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REVIEW

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Otitis media with effusion in Africa-prevalence and associated factors: A systematic review and meta-analysis

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Abstract

Objectives: To estimate the overall and subgroup prevalence of otitis media with effusion (OME) in Africa, and identify setting-specific predictors in children and adults.

Methods: PubMed, African Journals Online, African Index Medicus, Afrolib, SciELO, Embase, Scopus, Web of Science, The Cochrane Library, GreyLit and OpenGray were searched to identify relevant articles on OME in Africa, from inception to December 31st 2019. A random-effects model was used to pool outcome estimates.

Results: Overall, 38 studies were included, with 27 in meta-analysis (40 331 participants). The overall prevalence of OME in Africa was 6% (95% CI: 5%-7%; I^2 = 97.5%, P < .001). The prevalence was 8% (95% CI: 7%-9%) in children and 2% (95% CI: 0.1%-3%) in adolescents/adults. North Africa had the highest prevalence (10%; 95% CI: 9%-13%), followed by West and Southern Africa (9%; 95% CI: 7%-10% and 9%; 95% CI: 6%-12% respectively), Central Africa (7%; 95% CI: 5%-10%) and East Africa (2%; 95% CI: 1%-3%). There was no major variability in prevalence over the last four decades. Cleft palate was the strongest predictor (OR: 5.2; 95% CI: 1.4-18.6, P = .02). Other significant associated factors were age, adenoid hypertrophy, allergic rhinitis in children, and type 2 diabetes mellitus, low CD4 count in adults.

Conclusion: OME prevalence was similar to that reported in other settings, notably high-income temperate countries. Health care providers should consider age, presence of cleft palate, adenoid hypertrophy and allergic rhinitis when assessing OME in children and deciding on a management plan. More research is required to confirm risk factors and evaluate treatment options.

Level of Evidence: 3a

KEYWORDS

Africa, otitis media with effusion, prevalence, risk factors, systematic review

1 | INTRODUCTION

Otitis media with effusion (OME) is defined as the presence of fluid in the middle ear without signs or symptoms of acute ear infection.[1,2] About 90% of children develop OME before school age and, on average, suffer four episodes of OME every year.[3] Furthermore, 80% of children have had one or more episodes of OME by 10 years of age.[3] The main symptom of OME is conductive hearing loss caused by impaired transduction of sound waves in the middle ear due to the presence of middle ear effusion.[4] When this hearing loss persists or recurs frequently, it may have a negative impact on language, behavior and progress at school.[5] Moreover, children with a longer duration of OME are more likely to have problems with behavior and cognitive sequelae later in life.[5] This shows the potential severity of the condition and the necessity for early and efficient management. Proper management of OME requires adequate knowledge of the prevalence, risk factors, and treatment guidelines in the light of strongest and up-to-date evidence.

There exist clinical practice guidelines for OME that are intended to serve as a contribution toward continuous quality improvement in the management of OME, by improving diagnostic accuracy, identifying children susceptible to develop sequelae, improving OME surveillance, hearing and language evaluation, and encouraging OME detection by new-born screening.[1,6] However, many practitioners in low- and low-middle income countries (LMICs) in general, and in Africa in particular do not always follow these guidelines. The paucity of otolaryngologists in these settings[7,8] could explain this tendency. In addition, health care professionals in LMICs have suboptimal access to information regarding evidence-based clinical care, and where information is available, it is poorly disseminated.[4] Furthermore, the absence of setting-specific guidelines could also explain disparities in management approaches. Guidelines based on setting-specific prevalence rates and risk factors are important in diseases that are influenced by climatic conditions and can consequently vary depending on the geographical area considered. For instance, high humidity and wet climatic conditions specific to West Africa predispose to allergies and upper respiratory tract infections.[7] Inhabitants of the tropics, especially children, will therefore suffer frequent episodes of otitis media (OM), with a propensity toward chronicity.[7] Moreover, with the socio-demographic specificities of Africans, some risk factors unexplored by studies in high income countries could exist.

Therefore, it appears indispensable to obtain information on the prevalence of OME in Africa and pinpoint setting-specific risk factors. There is no previous work that synthesized available data on OME in Africa, to the best of our knowledge. This would enable practitioners and policy-makers to have a clearer picture of the scope of the problem and compare risk factors with those established in other settings. To achieve this, we conducted a systematic review whose objectives were to estimate the prevalence (overall and subgroup according to age group, African sub-region, time of study) of OME and identify setting-specific risk factors in children and adolescents/adults living in Africa.

Research question: In populations of children and adults residing in Africa, what are the prevalence and risk/associated factors of OME?

2 | METHODS

2.1 | Study protocol

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines[9] and was registered in the Prospective Register of Systematic Reviews (PROSPERO), ID: CRD42020178438.

2.2 | Search strategy

A comprehensive search of PubMed, African Journals Online, African Index Medicus, Afrolib, SciELO, Embase, Scopus, Web of Science, and The Cochrane Library was performed to identify all relevant articles on OME in Africa, from inception to December 31st 2019. Additionally, grey literature was sought from GreyLit and OpenGray databases. HINARI platform set up by the World Health Organization (WHO) for LMICs was used to access databases and articles published in subscription-based journals. The search strategy comprised text words, keywords and MeSH terms, using the syntax of the respective databases, based on our Population and Outcome (PICO) framework. For instance, the search strategy for PubMed was as follows: "Otitis Media" OR "Otitis Media With Effusion" OR "Middle Ear Inflammation" OR "Inflammation, Middle Ear" OR "Middle Ear Effusion" OR "Ear Effusion" OR "Ear Effusion, Middle" OR "Effusion, Middle Ear" OR "Secretory Otitis Media" OR "Otitis Media, Secretory" OR "Serous Otitis Media" OR "Otitis Media, Serous" AND "prevalence" OR "frequency" AND "risk factors" OR "predictors" OR "predictive factors" OR "associated factors" AND "therapeutics" OR "treatment" OR "management" AND "Africa" OR "Africa South of Sahara" OR "Sub-Saharan Africa." References of all relevant articles were further exploited to identify additional studies.

2.3 | Study selection

We included cross-sectional and cohort studies reporting on the prevalence of OME and its risk factors in Africa. Clinical trials pertaining to treatment of OME were also included. For duplicate studies we considered the most comprehensive and up-to-date version. Letters to the editor, editorials, commentaries, review articles, case series and studies lacking explicit method description or relevant data were excluded.

Abstract screening and data extraction were independently performed by two reviewers (ECN and ABS) using the web-based application Rayyan[10] and a standardized pre-established Google Form, respectively. Disagreements were discussed and resolved by a third reviewer (JRN).

2.4 | Risk of bias

Risk of bias assessment was done independently by two authors (ECN and ABS). The risk of bias was classified as low, moderate or high,

using the risk of bias tool proposed by Hoy et al[11] for observational studies. This tool provides a summary risk of bias assessment based on 10 items addressing four domains of bias; selection bias, nonresponse bias, measurement bias and bias related to the analysis, with a high rate of interrater agreement. Studies were included regardless of their quality. However, subgroup analysis was done with respect to study quality.

2.5 | Data abstraction and analysis

Information about the following variables were extracted: name of first author, study title, year of publication, country and region of Africa where the study was carried out (North, West, Central, East and Southern), study setting (hospital- or community-based), study design (cohort, cross-sectional, case-control or randomized clinical trial), population characteristics (mean age, sex proportions) and sample size.

The primary outcome measure was prevalence of OME, as presented by the authors and recalculated where possible, as the number of patients diagnosed with OME divided by the study sample size. We also recorded data on risk/associated factors of OME identified, diagnostic tools used and treatment of OME.

Data were analyzed and synthesized using the statistical software STATA version 13 (Stata Corp 2013), imported from a Google Form generated Microsoft Excel file. A meta-analysis using the random-effects model was conducted to summarize the prevalence of OME in Africa. Associated factors were reported in a narrative format. Heterogeneity was assessed and quantified by calculating the I^2 statistic (with values of 25%, 50%, and 75% being indicative

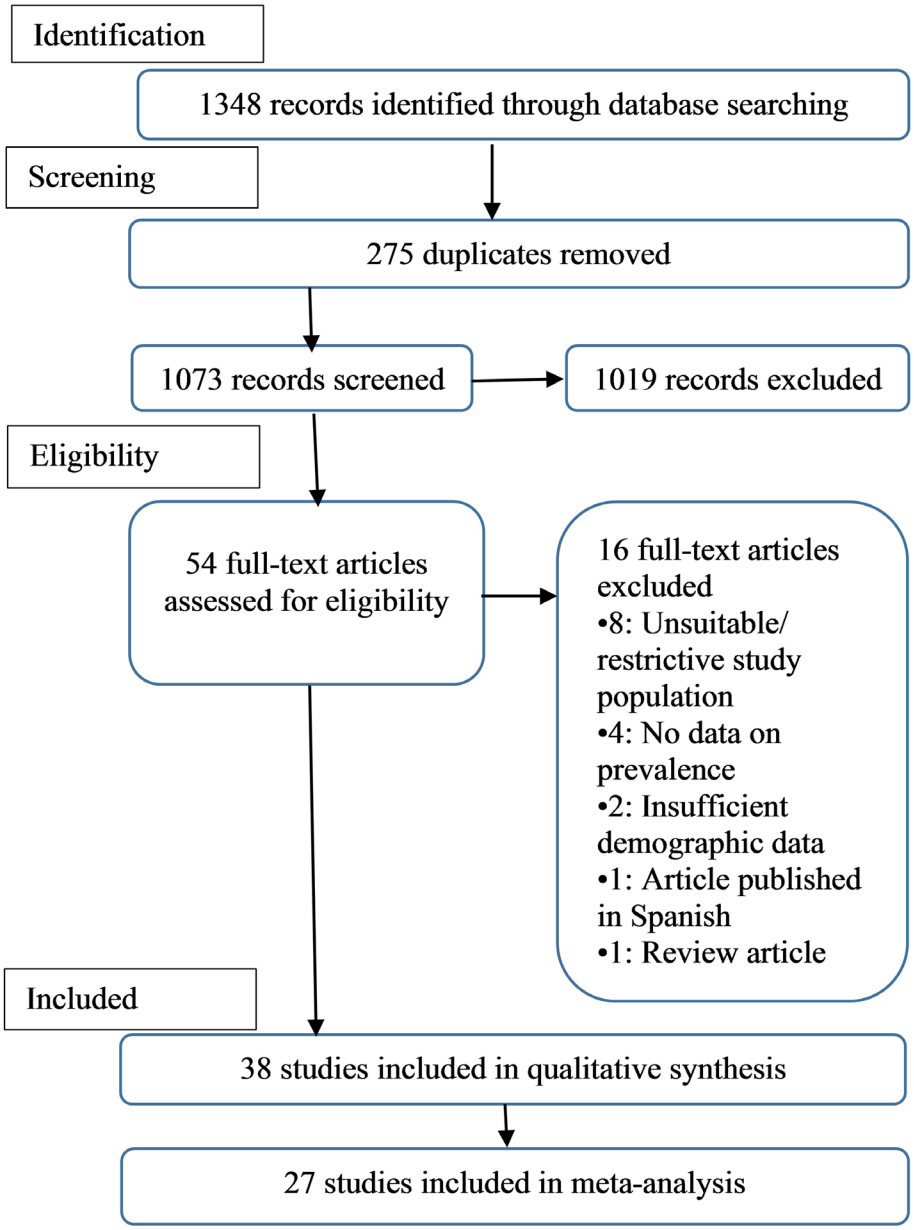

FIGURE 1 Study selection flowchart

TABLE 1 Meta-analysis of prevalence of otitis media with effusion in Africa

	Prevalence (%)	95% CI (%)	Population (n)	Studies (n)	I^2 (95% CI)	*P* heterogeneity
Overall	6	5-7	40 331	27	97.5	<.0001
By age group (children vs adolescents/adults)						
Children	8	7-9	29 184	24	97.2	<.0001
Adolescents/adults	2	0.1-3	11 147	3	–	–
By age group (years)						
0-4	18	8-28	1160	4	95.8	<.0001
4-8	8	7-10	12 082	16	96.6	<.0001
8-12	4	2-6	15 942	4	97.9	<.0001
12-16	0.1	0.02-0.7	802	1	–	–
>16	1	0.9-1.1	10 345	2	–	–
By geographic region						
North Africa	10	9-13	906	1	–	–
Southern Africa	9	6-12	7372	7	97.2	<.0001
West Africa	9	7-10	15 686	14	97	<.0001
Central Africa	7	5-10	529	1	–	–
East Africa	2	1-3	15 838	4	97.7	<.0001
By period						
1978-1990	8	4-12	1201	4	88.5	<.0001
1990-2000	8	5-10	9067	7	98.7	<.0001
2000-2010	6	3-9	10 919	5	97.8	<.0001
2010-2018	7	6-9	19 144	11	96.2	<.0001
By study setting						
Community	8	7-9	27 234	20	97.9	<.0001
Hospital	3	2-5	13 097	7	94.3	<.0001
By study quality						
Low risk of bias	8	7-10	21 784	17	97.8	<.0001
Moderate risk of bias	5	3-7	9258	7	94.8	<.0001
High risk of bias	3	1-5	9289	3	–	–
By diagnostic approach						
Simple otoscopy, tympanometry, acoustic reflex	31	27-36	401	1	–	–
Simple + pneumatic otoscopy, tympanometry	8	5-11	8155	7	96.7	<.0001
Simple otoscopy, tympanometry	7	5-8	25 621	10	97	<.0001
Simple + pneumatic otoscopy, tympanometry, acoustic reflex	6	4-8	437	2	–	–
Unclear	2	2-3	3224	2	–	–
Simple + pneumatic otoscopy	1	–0.1 to 2	1757	3	–	–
Simple otoscopy	1	0.1-2	736	2	–	–

Abbreviation: CI, confidence interval.

of low, medium and high heterogeneity, respectively).[12,13] Subgroup analyses were performed to explore possible sources of heterogeneity and comprised time of study, study quality, African sub-region involved, study setting (hospital- or community-based), age of participants, OME diagnostic approach. A cut-off age of 10 years was used to separate children from adolescents/adults, as defined by WHO.

A funnel plot served to assess publication bias, complemented with the Egger's test of bias. A value of $P < .05$ was considered statistically significant for all analyses.

3 | RESULTS

3.1 | Search results and study characteristics

A total of 1348 records were identified from database searches and an online University repository. From these, 275 duplicates were removed. After screening of titles, abstracts and when required full-texts, 1019 additional records were excluded. We retrieved 54 full-text articles, from which 16 more were excluded (see reasons in

TABLE 2 Diagnosis of otitis media with effusion for studies included in meta-analysis

Diagnosis of OME	Frequency (n = 27)	Percentage
Simple otoscopy, tympanometry	10	37.0
Simple + pneumatic otoscopy, tympanometry	7	25.9
Simple + pneumatic otoscopy	3	11.1
Simple + pneumatic otoscopy, tympanometry, acoustic reflex	2	7.4
Simple otoscopy	2	7.4
Unclear	2	7.4
Simple otoscopy, tympanometry, acoustic reflex	1	3.8

Abbreviation: OME, otitis media with effusion.

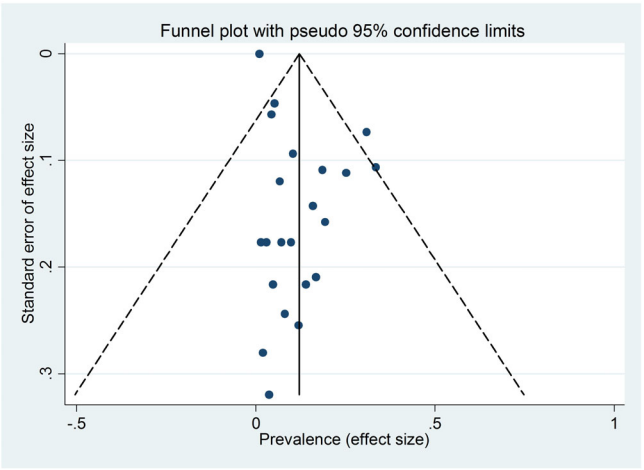

FIGURE 2 Funnel plot evaluating publication bias

Figure 1). Thirty-eight studies were included in qualitative analysis and 27 in quantitative analysis.

This review included studies published from 1977 to 2019, involving participants from 11 countries, with all five major African geographic sub-regions represented. Overall, 21 studies (55.3%) were community-based (20 of these included in meta-analysis[14-33]), and 17 (44.7%) hospital-based (seven included in meta-analysis[34-40]). Data were collected prospectively in 34 (89.5%) studies. Thirty-five studies were cross-sectional (92.1%), two (5.3%) were clinical trials and one was a cohort study (2.6%).

Risk of bias assessment of studies included in meta-analysis (27) showed that 63% (17) of studies had a low risk, 25.9% (7) a moderate risk and 11.1% (3) had a high risk of bias. Selection bias was the most involved domain.

3.2 | Study outcome measures

3.2.1 | Prevalence of otitis media with effusion in Africa

A total of 40 331 participants were obtained from 27 studies, with a pooled mean age of 8.4 years (range: 1.1-48). The overall prevalence of OME in Africa was 6% (95% CI: 5%-7%) with a degree of heterogeneity (I^2) of 97.5%, $P < .001$. Subgroup prevalence according to age showed the highest rate of OME in the 0 to 4 year group (prevalence of 18%, 95% CI: 8%-28%, I^2:95.8%, $P < .001$). The single study from North Africa presented the highest rate: 10% (95% CI: 9%-13%), followed by Southern Africa and West Africa (9% each). Results of subgroup analyses are provided in Table 1. Diagnosis was made by a combination of procedures, with the majority of studies (37%, 10 studies) using simple otoscopy + tympanometry (see Table 2). Publication bias was assessed with the aid of a funnel plot of effect size vs SE (Figure 2), complemented with Egger's test, which was not statistically significant for publication bias ($P = .63$).

3.2.2 | Associated factors and treatment of OME

Baggi et al[41] and Nwosu et al[27] found that OME was significantly associated with age (see Table 3). Cleft palate as a risk factor was confirmed by a cohort study in Nigeria[42] (odds ratio: 5.2, 95% CI: 1.4-18.6, $P = .02$). A significant association was also found for type 2 diabetes mellitus,[43] low CD4 cell count in Human Immunodeficiency Virus (HIV) infected adults[44] ($P = .03$ for both) and allergic rhinitis in the age group of children <5 years[45] ($P < .001$). Libwea et al[32,46] in Cameroon found an association between otitis media (OME included) and parental reporting of "current symptoms of upper respiratory tract infection" ($P = .001$). Daycare attendance was evaluated by Asoegwu et al,[30] they found only a borderline effect on the prevalence rate of OME ($P = .05$). Sickle cell disease (SCD) was evaluated by three studies[35,47,48] and showed no statistically significant difference in incidence between SCD and non-SCD patients. Whereas Els et al[39] found no significant ($P > .05$) relationship between the presence of OME and adenoid hypertrophy, Orji et al found that the incidence of OME was significantly higher in children with adenoid hypertrophy ($P < .001$).[49]

Treatment of OME was evaluated by Yagi,[50] who found no significant difference in results between a group treated with adenoidectomy only, and another treated with adenoidectomy, bilateral myringotomy and insertion of grommets. Another study[51] reported significant improvement of OME with steroid therapy (nasal or systemic), when compared with saline placebo ($P < .001$ in both cases), with no significant difference between systemic and nasal steroid therapy ($P = .21$).

4 | DISCUSSION

This systematic review and meta-analysis of data from 40 331 individuals residing in 11 African countries showed an overall OME prevalence of 6%, 8% in children and 2% in adolescents/adults, with substantial heterogeneity between studies (Figure 3). Diagnosis was

TABLE 3 Characteristics of studies included for review of associated factors

Author, year, country	Study characteristics	Inclusion criteria	Sample size (n)	Factors searched and not identified (*P*-value[a])	Factors identified (*P*-value[a])
Nwosu, 2017, Nigeria	Cross-sectional, community based, prospective, random sampling	Daycare and nursery school children, aged 1-6 years	226	—	**Age** group 1-2 years, *P* = .015
Baggi, 2013, Burundi	Cross-sectional, hospital based, prospective, consecutive sampling	Children aged <5 years hospitalized for lower respiratory tract infections	108	Gender (*P* = .51), type of associated lower respiratory tract infection (*P* = .16), malaria co-infection (*P* = .15)	**Age** (*P* < .0001),
Edetanlen, 2018, Nigeria	Cohort, hospital based, prospective, consecutive sampling	Children with cleft palate alone who first presented between March 2013 and April 2018	42 patient with cleft palate vs 42 controls	Age in cleft group (*P* = .13), gender in cleft group (*P* = .28)	**Cleft palate** (OR: 5.2, 95% CI 1.4-18.6, *P* = .02), **Size of cleft** (OR: 8.21. 95% CI 1.02-70.6, *P* < .001)
Obasikene, 2014, Nigeria	Cross-sectional, hospital based, prospective, consecutive sampling	Consenting HIV infected patients aged 18-45 years	97 HIV positive vs 49 HIV negative controls	—	**CD4 count** (*P* = .03)
Orji, 2010, Nigeria	Cross-sectional, hospital based, prospective, consecutive sampling	Children aged 4-8 years referred for obstructive adenoid disease	46 patients with adenoid hypertrophy vs 270 controls	—	**Adenoid hypertrophy** (OR: 7.5, *P* < .0001)
Libwea, 2013, Cameroon	Cross-sectional, community based, prospective, random sampling	Children aged 24-36 months, residing in the study area for at least 6 months	429	Gender (*P* = .93), age group (*P* > .4), no. of siblings sleeping in same bedroom (*P* > .5), no. of siblings sleeping in same bedroom (*P* > .1), history of otitis media (*P* = .14), breastfeeding period (*P* > .3), parental educational level *P* > .2), parental occupation (*P* > .02), parental smoking status (*P* = .7), wood/coal as household cooking fuel (*P* = .4)	**Noticed any current URT symptom** (*P* = .001)
Mapondella, 2018, Tanzania	Cross-sectional, hospital based, prospective, consecutive sampling	Patients with the diagnosis of allergic rhinitis	1984; 193 with allergic rhinitis	—	**Allergic rhinitis** in 0-5 year age group (*P* < .0001)
Adebola, 2015, Nigeria	Cross-sectional, hospital based, prospective, consecutive sampling	Known T2DM aged ≥30 years who had attended at least 2 visits at the outpatient diabetic clinic	97 known T2DM vs 90 controls	—	**T2DM** (*P* = .03)
Asoegwu, 2013, Nigeria	Cross-sectional, community based, prospective, random sampling	Daycare attendees aged 6-24 months	64 daycare attendees vs 88 non daycare attendees	Daycare attendance (*P* = .05)	—

TABLE 3 (Continued)

Author, year, country	Study characteristics	Inclusion criteria	Sample size (n)	Factors searched and not identified (*P*-value[a])	Factors identified (*P*-value[a])
Alabi, 2008, Nigeria	Cross-sectional, hospital based, prospective, random sampling	Children with HbSS and crisis free	80 HbSS vs 60 HbAA controls	SCD (no *P*-value provided)	—
Taipale, 2012, Angola	Cross-sectional, hospital based, prospective, consecutive sampling	Children attending a SCD polyclinic	61 SCD patients vs 61 controls	SCD ($P > .99$)	—
Olajuyin, 2018, Nigeria	Cross-sectional, hospital based, prospective, consecutive sampling	Children aged 5-7 years	84 SCD patients vs 84 controls	SCD ($P = .25$)	—
Els, 2018, South Africa	Cross-sectional, hospital based, prospective, consecutive sampling	Children aged 2-12 years, with recurrent tonsillitis or obstructive sleep apnoea	109; 47 patients with clinically significant adenoid hypertrophy	Age ($P > .05$), Gender ($P > .05$), Adenoid hypertrophy ($P > .05$)	—

Abbreviations: CI, confidence interval; HbSS, hemoglobin SS; HbAA, hemoglobin AA; HIV, human immunodeficiency virus; OR, odds ratio; SCD, sickle cell disease; T2DM, type 2 diabetes mellitus; URT, upper respiratory tract.

[a]*P*-values were obtained either by Fischer's exact test, Chi squared test or after multivariate logistic regression.

predominantly made by simple/pneumatic otoscopy with or without tympanometry, considering type B tympanogram as OME. Only two studies used simple otoscopy (Table 2) and reported the lowest prevalence.[18,38] OME clinical practice guidelines strongly recommend that clinicians use and document pneumatic otoscopy when diagnosing OME, based on systematic review of diagnostic studies with a preponderance of benefit over harm.[1] The prevalence of 8% in children was within the range of prevalence rates reported in high-income countries with predominant Caucasians.[1,52-54] This is contradictory to many studies in and out of Africa that suggested that the rate of OME is significantly lower in Blacks.[14,55,56] Another possible reason for an expected lower rate of OME in the tropics is the climatic disparity; climatic factors have been shown to influence OME, with a higher rate in colder seasons.[57,58] However, the transient nature of seasons and of OME itself might explain why the difference in climate between the tropics and temperate regions does not seem to greatly influence the overall prevalence. As previously established, OME prevalence reduced with increasing age, with the highest prevalence in the 0 to 4 year age group. Across Africa, North Africa presented the highest rate (10%),[19] followed by West and Southern Africa (9% each), then Central Africa (7%). East Africa presented the lowest prevalence (2%). Only one study was included from North and Central Africa each (see Figure 4). The prevalence of OME was stable over four decades from 1978 to 2018, close to the overall prevalence, with no major variation.

Unsurprisingly, studies that examined the relationship between age and OME found a significant association, with incidence reducing as age increased.[27,41] Reasons for this include a greater susceptibility to infection in children, the abundant quantity of nasopharyngeal lymphoid tissue, postural factors and suboptimal Eustachian tube function.[14] One cohort study[42] confirmed cleft palate as a risk factor for OME (OR: 5.2, 95% CI: 1.4-18.6, $P = .02$) as corroborated by prior studies.[59,60] In univariate analysis age, sex, and size of cleft were significantly associated with OME in patients with cleft palate. However, in multivariate analysis, only size of cleft was confirmed as an independent predictor ($P = .02$), unlike age ($P = .13$) and sex ($P = .28$). Children with extremely wide clefts were more likely to develop OME than those with narrow clefts (OR: 8.21, 95% CI: 1.02-70.6). A systematic review on the epidemiology of orofacial clefts in Africa suggested that the prevalence in Africa is low compared to Europe, America and Asia.[61] Despite this, barriers to care, economic and financial hardship at various levels still make orofacial clefts a major health problem in LMICs.[62] Likewise, allergic rhinitis appeared to be associated with OME in the group of patients aged 0 to 5 years.[45] Allergic rhinitis reduces the immune competencies of the mucosal immune system of the upper respiratory tract and makes the middle ear more prone to infection. Additionally, mucosal edema present in allergic rhinitis impairs the function of the Eustachian tube.[63] With respect to adenoid hypertrophy,[39,49] Els et al found no significant relationship between the presence of OME and clinically significant adenoid hypertrophy, whereas Orji et al found that the incidence of OME was significantly higher in children with gross adenoid hypertrophy ($P < .001$). It is noteworthy here that the former study included only

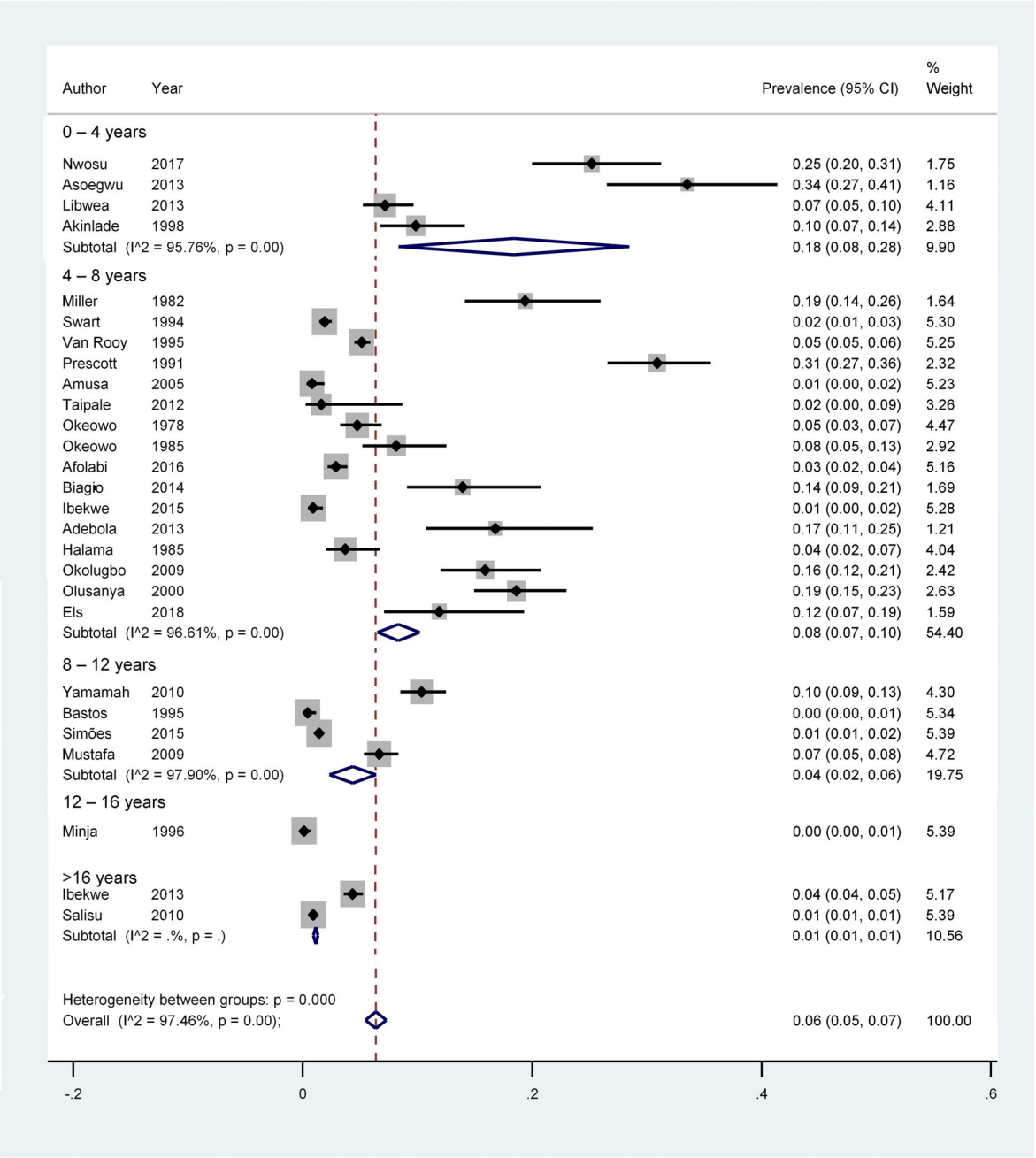

FIGURE 3 Forest plot for meta-analysis of prevalence of otitis media with effusion in Africa according to age group

patients with adenoid hypertrophy, and compared the incidence of OME in patients having clinically significant hypertrophy (defined as adenoid-nasopharyngeal ratio ≥ 0.71, quantified by analyzing a lateral radiograph of the postnasal space by Fujioka's method), with patients not having clinically significant hypertrophy. The role played by nasopharyngeal biofilm through shedding of inflammatory cytokines and planktonic bacteria[39] has been evoked as a predisposing factor for the development of OME. This would suggest that even in the absence of significant adenoid hypertrophy, children could still develop OME. Libwea et al[32] found a significant association between the "parent notifying the presence of an ongoing upper respiratory tract symptom" and OM (P = .001). This association should be interpreted in the context of the study, where the term OM encompassed chronic suppurative otitis media and OME. The association can therefore not be strongly attributed to OME alone.

Studies involving adults found an association between type 2 diabetes mellitus and OME (P = .03).[43] Analogously, HIV infection was significantly associated with OME. There was preponderance of type B tympanogram among HIV infected individuals, which correlated significantly with the CD4 cell count (P = .03).[44] This is foreseeable, as these conditions reduce the patient's immunity, making them prone to bacterial colonization and chronic infections.

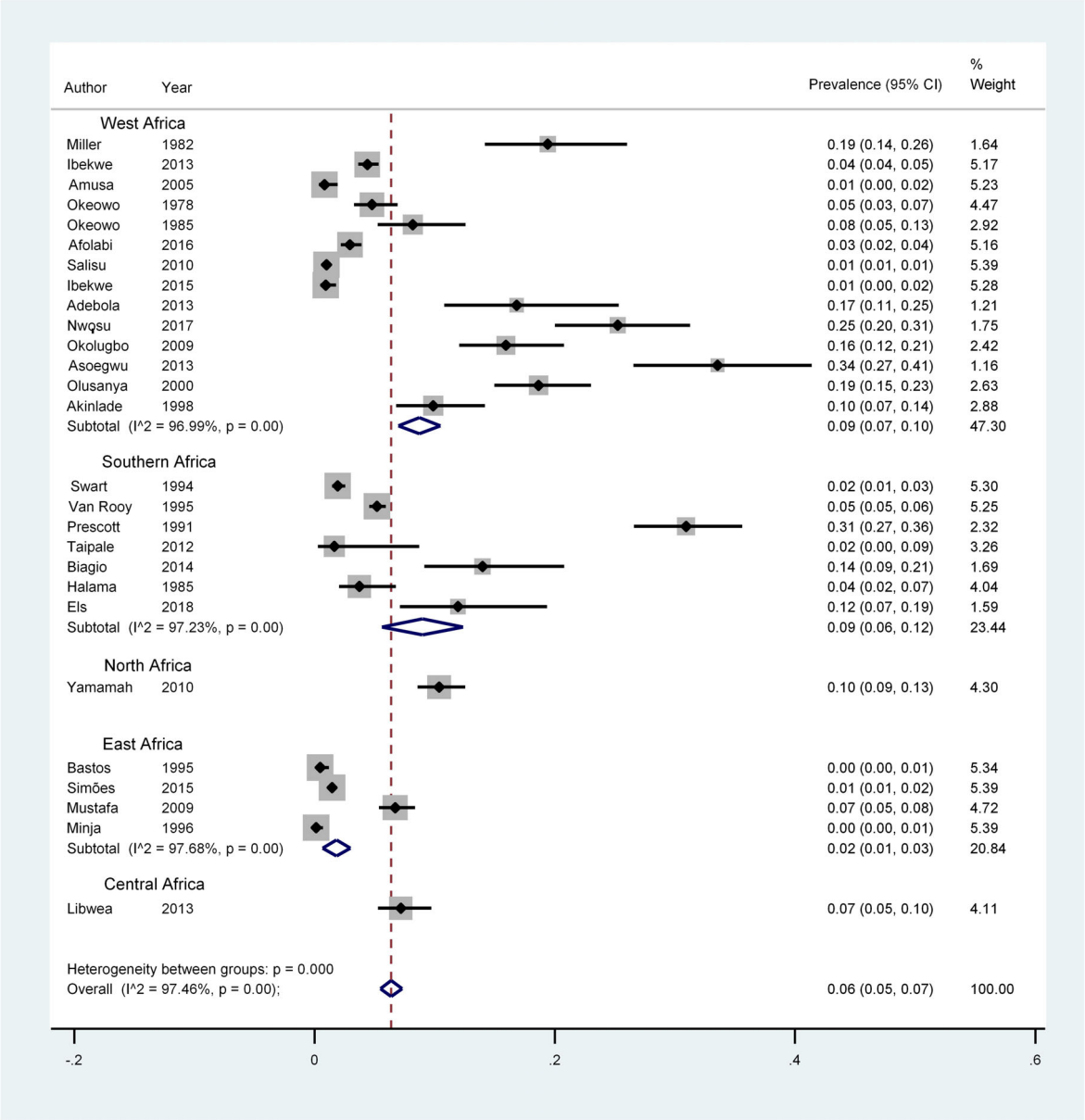

FIGURE 4 Forest plot for meta-analysis of prevalence of otitis media with effusion according to African sub-region

Interestingly, daycare attendance only showed a borderline effect on the occurrence of OME in children (P = .05). Factors found to significantly increase the prevalence of OME among daycare attendees included early age at enrollment (P = .001) and duration of attendance (P = .005). Available evidence shows that daycare attendance is a predisposing factor.[64,65] More studies need to be done to affirm this association in Africa where daycare facilities are present only in urban settings that are not representative of the general population in most countries.

Our quantitative analysis did not involve sex subgroup analysis due to unavailability of exploitable data on gender in many studies included. Qualitative analysis however revealed no association with sex.[39,41,42] Interestingly, sickle cell disease was also not associated with OME.[35,47,48] This finding is important in a setting where sickle cell anemia is still quite common,[66] with patients being prone to ear infections and variable levels of hearing loss.[47]

Our findings are relevant to health care providers, policy-makers and researchers. This is the first study summarizing data on prevalence and associated factors of OME in a tropical LMICs setting, to the best of our knowledge. Policy-makers should have an idea of the burden of this childhood ailment, permitting them to design and implement strategies to curb the condition. In the same manner, health care providers would better appreciate the burden of OME and factors to take into account when evaluating and managing patients. With about 90% of children developing OME before school age and 80% of children having had one or more episodes of OME by 10 years, a clearer idea of setting-specific risk/associated factors is imperative not to miss potential cases. Young children with identified

associated factors as well as adults with type 2 diabetes mellitus and HIV infection should benefit from rigorous follow-up with systematic pneumatic otoscopy at least, and a less conservative approach to avoid sequelae that could be severe. Training or refresher courses in pneumatic otoscopy, a cheap, efficient and easily available tool, for pediatricians and practitioners caring for HIV infected and diabetic patients could be valuable to upgrade their capacities and permit early diagnosis and proper management. More research is required to confirm risk factors with cohort studies as well as explore other factors somewhat specific to Africa, notably low socioeconomic status, low parental level of education, exposure to wood/coal smoke, vaccination status, overcrowding in homes, malnutrition and genetic predispositions in Africans. Finally, the paucity of local randomized clinical trials in this domain, revealed by this review, calls for action.

Nonetheless, our results should be interpreted while taking into account some limitations. First, results of pooled data showed a high level of heterogeneity, as is almost inevitable in meta-analyses.[67] We mitigated this by exploring possible sources of heterogeneity with subgroup analyses (see Table 1). When subgroup analysis was not possible, we proceeded by a narrative summary (Table 3). In addition, the validity of the pooled effect was increased by the absence of publication bias. Next, the inclusion of studies irrespective of the risk of bias could have influenced our results, though only three papers (11.1%) were high risk studies (see Table S1). This was tackled by subgroup analysis. Furthermore, studies were disproportionately represented across various subregions of the continent, especially in North Africa where only one study was found, making it hazardous to generalize the results. Finally, the cross-sectional nature of most studies made it difficult to evaluate management tendencies and to strongly affirm risk factors.

5 | CONCLUSION

This study revealed a prevalence of OME similar to that reported in other settings, notably high-income temperate countries, with higher rates in children than in adolescents and adults. Health care providers should take into account age, presence of cleft palate, adenoid hypertrophy and allergic rhinitis when assessing OME in children and deciding on a management plan. More research is required to confirm risk factors and evaluate treatment options in our setting.

CONFLICT OF INTEREST

The authors have no conflict of interest.

AUTHOR CONTRIBUTIONS

Emmanuel Choffor-Nchinda conceived the study and planned the protocol. Emmanuel Choffor-Nchinda, Antoine Bola Siafa and Jobert Richie Nansseu designed the study protocol. Emmanuel Choffor-Nchinda planned the search strategy. Emmanuel Choffor-Nchinda and Antoine Bola Siafa carried out study selection and data extraction. Emmanuel Choffor-Nchinda conducted data synthesis and analysis. Emmanuel Choffor-Nchinda and Jobert Richie Nansseu drafted the article. All authors approved the final version.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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