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Childhood hearing impairment and its associated factors in sub-Saharan Africa in the 21st century: A systematic review and meta-analysis

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Abstract

Background: Childhood hearing impairment is still a significant cause of disability in the 21st century in developing countries. Particularly, the burden is more severe in sub-Saharan Africa, where the majority of children with hearing problems is living. Thre are great variations and inconsistencies of available findings conducted in sub-Saharan Africa. Hence, the aim of this review was to determine the pooled prevalence of childhood hearing impairment and its associated factors in sub-Saharan Africa.

Methods: Studies were searched from main databases (PubMed, CINAHL, and African Journals Online), Google Scholar, and other relevant sources using electronic and manual techniques. All observational studies, written in English and conducted among participants (aged less than 18 years) from 2000 to 2018, were eligible. Heterogeneity between included studies was assessed using I^2, and publication bias was explored using visual inspection of the funnel plot. Statistical analysis was carried out to determine pooled prevalence using Stata version 14. In addition, subgroup analysis was carried out for the normality criteria of hearing thresholds and characteristics of the study populations.

Results: The pooled prevalence of hearing impairment was 10% (95% confidence interval (CI): 9%–11%). The magnitude of hearing impairment varies with the normality criterion used. The most commonly used threshold was 25 and 30 dB hearing level. The prevalence of hearing impairment based on normality criterion (>20 dB, >25 dB, >30 dB, and >35 dB) were 17%, 19%, 2%, and 1%, respectively. While in the questionnaire-based evaluation, the prevalence was 6% (95% CI: 3%–9%). In addition, based on population characteristics, the prevalence of hearing impairment for school or community-based children was 6% (95% CI: 5%–7%) while the prevalence for children with comorbidities was 23% (95% CI: 15%–31%). Chronic suppurative otitis media, impacted cerumen, advanced stage of human immunodeficiency virus, tuberculosis infection, and age of the children were associated with hearing impairment in sub-Saharan Africa.

Conclusion: Hearing impairment in children and adolescents in sub-Saharan Africa was high, and associated with preventable and treatable risk factors.

Keywords

Hearing impairment, children, sub-Saharan Africa, systematic reviews, meta-analysis

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Background

Hearing impairment is a significant cause of disability worldwide, and more than two-thirds of the population with hearing impairment live in developing countries.[1–5] Worldwide, 466-million people are living with disabling hearing loss and 34 million are children. If the current trend continues, it is

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estimated that by 2050, over 900-million people will have hearing impairment.[6] According to the World Health Organization (WHO), 60% of childhood hearing impairment is preventable.[1,6] Evidence has shown that 31% of hearing impairment cases can be attributed to prenatal and postnatal infections, 17% to birth-related causes, 4% to ototoxic medicines, and 8% to other causes such as substance abuse.[1,6–9]

The burden of hearing impairment is more in developing countries, specifically sub-Saharan Africa (SSA), where the majority of the children with significant hearing problems is living.[2,3,10,11] The sense of hearing is fundamental to facilitating communication and fostering social interaction.[12] In children, disabling hearing impairment impedes speech and language development and affects children's educational and vocational attainment.[13] Furthermore, it causes difficulty in obtaining, performing, and keeping a job, not to mention the stigma, feelings of isolation, loneliness, and depression,[12] coupled with the experience of violence, poverty, and poor health,[14–16] that create a huge social and economic burden on society worldwide.[17] Without suitable interventions, hearing impairment is a barrier to both education and social integration.[12] These consequences can be reduced by early detection with appropriate audiological and speech interventions.[18,19]

The integration of childhood hearing screening services in schools with existing public health initiatives by international organizations such as the WHO and United Nations Children's Fund (UNICEF), combined with sustainable capacity development and training of local health professionals, should reduce the burden of childhood hearing impairment in developing countries, and make a positive contribution to the United Nations Sustainable Development Goals (SDGs).[8] While hearing aid use to reduce the burden of hearing impairment in high-income countries, there is little evidence of their use in developing countries.[20] However, identifying the leading causes of hearing impairment and implementing preventive action could reduce the hearing-related problem in developing countries.[3,4,7,16,21,22]

Hearing impairment in children is defined as when the hearing loss measure (decibels hearing level) is greater than 30 decibels hearing level (dB HL) in the better hearing ear. However, various studies use the normality criteria which range from 20 to 40 dB.[22–33] Despite the ratification of existing laws and policies on disability by many countries, and some progress made in terms of legislative and policy reform, the realities for children with disabilities have not yet changed,[34,35] mainly because of poverty and lack of human resources.[36] Due to that, the number of children with hearing disabilities and those living with disabilities are grossly underestimated.[37]

In SSA, several pockets and fragmented primary studies were undertaken among children and adolescents to assess the prevalence of hearing impairment and its associated factors. Nevertheless, there are great variations and inconsistencies in the available findings.[20,36] This demonstrating the demand for a comprehensive analysis of the magnitude of hearing impairment to inform policymakers, program planners, service providers, advocators as well as concerned stakeholders to place more emphasis on childhood hearing impairment in developing countries. Hence, the aim of this systematic review and meta-analysis was to determine the pooled prevalence of childhood hearing impairment and its associated factors in SSA.

Methods

Study protocol development

The identification and screening of studies, as well as the eligibility assessment of full texts, were conducted as per Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement[38] (see Additional file 1 in the Supplemental material). The review protocol has been registered at the international prospective register of systematic reviews (PROSPERO) (ID: CRD42018104920), and the registration number of this review is available at https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42018104920.

Data source and search strategies

A literature search was carried out through main electronic databases and indexing platforms. PubMed, Medline (Ovid®), CINAHL (EBSCOhost), African Journals Online, and other relevant sources such as Google Scholar and WHO websites were used to search studies. The studies' search was performed using the search strings that have emerged from keywords, such as (a) population (child, child preschool, children, childhood, pre-adolescent, adolescent) AND (b) outcome (hearing impaired persons OR hearing impaired OR hearing disabled persons OR deaf persons OR deaf Person OR person, deaf OR persons, deaf OR hard of hearing persons OR hearing disorder OR hearing loss AND (c) study design (cross-sectional, prevalence, epidemiology, observational) AND (d) location (sub-Saharan Africa, or South of Sahara Africa). Finally, all studies, which were in line with the review title, were retrieved and screened for inclusion in the systematic review (see Additional file 2 in the Supplemental material).

Inclusion and exclusion criteria

All observational studies (cross-sectional, case–control, and cohort) and survey reports were included in the systematic review and meta-analysis. However, case reports, case series, commentaries, and editorials were excluded from the systematic review. All studies with the primary objective to determine the prevalence of hearing impairments and its associated factors among children in SSA were considered. We had included a community or facility-based studies. All studies that have reported the prevalence of hearing impairments, but not its associated factors, were also included. We had excluded

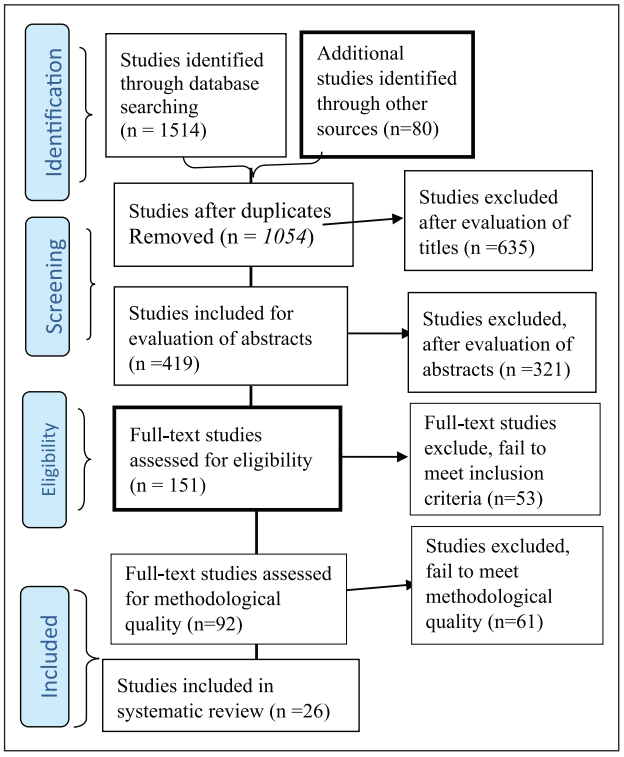

Figure 1. Flow diagram illustrating the studies' screening process.

studies that only investigated hearing impairments with a qualitative approach. However, we included studies that had both quantitative and qualitative study findings, by only considering the quantitative findings. Both published and unpublished studies from 2000 to 2018 which were written in the English language and fulfilled all other criteria were included in the systematic review.

Screening and eligibility of studies

Along with the application of appropriate limits, online records from each database or directory were exported to EndNote citation manger.[39] The studies were then merged into one folder to identify and remove duplicates using endnote. Thereafter, two authors (A.D. and T.F.G.) independently screened the studies based on preset inclusion criteria. Through title screening, the studies that clearly mentioned hearing impairment were selected for abstract screening. Consequently, studies that fulfilled the eligibility criteria based on their titles and abstracts were retrieved for full-text screening. The full-text screenings were carried out by two independent authors (A.D. and T.F.G.). In each case, third and fifth authors (A.S. and T.A.) were consulted to resolve disagreements. The study's selection process flow diagram was adapted from the PRISMA guidelines.[38] The detail of the selection process is illustrated using the flow chart (Figure 1).

Critical appraisal of studies

Studies were critically evaluated to ascertain the validity of their findings. Studies' methodological robustness and validity were appraised using the Joanna Briggs Institute (JBI) critical appraisal checklist for observational studies.[40] The JBI critical appraisal checklist for studies reporting prevalence data contain nine important questions (Q1–Q9) and for cohort (Q1–Q11), primarily addresses the methodological aspect of each study. Scores of the two authors (A.D. and T.F.G.) in consultation with the third and fifth authors (A.S. and T.A.) (in case of disagreement between the two authors' appraisal results) were used for the final decision. Studies with the number of positive responses (yes) greater than half of the number of checklists (i.e. a score of five and above) were included in the systematic review and meta-analysis. Particular attention was given to clear statements of the objective of the studies, sampling techniques, precision of measurement of outcomes of interest and exposure variables, as well as documentation of sources of bias or confounding (see Additional file 3 in the Supplemental material).

Data extraction

The data extraction template was constructed by (AD, AS, and TFG) using Microsoft Excel (2013). The two authors (A.D. and T.A.) extracted and stored data systematically using a data extraction form. In addition, studies' description was recorded using tables labeled design, aim, sample size, key finding (prevalence of hearing impairments), and secondary outcome (associated factors) (Table 1). Numerical data (frequency) were extracted and recorded in the Microsoft Excel sheet (see Additional file 4 in the Supplemental material).

Data synthesis and statistical analysis

The extracted data were imported from Microsoft Excel to Stata version 14 and Comprehensive Meta-Analysis (CMA) software for analysis,[41] for the pooled estimation of outcome measures (prevalence of hearing impairment). Subgroup analyses were also conducted to minimize the degree of heterogeneity. The data analysis was carried out by the two authors (A.D. and A.S.). The presence of statistical heterogeneity was checked by using the Cochran Q test. The levels of heterogeneity among the studies were quantified using the I^2 statistics, and substantial heterogeneity was assumed if the I^2 value was $\geqslant$60%. In the case of high heterogeneity, the subgroup analysis was performed using the random effect model. The presence of publication bias was checked by using a funnel plot.

Results

Search results

A literature search in main electronic databases including PubMed, Medline, CINAHL, and Google Scholar retrieved a

Table 1. Description of the studies included in the systematic review and meta-analysis.

Author, year, & country	Study design	Primary interest	Target population	Sample size (n)	Diagnostic method	Normality criterion	Key findings and risk factors
Basañez et al., 2015[46] Uganda	Cross-sectional	To examine the prevalence and etiology of hearing loss	Children 5–14 years	639	Hearing thresholds at 500, 1000, 2000, and 4000 Hz Diagnostic audiometry	>30 dB HL	Hearing impairment = 3.1%
Hrapcak et al., 2016[29] Malawi	Cross-sectional	To assess the prevalence and types of hearing loss	Children 4–14 years	380	Electronic medical record review, and otoscopy, tympanometry, TEOAE audiometry	>20 dB HL	Hearing impairment = 24%, conductive = 82%, and sensorineural = 14% Mixed = 4% Ear infections, ear drainage, WHO stages 3 or 4, and history of malnutrition
Alabi et al., 2008[23] Nigeria	Prospective cohort study	To determine the prevalence of sensorineural hearing loss	Children 4–15 years	HbSS = 80 Without = 60	PTA at frequencies of 250, 500, 1000, 2000, 4000, and 8000 Hz	>25 dB HL	SNHL = 3.8% CHL = 27.5% SNHL = 0% CHL = 25%
Christopher et al., 2013[44] Uganda	Cross-sectional	To determine the prevalence, types, and severity of hearing impairment in HIV	Children 6 months–5 years	370	ABR of 500–4000 Hz	>25 dB HL	Hearing impairment = 33.0% SNHL = 64.0%
Clark, 2008[24] Mozambique	Cross-sectional	To present results on the prevalence of hearing impairment and otology	Children 3–18 years	2668	OAE screen frequency (500, 1000, 2000, and 4000 Hz) PTA	>25 dB HL	Hearing impairment = 5%
Devendra et al., 2013[57] Malawi	Case–control	To estimate the prevalence of hearing impairment	Children 2–9 years	296 cases 296 controls	WHO protocol	None	Hearing impairment = 12% in the cases versus controls = 2%
Edmond et al., 2010[26] Senegal	Prospective cohort	To assess disabling sequelae of meningitis	Children >4 years	66 cases 66 controls	WHO protocol	>25 dB HL	Hearing impairment was 51.8% among cases and 30.3% among controls
Geda et al., 2016[47] Ethiopia	Cross-sectional	To assess the magnitude and types of hearing impairment	Children <15 years	21,572	UNICEF's disability screening tool	None	Hearing impairment = 1.94%
Hunt et al., 2017[27] Malawi	Cross-sectional	To determine the prevalence of chronic supportive otitis media and mild hearing impairment	Children 4–6 years	281	PTA	>25 dB HL	Unilateral hearing impairment = 24.5% Bilateral hearing impairment = 12.5%
Ilechukwu et al., 2016[5] Nigeria	Cross-sectional	To determine the prevalence of ear-related problems	Children <17 years	248	Otoscopy confirmed by the otolaryngologist	None	Hearing impairment = 7.3%
Olusanya, 2000[43] Nigeria		To assess the prevalence and pattern of hearing impairment	School children	359	Parental interviews, autoscopy PTA	>20 dB HL	Hearing impairment = 13.9%. Otitis media with effusion and impacted cerumen significant association with hearing impairment
Nakku et al., 2017[48] Uganda	Cross-sectional	To determine the types of hearing impairment	Children 6–12 years	227	PTA	None	Overall hearing impairment = 9.3%, conductive = 15.9%, SNHL = 6.2% Age = 11–12 years, previous ear infection, and the use of TB drugs
Mahomed-Asmail, 2016[28] South Africa	Cross-sectional	To identify the prevalence and characteristics of hearing impairment	Children Grades 1–3	1070	Otoscopic, tympanometry, and PTA of HL at 1, 2 and 4 kHz	>25 dB HL	Hearing impairment = 2.2%, mild 48.6%, mild-to-moderate 17.1%, moderate-to-severe 14.3%, severe-to-profound 20.0%

(Continued)

Table 1. (Continued)

Author, year, & country	Study design	Primary interest	Target population	Sample size (n)	Diagnostic method	Normality criterion	Key findings and risk factors
Seddon et al., 2013[45] South Africa	Cross-sectional	To determine the frequency and extent of hearing impairment in children	Children <15 years	94	Otoscopy, tympanometry, PTA, and DPOAEs at 1, 2, 4, and 8 kHz	>25 dB HL	Hearing loss = 24%. Tuberculosis
Tataryn et al., 2017[25] Malawi	Cross-sectional	To estimate the prevalence of hearing impairment	Children <18 years	7220	DPOAE PTA	>35 dB HL	Hearing impairment = 27%, and 73% of them had a bilateral hearing impairment
Westerberg et al., 2005[49] Zimbabwe	Cross-sectional	To determine the prevalence of significant hearing impairment	Primary school children	5528	Microaudiometric, thresholds at 1, 2, and 4 kHz in a quiet classroom	40 dB HL	A conductive hearing loss of 1.4%, sensorineural hearing impairment = 56/1.0%, and significant hearing impairment = 2.4%
Yousuf Hussein et al., 2018[42] South Africa	Cross-sectional	To determine and describe hearing impairment	Preschool children 3–6 years	725	Otoscopy, tympanometry, and PTA at 1, 2, and 4 kHz	>25 dB HL	Hearing impairment = 18.7%, conductive = 65.2%, SNHL = 28.2%, and mixed losses = 6.5%
Olusanya, 2003[56] Nigeria	Case–control	To determine whether impacted cerumen had been removed were at greater risk of hearing impairment	Children 4–10 years	113 cases	PTA at frequencies of 0.5, enlisted for 1, 2, and 4 kHz		23% case hearing lose
				113 controls		>20 dB HL	Hearing impairment = 4.4%. Otitis media and a history of impacted cerumen
Borenstein et al., 2015[41] Zimbabwe	Cross-sectional	To determine the prevalence, cause, and severity of hearing impairment	Children 5–17 years	359	Otoscopic and PTA	>26 dB HL	Hearing impairment = 32.3%. Recent CD4 count <350 cell/μL
Omondi et al., 2007[54] Kenya	Cross-sectional	Parental awareness of childhood hearing impairment and the pattern of access to and utilization of ambulatory care services	Primary school children	1411	PTA	>25 dB HL	Hearing impairment = 2.48%
Oluwatosin et al., 2013[55] Nigeria	Cross-sectional	To carry out otoscopic and audiologic examinations	Preschool children	101	PTA	>25 dB HL	Hearing impairment = 21.3% Impacted cerume (21.8) Otitis media with effusion (OME)
Westerberg et al., 2008[50] Uganda	Cross-sectional	To determine the prevalence and causes of disabling hearing loss	All ages	6041	WHO protocol	None	Hearing impairment = 10.2% in children Cerumen impaction, chronic suppurative otitis media, and meningitis resulted in disabling hearing loss in 41% of children
Couper, 2002[52] South Africa	Cross-sectional	To determine the prevalence of disability in children	Children <10 years	2036	WHO protocol	None	Hearing impairment = 1%
Louw et al., 2018[53] South Africa	Cross-sectional	Prevalence of hearing loss at primary health care clinics	Children 3–14 years	126	PTA	25 dB HL	Hearing impairment = 4.8% younger age-associated factors
North-Matthiassen, 2007[51] South Africa	Retrospective audit	The hearing profile among school learners	Children 6–12 years	1101	PTA	25 dB HL	Hearing impairment = 7.9%
Mactaggart et al., 2014[58] Cameron	Nested case–control	To assess prevalence of visual, hearing, and musculoskeletal impairment	Children 4–17 years	3567	OAE and PTA	35 dB HL	Hearing impairment = 3.6%

Note. TEOAE: transitory evoked otoacoustic emissions; OAE: otoacoustic emissions; WHO: World Health Organization; UNICEF: United Nations Children's Fund; PTA: pure tone audiometry; SNHL: sensor neural hearing loss; CHL: conductive hearing loss; HIV: human immunodeficiency virus; DPOAE: distortion product otoacoustic emissions; ABR: auditory brainstem response.

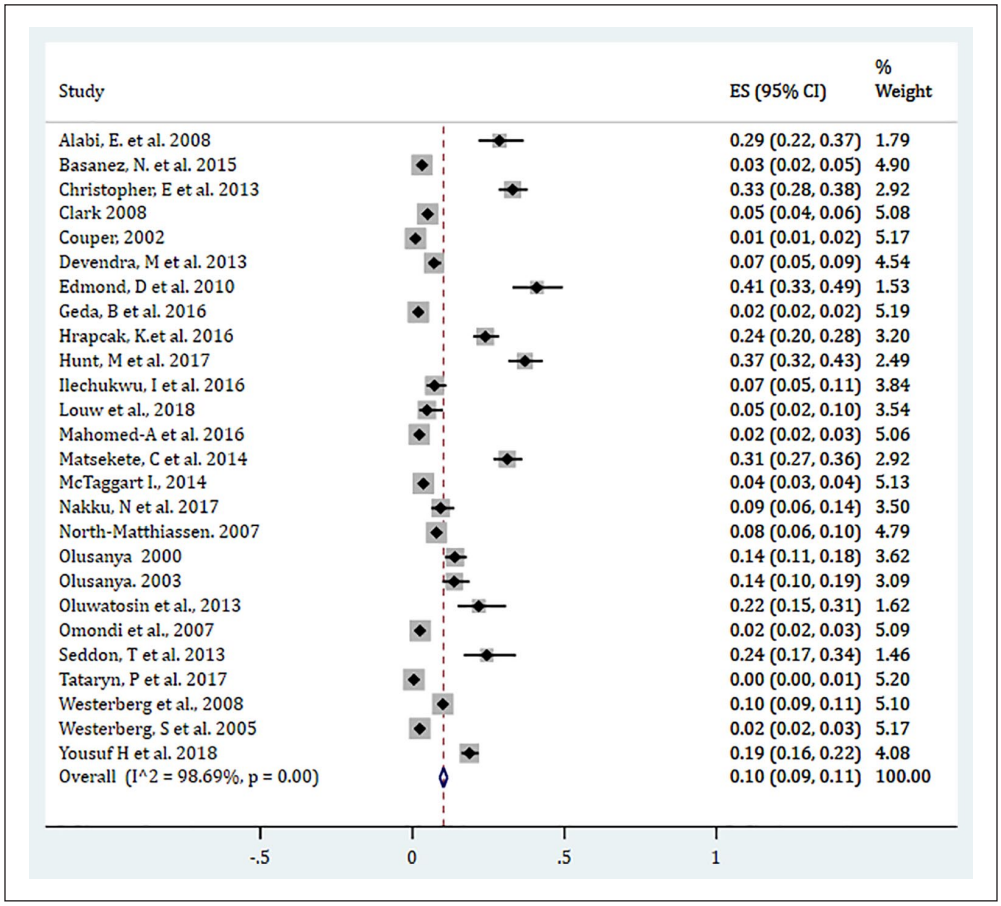

Figure 2. The pooled prevalence of hearing impairment in SSA (n = 26).

total of 1,594 studies. Of these, 540 studies were found to be duplicates through EndNote and manual tracing. The remaining studies were screened using their titles and abstracts, and 962 of them did not fulfill the inclusion criteria and were thus removed from the systematic review process. The full texts of 92 studies were thoroughly assessed to ensure the presence of at least the primary outcome measures in a sufficient and non-ambiguous way. In this regard, 61 studies did not meet the inclusion criteria and were thus removed. Eventually, 26 studies addressing the outcome of interest were included (Figure 1).

Study characteristics

From the studies included in the analysis, Twenty-one studies were cross sectional[5,24,25,27–30,42–55] while three studies were case–control,[56–58] and the remaining studies were prospective cohort.[23,26] All the included studies were conducted between 2000 and 2018 with the sample size ranging from 94 to 21,572. All included studies were written in English. General characteristics and descriptions of the studies are recorded (Table 1).

The pooled prevalence of hearing impairment

In studies with a sample of 57,572 children, the pooled prevalence of hearing impairment was 10% (95% confidence interval (CI): 9%–11%) (Figure 2). The prevalence of hearing impairment varied with normality criteria and the most commonly used normality criterion was 25 and 30 dB, but this also ranged between 20 and 40 dB. Based on this variability, we did subgroup analysis for normality criterion and study population characteristics. In three studies that used a threshold of >20 dB HL, the pooled prevalence of hearing impairment was 17% (95% CI: 11%–24%). In thirty studies that used a threshold of >25 dB HL, the pooled prevalence of hearing impairment was 19% (95% CI: 15%–23%). In a couple of studies that used a threshold of >30 dB HL, the pooled prevalence of hearing impairment was 2% (95% CI: 2%–3%). In another two studies that used a threshold of >35 dB HL, the pooled prevalence was 1% (95% CI: 1%–1%). On the other hand, in six studies that used questioners based on self-report or parental interview methods to assess childhood hearing impairment, the pooled prevalence was 6% (95% CI: 3%–9%) (Figure 3).

The magnitude of hearing impairment also varied with the characteristics of the study population. This review included articles with heterogeneous groups of study subjects; many of the studies done from school or community-based children, and others were based on specific groups of children like children living with HIV (human immunodeficiency virus), a survivor of meningitis, sickle cell anemia,

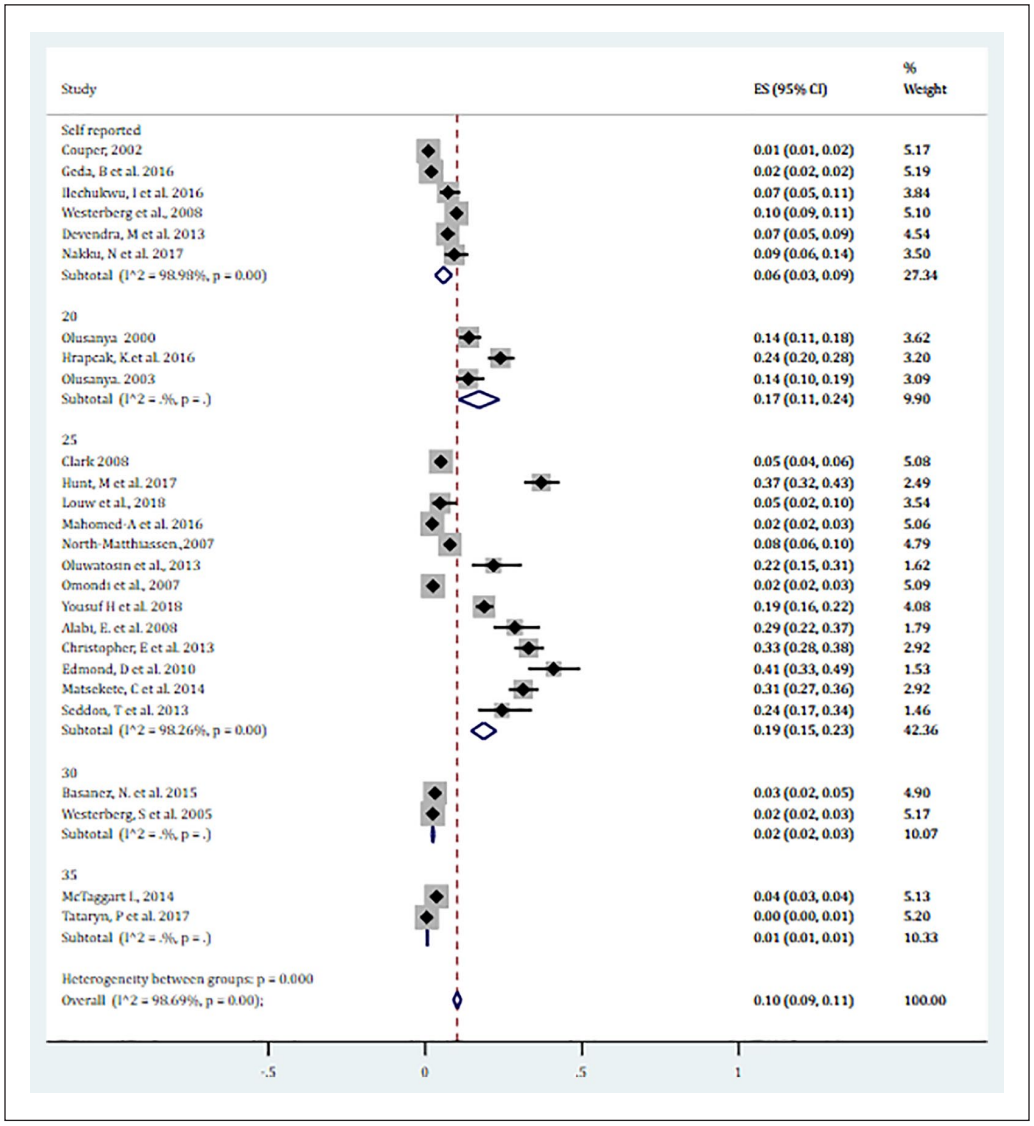

Figure 3. Subgroup analysis by cutoff points for hearing impairment in SSA (n = 26).

and tuberculosis. We did subgroup analysis based on population characteristics included in the study. The pooled prevalence of hearing impairment for school or community-based children was 6% (95% CI: 5%–7%). In addition, the pooled prevalence of hearing impairment for children with comorbidities was 23% (95% CI: 15%–31%); Figure 4).

The studies analyzed different populations, age groups, diagnosis criteria, and methods, revealing heterogeneity in the findings. There was variation in the diagnostic methods and normality criteria across the selected studies. In nine studies, auditory threshold and otoscopy were used for screening procedure.[5,24,28–30,42,45,46] In 14 studies, automated pure tone audiometry was applied.[23,27,28,30,42,48,49,51–56,58] In addition, several studies used TEOAE (transitory evoked otoacoustic emission) audiometric diagnosis,[24,25,29,44,45,58] and WHO or UNICEF questions based parental interview[26,43,47,50,52,57] to assess hearing impairment. Regarding normality criteria, there were differences even among those that utilized the same technique ranging from 20 to 40 dB. Due to these differences, there were variations in the prevalence values encountered, especially because some studies analyzed prevalence through different criteria and/or assessed a wider age group. Similarly, the study of associated factors was not homogeneous. Eighteen studies did not include an analysis of associated factors besides the prevalence of hearing impairment. Due to the low number of studies that evaluated associated factors, the causes established by the studies were indicated as associated factors.

Risk factors of hearing impairment

Chronic suppurative otitis media and impacted cerumen. In three studies, hearing impairment was significantly associated with chronic suppurative otitis media (CSOM) or ear infection. Although the strength of the association varies (ranging from 2 to 7 times), those children who had a story

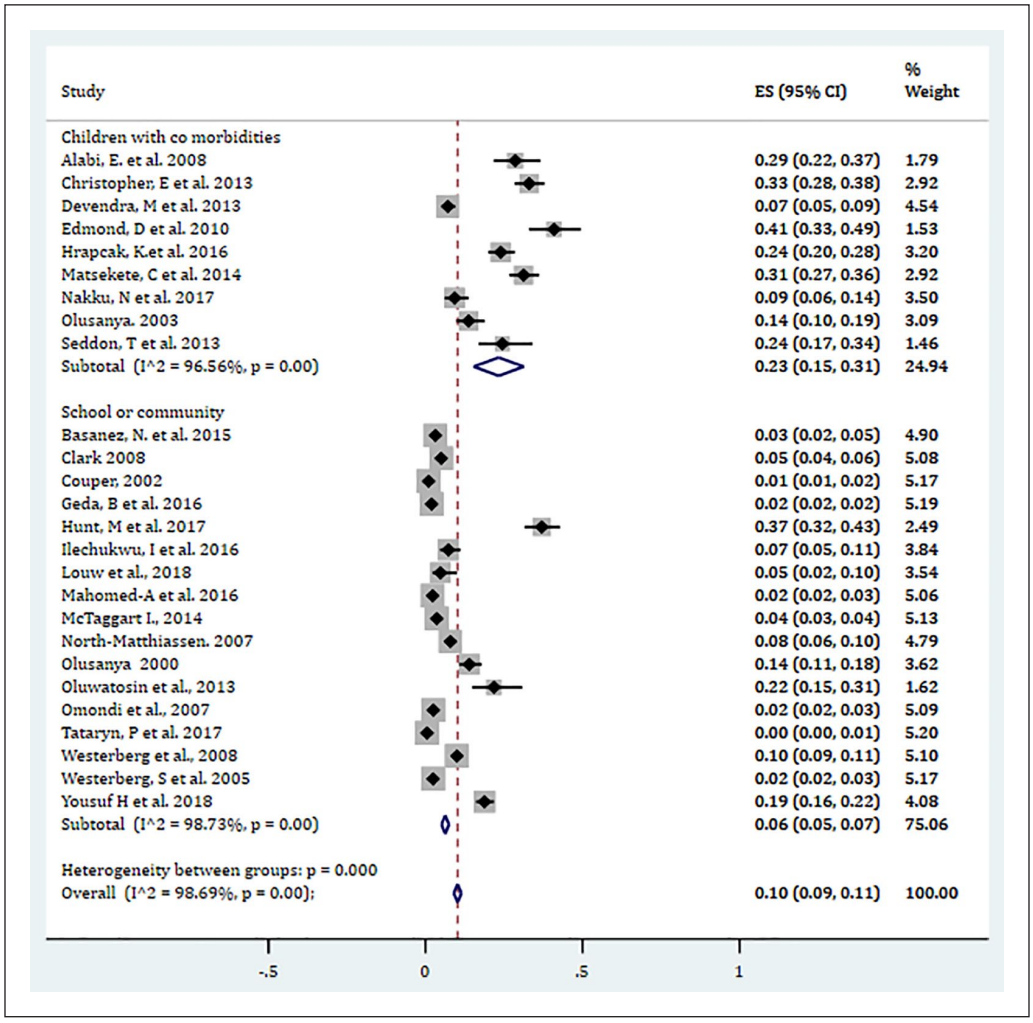

Figure 4. Subgroup analysis based on study population characteristics for hearing impairment in SSA (n = 26).

of recurrent ear infection were more likely to have than their counterparts.[29,48,56] Likewise, in some studies, children who had impacted cerumen were 6 times more likely to have hearing impairment than those who were not having impacted cerumen.[43,56]

HIV and tuberculosis infection. In two studies, children and adolescents who were at a severe immunodeficiency stage, that is, WHO stages 3 and 4 or their CD4 count less than 350 cells/μL, were 2 times more likely to have hearing impairment than their counterparts.[29,30] Furthermore, hearing impairment was associated with childhood exposure to anti-TB medication.[48] An additional only one study reported that malnourished children were 2 times more likely to have hearing impairment than well-nourished children.[48]

Age, gender, and ethnicity. In three studies, hearing impairment was associated with an age fewer than 12 years, and children of this age range were more prone to hearing impairment than older adolescents.[41,48,53] In one study, age or gender did not have an association with hearing impairment. Regarding ethnicity, one study reported that Caucasian children were 3 times more likely to have hearing impairment than African children who reside in Africa.[42]

Discussion

This systematic review and meta-analysis aimed to identify the prevalence of hearing impairment and its associated factors and made recommendations to prevent hearing impairment. The presence of hearing impairment in children as a health problem has been widely reported.[43,59] The challenge is more significant in developing countries because routine screening for hearing impairment and early intervention is unfortunately not carried out.[55] This systematic review summarized up-to-date empirical evidence and indicates key areas of action regarding hearing impairment in SSA. This is an important step forward to ensure child health program planners and policymakers related to disabilities in SSA make informed decisions regarding where the corrective

measures should be instituted and maximized. We found out that the pooled prevalence hearing impairment was 10% (CI): 9%–11%, and CSOM, impacted cerumen, advanced stage of HIV, TB infection, and age of the children were associated with hearing impairment in SSA.

Generating a coherent set of estimation become challenging due to clinical heterogeneity including variations in the identification methods for hearing impairment, normality criteria, and population groups, which result in variability in the prevalence of hearing impairment. Due to this, the subgroup analysis finding has shown that hearing impairment was 17% for using a threshold of >20 dB HL, 19% for >25 dB HL, 2% for >30 dB HL, and 1% for >35 dB HL, while the prevalence of hearing impairment using questionnaire-based self-report or parental interview method was 6% (95% CI: 3%–9%). Furthermore, this review included articles with heterogeneous groups of study subjects; many of the studies conducted from school-based or community children, and others were based on a specific group of children like living with HIV, and survivors of meningitis, sickle cell anemia, and tuberculosis. We did a subgroup analysis based on population characteristics. The prevalence of hearing impairment for school or community-based children was 6% (95% CI: 5%–7%) and 23% (95% CI: 15%–31%) for children with above comorbidities.

Regardless of this, hearing impairment estimation is relatively comparable with the systematic review of hearing impairment in Africa.[9,16] However, this finding was higher than a systematic review reported from Germany and worldwide children.[60,61] In fact, this might be due to children in SSA are living in poverty, malnutrition, and living with a high prevalence of infections that predispose for hearing impairment. Furthermore, the higher prevalence of hearing impairment may reflect a systematic bias of school-based surveys due to the exclusion of school non-attainders. In addition, this might be due to the lower thresholds used for defining hearing impairment in the included studies (20–30 dB). However, the prevalence of hearing impairment varies from 1.94%[47] to 32.3%.[30] While some studies utilized the threshold screening and otoscopy method,[5,24,28,29,30,42,45,46] others used the diagnostic assessment[23–25,27–30,42,43,49,51–56,58] and the use of WHO or UNICEF parental interview methods for screening purpose.[26,43,47,50,52,57] Thus, hearing impairment measurement variation may also result in difference in the magnitude of the hearing impairment.

Moreover, there was variability in the study of risk factors associated with hearing impairment. It must be highlighted that the age ranges with age groups were not the same. Some studies mixed toddlers and preschoolers with school-aged individuals and adolescent.[5,23–25,29,30,45,46,49,56,57] Unfortunately, many of the studies did not clearly present the causes of hearing impairment. However, we found the most common causes of hearing impairment like CSOM, the leading cause of preventable childhood hearing loss in developing countries.[29,48,56] This might be a result of low socioeconomic status, overcrowding, malnutrition, and exposure to wood smoke. In addition, hearing impairment in children and adolescents in developing countries may have been caused by higher rates of childhood infections such as tuberculosis, measles, HIV, and meningitis, which impacted cerumen, and from the use of ototoxic drugs.[29,30,43,45,48,56,60,62] Also, factors of hearing impairment were often not well assessed, limiting the utility for improving service delivery. Therefore, better data are demanded on the prevalence of hearing impairment and its associated factors in SSA.

The present review had certain limitations. First, the search was only limited to articles published in the English language. Second, despite the incorporation of studies from different parts of the region, the representativeness of the population is not as strong because the studies were observational in nature and had high heterogeneity. Finally, this review was not powered to formally assess potential associations of hearing impairment, and analysis was limited by the low number of articles observed. This review also has strengths like the selection and inclusion of both published and unpublished literature which has the potential to minimize publication bias. Moreover, our search strategy was extensive using multiple reputable databases and search engines. In addition, it fills the data gap and urges the concerned body to initiate the screening and intervention programs to reduce the burden of childhood hearing impairment.

Conclusion

There is a high prevalence of hearing impairment in children and adolescents in SSA, and also, many of the risk factors are preventable and treatable. Further, a well-designed epidemiological study in a more representative population using standardized definitions of hearing impairment and objective methods for case ascertainment seems warranted. This is because very few studies are available to investigate the associated factors of hearing impairment. Furthermore, the available studies used different cutoff making the comparison more difficult. Therefore, we recommend that the diagnosis modality should be standardized for studies in SSA and other developing countries. In addition, regular community and school-based screening activities for early detection and necessary intervention programs should be designed by concerned stakeholders on childhood hearing impairment.

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Author contributions

A.D. conceived and designed the review. A.D. carried out activities from inception to the draft of the manuscript and is the guarantor of the review. A.D., A.S.,T.A., and T.F.G. developed search strings, selection, and analysis. All authors provided intellectual contribution for interpretation and rigorously reviewed the manuscript. All authors read and approved the final version of the manuscript.

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Supplemental material

Supplemental material for this article is available online.

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