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Strabismus and Amblyopia in Africa – A Systematic Review and Meta-Analysis

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Strabismus and amblyopia in Africa – a systematic review and meta-analysis

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ABSTRACT

The objective of this review was to estimate the prevalence of strabismus and amblyopia in Africa. A systematic online literature search was conducted for articles on strabismus and amblyopia in Africa. Meta-analysis was performed, using the Freeman-Tukey double arcsine transformation, to estimate the prevalence of strabismus and amblyopia in Africa. Subgroup analyses were conducted according to age, gender, study year, and type of amblyopia. Meta-regression was used to evaluate the influence of predetermined factors on the prevalence of amblyopia. 8 (1 population-based & 7 school-based) and 21 (3 population-based & 18 school-based) studies on strabismus and amblyopia with sample sizes of 22,355 and 46,841, respectively, were included in the review. Overall prevalence of strabismus in Africa was estimated to be 0.8% (95% CI: 0.4% – 1.4%); exotropia was 0.2% (95% CI: 0.1% – 0.5%) and esotropia was 0.5% (95% CI: 0.1% – 1.2%). Overall prevalence of amblyopia was estimated to be 0.6% (95% CI: 0.3% – 0.9%); refractive and strabismic amblyopia were 1.1% (95% CI: 0.2% – 2.5%) and 0.4% (95% CI: 0.2% – 0.6%), respectively. Prevalence estimate of amblyopia in males was 1.8% (95% CI: 0.7% – 3.3%) and in females was 1.3% (95% CI: 0.4% – 2.6%). There was a significant association between the prevalence of amblyopia and the type of amblyopia ($p = .007$) and the study year ($p = .006$). Although there appears to be a relatively low prevalence of strabismus and amblyopia in Africa, there is a dearth of well-designed population-based studies on strabismus and amblyopia in Africa, resulting in the lack of epidemiological information on strabismus and amblyopia within the general African population. Information about the prevalence of strabismus and amblyopia across Africa can inform policy making and design and implementation of public health intervention program.

KEYWORDS

Africa; amblyopia; meta-analysis; strabismus; systematic review

Introduction

Strabismus is a developmental disorder in which the two eyes are not aligned when viewing an object.[1] Strabismus is a leading cause of visual impairment especially in children, with an estimated prevalence of 2–5% globally.[2–7] An estimated 0.80% of children in Singapore,[8] 5.65% children in China[9] and 2.47% children in the United States of America[10] have strabismus. Strabismus can have significant effects on the development of children if not treated early, affecting learning and impairing performance.[8,11] In adulthood, strabismus can affect the vision-related quality of life and have significant economic and public health significance.[12–14] Given the significance of strabismus, it is important to know the burden and the public health implications of the strabismus problem globally and across different geographical regions.

Strabismus is a common cause of amblyopia – which is a common developmental disorder of the visual system characterized by reduced best corrected visual acuity in one or both eyes (two-line difference between the eyes) with no obvious organic cause.[15,16] Risk factors for the development of amblyopia include obstruction in the optical pathway that reduces retinal image quality (deprivation amblyopia), refractive error (refractive amblyopia) or ocular misalignment that disrupts binocular fusion (strabismic amblyopia).[17,18] Amblyopia is the leading cause of monocular visual impairment in both children and adults and a common visual disorder

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affecting all age groups.[16] The global prevalence of amblyopia is estimated as 1–5% in children and 2.5–7.14% in adults.[19–22] The variation in reported prevalence is due to factors such as characteristics of selected cohort of the study, visual acuity criterion, and type of amblyopia. Also, definitions of amblyopia in literature are usually very heterogenous, making prevalence from different studies difficult to compare. Amblyopia can be treated, if detected early and treatment is initiated early enough.[23] However, if left untreated, amblyopia can disrupt vision in diverse ways, affecting contrast sensitivity, visual acuity, and binocular vision.[24] In Africa, amblyopia and strabismus have been moderately studied in few regions with varying prevalence reported.[25–36] Factors such as screening of school-going children to identify refractive errors and strabismus, spectacle coverage, availability of spectacles and/or contact lenses and eyecare personnel in Africa have an impact on incidence of amblyopia and strabismus.[37–39]

To date, there is no continental representative study on the prevalence of strabismus or amblyopia in Africa. As such, the burden of strabismus and amblyopia in Africa is not known. Given the significance of both strabismus and amblyopia as major causes of visual impairment in both children and adults, it is important to have information of their prevalence on the continental level. Therefore, it is important to provide a pooled prevalence estimate of amblyopia and strabismus as well as associated risk factors in Africa. The aim of the current systematic review and meta-analysis is to sum up the current available literature and provide a current and comprehensive reflection of strabismus and amblyopia epidemiology in Africa using appropriate meta-analytic techniques. In this study, all published data in Africa were evaluated and the overall prevalence estimate of amblyopia and strabismus in Africa was reported.

Methods

Guidelines in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[40] were followed.

Literature search strategy

Between 1 June 2021 and 15 July 2021, the following databases were searched for studies reporting prevalence of strabismus and amblyopia in African populations: PubMed, Web of Science, African Journals Online (AJOL), Scopus and Embase. Google scholar was used to access gray literature. No time filters were applied to search. Different variations of search text and medical search headings (MeSH) were used in the literature search, each being an appropriate combination of any of the search words or terms in Table 1. The search terms were first developed in PubMed and was applied in other databases. The PICO of the study was: population (adults and children in Africa), intervention (none), comparison (none) and outcome (prevalence of strabismus and amblyopia). The PICO was used to define the search strategy. The bibliography of eligible studies (from primary literature search) was reviewed for any relevant publication that might have been missed during the initial literature search. Literature search was conducted independently by two authors.

Inclusion and exclusion criteria

School- or population-based studies with prospective cross-sectional design conducted in the "normal" population were included. For this review, normal subjects were defined as individuals without any systemic/genetic/syndromic condition (e.g., Down Syndrome) known to predispose to strabismus or amblyopia. Available full-text articles of studies were used. However, if the full text of a study is not available but the abstract provides

Table 1. Search strategy for PubMed.

1	Strabismus [Text Word] OR Strabismus [MeSH Terms]
2	Exotropia [Text Word] OR Exotropia [MeSH Terms]
3	Esotropia [Text Word] OR Esotropia [MeSH Terms]
4	Squint [Text Word] OR Squint [MeSH Terms]
5	Amblyopia [Text Word] OR Amblyopia [MeSH Terms]
6	Lazy Eye [Text Word] OR Lazy Eye [MeSH Terms]
7	Pediatric [Text Word] OR Pediatric [MeSH Terms]
8	Children [Text Word] OR Children [MeSH Terms]
9	Adolescent [Text Word] OR Adolescent [MeSH Terms]
10	Adult [Text Word] OR Adult [MeSH Terms]
11	Aged [Text Word] OR Aged [MeSH Terms]
12	Prevalence [Text Word] OR Prevalence [MeSH Terms]
13	Frequency [Text Word] OR Frequency [MeSH Terms]
14	Africa [Text Word] OR Africa [MeSH Terms]

enough details for relevant information to be extracted, the study was included. Hospital-based and retrospective studies were excluded from the current review.

Studies screening and appraisal

Studies were initially screened using their titles and abstracts. Full-text articles of studies that passed the initial screening were assessed to ensure all inclusion criteria were met. The following information were extracted from the full-text articles: authors' names, year of publication, sampling period, study location (country), sample size, study design, age range of participants, gender of participants, the diagnostic criteria for strabismus or amblyopia used and the prevalence and number of participants with strabismus or amblyopia. Screening of articles for eligibility was performed by two authors; disagreements about article eligibility were resolved by discussions with a third author.

A 10-item check list produced from the Downs and Black checklist and the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement was used to rate and assess the quality of all the full-text articles included in the review. The maximum score a study could receive is 10. Assessment of study quality was conducted by two reviewers; disagreements were resolved by discussions with a third reviewer.

Data analysis

Statistical analysis was performed with R version 4.1.2 (R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/). Individual study proportions and pooled estimates were assessed with a 95% confidence interval. The Freeman-Tukey double arcsine transformation was used before pooling to minimize the effects of studies with extremely high or low prevalence estimates on the overall pooled estimate.[41–43] Heterogeneity between studies was assessed using the degree of inconsistency (I^2). The I^2 statistic provides an estimate of the percentage of heterogeneity across studies that is truly due to differences between studies but not chance. Following Higgins et al. recommendation,[44] I^2 >50% was defined as meaningful heterogeneity. The random effect model was used to analyze pooled effects when heterogeneity was meaningful. Subgroup analyses were conducted according to age, gender, study year, and type of amblyopia. To reflect the critical period in childhood where children are considered to develop amblyopia and due to the high variability in the age groupings used by the individual studies, ages were grouped broadly into two categories: ≤10 years and >10 years. Meta-regression analysis was conducted to evaluate the influence of predetermined factors (such as age, sex, type of amblyopia and study year) on prevalence of amblyopia. The Egger's test was used to evaluate the presence of publication bias. For all statistical analysis, a p-value <.05 was considered statistically significant.

Results

Four hundred and seven (407) records were identified from database search. Two hundred and seventy-six (276) duplicates were identified and removed. One hundred and thirty-one (131) articles were then screened and eighty-three (83) of them were excluded based on their titles and abstracts, leaving forty-eight (48) articles. Five (5) additional articles were identified from the secondary literature search. A total of fifty-three (53) studies were assessed for eligibility. Twenty-nine (29) studies were excluded for various reasons as shown in Figure 1. The final number of studies included in the review was twenty-four (24). Figure 1 shows the PRISMA flowchart outlining the steps in acquiring the articles for the systematic review and meta-analysis.

Studies included in this review are presented in Table 2 (strabismus) and Table 3 (amblyopia). Eight (8) studies (1 population-based and 7 school-based) reported on strabismus and 21 (3 population-based and 18 school-based) reported on amblyopia. The sample sizes of the included studies ranged from 352 to 8715. The lowest and highest age range of participants in the individual studies were ≤5 and

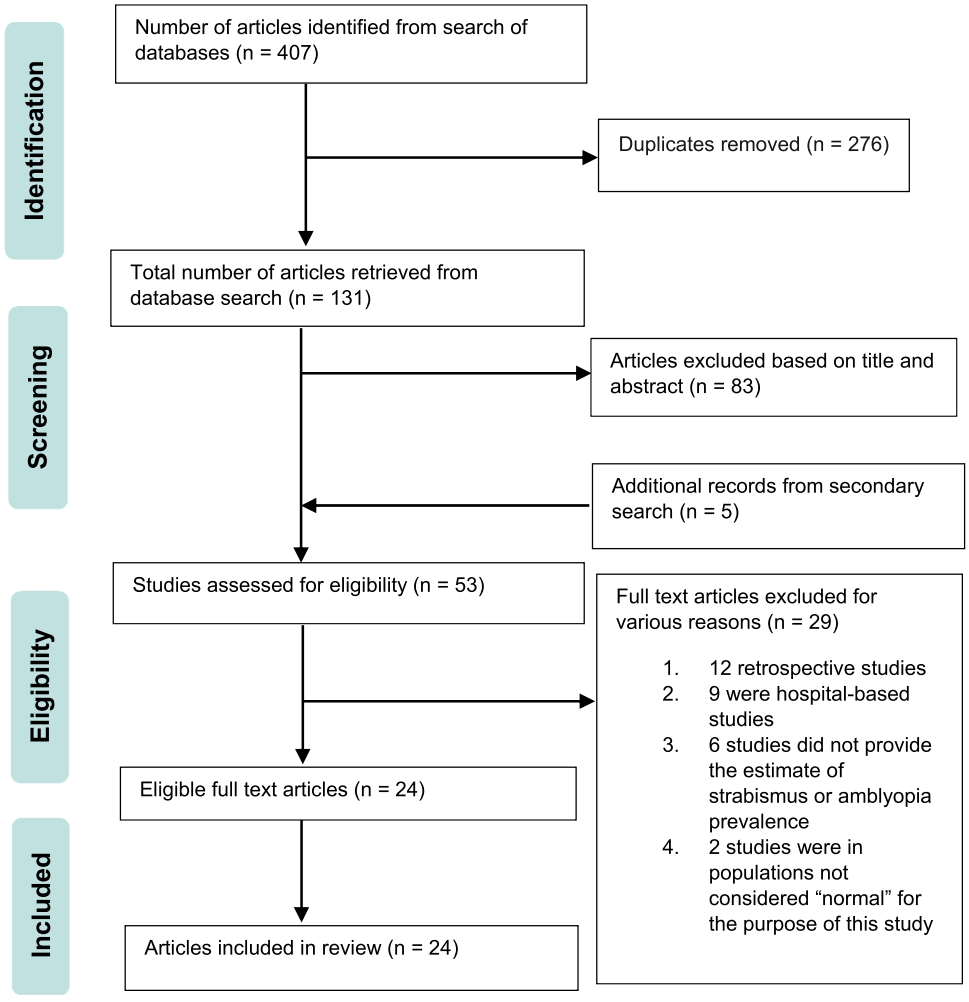

Figure 1. PRISMA flowchart outlining the steps in acquiring the articles for the systematic review and meta-analysis. 407 records were identified from database search; 276 duplicates were removed. The final number of studies included in the review was 24.

Table 2. Characteristics of studies included in systematic review and meta-analysis (Strabismus).

Author	Study location	Sampling period	Type of study	Sample size			Age of participants (years)	Method of strabismus assessment	Prevalence (%)			QOS
				Male	Female	Total			strabismus	XT	ET	
Elsahn, 2014[45]	Egypt	n.s.	School-based	n.s.	n.s.	6029	6 – 12	n.s.	0.13	0.01	0.12	7
Giorgis and Bejiga, 2001[46]	Ethiopia	2000	Population-based	889	1005	1894	≤5	Hirschberg's test	1.53	0.47	1.06	9
Azonobi et al, 2009[47]	Nigeria	n.s.	School-based	3766	3522	7288	2 – 17	Hirschberg's test	0.44	0.14	0.30	
Adegbehingbe et al, 2005[34]	Nigeria	2003	School-based	802	905	1707	8 – 22	n.s.	1.29	n.s.	n.s.	8
Akpe et al, 2014[31]	Nigeria	n.s.	School-based	1024	1115	2139	5 – 19	Hirschberg's test/ Krimsky's test	0.89	0.33	0.56	8
Taha et al, 2015[48]	Sudan	2010	School-based	n.s.	n.s.	768	5 – 14	n.s.	2.8	0.6	2.2	9
Wedner et al, 2000[49]	Tanzania	1998	School-based	n.s.	n.s.	1386	7 – 19	Hirschberg's test/cover test	0.51			8
Ajaiyeoba et al, 2006[29]	Nigeria	2002	School-based	504	640	1144	4 – 24	n.s.	0.26	0.17	0.09	9

n.s. – not stated XT – exotropia ET – esotropia.
QOS – quality of study.

Table 3. Characteristics of studies included in systematic review and meta-analysis (Amblyopia).

Author	Sampling period	Type of study	Sample size			Age of participants (years)	Prevalence (%)	Type of amblyopia	Diagnostic criteria	QOS
			Male	Female	Total					
Egypt										
Elsahn, 2014[45]	n.s.	School-based	n.s.	n.s.	6029	6 – 12	0.13	n.s.	n.s.	7
Rashad et al, 2018[50]	n.s.	School-based	193	159	352	8 – 12	1.98	Refractive (100%)	**Unilateral**: ≥2-line difference in BCVA. **Bilatera**l: BCVA worse than 6/12 in both eyes	8
Ethiopia										
Kedir and Girma, 2010[51]	2009	Population-based	308	262	570	11 – 15	0.35	Strabismic (100%)	n.s.	9
Giorgis and Bejiga, 2001[46]	2000	Population-based	889	1005	1894	≤5	0.79	Strabismic (100%)	**Unilateral**: ≥2-line difference in BCVA	9
Mehari and Yimer, 2013[52]	2010/ 2011	School-based	2272	1966	4238	7 – 18	0.92	n.s.	n.s.	8
Haile et al, 2017[53]	2015	School-based	582	705	1287	6 – 15	4.66	Refractive(76.6%), strabismic (6.7%), deprivational (8.3%)	**Unilateral**: ≥2-line difference in BCVA. **Bilateral**: BCVA worse than 6/9 in both eyes	8
Hailu et al, 2020[54]	2019	School-based	370	403	773	7 – 17	0.65	Refractive (100%)	n.s.	9
Ghana										
Ntim-Amponsah et al, 2007[26]	2000/ 2001	School-based	n.s.	n.s.	975	6 – 22	0.2	Strabismic (100%)	n.s.	9
Kumah et al, 2013[25]	2009	School-based	1143	1311	2454	12 – 15	0.45	n.s.	n.s.	9
Abu et al, 2015[28]	n.s.	School-based	463	566	1029	9 – 22	0.32	n.s.	n.s.	7
Malawi										
Thom et al, 2017[55]	2013	School-based	290	304	594	4 – 18	1.69	n.s.	n.s.	9
Nigeria										
Ajaiyeoba et al, 2006[29]	2002	School-based	504	640	1144	4 – 24	0.26	Strabismic (100%)	n.s.	9
Akpe et al, 2015[31]	n.s.	School-based	1024	1115	2139	5 – 19	0.23	Refractive only (40%), anisometropic and strabismic (20%), meridional (20%)	**Unilateral**: ≥2-line difference in BCVA. **Bilateral**: BCVA worse than 6/9 in both eyes	8
Adegbehingbe et al, 2005[34]	2003	School-based	802	905	1707	8 – 22	0.7	n.s.	n.s.	8
Megbelayin, 2012[32]	2010	School-based	535	640	1175	9 – 21	0.3	n.s.	**Unilatera**l: ≥2-line difference in BCVA. **Bilateral**: BCVA worse than 6/9 in both eyes	9
Ekpenyong et al, 2017[35]	n.s.	School-based	993	1117	2110	6 – 17	0.28	n.s.	n.s.	7
Ikuomenisan et al, 2016[30]	2014	School-based	899	803	1702	4 – 16	1.4	Refractive (58.23%), strabismic (20.83%), deprivational (20.83%)	**Unilateral**: ≥2-line difference in BCVA. **Bilateral**: BCVA worse than 6/9 in both eyes	10
South Africa										
Naidoo et al, 2003[56]	2002	Population-based	n.s.	n.s.	4890	5 – 15	0.29	n.s.	n.s.	9
Sudan										
Alrasheed et al, 2016[57]	2014/ 2015	School-based	827	839	1678	6 – 15	0.36	n.s.	n.s.	8
Tanzania										
Wedner et al, 2000[49]	1998	School-based	n.s.	n.s.	1386	7 – 19	0.22	n.s.	n.s.	8
Togo										
Kossi and Argudo, 2019[58]	2017/ 2018	School-based	n.s.	n.s.	8715	11 – 16	0.38	Refractive (100%)	n.s.	8

n.s. – not stated BCVA – best corrected visual acuity QOS – quality of study.

4–24 years. Included studies were published from 1996 to 2019. Egger's test revealed no publication bias for studies on strabismus (p = .06) and amblyopia (p = .08).

Pooled prevalence estimates of strabismus

Overall prevalence estimate of strabismus in Africa was pooled from eight studies with a total sample size of 22,355. Strabismus prevalence reported by these studies was in the range 0.1% – 2.9% and overall pooled prevalence of strabismus was 0.8% (95% CI: 0.4% – 1.4%; I^2 = 92.99%, p < .01). A forest plot for overall pooled strabismus prevalence is presented in Figure 2.

Overall prevalence of esotropia and exotropia were each pooled from six studies. Prevalence estimate for exotropia was 0.2% (95% CI: 0.1% – 0.5%; I^2 = 83.93%, p < .01) and prevalence for esotropia was 0.5% (95% CI: 0.1% – 1.2%; I^2 = 91.81%, p < .01) (Figure 3).

Pooled prevalence estimates of amblyopia

The overall prevalence estimate of amblyopia in Africa was pooled from 21 studies. Amblyopia prevalence reported by these studies was in the range 0.13% – 4.66%; overall pooled prevalence of amblyopia was 0.6% (95% CI: 0.3% – 0.9%; I^2 = 90.5%, p < .01). Forest plot for pooled amblyopia prevalence is presented in Figure 4.

Gender and age group-based prevalence of amblyopia

Prevalence of amblyopia in males and females were each pooled from six studies and their respective pooled prevalence estimates were 1.8% (95% CI: 0.7% – 3.3%; I^2 = 86%, p < .01) and 1.3% (95% CI: 0.4% – 2.6%; I^2 = 86%, p < .01) (Figure 5(a)). Meta-regression revealed no significant association between the prevalence of amblyopia and gender (p = .752). For analysis, the ages of participants in the included studies were grouped into ≤10 years and >10 years. The prevalence of amblyopia among individuals ≤10 years was pooled from three studies; prevalence estimate was 1.7% (95% CI: 0.4% – 3.8%; I^2 = 84.52%, p < .01). Estimated prevalence of amblyopia in individuals >10 years (pooled from 5 studies) was 1.5% (95% CI: 0.2% – 3.8%; I^2 = 89.53%, p < .01). Figure 5(b) represents the subgroup group analysis for age. There was no significant association between amblyopia and age (p = .10).

Prevalence of amblyopia based on study year

For analysis, studies were grouped based on data collection year – study performed after 2010 (>2010) and in or before 2010 (≤2010). Prevalence estimates of amblyopia in studies published >2010 (pooled from six studies) was 1.2% (95% CI: 0.3% – 1.2%; I^2 = 93%, p < .01) and for studies published ≤2010 (pooled from 9 studies) was 0.4% (95% CI: 0.2% – 0.6%; I^2 = 52%, p = .05). There was a significant association between prevalence of amblyopia and study year (p = .006). Figure 5(c) shows the subgroup group analysis for study year.

Prevalence of amblyopia based on amblyopia type

Subgroup analysis for type of amblyopia was performed when more than two studies reported type

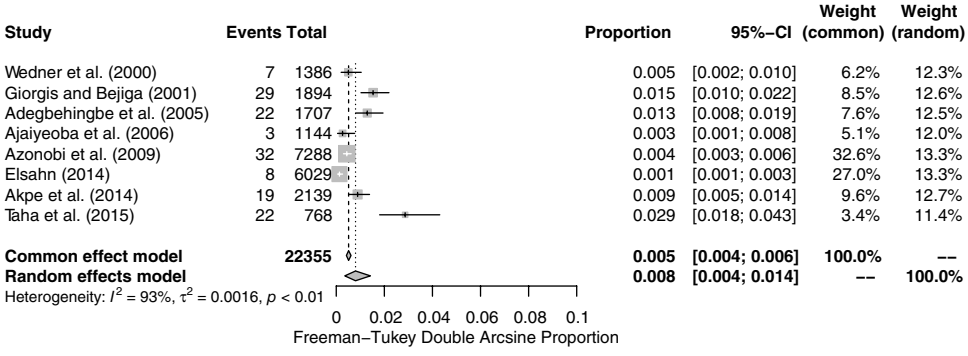

Figure 2. Forest plot of studies reporting on strabismus in Africa. Overall estimate of strabismus prevalence in Africa was calculated using a random effects model. Prevalence of strabismus in Africa was estimated to be 0.8% (95% CI: 0.4% – 1.4%).

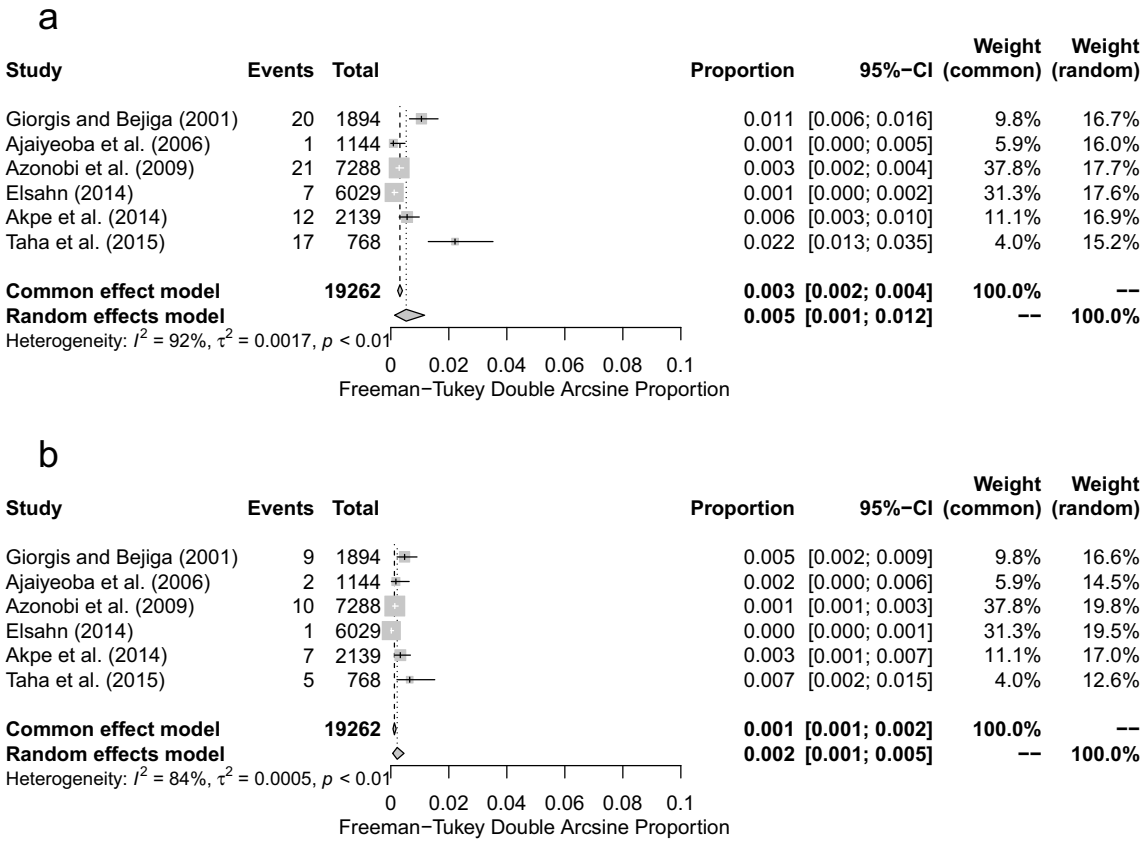

Figure 3. Forest plot of studies reporting on esotropia (a) and exotropia (b) in Africa. Estimated prevalence was calculated using a random effects model. Prevalence of esotropia and exotropia were 0.5% (95% CI: 0.1% – 1.2%) and 0.2% (95% CI: 0.1% – 0.5%), respectively.

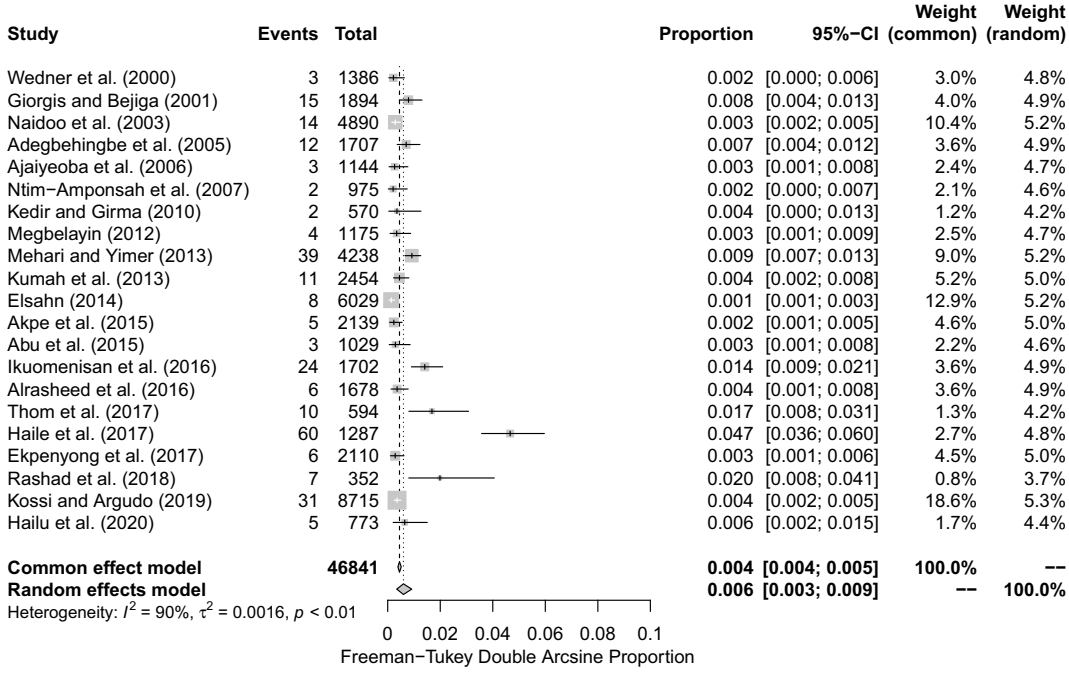

Figure 4. Forest plot of studies reporting on amblyopia in Africa. Overall estimate of amblyopia prevalence in Africa was calculated using a random effects model. Prevalence of amblyopia in Africa was estimated to be 0.6% (95% CI: 0.3% – 0.9%).

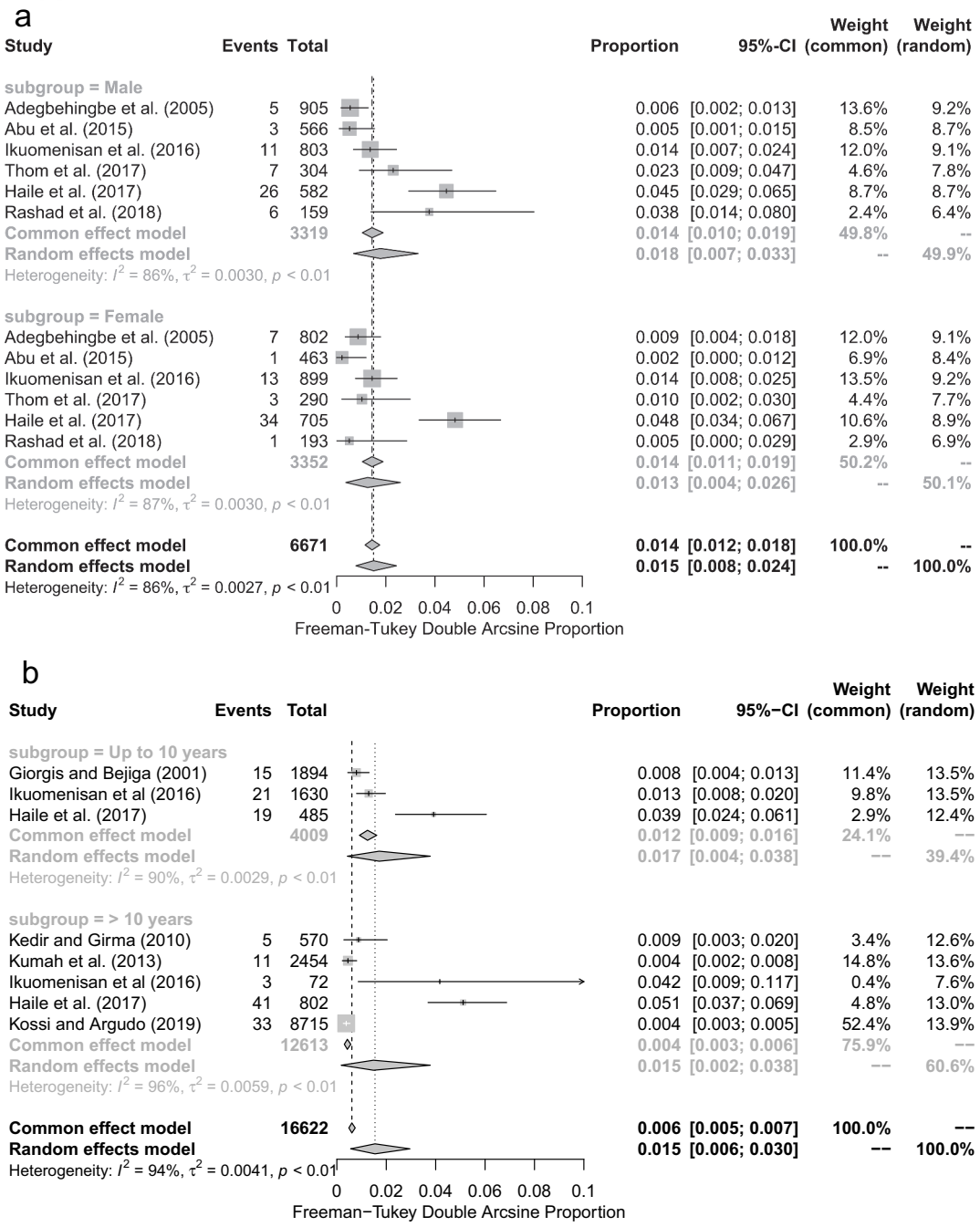

Figure 5. Prevalence of amblyopia in Africa according to gender (a) age, (b) study year, (c) and (d) type of amblyopia. The diamond marks illustrate the pooled prevalence estimates, and the width of each diamond mark represents the confidence interval of the pooled estimate.

of amblyopia. Estimated prevalence of strabismic (pooled from six studies) and refractive amblyopia (pooled from five studies) were 0.4% (95% CI: 0.2% – 0.6%; I^2 = 27%, p = .23) and 1.1% (95% CI: 0.2% – 2.5%; I^2 = 95%, p < .01), respectively (Figure 5(d)). There was a significant association between prevalence of amblyopia and type of amblyopia (p = .007).

Discussion

The current meta-analysis included eight studies (one population-based & seven school-based) on strabismus and 21 studies (3 population-based & 18 school-based) on amblyopia. The overall prevalence of strabismus was estimated to be 0.8% (95% CI: 0.4% – 1.4%); exotropia was 0.2% (95%

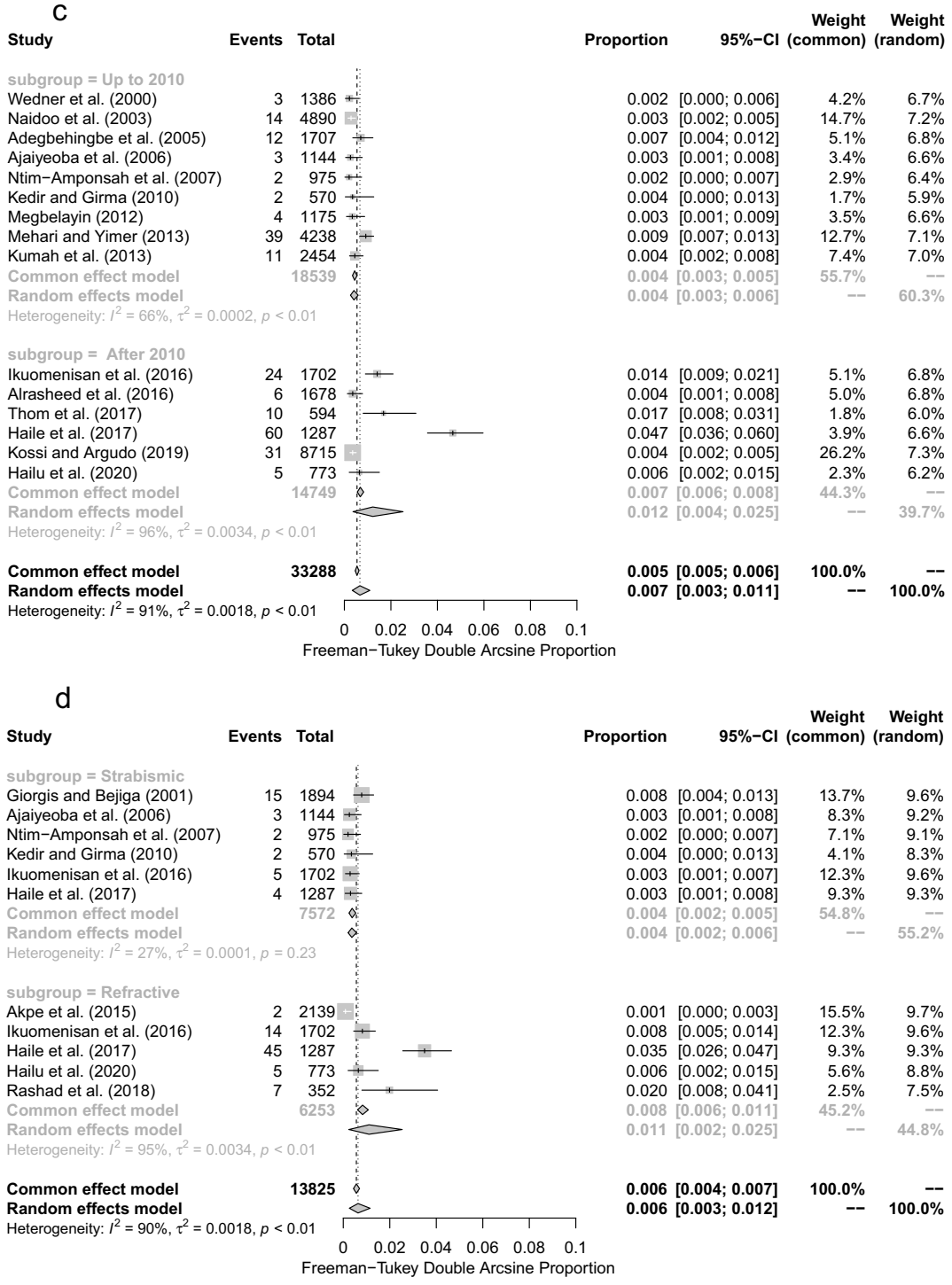

Figure 5. (Continued).

CI: 0.1% – 0.5%) and esotropia was 0.5% (95% CI: 0.1% – 1.2%). Prevalence of amblyopia was 0.6% (95% CI: 0.3% – 0.9%); refractive and strabismic amblyopia were 1.1% (95% CI: 0.2% – 2.5%) and 0.4% (95% CI: 0.2% – 0.6%), respectively. Prevalence estimate of amblyopia in males was 1.8% (95% CI: 0.7% – 3.3%) and in females was 1.3% (95% CI: 0.4% – 2.6%).

The estimated prevalence of strabismus and amblyopia in the current study is lower than prevalence estimated in other regions. Hashemi et al.[5,19] estimated the global prevalence of strabismus

and amblyopia to be 1.93% and 1.75%, respectively, and also provided estimates for the different global regions according to the World Health Organization regional grouping as follows: American Regional Office (strabismus 2.86%; amblyopia 2.77%); Eastern Mediterranean Regional Office (strabismus 1.96%; amblyopia 1.54%); European Regional Office (strabismus 2.41%; amblyopia 3.67%); Western Pacific Regional Office (strabismus 2.51%; amblyopia 1.19%); and the prevalence of amblyopia in South-East Asia Regional Office was 2.74%. Fu et al.[22] also estimated the global prevalence of amblyopia to be 1.44% with estimates in Europe, North America and Asia being 2.90%, 2.41% and 1.09%, respectively. Our current estimate of strabismus and amblyopia in Africa is comparatively lower than reported for the different regions in these global meta-analyses, but relatively higher than previously reported for Africa Regional Office (0.42% and 0.51% for strabismus and amblyopia, respectively) in the meta-analysis by Hashemi et al.[5,19] The comparatively lower prevalence estimate in the global meta-analysis could be due to the limited number of studies reviewed by the authors and the year of study considering that amblyopia prevalence has tripled since 2010 and was significantly associated with study year in the current study. For instance, in the meta-analysis by Hashemi et al., only three and six studies (all published by 2016) were included in estimating the prevalence of strabismus and amblyopia, respectively, compared to 8 (strabismus) and 21 (amblyopia) studies used in the current study. All three studies on strabismus and five out of the six studies on amblyopia included in the Hashemi et al study were included in the current meta-analysis. The current study therefore provides a relatively more representative estimate of strabismus and amblyopia prevalence in Africa. A possible reason for the comparatively lower prevalence of strabismus and amblyopia in the current study could be the inclusion of mainly school-based studies. Evidence suggests a relationship between socioeconomic status and school enrollment; enrollment is lower in groups with lower socioeconomic status compared to those with higher socioeconomic status.[59,60] Socioeconomic status has been shown to be a significant determinant of amblyopia prevalence; there is negative correlation between socioeconomic status and amblyopia prevalence.[21,61] Considering that majority of studies included in our analysis were school-based, it is plausible that these studies may have sampled individuals of relatively higher socioeconomic status and lower amblyopia prevalence and hence, the prevalence reported in these studies may reflect the prevalence of amblyopia in school-going children but not the general population. An additional reason for the low prevalence of strabismus in Africa may be the survival rate of preterm infants. The survival rate of preterm babies in developing regions is extremely low. According to the World Health Organization, more than 90% of extremely preterm babies (less than 28 weeks) born in low-income countries die within the first few days of life; yet less than 10% of extremely preterm babies die in high-income settings.[62] The lower prevalence of strabismus in our study may thus be explained by the low survival rate of preterm babies in Africa given that the prevalence of strabismus tends to be higher in preterm babies and can be as high as 42%.[63,64]

There is conflicting data on the commonest strabismus type. While some studies have reported that esotropia occurs 3–5 times as often as exotropia in children,[65] other studies also report exotropia to be more common than esotropia.[1,9,10] Although not significant, there was a higher prevalence of esotropia compared to exotropia in the current study. This is in contrast with global estimates where exotropia was the common strabismus type.[5]

In agreement with previous studies,[22,66] the current study reported no gender difference in amblyopia prevalence in Africa. No significant difference in amblyopia prevalence was found between individuals ≤10 years and those >10 years. Contrary to this, the meta-analysis by Hashemi et al.[5] reported the

prevalence of amblyopia to be higher in adults compared with children. Amblyopia occurs due to disorders in the development of the visual pathway during the critical period of neural development in childhood, but its effect lasts throughout adult lifetime. Amblyopia has a better prognosis when it is detected and treated early, with treatment more effective in children.[67] Comprehensive eye care services are lacking in most regions of Africa,[68,69] hence no effective and robust screening programs in many countries to help detect these early signs. This could result in significant undetected/undiagnosed amblyopia on the continent. Challenges within the general and eye health systems of many African countries such as low doctor-to-patient ratio, poor health care seeking behavior, lack of effective healthcare policies, and other socioeconomic factors,[70–72] means that even when the condition is detected, there are limited treatment options, and the cost involved for treatment may be a deterrent to affected individuals. Taken together, these challenges could prevent the early identification and management of strabismus and amblyopia. Accordingly, this highlights the need for and importance of comprehensive screening programs in Africa.

Amblyopia can present in different forms with distinct characteristics. Deprivation amblyopia has the greatest influence on visual acuity and other visual functions.[73] Refractive amblyopia on the other hand can be easily treated by correcting refractive errors using spectacle or contact lenses.[74,75] In the current study, refractive amblyopia was the most common type of amblyopia with a prevalence of 1.1%, with type of amblyopia being significantly associated with amblyopia prevalence in Africa. Although other studies have reported similar findings,[19,76,77] the peculiar issue of low spectacle coverage[78,79] in several African countries may be a significant contributory factor for the higher prevalence of refractive amblyopia in Africa.

A major limitation of this review is that studies were from only eight out of the 54 countries in Africa, even though effort was made to include studies from across the continent. Despite including more studies compared to previous reviews, the lack of representativeness from several African countries means the findings from this study should be interpreted with caution and highlights the need for well-conducted epidemiological studies on strabismus and amblyopia in many parts of Africa. Also, some of the studies included were not originally designed to assess prevalence of amblyopia or strabismus and as such might not have employed measures to prevent bias in reporting the prevalence. Another limitation is the lack of gender and age-specific prevalence of strabismus. There were not enough studies to pool the gender and age-specific prevalence of strabismus in Africa, highlighting the need for more studies, especially population-based studies on strabismus in Africa. Despite these limitations, the estimate from the current study still gives a good impression of the strabismus and amblyopia problem in Africa.

Conclusion

Strabismus and amblyopia are major causes of visual impairment in children and adults, and one of the main causes for public eye health concern. In adulthood, strabismus and amblyopia have an impact on lifestyle, wellbeing, and quality of life. Therefore, it is important to have information of the prevalence of strabismus and amblyopia, specifically in Africa, because the burden of strabismus and amblyopia is poorly studied in Africa contingent. Despite the comparatively low prevalence, the current systematic review and meta-analysis highlights the need for more comprehensive epidemiological studies on strabismus and amblyopia in Africa. Information from these studies can help inform policy making and design and implementation of public health intervention programs.

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