 4 African countries. This implies the problem should be prioritized by WHO, and the continent and the nations should fight it by developing different strategies that improve medication adherence among adult asthmatic patients including patient education and pharmacist-led interventions.⁴⁷

The low prevalence of medication adherence in adults with asthma is 1 of the reasons for the high prevalence of uncontrolled asthma and mortality in the continent. Previous primary studies and reviews reported a high prevalence of uncontrolled asthma in Africa region (45%–90%).^{49–52} In Africa, mortality rates from asthma is disproportionately high.⁵³ Therefore, emphasis should be given to improve medication adherence among asthmatic patients in Africa through the improvement of the availability, affordability and accessibility of essential medicines used for the treatment of asthma.⁴⁰ Studies found that educational programs aimed at improving medication adherence among adults with asthma effectively increase adherence rates among adults.^{54–57}

The current systematic review and meta-analysis estimated the pooled prevalence of medication adherence among adult asthmatic patients in the presence of high heterogeneity and conducted on studies only from 4 countries that are not representative of the region. All of the included studies

were observational which increases the risk of bias and use different type of self-report measurement tools. Additionally, most of the included articles in this review were conducted on small sample size. To the best of our knowledge, this is the first systematic review and meta-analysis conducted on the prevalence of medication adherence among adult asthmatic patients in Africa.

CONCLUSION

The pooled prevalence of medication adherence among adult asthmatic patients in 4 African countries is low. The 4 African countries should give priority to the problem and develop different strategies including educational programs that can improve medication adherence and tackle the problem. Since this review determines the pooled prevalence of medication adherence with observational studies having small sample sizes using self-report measures of adherence, researchers should conduct further multicenter longitudinal studies by using objective methods of adherence measurement.

Abbreviations

AA, Assefa Andargie; BKA, Belete Kassa Alemu; BM, Basazine Mekuria; CI, Confidence Interval; D-L, DerSimonian and Laird; EMB, Ewunetie Mekashaw Bayked; SZ, Segenet Zewdie; JBI, Joanna Briggs Institute; MMAS, Morisky Medication Adherence Scale; MARS, Medication Adherence Rate Scale; PRISMA, Preferred Reporting Items

for Systematic Review and Meta-Analysis; TAIs, Test of Adherence to Inhalers; WHO, World Health Organization.

Funding source

Not available.

Declaration of conflict of interest

The authors have no any competing interest regarding this work.

Registration

The protocol of this review is not yet registered.

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