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The Prevalence and Risk Factors of Myopia among School Children in Africa: A Structured Literature Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Systematic Review Article

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ABSTRACT

Aim: This review aims to provide current evidence on the prevalence and risk factors of Myopia among school children in Africa.
Background: Myopia has emerged the most prevalent and major cause of visual distress which may result in poor academic performance among school children compared to other refractive error conditions. Whereas the importance of optimal vision for competence in academic achievement has been emphasised. Hence, the association of increase in myopia prevalence with increase in age coupled with its projected critical rise to 26.9% in Africa by 2050 is worrisome.
Methodology: This review was conducted using the population, intervention, comparison, outcome (PICO) framework guidelines and PRISMA 2020 Flow Diagram for New systematic Reviews. Also, four digital databases; MEDLINE, CINAHL, PROQUEST, WEB OF SCIENCE and a Web Search Engine (Google scholar) were searched for studies on Prevalence and Risk factors of

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myopia among school children in Africa from January 2012 to March 2023. Studies were appraised for quality using Joanna Briggs Appraisal tool for prevalence studies. Data were analysed based on age, gender, and risk factors of myopia, while the myopia was defined as SE ≥-0.50D.
Results: Data from 10,031 school children and 6 quality appraised studies were included in this review. Overall, the prevalence of myopia ranged from 2.7% to 16.05% among school children in Africa. The prevalence of myopia was significantly higher among the older children (10–18-year-olds), while Age at school start, Level of education, family history of myopia, working distance at near, prolonged near work per day, private school of learning, time spent on mobile exposure, and presence of ocular abnormality were significantly associated with myopia.
Conclusion: Prevalence of myopia among school children is generally low in Africa but the retrieved studies offered geographical variations with outlying higher prevalence in some regions.

Keywords: Myopia; prevalence; risk factors; school children.

1. INTRODUCTION

Based on global indices, uncorrected refractive error is one of the significant causes of visual impairments in visually related tasks [1]. Therefore, the importance of optimal vision for proficiency in learning has been emphasised [2]. On the other hand, Myopia has emerged as the most prevalent and major cause of visual distress compared to other refractive error conditions such as Hyperopia, and Astigmatism among school children [3]. Hence, the current review aims to provide data on the prevalence and risk factors of Myopia among school children in Africa.

Myopia is a term used to describe a refractive error condition that occurs when rays of light from infinity attain a focus in front of the retina on entering the eyes due to long axial length or steeply curved cornea [4,5]. Although, extant studies have offered variety of definitions to identify individuals with Myopia, spherical equivalent refractive error (SE= sphere +1/2 cylinder) ≤ -0.5D has been accepted as a criterion for identifying Myopia by cycloplegic refraction in school children [6,7].

According to You et al., (2014), under correction of Myopia is also remarkable in the development of visual impairments among children. Notwithstanding, refractive error services are said to be underutilised by majority (88.9%) of children in most African countries [9]. Although, Fricke et al., [10], suggests the inadequacy of the current global refractive services to meet the potential health needs of an estimated 703 million cases of visual impairment because of uncorrected refractive error which includes Myopia. Relatively, this implies the existence of an unmet need among 10% of the world population. Though optical correction of Myopia is helpful, in most cases, it does not reverse the accompanying biometric changes in the eye which include axial length elongation [6,11], which may progress with age, and may result in high myopia and eventual pathologic myopia [12]. Consequently, this enables a potential higher risk of vision threatening complications such as retinal detachment, myopic maculopathy, glaucoma, and Cataract [11,13]. Therefore, age of onset of Myopia is an important factor as an early onset Myopia among primary school children may result in faster Myopia progression. Hence, a future higher risk of high Myopia [6,14,15], which also equates to the onset of blindness [16]. Incidentally, the majority of individuals with Myopia were found to have had the onset during childhood [14], especially within the last two generations [17].

Furthermore, social pressure in form of teasing and discrimination against the use of spectacle for Myopia among school children results in reduction of quality of life [18], as it is accompanied with a reduction in the uptake and use of prescribed spectacles especially among the younger children and an induced low self-assessment among adolescents with High Myopia [18]. This is important as Africa has been identified as the youngest aged, populated continent of the world with the median age of 19.7 years compared to global median age of 30.4 years in 2012 [19]**.** Likewise, the association of lifestyle and environmental factors with Myopia development and progression is of great concern [20], especially with the current extensive use of mobile devices known to be one of the risk factors of myopia among children [21]. Therefore, the lowest degree of uncorrected Myopia among school children is of great importance due to the potential longer duration of the disease and its associated adverse implications [22].

2. METHODOLOGY

2.1 Rational for Undertaking This Review

Although, the prevalence of Myopia among children in most African countries is reportedly low compared to Asian countries [2,23]. There is an undeniable need for a further exploration on Myopia among school children in Africa as the projected global increase by 2050 [24], and the continuous rise in the prevalence of Myopia among school children in Africa [19,25], may eventually suppress the reportedly weak eyecare system in Africa [26]. Especially, due to its evidential link to the current trend of indiscriminate usage of games devices and phones among children [20,21,26].

Moreso, Myopia associated complications have been reported to have a huge global negative economic impact [15]**.** Illustratively, the potential global productivity loss due to complications associated with uncorrected Myopia such as visual impairments and myopic Macular degeneration in 2015 were US$ 244 Billion and US $6 Billion respectively [15]. Consequently, the observed rising prevalence of Myopia among African countries may have a greater negative economic impact on low-income African countries [27].

Although, recent reviews have provided data on the prevalence and regional trends of Myopia among children and school children in Africa [19,25]. Based on extensive literature review, there is no existing data on review of Myopia risk factors among children in Africa. Therefore, this review may provide further data on the prevalence of Myopia and the risk factors among school children, which may enable the establishment of an impactful health policy and appropriate planning of health services to curb this menace [29].

2.2 Review Research Question

Although, many frameworks exist that are used to answer research questions [28–30], Population, Intervention, Comparison, Outcome (PICO) framework has proven to be widely adopted by health professionals for asking and analyzing diverse research questions [28]. But the comparison component was omitted in this review to adapt to the diagnostic nature of the research question [31].

2.2.1 Research question

(1) What are the modifiable risk factors of Myopia among school children in Africa using school based visual screening?

(2) Are there variations in the risk factors of Myopia among school children in Africa using school based visual screening?

2.3 Study Perspective

Due to the quantitative approach of the current study, primary quantitative studies on myopia such as prevalence studies based on numeric data collation and analysis were reviewed [32]. Moreso, other aspects of the methodology used by included studies, such as study design, sampling methods, analytical tools, were appraised for quality, reliability, and generalizability to ensure rigour. Hence, establish high quality evidence [33–35]. Owing to observed inconsistencies in the screening methods of different studies during school based visual screening, the instruments used by the included studies were also appraised for validity and reliability [36,37].

2.4 Inclusion and Exclusion Criteria

2.4.1 Types of included study designs

Considerations of the available quantitative research evidence based on hierarchy of evidence, and adaptability to research question was of great importance [31,39]. Consequently, this review explored for appraisal primary quantitative studies on randomized control trials (RCTs), in addition to cross-sectional studies and longitudinal studies because of their relevance in determining prevalence and association.

2.4.2 Participants

Primary studies on school children between the ages of 6-22 years were included in this review as children have been identified as the population at risk with regards to the prevalence of Myopia [15]. Although the age of onset of Myopia has been identified to be from 7 years of age [40], there were limited data resources that had the ages of the participants ranging from 7 years old. Therefore, the age range for the current review was extended to accommodate more primary studies and children with early onset Myopia [40].

2.4.3 Intervention

This review included only primary studies that identified Myopia by using school based visual screening. This was to reduce detection bias

which could arise from using different measurement approaches [41]. Furthermore, Brooks & Fuller, (2006), are of the opinion that variations in methodology which includes measurement approach during research studies results in variations in the outcome which may introduce bias [41]. Also, interventions that were limited to African regions were included.

2.4.4 Outcome

The basic outcome of the current review was the identification of the rate of prevalence of Myopia as well as the risk factors of myopia among the study population. However, there was a gap in literature on the risk factors of Myopia among African school children [19]. Therefore, primary studies that were focused on Myopia and those with data on risk factors of Myopia were included.

2.5 Search Strategy

A comprehensive electronic search that involved several databases such as MEDLINE EBSCO (Medical Literature Analysis and Retrieval System Online), CINAHL (Cumulative Index of Nursing and Allied Health Litereature), MEDLINE PROQUEST, WEB OF SCIENCE was carried out during the current review.

Also, literature search was carried out in Google Scholar and the internet to retrieve grey literature [43,44]. While, the date of publication (within ten years), was set as a limiter to encourage the retrieval of recent studies that will inform current practice [38]. Further, only studies published in English language were included to make good use of limited time resource [31].

2.6 Data Screening

This review employed the method of single screening of title and abstract which may be comparatively less effective. But it has been identified to be an appropriate and effective method in short term review with scarce resources [45,46]. Moreso, during the screening process, the flow of information was presented in PRISMA (Preferred Reporting items for Systematic Reviews) flow chart (See Appendix 1) to avoid omissions that may result in a biased conclusion.

2.7 Data Extraction Tool

A single data extractor method which has been identified to be less resource intensive but may be more error prone was adopted in this review due to limited time frame [47]. Consequently, working on one aspect of the extraction process at a time was employed to enhance effectiveness and reduce error [48].

2.8 Quality Assessment

Studies obtained during literature search were appraised for validity and risk of bias [49]. Thereby, establishing the strengths and inherent limitations of the retrieved studies [41]. Consequently, further exclusion of poor-quality evidence was carried out at this stage based on poor research design, execution, description, and biased conclusion [50]. Although there is a wide range of appraisal tools, this study applied Joanna Briggs Institute (JBI) Prevalence Critical Appraisal tool known to be appropriate for the critical appraisal of prevalence studies such as cross sectional and Longitudinal study designs [51].

3. RESULTS

3.1 Result of Search

The applied combined search strategy retrieved 3,156 potentially relevant studies after the application of limiters. Subsequently, screening the identified studies by title, resulted in 1,461 which was further limited to 389 after the removal of studies with non-African settings (1,048) and 24 duplicates. However, further screening by abstract led to the exclusion of 379 studies which did not meet the inclusion criteria. Also, the abstract of one study (Boaitey, 2015) was inaccessible resulting in the inclusion of 9 studies for full text retrieval. Furthermore, among the included studies, one of the abstracts [52] was in English Language but the full text was retrieved in French Language. Although, request was made for the English version, due to the paucity of available data within the study context and the limited time frame available for the current study, the French version was uploaded in Google Translator for its English translation. Whereas, 9 studies were identified for quality appraisal, only 6 studies were eventually selected for review. But the remaining 3 studies were excluded as shown in the Prisma Flow Chart below (see Appendix 1).

3.1.1 Included studies

The selected studies for review are represented in Table 1.

3.1.2 Description of included studies

This study adopted a systematic process to review pooled current research evidence, and data on the prevalence and risk factors of Myopia were the research interest. But no RTC or Longitudinal study that met the inclusion criteria of the current review was identified during the comprehensive search. All the selected studies reported using cross sectional study design and employed school based visual screening method for data collection. The studies enrolled a total number of 10,031 participants with a sample size range of 349-6192 and the overall number of children with Myopia was 428. Whereas five out six of the studies [5,53–56] reported the prevalence and risk factors of Myopia, one study (Chebil et al., [52]; had report majorly on the prevalence of Myopia. All the observational studies included in the current study were conducted in Africa. Half of the studies [5,53,56], were from East Africa, two [54,55], were conducted in West Africa, while the remaining one [52] was carried out in North Africa. None of the selected studies was from southern African Region (see Table 2). The inclusion criteria for the studies were highlighted to be all school children, 6–14-years old, 6–18-years old, 8-15years old, 13-20 years old, 15–22 years of age, provision of parent signed consent form, verbal assent from children <18 years and self-written and signed consent from children >18 years of age. All the included studies for this review were peer reviewed and had all their Abstracts in English Language. However, the full text of five of them were in English Language, while the full text of one of the studies [52] was translated from French to English.

3.1.3 Socio demographic characteristics of study population

A total of 10,031 school children were participants in the included studies and they were within the age range of 6-22 years. The age groups of the children based on the reports ranged from 7-15 years to 20-22 years. About half of the included participants were females 5,047 (50.3%), while 4,984 (49.7%) were Males. Based on school type, more than half of the children 2107 (54.9%), were in public schools while 1,732 (45.1%) were in private schools. In the study [52] that reported the inclusion of children from urban and rural settings, more than half of the participants were from urban setting 4,368 (70.5%) and 1,824 (29.5%) were from the rural setting. Furthermore, more than two third of the participant in the included studies were from primary school 7,336 (76.3%) while, 2,281(23.7%) were high school students. Regarding the educational level of the parents of the participants in the included studies, 145 (3.8%) were unable to read and write, 281 (7.3%) were able to read and write, 539 (14.0%) had primary level of education, 1,676 (43.7%), had High school level of education and 1,198 (31.2%) had university/college level of education. Other demographic characteristics of the study participants were not fully reported.

3.1.4 Quality Appraisal of Included studies

All the included studies were rated high in quality at the range of 7-9 on a 10-pointer appraisal scale [51].

Furthermore, five studies (83.3%) reported the use of cycloplegic refraction, while one Belete et al., [53] reported the adoption of non-cycloplegic refraction technique that involved the carrying out of refraction test in the absence of cycloplegic eye drop. Nevertheless, the over estimation of prevalence of myopia in non-cycloplegic studies have been widely reported [15]. Moreso, cycloplegic refractive suggestively is the gold standard for refraction in children especially in studies on risk factors as it gives a better estimate of prevalence compared to non-cycloplegic refraction [57].

All studies reported the type of optical equipment used for evaluation which were validated and appropriate for use for visual assessment [58,59]. Whereas half of the studies [52,54,55] employed the use automated screening protocol that involved the use of automated refraction to identify myopia, others used manual method of screening that did not use automated equipment. Reportedly, no significant difference has been found to exist between the outcome measured with automation compared to conventional measurement [58,59]**.** Therefore, both methods are proven valid methods of assessment of visual status [58]**.** The equipment's used by the studies were: Snellen Visual Acuity chart, retro illuminated LogMAR acuity chart, retinoscope, trial case and lenses, pinhole, handheld slit lamp, Direct ophthalmoscope, Biomicroscope, Jackson cross cylinder, and Cyclopentolate eye drop.

Table 1. Included studies and publication details

Author (year)	Topic	Source information
Assem, A.S; Tegegne, M.M. and Fekadu, S,A [5].	Prevalence and Associated Factors of Myopia Among school Children in Bahir Dar City, Northwest Ethiopia	Plos One 16(3): e0248936
Atowa, U.C; Wajuihian, S.O. and Munsamy, A.F [54].	Association between Near Work, Outdoor Activity, Parental Myopia and Myopia Among School Children in Aba, Nigeria	Int. J. Ophthalmol. Vol.13(2), p.309-316
Abera, E; Kidus, G. and Mekonnem, A, [56].	Prevalence and Risk Factors Associated with Myopia Among High School Students in Hawassa City, South Ethiopia, 2019.	Clinical Optometry (Auckland), Vol.14, p.35-43
Atowa, U.C; Munsamy, A.J.and Wajuihian, S.O [55].	Prevalence and Risk Factors among School Children in Aba, Nigeria	African Vision and Eye Health. Vol. 76 (1), p.1-5
Belete, G.T; Anbesse, D.H; Tsegaye, A.T, and Hussein, M.S [53].	Prevalence and Associated Factors of Myopia Among High School Students in Gondar Town, Northwest Ethiopia, 2016	Clinical Optometry (Auckland). Vol. 9. p.11-18
Chebil, A; Jedidi, L; Chaker, N; Korf, and Largueche, L [52].	Epidemiologic study of Myopia in a population of School Children in Tunisia	Tunisie medicale. Vol.94 (3). p.216-220

Furthermore, all the studies recorded the use of questionnaire to gather sociodemographic data of the participants. Nevertheless, four except [52,53] revealed their questionnaire were pretested before use to ensure validity [51,55]. Furthermore, one study [5], applied the use of inter and intra observers especially in VA determination and refraction to enhance rigour.

Moreso, each of the studies documented the engagement of qualified optometrists, ophthalmic nurses, and other health workers in data collection. However, only three [54–56] studies recorded the training of the team before data collection. This is to reduce measurement bias and enhance the reliability of measured outcome. Nevertheless, there was no record of the type of training given by any of the studies and the duration of the training before data collection [51,60].

However, the use of validated equipment and trained personnel for data collection has been reported to enhance validity and reliability of survey result [51].

Furthermore, each of the studies except one [52] established the use of bivariant and multivariable logistic regression to determine association. This enables the limitation of the effects of confounders while actual risk factors are revealed [61,62]. All the studies reported data was analysed at 95% confidence interval ($P<0.05$) in their studies.

3.1.5 Results of individual studies on myopia prevalence

The results among the reviewed individual studies on the prevalence of myopia are summarised below.

3.1.6 Results summary on the prevalence of myopia

The prevalence of Myopia was relatively low (<10%) in two third of the studies at 2.7%, 2.7%, 3.7%, and 8.4%. Nonetheless, Assem et al., [5] and Belete et al., [53] reported comparatively higher prevalence of Myopia at 11.9% and 16,1% respectively. But half (49.3%) and more than half (64%) of the participants in both studies respectively were found to have had early school start age of 3-6 years old which reportedly causes high prevalence of Myopia in children [63]. Moreso, the highest prevalence of Myopia (16.05%) was reported by a study in Ethiopia [64], while the lowest (2.7%) was reported by a study in Nigeria [54]. Notably, there appears to be inter and intra-regional variations in the prevalence of Myopia among the studies.

Table 2. Description of included studies

Study	study location	inclusion and exclusion criteria	Study design	No of participants	level of education
Assem, et al., [5]	East Africa (Bahir Dar City, Northwest Ethiopia)	Inclusion: All school children Aged 6-18 years. Exclusion: Children with a history of recent ocular trauma and suggery	Cross sectional Study Design	601	Primary / High school
Atowa, et al., ([4]	West Africa (Aba Abia State Nigeria)	Inclusion: All school children Aged 8-15years. Provision of Consent form. Exclusion: Presence of anterior or posterior eye diseases of systemic diseases that affect vision	Cross sectional Study Design	1197	Primary / High school
Abera, and Mekonnem, [56].	East Africa (Hawassa City, Southern Ethiopia)	Inclusion: Students 13-20 years of Age Exclusion: Children with Eye conditions that obstructed refraction	Cross sectional Study Design	349	High School
Atowa, et al., [55]	West Africa (Aba Abia State Nigeria)	Inclusion: All children 8-15 years. Provision of consent form	Cross sectional Study Design	1197	Primary / High school
Belete, et al., [53]	East Africa (Gondar Town, Northwest Ethiopia)	Inclusion: 15 – 22 years of age Exclusion: Ocular trauma and infection that affected the Cornea or Crystalline Lens	Cross sectional Study Design	495	High School
Chebil, et al., [52]	North Africa (Ariana, Nebeul, Kef, Kasserine, Sfax, Gafsa, and Tata in Tunisia)	Inclusion: All Children 6-14 years of Age.	Cross sectional Study Design	6192	Primary school

Further, about 80% of the studies reported Low Myopia as the dominant degree of Myopia in their studies. In contrast, [5] identified moderate degree Myopia as the dominant degree of Myopia in their study. Arguably, the inclusion of more than 50% older aged children (14-18 years) in their study may have influenced the outcome as the degree of Myopia is known to increase with increase in age [65]. Overall, the lowest (3.1%) and highest (27.5%) proportion of High degree myopia were reported by studies in Nigeria [54,55] and Ethiopia [5] respectively.

4. DISCUSSION

The influence of various factors in the prevalence of Myopia in school children evaluated in this review were, Age, Age of school start, Level of Education, Gender, Family history of myopia, working distance at near, Total hours of close work per day, Distance to the screen, Outdoor activity, School type, mobile exposure per day, Active rest during studying, Family income, Parents level of education, urban and rural setting of schooling, ocular abnormality, Duration of schooling, and Type of illumination. However, differences exist in the type of variables evaluated among the studies, with >80% of the variables not evaluated by each of the included studies.

Basically, the prevalence of Myopia among school children is generally low (<10%) in the current review based on the reports of four of the included studies [52,54,55,64], but ranged from 2.7% -16.05% comprehensively. This relates to the findings of previous systematic review study among children in Africa [19], that documented Myopia prevalence range of 0.5% - 10.4% and 1.7% -22.6% among reviewed studies that used cycloplegic and non-cycloplegic refraction respectively. Interestingly, the highest prevalence of Myopia in the current review was identified with cycloplegic refraction known to give a more accurate estimate of refractive error prevalence compared to non-cycloplegic [57]. Attributably, children in Africa experience a comparatively lower level of exposure to most associated factors for the development of Myopia. Particularly, they experience lower level of literacy, higher school start age, lower level of urbanization etcetera [25]. Comparatively, the concerned education variables observed may be linked to the presence of underdeveloped formal education system in most African countries, as well as lack of motivation because of socioeconomic inequalities and language barrier [70].

Moreover, there was an observable variation in the prevalence rates of Myopia among the studies, which is consistent with the finding of a previous study [25]. Obviously, differences in geographical settings, cultural norms and policies play a huge role in observable inter and intra-regional variations in the prevalence of diseases which includes Myopia in epidemiological studies [71–73].

Although, the prevalence of Myopia was comparably higher for two studies from Ethiopia among others [5,53], at 11.9% and 16.1% respectively, it is still lower than the prevalence of Myopia among children in Asia [6]. This relates to the finding on Myopia prevalence among children in Australia, and Northern China at 11.9%, and 16.2% respectively [25,72]. Nevertheless, both studies reported inclusion of high proportion of children (49.3% and 64.1% respectively) with an early school start age of 3-6 years which is one of the identified risk factors of Myopia development and prevalence [74].

In the view of this, a significant association was identified between age of school start with Myopia prevalence in both studies in Ethiopia [53,64]. Evidently, 3-6 years age of school start showed higher Myopia prevalence compared to 7-10 years age of school start in the current review. But studies in Nigeria, which is the largest country by population in Africa, [75–77], and linked with the lowest prevalence of Myopia (2.7%) in this study [54,55], revealed a currently low implementation (35%) of early childhood education (3-5 years) policy in Nigeria. Comparatively, Ethiopian education system seems to vary. This is an indication for the need to review any educational policy that potentially promotes the prevalence of Myopia among children within African countries.

Subsequently, the current review suggests similarity in the observed degree of Myopia in five of the included studies except one, whereby low degree Myopia was dominantly prevalent, followed by Moderate and High Myopia respectively. This finding is consistent with the report of previous study on Myopia in Nigeria among 5-14 years old school children [9]. In contrast, one of the included studies [5], showed Moderate degree of Myopia as the predominantly prevalent at 60.8%, followed by High Myopia (27.5%) and Low degree Myopia (11.8%). However, the age distribution of the study

Table 3. The Proportionate distribution of prevalence and categories of myopia

Study	Low	Moderate	High	Prevalence
Belete et al.,[52]	67%	25.4%	6.8%	11.9%
Atowa, et al., [54]	87.7%	9.4%	3.1%	2,7%
Chebil, et al., [52]	60%	27%	12%	3.7%
Atowa, et al., [55]	NIL	NIL	NIL	2.7%
Abera, et al., [56]	64%	17.9%	16.1%	16.05 %
Assem, et al., [5]	11.8%	60.8 %	27.5%	8.4%

participants tilted towards older age range as more than half (50.1%) of the study participants belonged to the oldest age group (14-18 years). According to previous reports Myopia is known to increase with increase in age [78], with due considerations to early onset Myopia that may progress to high Myopia in adulthood [65,79]. This was shown in a 10-year population-based cohort study that evaluated the pattern of progression of Myopia in 14–16-year-olds in China, whereby an observed predominance of low Myopia at the beginning of the cohort metamorphosed to Moderate Myopia within 3 years of the cohort as the age of the participants increased [80].

Moreso, older age showed a significant association with the prevalence of Myopia among the studies [5,52,54,55], which is consistent with previous findings [81,82]. Although, it is contrary to the findings of previous systematic reviews among children in Africa [19,25]. Similarly, the prevalence of Myopia showed significant association with higher level of education compared to lower level of education [54,55]. Potentially, older age is synonymous with higher level of education which may be associated with more intense academic activities, hence, Myopia development or progression [83].

Furthermore, three of four studies that reported on impact of family history on Myopia prevalence, showed a significant association between family history of Myopia and Myopia prevalence [53,55,64]. Undoubtfully, this may reflect the impact of genetics on the development and prevalence of Myopia which agrees with the reports of several studies [84–88]. Though, Pan et al., (2012), suggests that parental Myopia may be an indicator for genetic predisposition and mutual environmental exposure. Comparatively, a study by Assem et al., [5] which reported the identification of only 14.8% of children with family history of myopia showed an insignificant association between family history of Myopia and Myopia prevalence among the study participants in Ethiopia. Notably, this may indicate a greater influence of environmental compared to genetic factors on the prevalence of Myopia in their study.

Prolonged near work and lack of outdoor activities were also significantly associated with Myopia prevalence in this study [53,55,64] while weekly outdoor sport was found to play a protective role in the development of Myopia. Comparably, this aligns with the findings from several studies [72,73,85,90]. Although, two of the studies [53,64], reported that 9-11 hours compared to <3hours in close work activity such as reading, writing, using computer, etcetera per day was associated with Myopia prevalence in their study population, Atowa et al., [54], identified longer duration in reading activity only as a risk factor for Myopia among the participants. The observed prolonged near work as a risk factor for Myopia is consistent with the finding of a study that employed objective method of evaluation of near work known to be potentially more reliable than subjective method [91,92].

Private school of learning also showed an inconsistent conclusion as only one study [53] out of three reported a significant association between school type and Myopia. Although in one of the studies [55], a positive association between private school learning and Myopia was observed during bivariant analysis, it was no longer the case after adjusting for age during multivariant analysis. Likewise, a study by Assem et al., [5], did not find any significant relationship between type of school of learning and Myopia. This relates to the report of a previous study that did not find an association between Myopia prevalence and academic setting [25]. Furthermore, the presence of Ocular abnormality was revealed to be a risk factor for the prevalence of Myopia [53], and this relates to a previous finding that linked presence of ocular abnormality in children to development of high Myopia in adulthood [93].

Finally, two out of four studies [53,64], reported a significant association between the prevalence of Myopia and VDU usage compared to non-usage among the participating children. Subsequently, two [5,55], evaluated the impact of duration of mobile exposures on prevalence of Myopia among the children. Whereas, VDU exposure of > 2 hours per day was significantly associated with Myopia prevalence in one study [5], the duration of mobile exposure was not found to be associated with Myopia prevalence in the other [55]. Although, Assem et al., [5], reported collecting data from the parents of participants, there was no clear report on data collection in the later study [55], which may have been a source of bias. Besides, the predominance of Low degree Myopia (87.7%) in the later study, is noteworthy.

Notwithstanding, VDU usage showed a significant association with the development and progression of Myopia in children among previous studies [20,21,69]. Lanca & Saw, [63]), suggests Lanca & Saw, [94]), suggests a current inconsistency in the available reports on the influence of mobile exposure on Myopia prevalence in children, which may have resulted from the subjectiveness of adopted evaluation techniques. Hence, recommends application of objective methods for more consistent results. Reportedly, variations in the method of data collection among epidemiological studies have been linked to differences in the reported outcome obtained from such studies [42].

Notably, the presence of regional variation in the identified risk factors of Myopia among the participants was not defined. This could be due to paucity of data and heterogeneity of evaluated variables among the studies. Nevertheless**,** among four variables (Age, family history of myopia, Total hours of close work per/day and outdoor Activity) that were uniformly evaluated by three to five studies in the review, no regional variation was also evidenced.

Although, Chiang et al., [95], suggest the existence of ethnic and racial disparity in the risk factors of Myopia, the ethnic and racial uniformity among the study population in this review may have engendered the observed absence of variation.

5. METHODOLOGICAL LIMITATION OF INCLUDED STUDIES

Although, the included studies were rated high quality, there was observed Heterogeneity among various aspects of the studies such as, the sample size, evaluation technique employed, age range of included participants, analytical methods used and level of education of included participants. According to Lin et al., [96]), heterogeneity has an implication in the reliability of synthesised results during meta-analysis as the appropriate combination of collected studies may be impacted. Also, the use of non-cycloplegic refraction in one of the included studies may have introduced measurement bias and reliability of the findings. Bias has been known to impact on the reliability and validity of research evidence which may have a negative implication for practice [68]. Report of each included study showed the use of validated equipment and assessment procedures for data collection. But there was no clear report on the source of the participants sociodemographic data during the study, for three of the studies [52,54,55]**,** which may be a source of information (measurement) bias [51].

6. STRENGTHS AND LIMITATION OF CURRENT REVIEW

The current review was rigorously conducted in a systematic manner involving a comprehensive search of literature. All selected databases were methodically searched with keywords, using PICO framework as a guide. Also, studies reviewed in this research were current studies (2016-2022), hence, will prove current evidence to update existing database. Further only studies that used SE – 0.50D as the definition of myopia were included. Suggestively, comparison of study results from different geographical settings proves difficult if there is a disparity in the definition of Myopia or other refractive errors [2]. The study had a clear aim and research question, while the inclusion and exclusion criteria were clearly defined. Notably, five (83.3%) of the studies in this review adopted the use of cycloplegic refraction known to give a better estimate of myopia in epidemiological studies [57]. All visual assessments were school based to maintain uniformity of methodology [42].

7. LIMITATIONS OF CURRENT REVIEW

The selection of identified databases for literature search in the current review may have limited the search as there may be some unidentified databases with possible relevant literature for this study. Also, due to the limited time frame for this study, some new research evidence relevant for this study may have been published after the literature search phase (March 14th-April 5th).

Although, there were definite attempts to eliminate bias in this study, single extraction method of data extraction known to generate more errors than double-extraction method engaged in this review due to the thesis nature may have made this study prune to report bias [47,97].

Due to paucity of data, there was no data found for southern Africa for this review, therefore comparison on inter regional variations of risk factors of myopia among school children in Africa could not be established.

Finally, the heterogeneity of the variables in the included studies, limited the establishment of robust evidence on the influence of some of the scarcely evaluated variables on myopia prevalence such as presence of ocular abnormality, level of education, and Age of start of school.

8. IMPLICATION FOR FUTURE RESEARCH

Regarding the attributes of cross-sectional studies included in this review based on hierarchy of evidence [98]**,** a further review may be required on this topic using Randomised control Trials in the future. Also, to establish clarity on the role of the scarcely evaluated variables, there is need to pool greater number of research studies for future review.

9. IMPLICATION TO POLICY MAKER

Social determinants play a notable role in the development of diseases and its prevalence. The review emphasised the modifiable lifestyle and environmental risk factors of myopia as use of VDU's, duration of near work activity per day, and outdoor activity. Suggestively, there is need to incorporate the identified social determinants of health into policies and health programs concerning children to reduce health inequality among school children. While policy for school based visual screening on enrolment should be established for early identification of children with Myopia.

10. IMPLICATION FOR PRACTICE

Based on the finding of this review, myopia shows a higher prevalence among the older children 10-18 years of age and children in higher school of learning. Hence, health programs would be more impactful if they target these population of children. While, shortened reviewed period may be required.

11. COMPARISON OF FINDINGS WITH CURRENT EVIDENCE BASE

Recent systematic studies and meta-analysis among children (≤18 years and school 5-18 years old respectively) in Africa, by Kobia-Acquah et al., [25] and Ovenseri-Ogbomo et al., [19], reported an overall Myopia prevalence rate of 4.7% in their studies with the prevalence rate ranging from 0.4% - 36.9% and 0.5% - 22.6% among the reviewed studies respectively. In addition, Ovenseri-Ogbomo et al., [19], documented that Myopia showed >10% prevalence among 5 studies in their review and geographical variation was observed. This is consistent with the finding of the current review. Though descriptive, Myopia prevalence was generally low but ranged from 2.7% - 16.05%, with higher outliers (>10%) observed in two studies. Moreso, geographical variation in the prevalence was evident.

According to the previous evidence, age was not significantly associated with Myopia. But older age was associated with Myopia in the current review. Furthermore, Kobia-Acquah et al., [25], did not find any association between type of school and Myopia prevalence which is consistent with the report of the current review. Nonetheless, none of the previous studies provided evidence on the risk factors of myopia [19,25] which was evaluated in the current review.

12. CONCLUSION

Generally, the prevalence of Myopia was observably low amongst the study population, but higher prevalence existed in individual studies within regions where the enabling environmental factors were potentially in place as seen in two of the studies [5,53], which is consistent with a recent systematic review on prevalence of Myopia among school children in Africa [19]. Also, this review shows that the prevalence of Myopia among school children in Africa exhibits, inter and intra geographical variation known to be related to the presence of cultural, geographical, and genetic differences among and within regions [72,99], In addition, this review highlighted Age, Age of start of school, Level of education, family history of Myopia, working distance at near, prolonged near work per day, private school of learning,

time spent on mobile exposure, and presence of ocular abnormality as the risk factors of Myopia among school children in Africa**.**

Obviously, the identified risk factors of Myopia in this review are comparable to the identified risk factors of Myopia in other regions of the world. This could relate to the observed increasing rate of urbanisation in Africa with its covert and overt influences on school children [25]. In as much as Myopia development has been associated with genetic factors, its progression has been revealed to be mostly environmental, with genetic factors playing a minimal role [100].

Consequently, the pattern of Myopia development and progression among African children is gradually becoming indistinguishable from those of other non-African regions with established reference to higher prevalence of Myopia [72]. Therefore, inappropriate adoption of westernization among African children is of great concern [15]. Emphatically, use of VDU's > 2hours per day, prolonged duration of near work activity per day, and lack of outdoor activity were the identified modifiable risk factors of Myopia in this review. Hence, considering the peculiarity of the population, the role of environment should be the target for establishing modification policies to eradicate myopia among school children.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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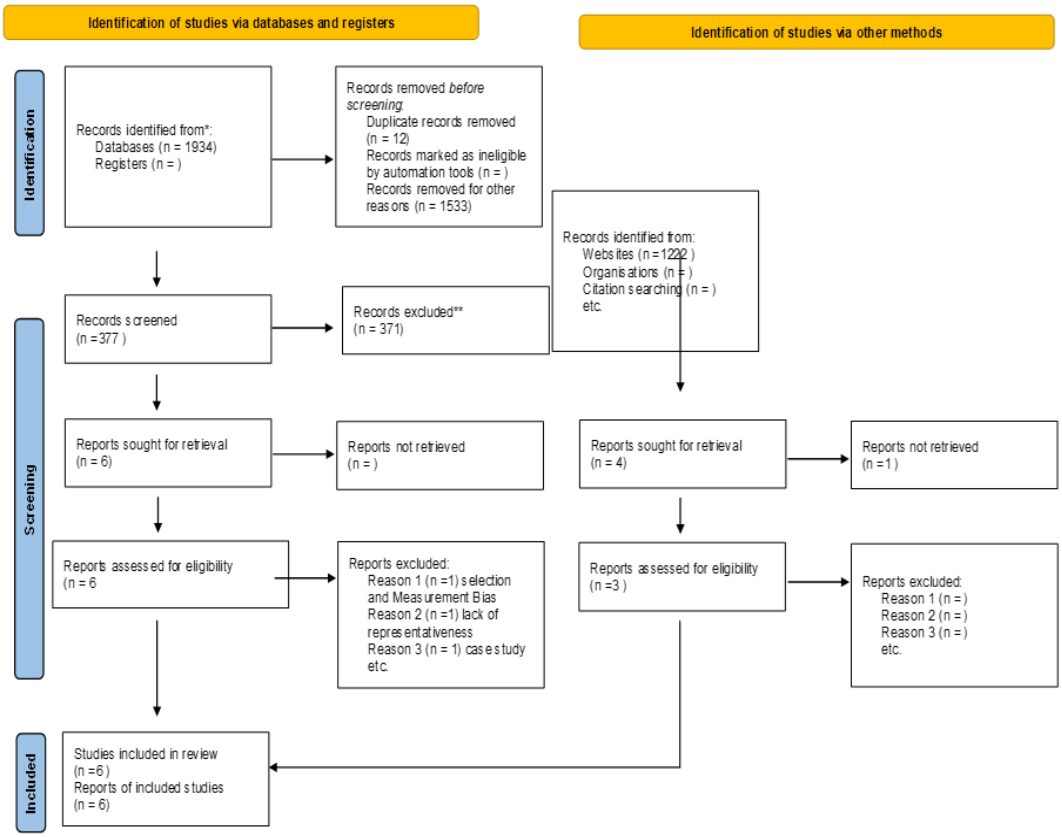
APPENDIX

Appendix 1. Prisma 2020 flow diagram for new systematic reviews showing number of included studies



Adopted from Sohrabi et al., [101]

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