SCHOOL VISION SCREENING PROGRAMS IN REDUCING CHILDREN WITH UNCORRECTED REFRACTIVE ERROR IN LOW AND MIDDLE-INCOME COUNTRIES (LMIC) (SYSTEMATIC REVIEW)

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(OPRABR001)

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ACKNOWLEDGMENT

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I will also like to say a big thank you to all the authors of the various studies I cited in this thesis write-up.

Definitions of terms

Compliance	Adherence to a recommended treatment course
Effectiveness	The extent to which something is successful in producing the desired result
Screening	A method used to identify the presence of conditions among individuals with no signs or symptoms
Spectacles	Optical devices used in ophthalmology to correct certain eye defects

List of abbreviations

LMIC	Low and middle-income countries
RCTs	Randomized control trials
Non-RCTs	Non-randomized control trials
PROSPERO	Prospective register of systematic reviews protocols
GRADE	Grading of Recommendations Assessment, Development and Evaluation
PRISMA	Preferred reporting item for systematic review and Meta-analysis
WHO	World Health Organization
ALK	Automated lamellar keratoplasty
LASIK	Laser-assisted in situ keratomileusis

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SYNOPSIS

This Master of Public Health (MPH) mini-dissertation undertakes a systematic review to assess the effectiveness of school vision screening programs in reducing children with uncorrected refractive error in low and middle-income countries (LMIC)

This dissertation is in three parts;

Part A is a research protocol which highlights the processes guiding the conduct of this systematic review and provide background information on both the condition (refractive error) and health intervention (school vision screening program) being investigated.

Part B is a review of current literature on refractive error and school vision screening programs and highlights why the need on assessing the effectiveness of school screening programs in reducing children with uncorrected refractive error in LMIC is deemed necessary.

Part C presents the entire research in a format that is suitable for publication in the PLOS ONE journal.

PART A: PROTOCOL

Part A: protocol

1.0 Background

Population-based studies from different countries across the world have shown refractive error to be a major cause of visual impairment especially among children of school-going age (1-4). An increase in the number of children living with the condition in recent times has also been reported in a number of studies conducted among school children in Asia and other LMIC (4-7). Uncorrected refractive error has therefore been declared an issue of public health concern by the WHO (8). In eyes with uncorrected refractive error, parallel rays of light from a distant object are focussed either in front or behind the retina with accommodation fully relaxed (9). This leads to blurry visions in those affected.

Due to the negative impact of uncorrected refractive error on the academic performance and overall quality of life of children affected, early detection and correction of the condition have been given top priority under the World Health Organization's (WHO) vision 2020 initiative. Central to the various intervention programs suggested by the WHO to help deal with the condition is school vision screening. This involves the use of a simple visual acuity test to identify school children suffering from the condition and providing them with appropriate spectacle or contact lens correction (10).

School vision screening programmes are relatively common in high income countries in Europe and America compared to Low and Middle-income countries in Africa and Asia (11). Few countries in LMIC settings have introduced school vision screening programs into their health care delivery system. Various factors have been cited for the lack of stakeholder's commitment towards the introduction of the program in LMIC. These include inadequate infrastructure, lack of funding, a limited number of eye care professionals and lack of evidence to show whether the program is effective in reducing the number of children with uncorrected refractive error in the long term (12, 13).

Considering the fact that the prevalence of uncorrected refractive error among school children in LMIC is on the rise and school vision screening programs are currently being advocated for to help deal with the situation, a systematic review that examines all available studies assessing the effectiveness of the program with the aim of appropriately informing the introduction of future programs is deemed necessary and is the is focus of this thesis.

2.0 Objective

1. Evaluate the effectiveness of school vision screening programs in LMIC to reduce the proportion of children with uncorrected refractive error.

3.0 Methods

This protocol has been registered with the International prospective register of systematic reviews (PROSPERO) with registration number CRD42018089631. The protocol also follows the preferred reporting item for systematic review and meta-analysis (PRISMA) guidelines (14) as shown in **appendix 5.4**

3.1 Criteria for considering studies for this systematic review

3.1.1 Types of Studies

- RCTs, cross-sectional studies, case-control studies, and cohort studies

3.1.2 Type of Participants

Children who have undergone vision screening as part of school vision screening programs in the LMIC setting and found to have a refractive error. Participants with other ocular pathologies accounting for poor vision will be excluded from this systematic review.

3.1.3 Types of outcome measure

Primary Outcome

The proportion of children with uncorrected or sub-optimally corrected refractive error.

Secondary outcomes

- Long term effect of school screening programs on the academic performance of participants
- The adverse effect of school vision screening programs (i.e. anxiety from interviews, misdiagnosis, symptoms associated with the use of prescribed spectacles, etc.)
- Cost-effectiveness of school vision screening programs.
- Influence of school vision screening programs on compliance with spectacle wearing.

3.2 Search methods

3.2.1 Identification of studies

To identify studies suitable for this systematic review, a comprehensive and systematic search strategy will be employed. A search of eligible articles will be performed using keywords, truncated terms, the Boolean operator and Medical Subject Heading (MESH) terms. Search will be restricted to articles published between 1980 and 2018 and search for articles will be done from January to June August 2018. The following electronic database will be searched PubMed, Cochrane Central Register of controlled trials (CENTRAL) which contains the Cochrane Eyes and vision Trial Register, the Cochrane Library, Medline (1980- 2018), CINAHL, Academic Search Premier, Web of Science, the WHO's Library Information System, Africa-Wide and Scopus. Combined search of MESH terms, titles and abstract will be used for each step of the search. Search will be restricted only to articles written in English. Since this systematic review seeks to summarize evidence on the effectiveness of school vision screening programs to reduce the proportion of children with uncorrected refractive error, studies involving vision screening programs that targeted subgroup population such as children with specific ocular pathologies other than a refractive error (e.g. congenital glaucoma, congenital cataract, etc.) will be excluded.

Filters will also be used during the search for articles to ensure that only studies in LMIC are included in this systematic review. Countries names and regional names will be used in the electronic search. This is to ensure that both country-specific records and records indexed by a regional term such as 'West Africa' are included in this systematic review. In instances where a country has English and local name, both names will be used to increase the sensitivity of the electronic search in identifying all the relevant articles for the review. Efforts will be made to identify unpublished studies, government reports, theses, dissertation and conference papers by searching google (including google scholar) and WorldCat. Additionally, the reference list of all the included studies will also be searched for any articles that may have been missed during the initial search. A detailed description of the search strategies used is included in **appendix 5.1**

3.3 Data collection and analysis

3.3.1 Selection of Studies

Selection of studies to be included in this systematic review will go through three phases involving two independent reviewers. In the first phase, two reviewers will check the electronic search result and select all studies that made reference to refractive error, myopia, hyperopia, astigmatism, and vision screening. Any identified article that is found to be clearly irrelevant at first glance will be excluded. In the second phase of the selection process, two independent reviewers will screen the titles and abstracts of studies identified to be relevant in the first phase to determine their eligibility for inclusion in this systematic review. The full text will be obtained for studies that have no abstract. In the third and final phase of the selection process, the two independent reviewers will perform a full-text review of all articles whose abstracts were found to be relevant in the second phase. A full-text review will also be done for articles whose abstract failed to provide a clear description of the study.

Using the study's inclusion and exclusion criteria, the two reviewers will finally select the studies to be included in the systematic review. In instances where the two reviewers are unable to determine whether a study is eligible for inclusion, an arbitrator who is an expert in the field will be consulted.

3.3.2 Data extraction and management

Data from the selected studies will be extracted using a standardized Cochrane collaboration data extraction form that will be modified to suit this systematic review. **(Attached as Appendix 5.2)**. Initial piloting of the data extraction form will be done to ensure uniformity among the two independent reviewers. Wherever possible, reviewers will extract information on study participants including their age, sex, school grade and the number of participants. An epidemiologic measure of the frequency and/or indicators of the severity of refractive error will also be extracted. Additionally, any data deemed to be an appropriate indicator of the effectiveness of school vision screening program such as the number of people who have benefited from spectacle correction of their refractive error, etc. will also be extracted.

3.3.3 Assessment of risk of bias in included studies

Assessment of risk of bias for cross-section and prevalence studies will be done using the Hoy criteria tool **(attached as appendix 5.3a).** For RCTs investigating the effectiveness of school vision screening programs in reducing the proportion of school children with uncorrected refractive error, risk of bias will be assessed using the Cochrane Effective Practice and Organization of Care (EPOC) tool **(Attached as appendix 5.3b)**. Risk of bias for cohort studies will be assessed using the Cochrane risk of bias tool for cohort studies. Where and when deemed necessary, the funnel plot will be used to check for publication bias across the studies included in this review.

3.3.4 Subgroup analysis

When and where appropriate, subgroup analysis will be done to determine the effect of the definition used as an indication of spectacle compliance on the pooled spectacle compliance.

3.3.5 Dealing with missing data

In instances where data is found to be missing in the studies included in this systematic review, efforts will be made to retrieve them by contacting the corresponding authors either through emails or contact details provided at the time of publication. In cases where missing data of studies cannot be retrieved because authors no longer have access to them or authors could not be contacted, such studies will be excluded from this systematic review and their impact on the review will be appropriately reported.

3.3.6 Heterogeneity assessment

Studies included in this systematic review will be check for heterogeneity by examining their characteristics (study design, population, setting, etc.). The Cochran's Q-test and the Higgins Chi-square test for heterogeneity will be used to statistically explore any heterogeneity among the included studies. In addition, the confidence interval of the various studies will also be examined for any overlap using the forest plot where necessary.

3.3.7 Data synthesis and analysis

Analysis of quantitative data will be done using RevMan 5.3 software. In instances where data from included studies are dichotomous, risk difference and proportion will be used as the measure of effect and in all instances, the 95% confidence interval will be presented. For studies with continuous data, the weighted mean with their corresponding 95% confidence interval will be used as the measure of effect. Additionally, the STATA 14 statistical package will be used to obtain estimates of the proportion of children with an uncorrected refractive error where necessary. In cases where statistical analysis of data is not possible, a narrative technique will be employed in presenting the result. A subgroup analysis will be done where deemed necessary to examine the impact of the definition used as an indication of spectacle compliance on the overall estimate of spectacle compliance. Cluster RCTs will be analyzed according to the guidelines in Chapter 16 of the Cochrane Handbook for Systematic Reviews of Interventions.

3.3.8 Grading the quality of evidence

The quality of the evidence presented in this systematic review will be assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. Based on the level of confidence we have in the outcome, we will consider the methodological quality of included studies and strength of evidence and adapt the basic principles of the GRADE approach (15).

3.3.9 Reporting

The findings of this systematic review will be published is a recognizable peer-review journal

3.4 Ethics

Since this review will make use of secondary data which will be extracted from published studies, there will be no need to obtain ethical approval. A waiver for ethical clearance will, however, be sought from the Health Science Research Committee at the University of Cape Town in South Africa.

3.5 Conflict of Interest

None declared

3.6 Funding Source

No external funding is available for this systematic review

PART B: LITERATURE REVIEW

Part B: Literature review

1.0 Refractive Error

Refractive error is a relatively common defect of the eye in which rays of light from a distant object are focused either in front or behind the retina of the eye with accommodation fully relaxed (16, 17). There are three main types of refractive error which affect people of all ages, sex, and race. These include myopia, hyperopia, and astigmatism.

1.1 Myopia

Myopia is a type of refractive error in which rays of light from a distant object are focused in front of the retina of the eye with accommodation fully relaxed.

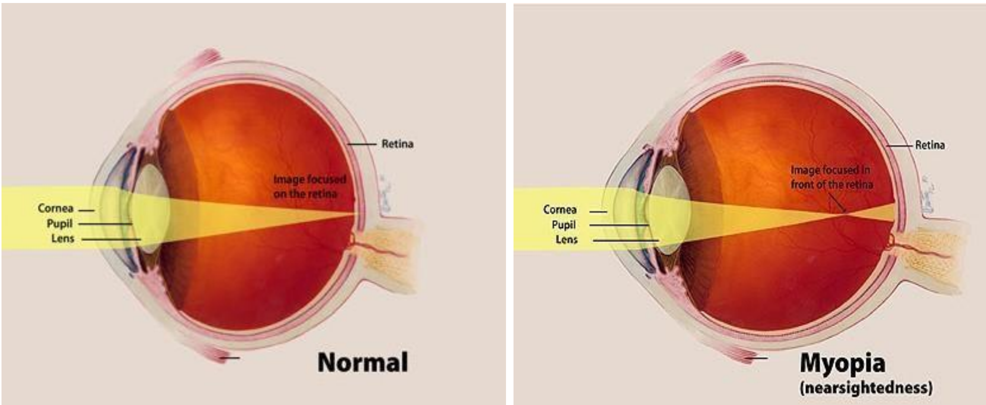


Figure 1: Focus of image in front of the retina in myopia (source: National Eye Institute)

Several risk factors predispose a person to the development of myopia. This includes heredity, education and near work (18-20). Among these, environmental factors have been shown in a number of studies to be a predominant determinant of the current pattern of the condition (20-22). Myopia is a common cause of vision loss, with its progression being a major risk factor for sight-threatening eye conditions like retinal detachment (23).

Myopia development has also been associated with certain environmental and school related factors such as reading, writing, and visual work when using a computer (20-22). Encouraging Outdoor activities that require less close work is currently believed by many researches to be effective in reducing the prevalence of myopia and it progression

1.2 Hyperopia

In hyperopia, parallel rays of light from optical infinity are refracted to a focus behind the retina.

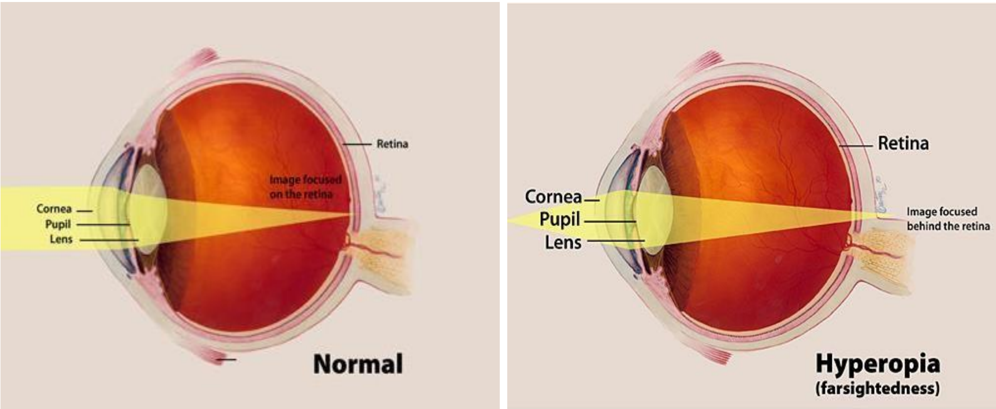


Figure 2: Focus of image behind the retina in hyperopia (source: National Eye Institute)

Heredity is considered to be an important risk factor for hyperopia. Various congenital abnormalities such as Leber's congenital amaurosis, Down syndrome and Aarskog-Scott syndrome have also been reported to affect the process of emmetropization grossly leading to the development of the condition (24, 25). Compared to other refractive errors, hyperopia is associated with greater symptoms of discomforts such as headaches, tearing eyes, decreased binocularity and eyestrain (26). Vision loss from hyperopia usually results from the development of one of the complications of the condition such as amblyopia and is more common among children with high degrees of hyperopia during infancy (12).

1.3 Astigmatism

In the case of astigmatism, rays of light coming from a distant object are refracted to multiple or a line focus instead of a point focus by the eye's optical system (27, 28).

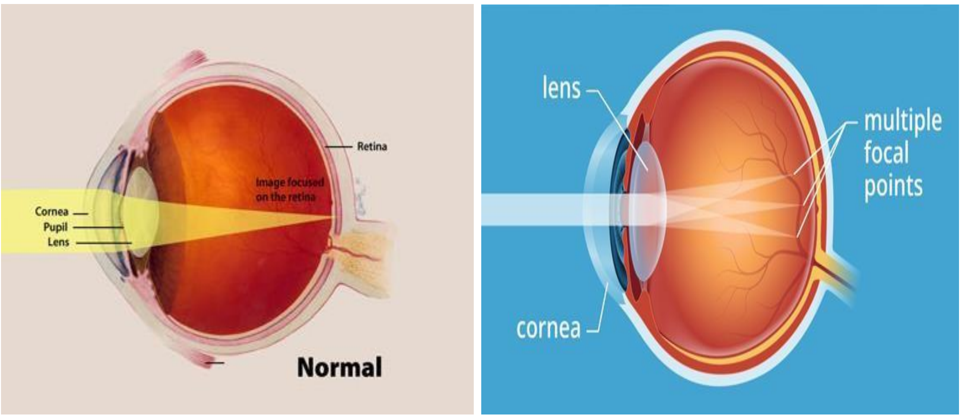


Figure 3: Multiple or line focus instead of a point focus of the image in astigmatism (source: National Eye Institute)

There are several factors in the school health environment that can contribute to the development of astigmatism. Prominent among these include dusty environment leading to constant rubbing of the eyes and exposure to ultra violet radiation from outdoor activities (27-28). Promotion of behaviors such as regular hand washing and reduced exposure to the sun have been shown in some studies to reduce the incidence of the condition (28)

The condition which usually presents together with other refractive errors results from an imperfect shape of the cornea or the lens of the eye. The symptoms of astigmatism tend to be common to that of other refractive errors though can be more severe in certain age groups such as school-age children where demand for close work like reading and writing is high.

2.0 Treatment

Correction of refractive errors is provided in different forms depending on the type of defect, the age of the person and the requirements in terms of work or activity performed (29). Management ranges from less complicated methods such as the use of corrective glasses and contact lenses to more complicated methods like refractive surgery. If detected and corrected in time and by eye-care professionals, a refractive error can be prevented from leading to sight-threatening eye conditions like amblyopia (29). Recent advancement in technology has led to an increase in the available treatment options for the various types of refractive error (30).

2.1 Available Treatment Options for Myopia

The aim of correcting myopia is to achieve clear binocular vision without compromising on patients' comfort. Available treatment options to achieve this include the use of optical corrections (spectacles and contact lens), use of medication (Pharmaceutical), refractive surgery and Orthokeratology.

2.1.1 Optical Correction

Optical correction of myopia involves the use of either concave spectacles or contact lenses to reduce the refractive power of the eye's optical system (30).

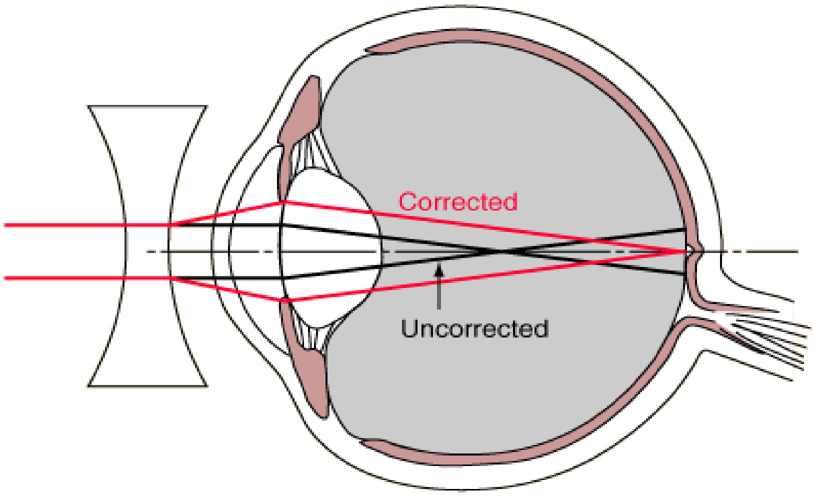


Figure 4: Correction of myopia with concave spectacle lens (source: www.iblindness.org)

The choice of either spectacles or contact lens for the correction of the condition depends on a number of factors. These include the age of the patient, the outcome of the clinical assessment of the patient's cornea, patient's motivation, anticipated compliance with prescribed spectacle or contact lens and patient's economic status. Comparatively, spectacles remain the most popular form of optical correction of the condition according to a number of studies (31). Despite the widespread use of spectacles for the correction of myopia, a number of studies have found it to be associated with an increase in the axial length of the eye resulting in myopia progression (32, 33). This association between spectacle correction and myopia progression has also been reported to be relatively higher in children corrected with single vision spectacle (32, 34, 35). A common treatment strategy currently being advocated to help deal with the issue of myopia progression among children corrected with single vision lenses is under-correction of the myopic error (36).

2.1.2 Refractive surgery

Several surgical methods are available for the correction of myopic refractive error but the two main procedures currently used in the treatment of the condition are Excimer laser photorefractive keratectomy and laser-assisted in situ keratomileuses (37). Excimer laser photorefractive keratectomy involves the use of a laser to abrade the central part of the cornea, reducing its power in the process.

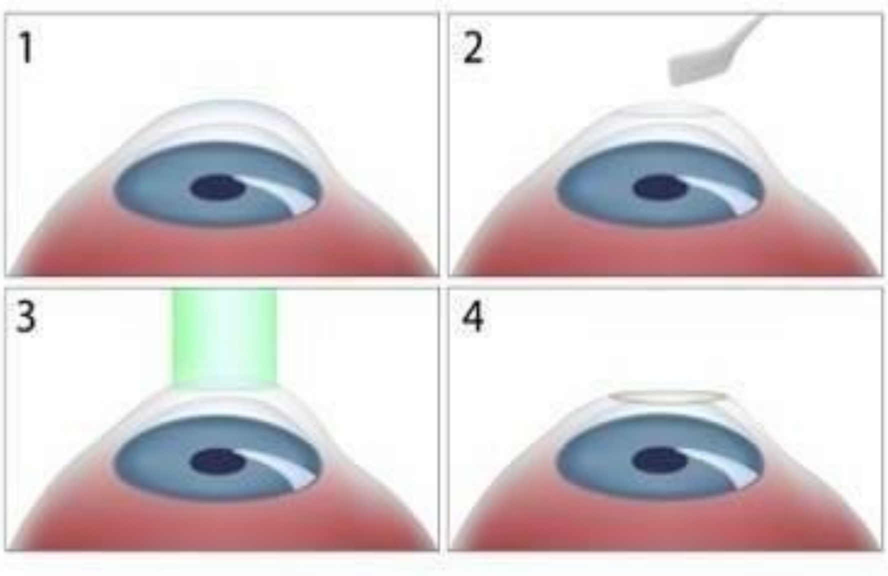


Figure 5: Excimer laser photorefractive keratectomy procedure for the correction of myopia (source: www.practo.com/health)

The procedure based on the result of several studies has a relatively high visual outcome with most studies reporting between 48-92% of patients achieving 6/6 unaided visual acuity (38-40).

In laser-assisted in situ keratomileuses (LASIK) refractive surgery, a modified microkeratome is used to create a central corneal flap followed by the use of an ArF excimer laser to produce a 3mm diameter ablation on the central part of the exposed stromal bed (41).

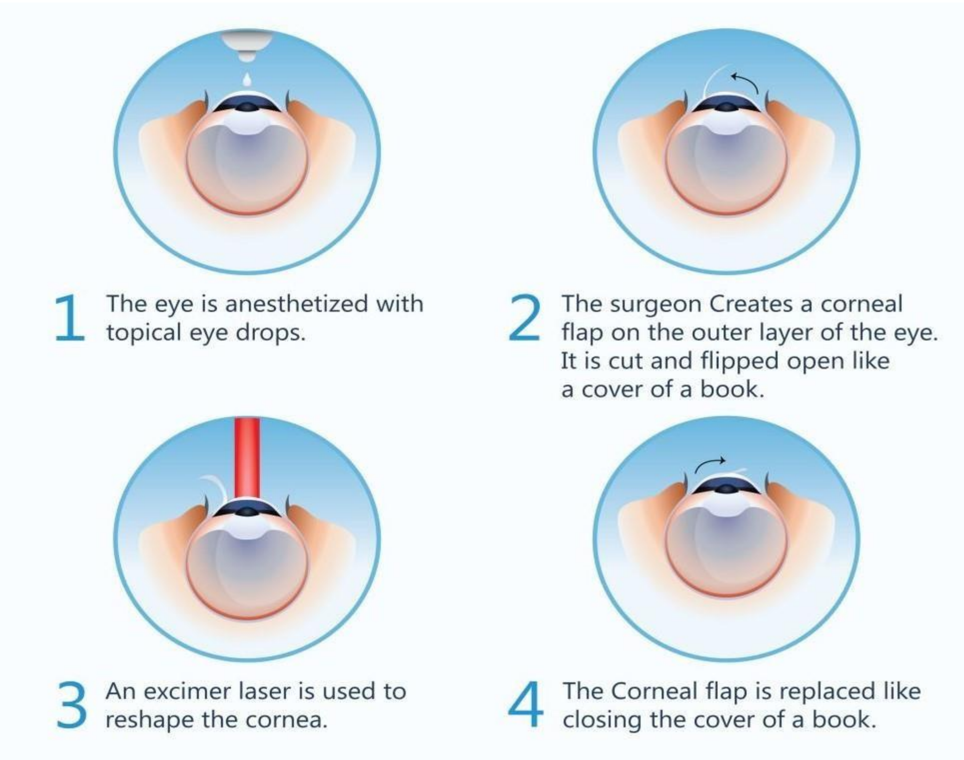


Figure 6: Lasik surgical procedure for the correction of myopia (source: www.iblindness.org)

LASIK has been reported to be an acceptable refractive surgical technique for the correction of refractive error with effective outcomes (42-44)

2.1.3 Medical (Pharmaceutical)

Medical treatment of myopia involves the use of cycloplegic agents such as atropine to inactivate the ciliary muscle of the eye, reducing the refractive power of the lens in the process. Despite a number of published studies reporting a reduction in the progression of myopia among children treated with a daily topical administration of atropine and cyclopentolate, other studies have associated this treatment option with other vision-related adverse effects, allergic reactions and systemic toxicity (45, 46).

2.1.4 Orthokeratology

This method of myopia treatment involves the programmed fitting of a series of contact lenses over a period to flatten the cornea of the eye and reduce its refractive power. The suitability of this treatment option depends to a large extent on the degree of myopia and the shape or integrity of the cornea of patients undergoing the procedure. Corneas with greater peripheral flattening are thought more likely to have successful central flattening, thus leading to reduced myopia via orthokeratology (47). Orthokeratology has also been shown to be more effective in adults compared to children (48).

2.2 Available Treatment Options for Hyperopia

Like in the case of myopia, correction of hyperopia is aimed at achieving clear binocular vision without compromising on patients' comfort. Numerous treatment option exists for hyperopia correction.

2.2.1 Optical Correction

Among the numerous treatment options for hyperopia correction, optical correction with convex spectacle lens or contact lens is the most widely accepted and commonly used in the management of the condition by most clinicians. These lenses work by increasing the degree to which light from either a distance or near objects is bent as they go through the eye, shifting its focus from behind the retina unto the retina.

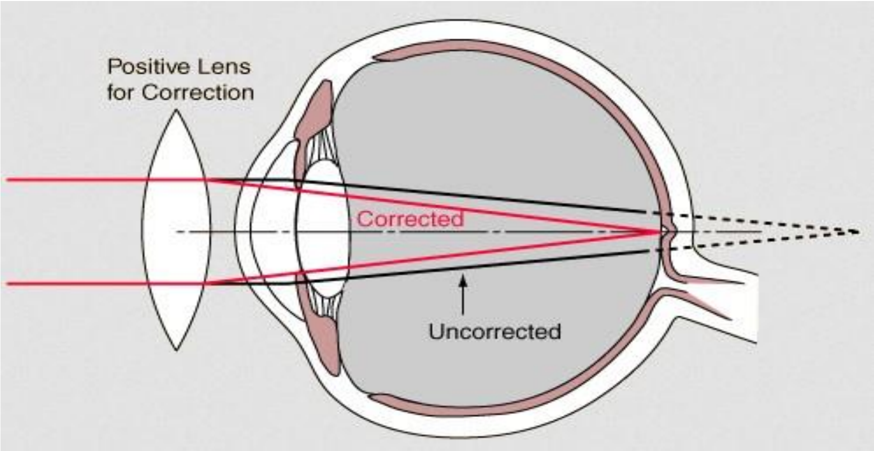
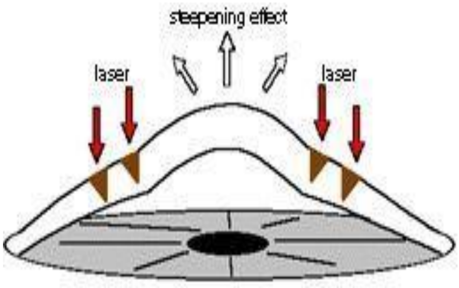


Figure 7: Correction of hyperopia with convex spectacle lens (source: www.iblindness.org)

2.2.2 Refractive surgery

The commonly used refractive surgery procedure for the management of hyperopia include Holmium YAG laser thermal keratoplasty, automated lamellar keratoplasty (ALK), excimer laser clear lens extraction with intraocular lens implantation and spiral hexagonal keratotomy (49, 50). The use of refractive surgery for the correction of hyperopia has been found to be more effective in the correction of lower degrees of hyperopic errors (<3.00D) (51). The long-term outcome of the various refractive surgery procedure for hyperopia has not been established due to limited number of studies in that area.



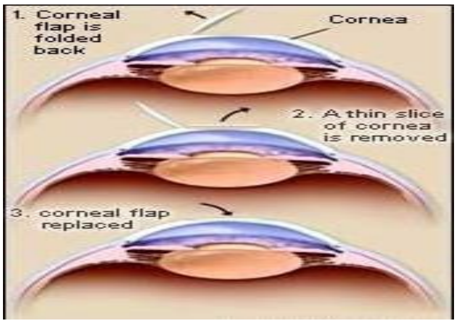


Figure 8: Illustration of hyperopia using Holmium YAG Laser (www.dr.maime.com) *Figure 9: Illustration of hyperopia Using ALK (www.urbaneye.com)*

2.2.3 Medical (Pharmaceutical)

This treatment option is normally reserved for patients who cannot benefit from more suitable methods like a spectacle or contact lenses. It involves the use of mitotic agents such as pilocarpine to mimic the accommodative effect of convex lenses resulting in the focus of images unto the retina (52, 53).

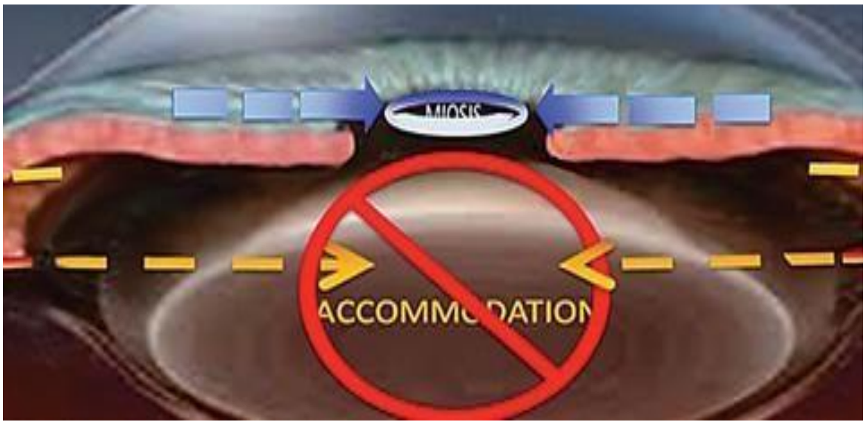


Figure 10: Illustration of the use of Miotic agents (pilocarpine) to mimic the accommodative effect of convex lenses in correcting hyperopia (source: www.reviewofoptometry.com)

2.3 Available Treatment Options for Astigmatism

Available treatment option for the correction of astigmatism includes optical, medical (pharmaceutical) and refractive surgery. The type of treatment option considered for a particular patient normally depends on the degree of the astigmatic error.

2.3.1 Optical Correction

Toric spectacle and contact lenses are the most commonly used treatment modalities for the correction of astigmatism. These lenses which have curvature at different angles work to refract parallel rays of light from a distant object to a point focus instead of multiple or a line focus, correcting the astigmatic error in the process (54, 55).

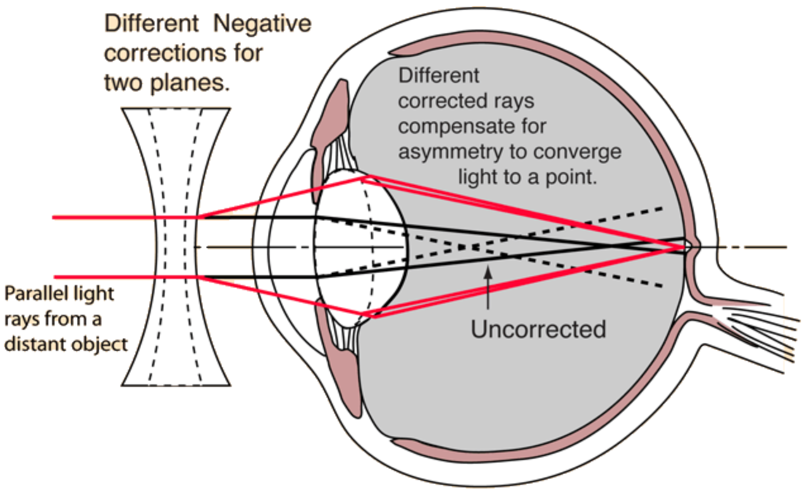


Figure 11: Correction of astigmatism with toric spectacle lens (source: www.iblindness.org)

Although toric spectacle lenses are a good treatment option for astigmatism of low degree, there are studies indicating that they may provide sub-optimal correction for the astigmatic error of moderate to a high degree (56). This is because the slightest tilt in the way the spectacles sit on a patient’s face affect the refraction of light by various curvature of the spectacle lenses, leading to poor image quality. Most studies have however recommended the use of rigid gas permeable toric lenses for the correction of moderate to a high degree of astigmatism in patients who can tolerate them (55, 57, 58).

2.3.2 Refractive surgery

Due to the limitation associated with the use of spectacles for the correction of moderate to a high degree of astigmatism and the inability of most patients to adapt properly to rigid gas permeable contact lenses, the use of refractive surgery for correction of the condition is becoming popular among patients and clinicians alike. The common refractive surgery procedure for the condition include laser-assisted in situ keratomileuses (LASIK), toric intraocular lens implantation and photorefractive excimer laser surgery. Among these methods, excimer laser surgery has been reported by several studies to have the best visual outcomes with most studies reporting an uncorrected visual acuity of 20/25 or better in over 90% of eyes, years after surgery (59, 60).

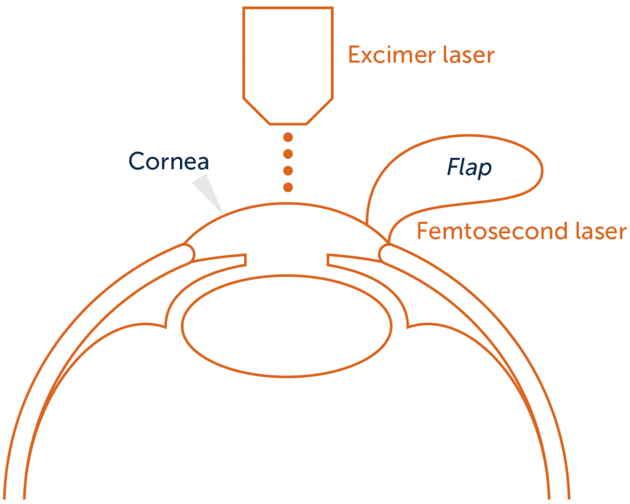


Figure 12: illustration of excimer laser surgery for the correction of astigmatism

2.3.3 Significant Refractive error

Refractive error can also be classified based on its effect on vision. According to the WHO, refractive error is considered to be significant in adults if the visual acuity is less than 6/18 in both eyes while in children, visual acuity of less than 6/12 in both eyes is indicative of significant refractive error warranting appropriate and timely management. In practice, however, significant refractive error is said to be present in the patients if he/she is given the correct spectacle and he/she wears them (29, 61, 62).

3.0 Epidemiology of Refractive Error

Refractive error is considered an issue of public health concern. According to recent studies and WHO report, refractive errors remain the major cause of visual impairment and the second leading cause of vision loss across the world. Despite the relatively easy treatment options available for the management of the condition, it is estimated that over 101.2 million people across the world are visually impaired and 6.8 million people are blind from the condition due to lack of assessing to appropriate treatment (23, 63, 64). An uncorrected refractive error has also been reported in a number of studies to be associated with limitations in vision-related tasks and a significant decrease in the quality of life of those affected (65, 66). The increasing number of studies reporting an improvement in the vision-related quality of life following the correction of refractive error among children and adult's population further demonstrates the need to prioritize the condition (67, 68).

The prevalence of refractive error varies globally depending on the geographical location, ethnicity, sex and age (69, 70). The prevalence of myopia has been

shown by a number of studies to be higher in East Asia with hyperopia having a higher prevalence in Europe and some western countries (1, 71-73)
The prevalence of refractive errors is reported to be relatively lower in Africa compared to East Asia and Europe. Studies that have been done in Nigeria (74), Ethiopia (75), South Africa (1), Uganda (76) and Ghana (77) have reported the prevalence of myopia to be 4.4%, 2.6%, 4.0%, 4.4%, and 1.7% respectively. There are some controversies however regarding this low prevalence of the condition in Africa due to the limited number of studies and the possibility of underestimation of the prevalence due to lack of detection of the condition among people in low-income settings with limited access to eye care services.

While a systematic review in 2018, for example, found the prevalence of myopia in adults to be higher in East Asia compared to Europe and Africa, the prevalence of the condition among children was relatively higher in Africa compared to South- East Asia as shown in **table 1.0**. The result of this systematic review agreed with the reported high prevalence of myopia among adults in South East Asia and low prevalence among the adult population in Africa but differed from the well documented high prevalence of the condition in East Asian children and low prevalence in African children (64). It is, however, important to acknowledge that the review only included prevalence studies that met their inclusion criteria instead of all prevalence studies (64). The authors in their discussion also admitted that “it difficult to explain the low prevalence of myopia in South-East Asian children, but it seems that one of the reports from Nepal (78) with a very large sample size decreased the estimated prevalence of myopia in that region.

3.1 Estimated Pool prevalence (EPP) of myopia, hyperopia, and astigmatism in children and adults by WHO regions

Astigmatism	Astigmatism	Hyperopia	Myopia
	%EPP(95%CI); weight	%EPP(95%CI); weight	%EPP(95%CI); weight
Children			
Africa	14.2 (9.9–18.5); 10.33	3.0 (1.8–4.3); 10.57	6.2 (4.8–7.6); 16.48
Americas	27.2 (26–28.4); 2.11	14.3 (13.4–15.2); 4.14	8.4 (4.9–12); 6.09
South-East Asia	9.8 (6.3–13.2); 16.47	2.2 (1.2–3.3); 20.89	4.9 (1.6–8.1); 8.52
Europe	12.9 (4.1–21.8); 6	9 (4.3–13.7); 1.04	14.3 (10.5–18.2); 16.04
Eastern Mediterranean	20.4 (14.5–26.3);29.1	6.8 (4.9–8.6); 30.75	9.2 (8.1–10.4); 26.69
Western Pacific	12.1 (8.4–15.8); 35.98	3.1 (1.9–4.3); 32.59	18.2 (10.9–25.5); 26.18
All	14.9 (12.7–17.1); 100	4.6 (3.9–5.2); 100	11.7 (10.5–13.0); 100
Adult			
Africa	11.4 (2.1–20.7); 8.85	38.6 (22.4–54.8); 6.54	16.2 (15.6–16.8); 2.01
Americas	45.6 (44.1–47.1); 2.95	37.2 (25.3–49); 13.05	22 (16.4–27.7); 7.98
South-East Asia	44.8 (36.6–53.1);17.58	28 (23.4–32.7); 21.79	32.9 (25.1–40.7); 18.02
Europe	39.7 (34.5–44.9); 8.82	23.1 (6.1–40.2); 4.36	27 (22.4–31.6); 29.99
Eastern Mediterranean	41.9 (33.6–50.2);29.39	33 (26.9–39); 19.54	24.1 (14.2–34); 13.98
Western Pacific	44.2 (30.6–57.7);32.41	28.5 (20.1–37); 34.73	25 (20–30.1); 28.01
All	40.4 (34.3–46.6); 100	30.9 (26.2–35.6); 100	26.5 (23.4–29.6); 100

Table 1: EPP of myopia, hyperopia and astigmatism in children and adults by WHO regions (64).

4.0 Magnitude of Uncorrected refractive error among school children

Over the past decade, Refractive Error in Children (RESC) surveys conducted in different countries across the world have shown an increasing prevalence of uncorrected refractive error among school-age children (1, 79-82). Currently, it is estimated that over 12.8 million children between the age group of 5-15 years in the world have uncorrected refractive error leading to visual impairment (83). The global prevalence of uncorrected refractive error among children in this age group is also reported to be 0.96%. A significant number of these children are found in LMIC like China, India and some parts of Africa. The prevalence of the various type of refractive error among children between the ages of 5-15 years has varied among studies. The prevalence of myopia, hyperopia, and astigmatism have ranged from 3%- 35%, 0.4%-17% and 2.2%-34% depending on the cut-off used as definitive of refractive error and the region or setting in which studies are conducted (64).

5.0 Economic/Social Impact of Uncorrected refractive error among children

Uncorrected refractive error has been shown in a number of studies to have a significant economic impact (65, 80, 84). According to a recent study, uncorrected refractive error in children and young adults account for an annual global economic loss of $269 billion (65). The impact of uncorrected refractive error on the socio-economic status of those affected is 2-fold. While poverty and inability to access treatment has been found to drive the increasing prevalence of the condition, the visual impairment resulting from uncorrected refractive error also negatively impact the educational and employment opportunities of children and people affected. This negative impact of uncorrected refractive error on the socio-economic status, academic performance, overall quality of life of children and its potential to lead to sight-threatening eye conditions like amblyopia is well documented in a number of studies (65, 84, 85).

Given the increasing prevalence of visual impairment due to uncorrected refractive errors in children and the simplicity of treatment, the introduction of vision screening programs that aim to detect and treat the condition among school-aged children has been made one of the priorities of the WHO's Vision 2020 initiative (86)

6.0 Description of Intervention (School Vision screening programs)

School screening programs have become popular in many developed countries as a way of identifying children with eye conditions such as refractive error so early intervention can be made (87). In most of these developed countries, school vision screening programs are incorporated into the health care delivery system (88). For example, countries like the United States, United Kingdom, and Sweden have successfully incorporated vision screening program into their educational system allowing children to receive visual acuity screening either before or after school entry (89-91). The situation, however, is different in LMIC where factors such as limited funding to support the programs and lack of stakeholder commitment prevent children from benefitting from early detection of eye conditions which potentially can impact their academic performance.

6.1 Policies on School Vision Screening

There exists considerable variation in the guidelines, policies, and requirements for vision screening across the world (92). Important areas of variation include; visual function to be assessed as part of vision screening programmes and the particular tests to be used to assessed those visual functions, the type of personnel to be used for vision screening, the ideal age of children eligible for vision screening, the frequency of vision screening, the criteria for referral of children for further assessment and most importantly what additional intervention should be provided as part of vision screening programs (free spectacles, education, teacher incentive, etc.) (92).

6.1.1 Legislations on School vision screenings

While countries such as the United States have legislation in place ensuring mandatory screening of all children of school going age for eye conditions that can potentially affect their academic performance prior to school entry, most LMIC do not have such legislation. Vision screenings in these countries are therefore conducted on an ad hoc basis by various health care professionals including optometrists, medical practitioners, ophthalmologist and orthoptists in both the government and private sector (92). This lack of legislation to regulate vision screening programs in these LMIC has had a negative effect on the development of the program especially in countries where the commitment of eye care professionals in the private and government sector is lacking (93).

6.1.2: Age for Vision screening

The ideal age at which vision screening is recommended has been the subject of debate for most countries that have made efforts to introduce national vision screening programs (94). While some countries have focused on vision screening for preschoolers with the aim of identifying children with eye defects that can lead to more serious conditions like amblyopia and strabismus, other countries advocate for vision screening among children already enrolled in schools as the chances of detecting eye conditions such as refractive error that may have an effect on their academic performance is high (94, 95).

6.1.3: Personnel for School Vision screening

In most countries where school vision screening is either part of the national eye health program or conducted by private organizations, eye care professionals including optometrists, ophthalmologist, orthoptist and ophthalmic nurses are usually used as the vision screening personnel. Unfortunately, due to a limited number of these eye care professional in LMIC, the use of other trained personnel such as ophthalmic assistants and teachers have become popular in recent years. Several studies have investigated the effectiveness of using other personnel such teachers for school vision screening and the result of these studies have indicated that this may be a more cost-effective method of ensuring the sustainability of school vision screening programs in countries or setting with few numbers of trained eye care professionals (96-98).

6.1.4 Additional intervention (Spectacle Provision as part of Vision Screening)

Despite spectacle provision being commonplace in most school vision screening program, it is important to acknowledge that school screening is an entry level procedure and provision of spectacles is only an extension of the program (98). There is some level of evidence indicating that the provision of free spectacles as part of school vision screening programs can have a positive effect on program outcome in terms of improved academic performance among children, there still exist a lot of debate on its effectiveness in reducing the proportion of children with uncorrected refractive error in the long term. Some studies have reported a low level of compliance with the use of spectacles provided as part of school vision screening programs, questioning the cost-effectiveness of this approach in school vision screening programs.

7.0 Systematic reviews of the effectiveness of school screening in reducing children with uncorrected refractive error/ relevance of the current review

To the best of our knowledge, there exists no systematic review that has assessed the effectiveness of school vision screening programs in reducing children with uncorrected refractive error in LMIC. In light of this, a systematic review that aims to answer the important question; Are school vision screening programs effective in reducing children with uncorrected refractive error in LMIC? is deemed appropriate and is the focus of this systematic review.

8.0 Summary and Conclusion of the Literature Review

There is an increase in the prevalence of uncorrected refractive error among school-age children in recent times. School vision screening has been advocated for by various national and international organizations to help deal with the issue. There exist a lot of debate however on the effectiveness of the program in the LMIC settings where the limited resources available cannot be afforded to be wasted on health care interventions that do not work in the long term. This has made a study assessing the effectiveness of school vision screening programs necessary.

PART C: MANUSCRIPT

Part C: Manuscript

Abstract

Background: The prevalence of uncorrected refractive error among school-age children is on the rise with a detrimental effect on academic performance and socio-economic status of those affected. School vision screening appears to be an effective way of identifying children with uncorrected refractive error so early intervention can be made. Despite the increasing popularity of school vision screening programs in recent times, there is a lot of debate on its effectiveness in reducing the proportion of children with uncorrected refractive error in the long term especially in settings where resources are limited.

Objective: To assess the effectiveness of school vision screening programs in reducing children with uncorrected refractive error in LMIC.

Search Methods: To identify studies suitable for this systematic review, a comprehensive and systematic search strategy was employed. We searched various databases and the search was restricted to articles published in English.

We included RCTs, cross-sectional studies, case-control studies, and cohort studies. Participants included school children who had undergone vision screening as part of school vision screening programs in the LMIC setting and found to have a refractive error.

Two independent reviewers screened the result of the search output and performed a full-text review of the search result to identify papers that met the pre-defined inclusion criteria. Data extraction and risk of bias assessment for the included studies was performed by the two independent reviewers and discrepancies were resolved by consensus and through consultation. The certainty of the evidence was assessed using the GRADE approach.

Main Result: We found thirty relevant studies conducted in ten different countries that answered our review questions. Our review showed that school vision screening may be effective in reducing the proportion of children with an uncorrected refractive error by 81% (95% CI: 77%; 84%, moderate certainty evidence), 24% (95% CI: 13%; 35%, moderate certainty evidence,) and 20% (95% CI: 18%; 22%, moderate certainty evidence) at two, six, and more than six months respectively after its introduction.

Our review also suggest that school vision screening may be effective in achieving 54% (95% CI: 25%; 100%, moderate certainty evidence), 57% (95% CI: 46%; 70%, low certainty evidence), 38% (95% CI: 29%; 51%, moderate certainty evidence) and 41% (95% CI: 24%; 68%, low certainty evidence) level of spectacle wear compliance among school children at less than three months, at three months, at six months and at more than six months respectively after its introduction.

Our review further found moderate to high certainty evidence indicating that school vision screening together with the provision of spectacles may be relatively cost-effective, safe and has a positive impact on the academic performance of children.

Conclusion: Result of this review shows that school vision screening together with the provision of spectacle may be a safe and cost-effective way of reducing the proportion of children with uncorrected refractive error with a long-term positive impact on academic performance of children. Most of the studies included in this review were however conducted in Asia and the applicability of this finding to countries in other regions especially those outside the LMIC circle is not clear.

Keywords: Refractive error, low- and middle-income countries, vision screening

1.0 Background

Refractive error is the most common cause of visual impairment especially among children according to recent studies and the WHO's report (63). Globally, it is estimated that 43% of visual impairment can be attributed to refractive error (62). Refractive error is an intrinsic optical defect of the eye in which parallel rays of light coming from optical infinity are focused either in front or behind the retina with accommodation fully relaxed (16, 17)**.** Without timely treatment, refractive errors due to the poor image they present to the retina can lead to more serious eye conditions like amblyopia (29, 87).

School vision screening program has been developed in different countries and settings to detect the condition especially during the assumed critical period of visual development where early treatment can prevent more complicated conditions like amblyopia (87-88). Most school vision screening programs are however concentrated in developed countries where they are mostly provided as part of the healthcare system by the government or incorporated into the educational system (89). In LMIC however, the situation is different. Despite the WHO's advocate for the incorporation of vision screening programs into the health care delivery system of these countries as part of it Vision 2020 initiative, lack of government commitment, inadequate infrastructure, funding and a limited number of health care professionals continue to be a major hindrance (99, 100). The lack of government's commitment and support for the introduction of vision screening programmes in most LMIC have mainly been attributed to the lack of evidence to support the effectiveness of these programmes in areas where they have already been introduced (89, 101) Few studies that have sought to assess the effectiveness of these programs have also looked mainly at vision screening programs in developed countries (89).

In January 2018, a revised Cochrane review examined vision screening for correctable visual deficit due to a refractive error in school-age children and adolescents (13). In their conclusion, the authors acknowledged that despite the evidence from China (where five out of the seven studies included in their review were conducted) suggesting that vision screening may be effective in improving spectacle wearing and educational outcome, the applicability of the finding to other parts of the world where few or none of the studies that met their inclusion criteria were conducted was not clear (13). A recommendation for more studies to be conducted in these areas was made. The Cochrane review, however, included only RCTs making other non-RCTs that possibly provides the best opportunity at present to evaluate the effectiveness of the programs in these areas' ineligible for inclusion. Considering the fact that only a few RCTs have assessed school vision screening in LMIC, it has become necessary for a review that examines all the available evidence at present regardless of the study type to be conducted. The current review, therefore, hopes to achieve this by including both RCTs and non- RCTs evaluating the effectiveness of the programs in the context of LMIC.

2.0 Objective

To evaluate the effectiveness of school vision screening programs in LMIC to reduce the proportion of children with uncorrected refractive error.

3.0 Methods

This was a systematic review evaluating the effectiveness of a health care intervention. Reporting of the finding was guided by the PRISMA guidelines (14) as shown in **appendix 5.4.**

3.1 Criteria for considering studies for this systematic review

3.1.1 Types of Studies

We included the following study design type in this review; RCTs, cross-sectional studies,case-control studies, and cohort studies.

3.1.2 Type of Participants

We included children who had undergone vision screening as part of school vision screening programs in the LMIC setting and found to have a refractive error. Participants with other ocular pathologies accounting for poor vision were excluded from this systematic review.

3.1.3 Types of outcome measure

Primary Outcome

The proportion of children with uncorrected or sub-optimally corrected refractive error.

Secondary outcomes

- Long term effect of school screening programs on the academic performance of participants

- The adverse effect of school vision screening programs (i.e. anxiety from interviews, misdiagnosis, symptoms associated with the use of prescribed spectacles, etc.)
- Cost-effectiveness of school vision screening programs.
- Influence of school vision screening programs on compliance with spectacle wearing.

3.2 Search methods

3.2.1 Identification of studies

To identify studies suitable for this systematic review, a comprehensive and systematic search strategy was used. A search of eligible articles was performed using keywords, truncated terms, the Boolean operator and Medical Subject Heading (MESH) terms. The search was restricted to articles published between 1980 and 2018 and the search was done from January to August 2018. The following electronic database was searched; PubMed, Cochrane Central Register of Controlled Trials (CENTRAL) which contains the Cochrane Eyes and vision Trial Register, the Cochrane Library, Medline (1980-2018), CINAHL, Academic Search Premier, Web of Science, the WHO's Library Information System, Africa-Wide and Scopus. Combined search of MESH terms, titles and abstracts were used for each step of the search. The search was restricted only to articles written in English. Since this systematic review seeks to summarize evidence on the effectiveness of school vision screening programs to reduce the proportion of children with uncorrected refractive error, studies involving vision screening programs that targeted subgroup population such as children with specific ocular pathologies other than a refractive error (e.g. congenital glaucoma, congenital cataract, etc.) were excluded.

Filters were also used during the search for articles to ensure that only studies in LMIC were included in this systematic review. Countries names and regional names were used in the electronic search. This was to ensure that both country-specific records and records indexed by a regional term such as 'West Africa' were included in this systematic review. In instances where a country has English and local name, both names were used to increase the sensitivity of the electronic search in identifying all the relevant articles for the review. Efforts were made to identify unpublished studies, government reports, theses, dissertation and conference papers by searching google (including google scholar) and WorldCat. Additionally, the reference list of all the included studies was searched for any articles that may have been missed during the initial search. A detailed description of the search strategies used is included in **appendix 5.1**

3.3 Data collection and analysis

3.3.1 Selection of Studies

Selection of studies to be included in this systematic review went through three phases involving two independent reviewers. In the first phase, two reviewers; Abraham Opare (AO) and Leila Abdullahi (LA) checked the electronic search result and selected all studies that made reference to refractive error, myopia, hyperopia, astigmatism, and vision screening. Any identified article that was found to be clearly irrelevant at first glance was excluded. In the second phase of the selection process, the two independent reviewers (AO and LA) screened the titles and abstracts of studies identified to be relevant in the first phase to determine their eligibility for inclusion in the systematic review. The full text was obtained by AO for studies that had no abstract. In the third and final phase of the selection process, the two reviewers (AO and LA) performed a full-text review of all articles whose abstracts were found to be relevant in the second phase. The full-text review was also done for articles whose abstract failed to provide a clear description of the study. Using the study's inclusion and exclusion criteria, the two reviewers (AO and LA) finally selected the studies to be included in the systematic review. In instances where we were unable to come to an agreement on whether a paper was eligible for inclusion, an arbitrator Colin Cook (CC) who is an expert in the field was consulted. The search and selection of articles for this systematic review were summarized using the PRISMA flow chart. The characteristics of all included studies in this review and the reason for exclusion of studies has been well documented using tables.

3.3.2 Data extraction and management

Data from the selected studies were extracted using a standardized Cochrane collaboration data extraction form that was modified to suit this systematic review. **(Attached as Appendix 5.2)**. Initial piloting of the data extraction form was done to ensure uniformity among the two independent reviewers (AO and LA). Where it was possible, we extracted information on study participants including their age, sex, school grade and number of participants, study setting (city and country), additional intervention (spectacle provision, health education, teacher incentive etc.) and type of outcome measure (spectacle compliance, cost of screening, improvement in academic performance etc.). Indicators of the severity of refractive error such as the visual acuity in the worse eye were also extracted. Additionally, any data deemed to be an appropriate indicator of the effectiveness of a school vision screening program such as the number of children who benefited from spectacle correction of their refractive error, compliance with wearing of spectacles provided as part of vision screenings, etc. was also extracted.

3.3.3 Assessment of risk of bias in included studies

Assessment of risk of bias for prevalence studies was done using the Hoy criteria tool **(attached as appendix 5.3a)**. A 10-point scale was applied to all the cross-sectional studies to assess both their internal and external validity. A score of 8 or more "yes" in the 10-point scale was considered a low risk of bias, 6-7 score, moderate risk of bias and 5 or less "yes" high risk of bias. For RCTs investigating the effectiveness of school vision screening programs in reducing the proportion of school children with uncorrected refractive error, risk of bias was assessed using the Cochrane Effective Practice and Organization of Care (EPOC) tool (Attached as **appendix 5.3b**). For each study, we independently reported our judgment of the risk of bias as either being low, high or unclear and cases of disagreements were resolved by an arbitrator (CC) who is an expert in the field. Where deemed necessary, the funnel plot was used to check for publication bias across the included studies.

3.3.4 Subgroup analysis

When and where appropriate, subgroup analysis was done to determine the effect of the definition used as an indication of spectacle compliance in the various studies on the pooled spectacle compliance.

3.3.5 The measure of the intervention effect.

We expressed the result of each study which assessed our primary outcome as a risk difference with the corresponding 95% confidence interval (CI). Compliance with spectacle wearing was expressed as proportions with the corresponding 95% CI. We grouped studies based on the follow-up period, study design and definition used as an indication of spectacle compliance to get reasonable results for an overall estimate of effect.

3.3.6 Dealing with missing data

We did not have cases of missing data in this systematic review and therefore made no contact with primary study authors for missing data.

3.3.7 Heterogeneity assessment

Studies included in this systematic review were checked for heterogeneity by examining their characteristics (study design, population, setting, etc.) and risk of bias. The Cochran's Q-test and the Higgins Chi-square test for heterogeneity was used to statistically explore any heterogeneity among the included studies using an alpha level of 10%. Heterogeneity was considered as significant if the Chi-square was above 50%.

3.3.8 Data synthesis and analysis

Analysis of quantitative data was done using RevMan 5.3 software. Data from studies with a low or medium risk of bias found to be relatively similar in terms of outcome, follow-up period and participants were pooled together in a meta-analysis using the random-effect model. The measure of effect used as an estimate for the reduction in the proportion of children with uncorrected refractive error after the introduction of school vision screening was risk difference. This was calculated by subtracting the proportion of children with uncorrected refractive error prior to exposure to school vision screening from the proportion of children with uncorrected refractive error post-exposure to school vision screening. In all instances, the 95% CI was presented. Additionally, the STATA 14 statistical package was used to obtain estimates of the proportion of children with uncorrected refractive error where necessary. In cases where statistical analysis of data was not possible, a narrative technique was employed in presenting the result. A subgroup analysis was done where deemed necessary to examine the impact of the definition used as an indication of compliance with spectacle wear on the size and direction the effect.

3.3.9 Quality of evidence

The quality of the evidence presented in this systematic review was assessed using the GRADE approach. Based on the level of confidence we have in the outcome, we graded the evidence as either low, moderate or high certainty evidence.

We judged the effect estimate in this review as high certainty evidence if we were very confident the true effect lies close to that of the estimated effect. Estimates were judged as moderate certainty evidence if we were moderately confident that the true effect lies close to that of the estimate of effect. In instances where had very little confidence that the true effect lies close to an effect estimate, that estimate was judged as low certainty evidence (15).

4.0 Results

4.1 Search Result

Our electronic search identified 2101 articles. After removal of duplicates, 1583 articles remained for screening. 1532 articles which were found to be irrelevant to this review were excluded leaving 51 articles for full-text review. Using the predefined inclusion and exclusion criteria as a guide, 18 articles were excluded based on reasons given in **table 3**, and full text for 3 articles could not be obtained (**table 4)**. Thirty (30) articles which met the inclusion criteria were included in this review. The processes involved in the search, screening, and selection of articles for inclusion in this review is summarized using the PRISMA flow diagram **(figure 13)**

4. 2 PRISMA Flow Diagram

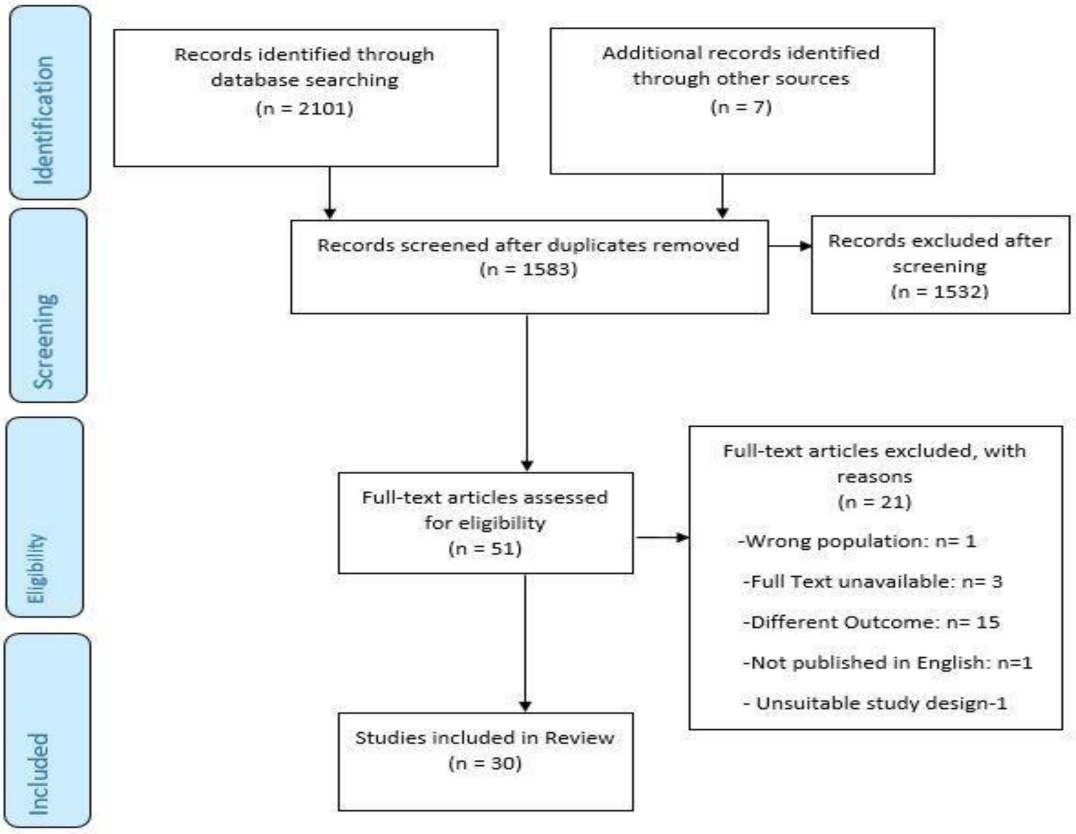


Figure 13: PRISMA flow diagram

4.3 Description of Included studies

Thirty articles retrieved from the electronic search met our inclusion criteria. Out of these, six were cluster RCTs with schools as clusters (11, 102-106), four were RCTs with randomization done at the individual level (107-110), three were non-RCTs (111-113), six were cohort studies (10, 114-118) and eleven were cross-sectional studies (119-129)

Twelve of the eligible studies were conducted in India (10, 108, 112, 113, 116, 117, 121-124, 127, 128), eight were conducted in China (102-107, 109-111). One study was conducted in Chile (129), one was done in Tanzania (11), one was conducted in South Africa (115), one was from Mexico (107), one was conducted in Oman (119), one was conducted in Nepal (120), one was done in Thailand (129) and one was conducted in Botswana (125). All the included studies enrolled both males and females', children. A detailed description of all included studies is provided in the **table**

2. A summary of countries where selected studies were conducted is also given in **figure 14**

Table 2: Characteristics of Included studies

Study ID	Study Design	Population /Setting (Location and social context)	Total no. enrolled	Sex/Age (Years)	Main Intervention if applicable	Duration of participation
Wedner, 2008	Cluster randomized trial	School children were drawn from 37 senior secondary schools in Dar es Salaam	6904	Male and female, aged 11-25 years	free spectacles	6-month period
Ma, 2014	Cluster randomized trial	Primary school children in fourth and fifth grades in Western China	3177	Male and female, mean age 10.5years	free spectacles or voucher for spectacle	8-month period
Ma, 2015	Cluster randomized trial	Primary school children in fourth and fifth grades in Western China	3177	Male and female, mean age 10.5years	free spectacles or voucher for spectacle	8-month period
Yi, 2015	Cluster randomized trial	School in schools at Shanghai and Suzhou/Wuxi in China	4376	Male and female, aged 10-12 years	free spectacles +Educational intervention	6-month period
Morjaria, 2017	Non-inferiority, double-masked, randomized clinical trial	School children in government secondary schools in urban and peri-urban areas surrounding Bangalore in Karnataka State in India	23345	Male and female, aged 11-15 years	less expensive ready-made spectacles	3-4-month period
Congdon, 2011	A randomized, controlled trial.	School children in years 1 and 2 of all 20 junior and senior high schools in 3 rural townships in Guangdong, China	11423	Male and female, aged 12-17 years	an educational intervention to promote spectacle purchase	6-month period
Zeng, 2009	Randomized, double-blind, clinical trial.	Junior high school students from urban Guangzhou, China	4607	Male and female, aged 12-15 years	Ready-made spectacles	1-month period
Zhou, 2017	a randomized, double-masked non-inferiority trial	School children in grades 7 and 8 (in nine Chinese secondary schools	9889	Male and female, aged 12-15 years	Ready-made spectacles, rural refractionist, Self-refraction	2 Month period
Wang, 2017	cluster randomized, investigator-masked, controlled trial	School children from primary schools in 9 counties in Guangdong and Yunnan provinces, China	10,234	Male and female, aged 9-12 years	Vouchers exchangeable for free glasses (Free Glasses group) Vouchers exchangeable for free glasses + $15 upgrade (Free + $15 Upgrade group) Vouchers for free glasses+ $30 upgrade (Free + $30 Upgrade group)	6-month period
Ma, 2018	cluster randomized,in vestigator-masked, controlled trial	School children in grades 4 through 6	2613	Male and female, aged approx. 10-12	Early Referral to a local vision Centre for refraction and free glasses from September to October of screening to December 2014-February 2015) of referral	About 6-month period
Kaey,2010	prospective clinical trial	Students in 5 junior high schools in Guangzhou, China	428	Male and female, aged 12-15 years	Provision of new spectacles as part of school screening program	1-month period

Narayanan,2018	experimental study	School children in 11 government schools in and around Chennai, India	8,442	Male and female, aged 13-15 years	Conventional school screening protocol + 23 step intervention involving 1. Awareness of eye and vision care to all children, spectacle use and benefit, the incentive for use of spectacle (Interventions were broadly classified as frame-and-fit-related solutions, solutions pertaining to education and motivation, and conduct of the screening.)	12-month period
Priya, 2014	prospective, non-randomized control study	School children in primary schools in India	80463	Male and female, aged 6-17 years	All Class Teacher	N/A
Von-Bischhoffshausen, 2014	Cohort study	School children in schools in the city of Concepcion, Chile	270	Male and female, aged 4-9 years	Spectacles as part of a school vision screening program	12-month period
Gogate, 2013	Cross-sectional follow-up study	School children in rural secondary schools in Pune District of India	1035	Male and female, aged 8-16 years, mean age (12.1 years)	Spectacles as part of a school vision screening program	12-month period
Congdon,2008	A prospective study (cohort)	School children from 1 rural and 12 urban secondary schools in Umtata in the Eastern Cape Province of South Africa	8520	Male and female, aged 6-19 years	Spectacles as part of a school vision screening program	4-11 Month period
Shukla, 2018	cross-sectional study	Primary school children from government schools in India	6056	Male and female, aged 7-10 years	Spectacles as part of a school vision screening program	About 6 Month period
Castanon, 2006	prospective cohort study	Primary and secondary school from schools in Oaxaca, Mexico.	634	Male and female, aged 5-18 years	Spectacle provision as part of a school vision screening program	18 Month period
Rewri,2013	prospective cohort study	Students in standard 6th to 12th in a rural area of northern India	7411	Male and female, aged 10-19 years	Spectacles provision as part of a school vision screening program	2 Month period
Aldebasi,2013	cross-sectional descriptive study	The primary school children I of Qassim Province who has been prescribed the spectacles during the school year 2010-2011.	631	Male and female, aged 7-13 years	Spectacle prescription as part of the school vision screening program	6-month period
Limburg, 1995	cross-sectional descriptive study	Middle school children in New Delhi, India	46672	Male and female, aged 10-15 years	N/A	N/A
Sumana, 2015	cross-sectional descriptive study	School going children in Salagame, Hassan in India	391	Male and female, aged 9-16 years	School eye screening program	6-month period
Rustagi,2012	intervention study	middle and secondary government schools' children in the northwest district of Delhi	1123	Male and female, aged 11-18 years, mean age 14.25	School eye screening program + provision of prescription for spectacles	8-month period

Limburg, 1999	Retrospective Cohort study	primary and middle schools' children from 61 districts in India	5.39 million	Male and female, aged 6-15 years	School vision screening + Provision of free spectacles	60-month period (5yrs)
Khandekar, 2008	cross-sectional descriptive study	School children in 2 regions in Central India	77	Male and female, age not reported	School screening vision + Provision of free spectacles	3 to 4-month period
Bhandari, 2016	population-based, cross-sectional study	school children within schools within Chitwan district in Nepal	170	Male and female, aged 7-16 years	School screening vision + Provision of free spectacles	12-month period
Pavithra, 2014	cross-sectional study	government school children in both rural and urban field practice areas of a medical college in Bangalore	1378	Male and female, aged 7-15 years	School screening vision + Provision of free spectacles	3-month period
Bhatt, 2017	cross-sectional study	School children in Rohtak, Haryana, India	200	Male and female, aged 6-15 years	School screening vision + Provision of free spectacles	3 Month period
Tengtrisorn, 2009	cross-sectional study	Primary school children from 11 schools in Nakhon Hatyai municipality, Songkla province-southern Thailand	1900	Male and female, aged 6-12 years	School vision screening program	11 Month period
McCormick, 2018	cross-sectional study	School children screened across 49 schools in Goodhope district in the Southern region of Botswana	300	Male and female, median age 15 years	School screening vision + Provision of free spectacles	3-4 Month

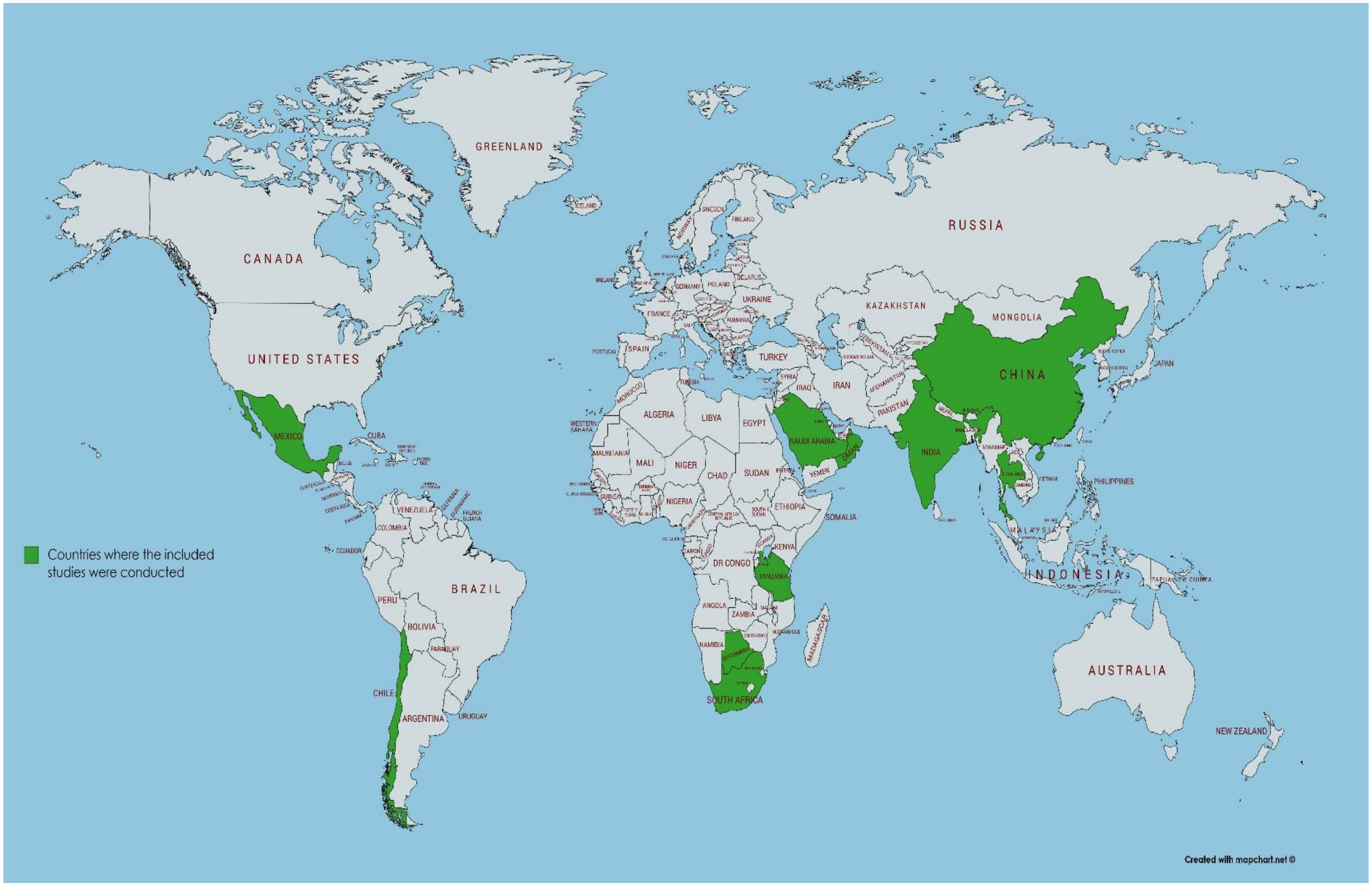


Figure 14: Countries where selected studies were conducted

4.4 Characteristics of excluded studies

Eighteen studies which did not meet the pre-defined inclusion criteria were excluded from this review. **Table 3** gives a detailed description of the excluded studies and the reasons for their exclusion.

Table 3: Characteristics of Excluded studies

Author, Year	**Reason for Exclusion**
Odedra, 2008	Not the outcome of interest
Rono, 2018	Not the outcome of interest
Noma, 2012	Not the outcome of interest
Sudhan, 2012	Not the outcome of interest
Zhang, 2009	Not the outcome of interest
Khandekar, 2009	Not the outcome of interest
Chang, 2017	Not the outcome of interest
Kaur, 2016	Not the outcome of interest
Diao, 2016	Not the outcome of interest
Ondrejkova, 2013	Not the outcome of interest
Arif, 2014	Not the outcome of interest
Ajuwon, 1996	Not the outcome of interest
Esteso, 2007	Not the outcome of interest
Santos, 2011	Non-English publication
Frick, 2009	Cost-effectiveness assessed using a hypothetical school vision screening program (modeling) rather than through a primary study.
Frick, 2009	Cost-effectiveness assessed using a hypothetical school vision screening program (modeling) rather than through a primary study.
Shaik, 1992	Not the outcome of interest
Khandekar, 2013	Not the outcome of interest
Angell,2018	Wrong Population

4.5 Characteristic of studies awaiting assessment

Three studies for which full text could not be obtained are currently awaiting assessment. We have already contacted the authors of these three studies via email and we are waiting for their response. Once full text for these studies are obtained, information relevant to this systematic review will be abstracted and this will be taken into consideration in the presentation of the final result of this review. **Table 4** below gives a summary of these studies.

Table 4: Characteristics of studies awaiting full text

Author, Year	Title	Outcome assessed	Comment
Bagchi, 2008	Vision screening programs among school children--evaluation of the outcome in a selected urban locality.	profile of the visual acuity status, refractive error and other ocular morbidities and to assess the performance at different stages following a vision screening program in school	The author contacted via email for full- text paper
Glewwe, 2016	A better vision for development: Eyeglasses and academic performance in rural primary schools in China	Effect of spectacles provided via a school vision screening program on the academic performance of the student and the cost-effectiveness of spectacle provision as part of a school vision screening program	The author contacted via email for full- text paper
Yabumoto,2009	Factors Associated with Spectacles-Use Compliance in a Visual Screening Program for Children From Southern Brazil.	Acceptance and factors related to the spectacle- use compliance in low-income South Brazilian children, and its effect on scholar activities performance.	The author contacted via email for full- text paper

4.6 Risk of bias assessment (RCTs and non-RCTs)

Risk of bias for RCTs and non-RCTs were assessed using the Cochrane Effective Practice and Organization of Care (EPOC) tool. A summary of the risk of bias assessment for RCTs and non-RCTs is shown in **Table 5** and **figure 15.**

4.6.1 Allocation (Selection bias)

Nine studies (11, 102, 103, 106-111) were judged to have a low risk of selection bias (random sequence generation). Three studies (104, 105, 112) were judged to have an unclear risk of selection bias (random sequence generation).

With the exception of one study, (112) which was judged to have an unclear risk of selection bias (Allocation concealment), all the other RCTs and non-RCTs were judged to have a low risk of selection bias (Allocation concealment)

4.6.2 Blinding (Detection and performance bias)

We judged ten studies (11, 102-106, 108-111) to have a low risk of performance bias while two studies (107, 112) were judged to have an unclear risk of performance bias.

Low risk of detection bias was the judgment for nine studies (102, 103, 105, 106, 108-111) while three studies (11, 104, 115) were judged to have an unclear risk of detection bias.

4.6.3 Incomplete Outcome data (Attrition bias)

Risk of attrition bias was judged to be low for all the twelve RCTs and non-RCTs (11, 102-112).

4.6.4 Selective reporting (Reporting bias)

Six studies (11, 102-105, 108, 110, 112) were judged to have a low risk of reporting bias, three studies, (102, 103, 106) were judged to have an unclear risk of reporting bias and three studies (107, 109, 111) were judged to have a high risk of reporting bias.

4.6.5 Baseline Imbalance

Assessment of baseline imbalance was done for only cluster RCTs. This was found to be low for four cluster RCTs (102-104, 108) and unclear for two cluster RCTs (11, 105)

Table 5: Risk of Bias Assessment for Randomized and Non-Randomized control trials

Study ID	Random Sequence Generation (Selection bias)	Allocation Concealment (Selection bias)	Blinding of participants and personnel (Performance Bias)	Blinding of outcome assessment (Detection bias)	Incomplete outcome data (Attrition bias)	Selective reporting (Reporting Bias)	Baseline imbalance (cluster RCTs only)	Are the study results valid?	Others (specify)
Wedner, 2008	Low	Low	Low	Unclear	Low	Low	Unclear	Yes	limitations are made clear - results are internally valid
Ma, 2014	Low	Low	Low	Low	Low	Unclear	Low	Yes	limitations are made clear - results are internally valid
Ma, 2015	Low	Low	Low	Low	Low	Unclear	Low	Yes	limitations are made clear - results are internally valid
Yi, 2015	Low	Low	Low	Low	Low	Unclear	Unclear	Yes	limitations are made clear - results are internally valid
Morjaria, 2017	Low	Low	Low	Low	Low	Low	N/A	Yes	limitations are made clear - results are internally valid
Congdon, 2011	Low	Low	Unclear	Unclear	Low	High (Some planned results to be reported from the registration of the trial not reported)	N/A	Yes	limitations are made clear - results are internally valid
Zeng,2009	Low	Low	Low	Low	Low	High (Some planned results to be reported from the registration of the trial not reported) some of the missing. outcomes will have been of relevance to this review e.g. continued spectacle use at 6-12 months after dispensing and cost-effectiveness	N/A	Yes	limitations are made clear - results are internally valid
Zhou, 2017	Low	Low	Low	Low	Low	Low	N/A	Yes	limitations are made clear - results are internally valid
Wang, 2017	Unclear	Low	Low	Low	Low	Low	Unclear	Yes	limitations are made clear - results are internally valid

Ma,2018	Unclear	Low	Low	Unclear	Low	Low	Low	Yes	imitations are made clear - results are internally valid
Kaey, 2010	N/A	Low	Low	Low	Low	High (Some planned results to be reported from the registration of the trial not reported) some of the missing outcomes will have been of relevance to this review e.g. continued spectacle use at 6-12 months after dispensing and cost-effectiveness	N/A	Yes	limitations are made clear - results are internally valid
Narayanan, 2018	N/A	unclear	Unclear	low	Low	Low	N/A	Yes	limitations are made clear - results are internally valid
Priya, 2014	N/A	Unclear	Low	Unclear	Low	Low	N/A	Yes	limitations are made clear - results are internally valid

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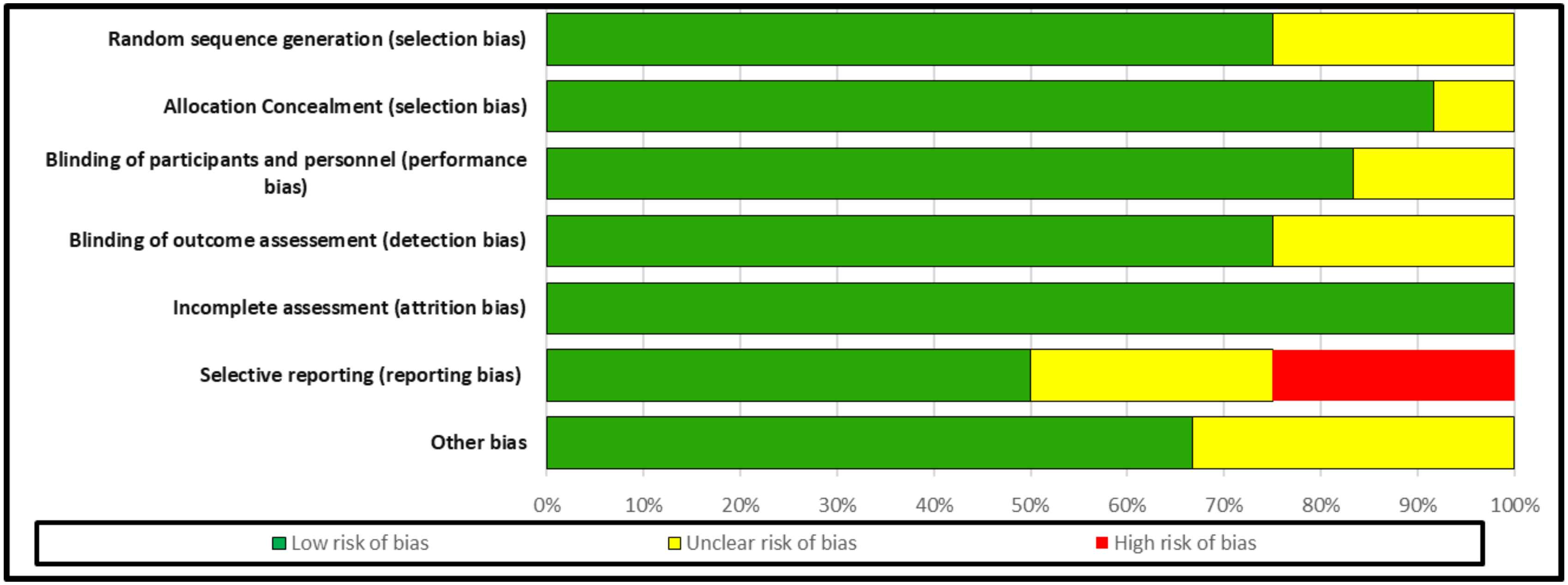

Figure 15: Risk of bias assessment for randomized and non-randomized control trial

4.7 Risk of bias assessment (Prevalence studies)

Risk of bias assessment for prevalence studies was done using the Hoy risk of bias assessment tool which was modified to suit this systematic review**. Table 6** and **figure 16** summarizes the risk of bias assessment for all the prevalence studies.

Table 6: Quality assessment for prevalence studies

Study, year	**Was the study's target population a close representation of the national population in relation to relevant variables, e.g. age, sex, occupation?**	**Was the sampling frame a true or close representation of the target population?**	**Was some form of random selection used to select the sample? OR, was a census undertaken?**	**Was the likelihood of nonresponse bias minimal?**	**Were data collected directly from the subjects (as opposed to a proxy)?**	**Was an acceptable case definition used in the study?**	**Was the study instrument that measured the parameter of interest (e.g. prevalence) shown to have reliability and validity (if necessary)?**	**Was the same mode of data collection used for all subjects?**	**Was the length of the shortest prevalence period for the parameter of interest appropriate?**	**Were the numerator (s) and denominat or(s) for the parameter of interest appropriat e?**	**Overall Score**	**Risk of bias**
Gogate, 2013	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	7	Moderate
Shukla, 2018	No	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	N/A	Yes	6	Moderate
Aldebasi,2013	Yes	Yes	Unclear	Yes	Yes	Unclear	Yes	Yes	N/A	Yes	7	Moderate
Limburg, 1995	No	Unclear	Unclear	Unclear	Yes	Yes	Yes	Yes	N/A	Yes	5	High
Sumana, 2015	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	8	Low
Khandekar, 2008	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	N/A	Yes	8	Low
Bhandari, 2016	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes	8	Low
Pavithra, 2014	No	Yes	No	Yes	Yes	Yes	Yes	Yes	N/A	Yes	7	Moderate
Bhatt, 2017	No	Unclear	No	Unclear	Yes	Yes	Yes	Yes	N/A	Yes	5	High
Tengtrisorn, 2009	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	N/A	N/A	7	Moderate

Scoring: LOW RISK OF BIAS: 8 or more "yes"; MODERATE RISK OF BIAS: 6 to 7 "yes"; HIGH RISK: 5 or fewer "yes"; N/A. not applicable

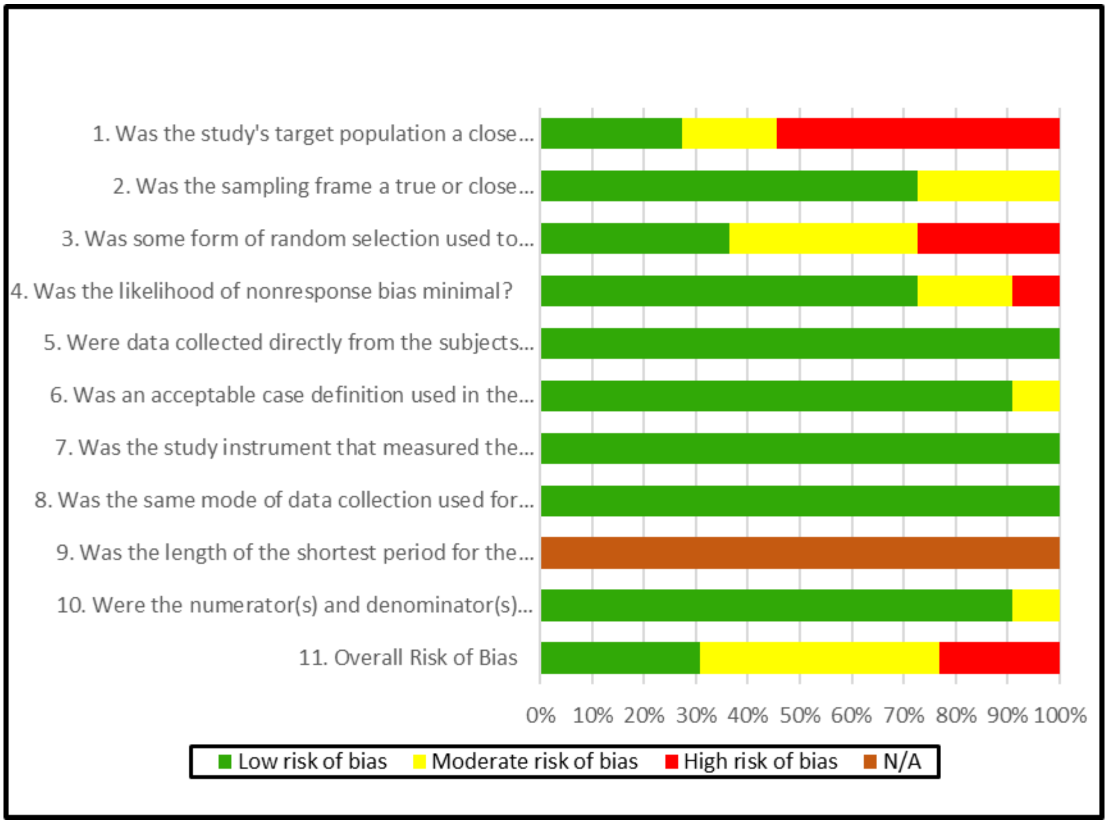

Figure 16: Risk of bias assessment chart for prevalence studies

4.8 Risk of bias assessment (cohort studies)

Risk of bias assessment for cohort studies was done using a risk of bias assessment tool for cohort studies developed by Cochrane. **Table 7** and **figure 17** summarizes the risk of bias assessment for all the cohort studies included in this systematic review.

Table 7: Risk of bias assessment for cohort studies

Study, year	Was selection of exposed and non-exposed cohorts drawn from the same population?	Can we be confident in the assessment of exposure?	Can we be confident that the outcome of interest was not present at the start of the study	Did the study match exposed and unexposed for all variables that are associated with the outcome of interest or did the statistical analysis adjust for these prognostic variables?	Can we be confident in the assessment of the presence or absence of prognostic factors?	Can we be confident in the assessment of outcome?	Was the follow up of cohorts adequate?	Were co-Interventions similar between groups?	Overall score	Risk of Bias
Von- Bischhoffshausen, 2014	N/A	Definitely yes	Definitely yes	N/A	Mostly yes	Definitely yes	Definitely yes	N/A		
Congdon,2008	Definitely yes	Definitely yes	Definitely yes	Mostly yes	Probably yes	Probably yes	Definitely yes	N/A	3	Moderate
Castanon, 2006	Mostly yes	Definitely yes	Definitely yes	Mostly yes	Mostly yes	Definitely yes	Definitely yes	N/A	4	Moderate
Rewri,2013	N/A	Definitely yes	Definitely yes	N/A	Probably yes	Probably yes	Probably no	N/A	2	High
Rustagi,2012	N/A	Definitely yes	Definitely yes	N/A	Probably No	Definitely yes	Definitely yes	N/A	4	Moderate
Limburg, 1999	N/A	Probably No	Mostly yes	N/A	Probably No	Probably yes	Definitely yes	N/A	1	High

5 or more "definitely yes" Low risk of bias, 3-4 "definitely yes" moderate risk of bias, 2 or few "definitely yes" high risk

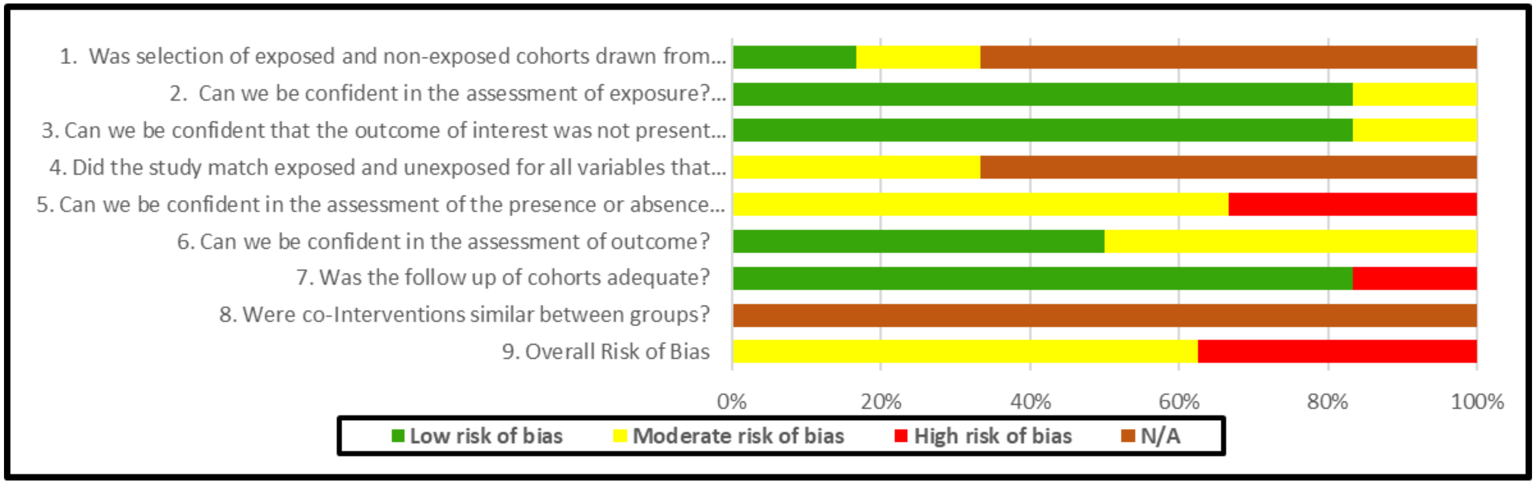

Figure 17: Risk of bias assessment chart for cohort studies

4.9 Quantitative Data synthesis

4.9.1 Outcome: Effectiveness of school vision screening programs in reducing children with uncorrected refractive error

a. Reduction in the proportion of children with uncorrected refractive error, 2 months after a school vision screening

One study (110) suggests that school vision screening may be effective in reducing the proportion of children with an uncorrected refractive error by 81% (95% CI: 77%; 84%), two months after its introduction (**figure 18**). This was judged to be moderate certainty evidence, downgraded one level for indirectness as this effect estimate might only be specific to China where the study was conducted.

Study or Subgroup	% Uncorrected RE-Baseline Events	% Uncorrected RE-Baseline Total	% Uncorrected RE-2 Month Events	% Uncorrected RE-2 Month Total	Risk Difference M-H, Random, 95% CI
Zhou, 2017	360	426	17	426	0.81 [0.77, 0.84]

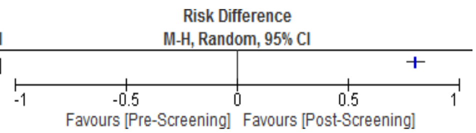

Figure 18: Forest plot showing a reduction in the proportion of children with an uncorrected refractive error at 2 months

b. Reduction in the proportion of children with uncorrected refractive error, 6 months after a school vision screening

Five studies (11, 104-106, 127) assessed the reduction in the proportion of children with an uncorrected refractive error at 6 months after school vision screening. These studies show that school vision screening programs may be effective in reducing the proportion of children with an uncorrected refractive error by 24% (95% CI: 13%; 35%,

I^2=95%), (**figure 19**). We judged this to be moderate certainty evidence, downgrading one level for inconsistency.

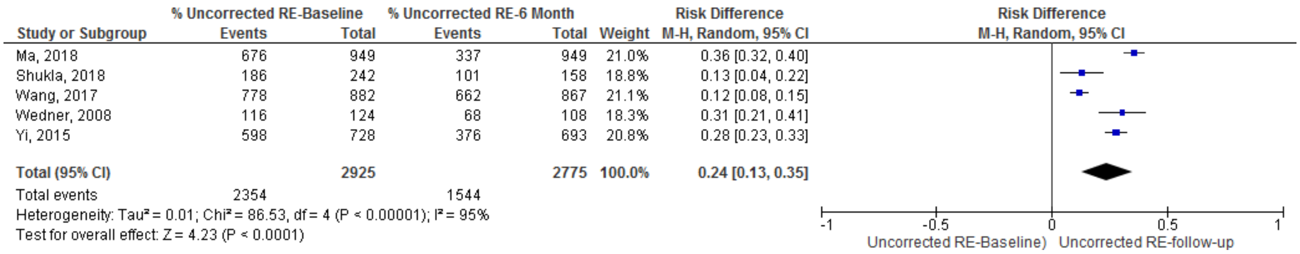

Figure 19: Forest plot showing a reduction in the proportion of children with an uncorrected refractive error at 6 months

c. Reduction in the proportion of children with uncorrected refractive error, 8 months after a school vision screening

This was assessed by one study (102). This study shows that school vision screening programs may be effective in reducing the proportion of children with an uncorrected refractive error by 20% (95% CI: 18%; 22%), (**figure 20**) at 8 months after its introduction.

We judged this to be moderate certainty evidence, downgrading one level for indirectness since the effect estimate may be specific to China where the study was conducted.

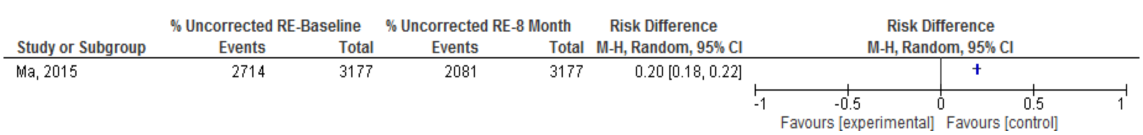

Figure 20: Forest plot showing a reduction in the proportion of children with an un-corrected refractive error at 8 month

Table 8: Reduction in the proportion of children with un/undercorrected refractive error

Study ID	Study design	Follow-Up Period	Number assessed for compliance at baseline	Number Eligible for follow-up	Number assessed for compliance at follow-up	% Follow-Up	Definition of Compliance	The proportion of children with un/under corrected RE at baseline (Before School vision screening)	The proportion of children with un/under corrected RE at follow-up (After School vision screening)	Reduction in Proportion of children with un/under corrected RE at follow-up (After School vision screening) (95% CI)
Zhou, 2017	randomized, double-masked non-inferiority trial	2 Month period	426	426	426	100%	Self-reported wear	84.5% (n=360)	4% (n=17)	**80.5% (CI: 77%, 84%)**
Wedner, 2008	Cluster randomized trial	6 month period	124	125	108	86%	Wearing or Having spectacle at school	93.6% (n=116)	63% (n=68)	**30.6% (CI: 21%, 41%)**
Wang, 2017	cluster randomized, investigator-masked, controlled trial	6 month period	882	882	867	98.3%	Wearing or Having spectacle at school	88.2% (n=778)	76.4% (n=662)	**11.8% (CI 8%, 15%)**
Ma, 2018	cluster randomized, investigator-masked, controlled trial	About 6 month period	949	949	949	100%	Self-reported wear	71.2% (n=676)	35.5% (n=337)	35.7 (32%, 40%)
Shukla, 2018	cross-sectional study	About 6 month period	242	186	158	84.9%	Wearing or Having spectacle at school	76.9% (n=186)	63.9% (n=101)	**13% (CI: 4%, 22%)**
Yi, 2015	Cluster randomized trial	6 month period	728	728	693	95.2%	Wearing or Having spectacle at school	82.1% (n=598)	54.3% (n=376)	**27.8% (CI: 23%, 33%)**
Ma, 2015	Cluster randomized trial	8 Month period	3177	3177	3177	100%	Wearing or Having spectacle at school	85.0% (n=2714)	65.50 (n=2081)	**19.5% (CI: 18%, 22%)**

4.9.2 Outcome: School vision screening and compliance with spectacle wear

a. Spectacle compliance Less than three months after a school vision screening

Compliance with spectacle wear at less than 3 months after school vision screening was assessed by three studies, (110, 111, 117). These studies show that 54% of children provided with spectacles as part of school vision screenings may be compliant with it wear at less than 3-month follow-up (95% CI: 25%; 100%, I^2=100%) (**Figure 21**). We judged this to be moderate certainty evidence downgrading 1 level for inconsistency. The level of spectacle compliance differed (high heterogeneity) based on the definition used in the various studies. One study (110) which defined spectacle compliance as 'self-reported wear by children' on the day of the assessment, found it to 96% (95% CI: 94%; 98%). Another study (111) which defined spectacle compliance as 'wearing or having at school' on the day of assessment found it to be 49% (CI: 45%; 54%), while a study (117) which defined compliance as 'observed wear' on the day of assessment found it to be relatively low; 33% (95% CI: 29%; 37%).

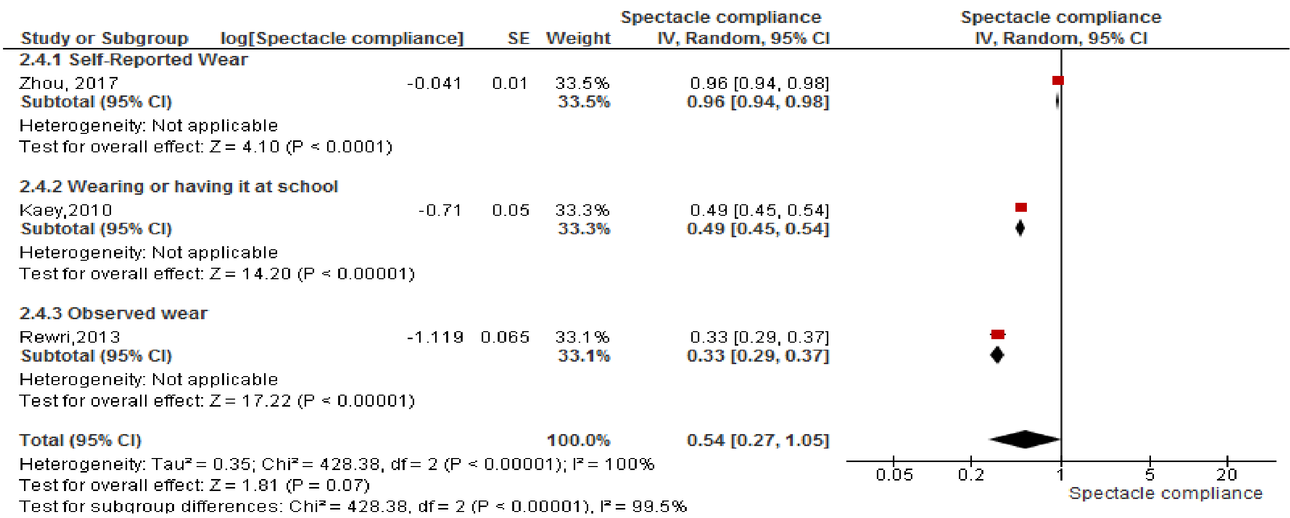

Figure 21: Forest plot showing spectacle compliance at < 3 month

b. Spectacle compliance three months after a school vision screening

Six studies (11, 108, 121, 123, 125, 126) assessed spectacle compliance at 3 months after school vision screening. These studies indicate that 57% of children provided with spectacles as part of school vision screening programs may be compliant with it wear at three-month follow-up (95% CI: 46%; 70%, I^2=94%) **(Figure 22).** We judged this evidence to be of low certainty, downgrading 2 levels for high risk of bias and inconsistency.

Four studies of these studies (11, 108, 123, 126) defined spectacle compliance as 'wearing or having spectacle at school' and found 62% of children to be compliant with it wear (95% CI: 51%; 77%, I^2=93%). Two studies (121, 125) which defined compliance as 'observed spectacle wear' on the day of assessment found 57% of children to be compliant with it wear (95% CI: 47%; 70%, I^2=94%).

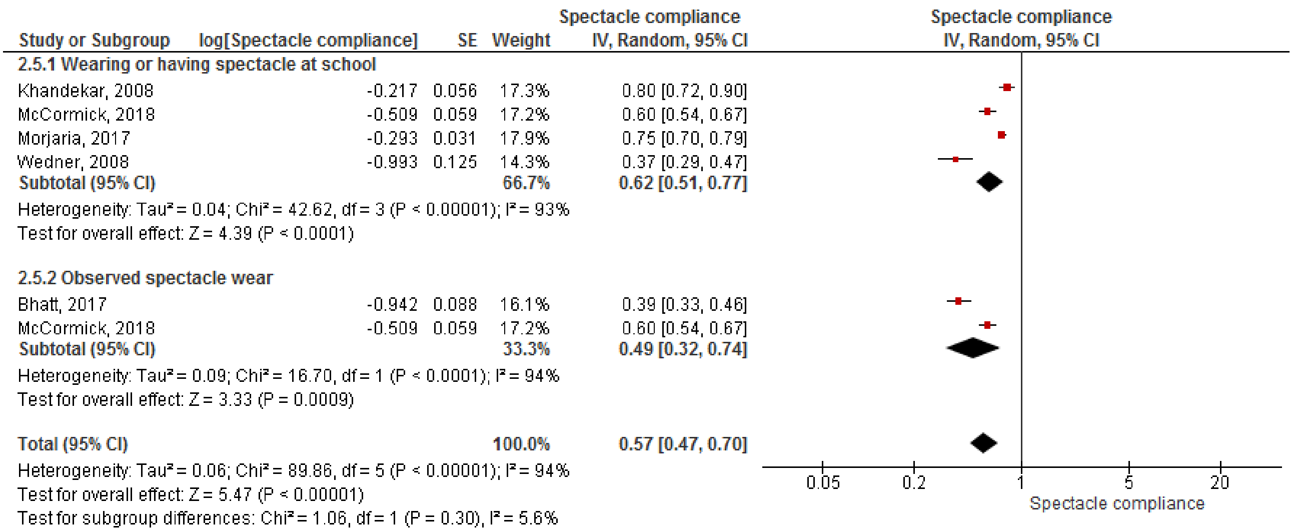

Figure 22: Forest plot showing spectacle compliance at 3 months

c. Spectacle compliance six months after a school vision screening

This was reported by nine studies (11, 104-107, 115, 119, 127, 128). These studies revealed that 38% of children provided with spectacles as part of school vision screening may be compliant with it wear at six-month follow-up (95% CI: 29%; 51%, I^2=94%], moderate certainty evidence (downgraded one level for inconsistency) **(Figure 23).**

One study (104) which defined spectacle compliance based on 'self-reported wear' found compliance among school children to be relatively high, 64% (95% CI: 62%; 68%) while five studies (11, 105-107, 115) which defined compliance as children 'wearing or having their spectacles at school' on the day of assessment found the pooled spectacle compliance among children to be low; 32% (95% CI: 23%; 45%, I^2=97%, moderate certainty evidence).

Three studies (119, 127, 128) defined spectacle compliance based on 'observed wear' on the day of assessment and found the pooled spectacle compliance among children to also below 35% (95% CI: 32%; 39%, I^2=25%, moderate certainty evidence).

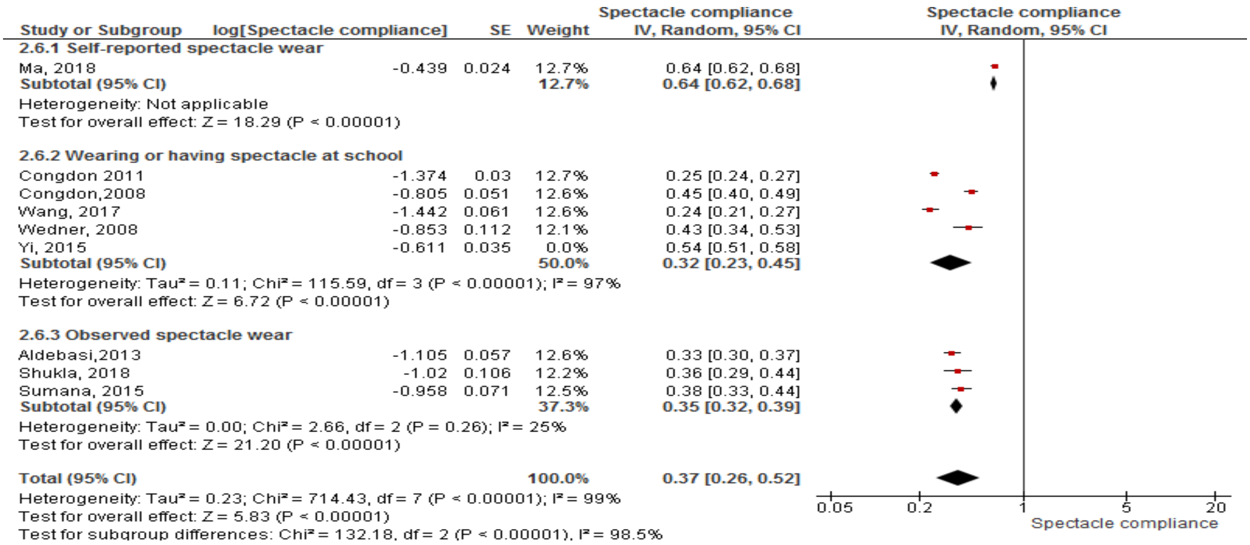

Figure 23: Forest plot showing spectacle compliance at 6 months

d. Spectacle compliance more than six months after a school vision screening

Seven studies (10, 102, 114, 116, 118, 120, 122) assessed spectacle compliance at more than 6 months after school vision screening. The results of these studies indicate that 41% of children provided with spectacles as part of school vision screening may be compliant with it wear at more than six months follow-up (95% CI: 24%; 68%, I^2=100 %,) **(Figure 24).** We judged this to be low certainty evidence, downgrading 2 levels for high risk of bias and inconsistency.

One of these studies from India, (116) which defined spectacle compliance based on 'teacher reported wear' found the level of spectacle compliance among children to be very high; 96% (95% CI: 96%; 97%). This study was however judged to have a high risk of bias**. (Table 6)**

Three of the studies; (102, 114, 120) which defined compliance as ‘wearing or having spectacle at school’ on the day of assessment found the pooled spectacle compliance among children to be relatively low; 34% (95% CI: 11%; 100%, I^2=100 %, Low certainty evidence).

Two studies; (118, 122) which defined spectacle compliance as ‘observed wear” by children on the day of assessment found the level of spectacle compliance among children to be even lower 32% (95% CI: 14%, 72%, I^2=24 %, moderate certainty evidence).

Definition of spectacle compliance was not clearly reported by one study (10). The authors, however, reported that regular use of spectacle was found among 20.4% (95% CI 12%; 35%)

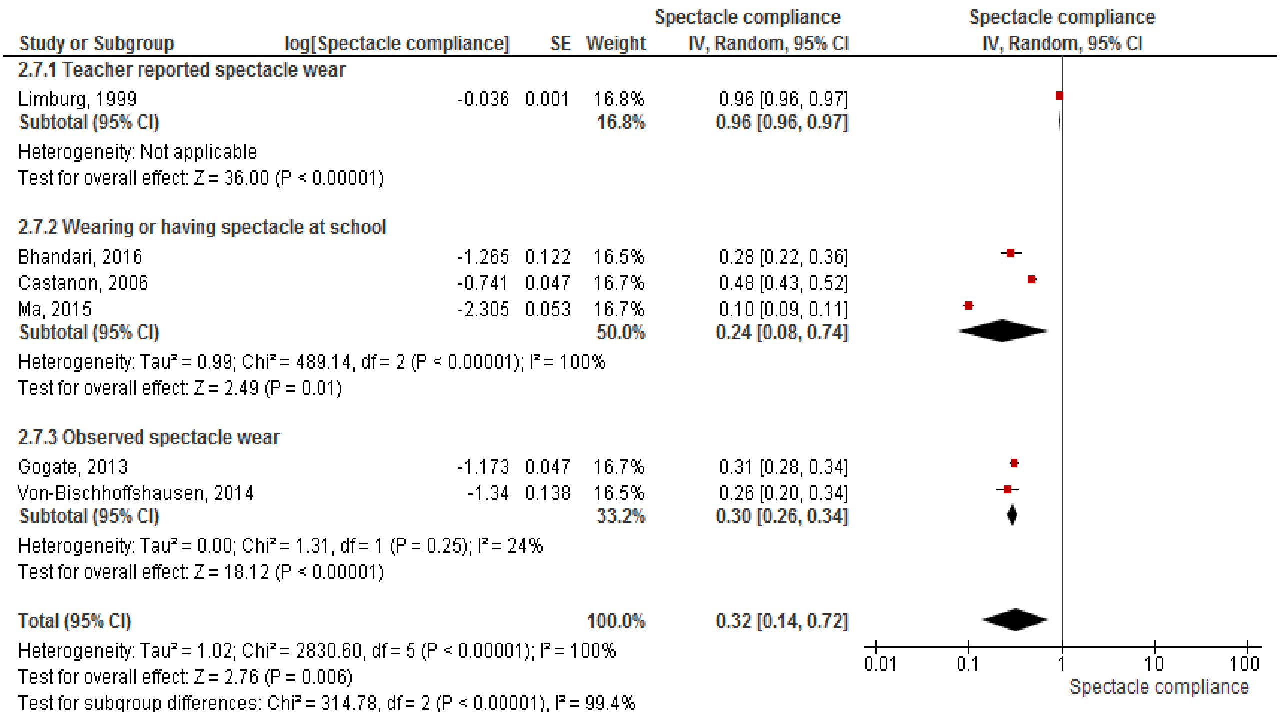

Figure 24: Forest plot showing spectacle compliance at >6 month

Spectacle compliance < 3 months after a school vision screening

Study ID	Study design	Follow-Up Period	Number Eligible for follow-up	Number assessed/sampled for compliance	% Follow-Up	Definition of Compliance	Spectacles wearing (compliance) At < 3 month Follow-up
Zhou, 2017	randomized, double-masked non-inferiority trial	2 Month period	426	426	100%	Self-reported wear	96% (n=409)
Kaey,2010	prospective clinical trial	1-month period	428	415	97%	Wearing or Having spectacle at school	49.2% (n=204)
Rewri,2013	prospective cohort study	2-month period	742	493	66%	Observed wear	32.7% (n=161)

Spectacle compliance 3 months after a school vision screening

Study ID	Study design	Follow-Up Period	Number Eligible for follow-up	Number assessed/sampled for compliance	% Follow-Up	Definition of Compliance	Spectacles wearing (compliance)
Khandekar, 2008	cross-sectional descriptive study	3- 4-month period	77	77	100%	Wearing or Having spectacle at school	80.5% (n=62)
Wedner, 2008	Cluster randomized trial	3&6-month period	125	108	86%	Wearing or Having spectacle at school	37.0% (n=40)
Morjaria, 2017	Non-inferiority, double masked, randomized clinical trial	3-4-month period	460	362	78.7%	Wearing or Having spectacle at school	74.6% (n=270)
Pavithra, 2014	cross-sectional study	3-month period	97	83	85.6%	Observed wear	57.8% (n=48)
Bhatt, 2017	cross-sectional study	3-month period	200	200	100%	Observed wear	39% (n=78)
McCormick, 2018	Cross-sectional study	3-4-month period	286	193	67.4%	Wearing or having spectacle at school	60.1% (n=116)

Spectacle compliance 6months after a school vision screening

Yi, 2015	Cluster randomized trial	6-month period	728	693	95.2%	Wearing or Having spectacle at school	45.7% (n=376)
Congdon, 2011	Randomized, controlled trial.	6-month period	4448	3200	71.94%	Wearing or Having spectacle at school	25.3% (n=810)
Wang, 2017	cluster randomized, investigator-masked, controlled trial	6-month period	882	867	98.3%	Wearing or Having spectacle at school	23.6% (n=205)
Ma, 2018	cluster randomized, investigator-masked, controlled trial	About 6-month period	949	949	100%	Self-reported wear	64.5% (n=612)
Congdon,2008	Prospective study (cohort)	4-11-month period, mean 6.4 months	810	483	60%	Wearing or Having spectacle at school	44.7% (n=216)
Shukla, 2018	cross-sectional study	About 6-month period	186	158	84.9%	Observed wear	36.1 (n=57)
Aldebasi,2013	cross-sectional descriptive study	6 month period	631	631	100%	Observed wear	33.1% (n=209)
Sumana, 2015	cross-sectional descriptive study	6-month period	362	318	88%	Observed wear	38.4% (n=122)
Wedner, 2008	Cluster randomized trial	3&6-month period	125	108	86%	Wearing or Having a spectacle at school	42.6.% (n=46)

Spectacle compliance >6 months after a school vision screening

Von-Bischhoffshausen, 2014	Cohort study	12 Month period	204	199	97.5%	Observed wear	58.3% (n=116)
Gogate, 2013	Cross-sectional follow-up study	12 Month period	1035	1018	98.3%	Observed wear	31% (n=315)
Rustagi,2012	intervention study	8-month period	51	49	96.1%	Not clearly defined (reported as "regular use" by authors)	20.4% (n=10)
Limburg, 1999	Retrospective Cohort study	60-month period	43922	43922	100%	Teacher reported	96.5% (n=42390)
Castanon, 2006	prospective cohort study	18-month period	493	493	100%	Wearing or Having spectacle at school	47.7% (n=235)
Ma, 2015	Cluster randomized trial	8 Month period	3177	3177	100%	Wearing or Having spectacle at school	34.50% (n=1096)
Bhandari, 2016	population- based, cross – sectional study	12-month period	170	170	100%	Wearing or Having spectacle at school	28.2% (n=48)

4.9.3 Outcome: Cost-effectiveness of school vision screening

Five studies (11, 103, 113, 124, 129) reported school vision screenings to be cost-effective (Moderate certainty evidence). One study (11) estimated the overall cost of screening and provision of spectacle for each student to be $0.87. This was reported to be nearly one-fourteenth of the Tanzania total health expenditure on health of $12 per capita in 2004. This evidence was however judged to be of low certainty after downgrading two levels for indirectness since the cost estimate was specific to Tanzania and estimation was done about ten years ago.

One study (103) estimated the cost of buying high quality spectacles in bulk which is normally the case in most school vision screening programmes to be less than $5 compared to the median price of approximately $60 (almost half the monthly income for rural families in China) paid by each child who owned a pair of spectacles outside the school vision screening context. We judged this to be moderate certainty evidence, downgrading one level for indirectness since the cost estimate was specific to China.

One study (113) compared the cost of screening per child using an "all class teacher model" versus a "selected class teacher model" in India and found school vision screening programs involving all class teachers to be efficient and cost-effective (moderate certainty evidence). The cost of screening one child using the 'all class teacher model" was estimated to be $ 1.91 compared to the $4.83 per child screened using the "selected teacher model"

One study (124) estimated the overall cost of screening one child based on the cost of the materials used in school vision screening (visual acuity cards, tape measure, etc.). The cost of screening one child with no refractive error was estimated to be less than $0.03 while the cost of screening and providing spectacles for a child with the refractive error was estimated to be $2.55. We judged this to be low certainty evidence downgrading two levels for indirectness since the cost estimate was specific to India and cost estimation was done about 23 years ago.

The direct cost of screening one student with no ocular abnormality (excluding project management and traveling expenses) was estimated by one study (129) to be approximately $0.5. This cost, however, increased to $34.2 per child for implementation of nationwide programs targeting children with treatable mild, moderate and severe problems and $76.2 for nationwide programs targeting only children with moderate and severe conditions. The certainty of this evidence was judged by us to be low, downgraded 3 levels for imprecision based on the risk of bias assessment and indirectness as cost estimate is specific to Thailand and estimation was done 9 years ago.

4.9.4 Outcome: Impact of school vision screening on the academic performance of children

Five studies; (103, 104, 106, 122, 126) reported on the impact of school vision screening on the academic performance of children. All five studies reported that school vision screenings had a positive impact on the academic performance of children. Improvement in mathematics test score from 0.22 (SD; 0.99) at baseline to 0.34 (SD; 0.99), eight months after school vision screening (change of 0.13, CI: 0,008-0.17) was reported by one study (103). The authors reported that despite the low level of compliance with spectacle wear observed in the study, screening, and provision of spectacles had a statistically significant impact on the academic performance of children. We judged this to be moderate certainty evidence; downgrading one level for indirectness.

One study (106) compared the improvement in mathematics test score between children who received free spectacles and teacher incentive to improve spectacle compliance with and that of children who only received a prescription for spectacle and found an improvement in mathematics test score in the two groups, six months after school vision screening. The authors reported that children in schools that received the free spectacles and teacher incentive as part of school vision screening performed slightly better in the mathematics test but this was not statistically significant. We graded this evidence to be of moderate certainty, downgrading one level for indirectness.

In one study (104), improvement in mathematics test score was compared between children in the “early referral to the hospital” and “late referral to hospital” group. The mean baseline mathematics test score was reported to be 0.09 (SD; 1.1) and -0.05 (SD; 1.0) in the “early referral to hospital” and “late referral to hospital” groups respectively. The mean mathematics test score increased at 6 months follow up to

0.14 (SD; 1.01) and -0.16 (0.97) in the “early referral to the hospital” and “late referral to hospital” group respectively with the adjusted effect on mathematics test score comparing the two groups reported being 0.25 SD (95% CI, 0.01; 0.48, 1-sided P=0.04). The authors reported that this point estimate of the effect of the intervention was equivalent to half a semester additional learning. We graded this to be moderate certainty evidence, downgrading one level for indirectness.

One study (126) reported that among children who were compliant to wearing spectacles prescribed as part of school vision screening, 42 (87.5%) had an improvement in academic performance which was confirmed in 36 (85.7%) of the students by teachers. We judged this to moderate certainty evidence after downgrading one level for indirectness.

Another study (122) also reported a higher average academic score among children who were compliant with spectacle wear compared to those who were non-compliant but this evidence was judged to be of low certainty, downgrading two levels for imprecision (a small number of events) and indirectness.

4.9.5 Outcome: The adverse effect of school vision screening

The adverse effect of school vision screening was reported by three studies (106, 108, 109). One study (106) reported a reduction in LogMar visual acuity from 0.59 (SD; 0.22) at baseline to 0.71(SD 0.21) at six-month follow-up with a change of -0.12 (95% CI 0.14, 0.10). This evidence was judged to be of moderate certainty after downgrading one level for indirectness.

One study (109) found spectacles provided as part of school vision screening to be associated with 27.2% report of headache, 34.6% report of dizziness, 6.18% report of disorientation, 9.90% of nausea and 48.76% of eye strain. This reported effect however reduced to 21.50% headache, 7.00% disorientation, 22.2% dizziness, 7.48% nausea and 48.55% eye strain at 1-month follow-up. We judged this to be moderate certainty evidence.

Another study (108) also reported the presence of symptoms of headache and dizziness among children who received spectacles at the start of the school vision screening which reduced at a one-month follow-up.

5.0 Discussion

5.1 Summary of main results

School vision screening programs for refractive error are mainly aimed at reducing the number of children with uncorrected refractive error. Effectiveness of these programs depends on correctly identifying children with uncorrected refractive errors. In addition, it also depends on ensuring that children identified with the condition are given the appropriate spectacle or contact lens correction at reasonable costs, and these spectacles or contact lenses are worn on regular basis (compliance).

The purpose of this review was to assess the effectiveness of school vision screening programs in reducing children with uncorrected refractive error and evaluate the level of compliance with wearing of spectacles provided as part of school vision screening programs. We further sought to assess the cost-effectiveness of school vision screening programs, the effect of school vision screenings on the academic performance of children and adverse effect of school vision screenings in the LMIC context.

Our review found that introducing vision screening programs in schools may be an effective way of reducing the number of children with uncorrected refractive error. Considering the fact that the provision of free spectacles to children with uncorrected refractive error has become central to most school vision screening programs in recent times, this finding is not unexpected.

This review also found school vision screening together with the provision of spectacles be relatively cost-effective. This result agrees well with a recent Cochrane review
(13) which found vision screening and provision of spectacles to be a relatively cost-saving way of correcting children with uncorrected refractive error in the LMIC settings.

In terms of the impact of school vision screening programs on the academic performance of children, our review found a positive association between the introduction of school vision screening programs and improvement in the academic performance of children. This result also agrees with a recent Cochrane review (13) which to the best of our knowledge is the only systematic review that has attempted to assess the impact of school vision screening on the academic performance of children in the LMIC context.

While symptoms such as dizziness, disorientation, nausea, and eye strain were found to be associated with the initial use of spectacles provided as part of school vision screening programs, our review found that these symptoms improved significantly at follow-up indicating that school vision screening is relatively safe in identifying and treating children with uncorrected refractive error.

Compliance with the wearing of spectacles provided as part of school vision screening, similar to a Cochrane review (13) was found to vary among the various studies and ranged between 32% to 96%. The possible reason for this could be the different definition of compliance used in these studies. Spectacle compliance was defined as ‘wearing or having it at school’, ‘self-reported wear’ or ‘observed wear’ by the various studies included in this systematic review. Considering the fact that the different definition used as an indication of spectacle compliance by the various studies could have had an effect on the pooled spectacle compliance found in this review, we conducted a sub-group analysis based on the definition and the result is presented in **Figure 21, Figure 22, Figure 23 and Figure 24.** This should be taken into consideration when interpreting the result of this review.

5.2 Overall Completeness and applicability of evidence

Considerable effort was made to ensure the overall completeness of this systematic review by including all studies conducted in LMIC that assessed our review objectives. Our study found school vision screening programs to be a relative cost-effectiveness method of reducing the proportion of children with uncorrected refractive error. Despite a comprehensive search strategy to ensure all studies conducted in LMIC that met our eligibility criteria were included, most of the papers included in this review came from Asia and the applicability of this evidence to other LMIC where none of the included studies came from may be limited. This is especially the case as vision screening programs have been shown to vary across different settings. This means that the result of this review should be applied with cautious when assessing the effectiveness of school vision screening in other countries or settings especially those outside the LMIC.

Another important limitation of this review is that the pooled spectacle compliance found in this review was obtained from studies that used different definitions as an indication of spectacle compliance. Studies that defined spectacle compliance based on 'self-reported wear' reported a higher level of compliance which may have overestimated the overall effect and studies that defined spectacle compliance based on 'observed wear' reported lower spectacle compliance which may have underestimated the pooled spectacle compliance. This should be taken into consideration in interpreting the result of this review.

This review also included only papers published in the English language. This means that papers published in other languages were missed and the effect of excluding these papers on the overall effects reported in this review is not clear.

5.3 Certainty of evidence

We made use of the GRADE approach to judge the certainty of the evidence presented in this systematic review. Our primary outcome was graded as moderate certainty evidence, usually downgrading one level for either inconsistency or indirectness.

Concerning spectacle compliance, all the outcomes presented in this review were graded as moderate certainty evidence except spectacle compliance at three months and more than three months post-school vision screening which were graded as low certainty evidence, downgrading two levels for high risk of bias and inconsistency.

The outcomes for the cost-effectiveness of school and impact of school vision screening on academic performance of children were graded as moderate certainty evidence, downgrading one level in both cases for indirectness as estimates are more likely to be specific to the countries in which the included studies were conducted.

The outcome for the adverse effect of school vision screening was graded as high certainty evidence.

5.4 Potential bias in the review process

An effort was made to reduce bias in the conduct of this systematic review by conducting a comprehensive and systematic search for eligible papers, involving two independent reviewers in the assessment of study eligibility, extraction of study data and assessment of the risk of bias of the included studies. The review was however limited to studies published in the English language and the effect of excluding these studies on the outcome reported in this review is not clear. The potential bias that could have resulted from reporting the result of this systematic review was also avoided by adhering to the PRISMA guidelines.

5.5 Agreement and disagreement with other studies or reviews

To the best of our knowledge, no current systematic review has assessed the effectiveness of school vision screening in reducing the proportion of children with uncorrected refractive error. One Cochrane review (13) assessed the cost-effectiveness and impact of school vision screening on the academic performance of children. Our result on cost-effectiveness and impact of school vision screening agrees well with the result of this Cochrane review. The outcome for the level of compliance with spectacle wearing found in this systematic review is slightly lower than was reported in the Cochrane review (13). This outcome was however assessed from ten studies compared to only two studies from the Cochrane review and the use of "observed wear' as indication for spectacle compliance in eight of the studies included in our review compared to "self-reported wear' in the two studies included in the Cochrane review could have led to an over-estimation of the pooled level of spectacle compliance found in the Cochrane review.

6.0 Authors' conclusion

6.1 Implication for practice

Result of this review shows that school vision screening together with the provision of spectacle may be a safe and cost-effective way of reducing the proportion of children with uncorrected refractive error. Most of the studies included in this review were conducted in Asia and the applicability of this finding to countries in other regions of the world especially those outside the LMIC circle is not clear.

6.2 Implication for research

RCTs assessing the effectiveness of health intervention are known to provide the highest form of evidence compared to other study designs. Our review found no RCT that compared school vision screening to no vision screening which in our opinion will have provided better evidence of the effectiveness of school vision screening in resource-limited settings. Additionally, considerable variation was found in the definition of spectacle compliance by the various studies which likely had an effect on the pooled spectacle compliance reported in this review. Establishing a common global definition for spectacle compliance to be used in subsequent studies may be an effective way to ensure accurate estimation of overall spectacle compliance in subsequent reviews.

This review further found only a few studies conducted outside Asia that assessed the effectiveness of school vision screening, limiting the applicability of the outcome of this review to that area. Studies especially RCTs aimed at assessing the effectiveness of school vision screening in areas where no studies were found is highly recommended.

As this was a mini-dissertation which required focussing on fewer secondary objectives, this review was unable to assess the barriers to school vision screening and available evidence regarding the benefits of integrating school vision screening into the global educational system. Reviews that seek to add to knowledge in this area is also highly recommended

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5.0 APPENDICES

5.1 Search strategy

PubMed Search strategy, modified as needed for other electronic databases

Population		
1.	MeSH	Child [MeSH] OR Adolescents [MeSH]
2.	Free text	Child OR children OR adolescent OR adolescents OR teenager OR teenagers OR student OR students OR pupil OR pupils OR learner OR learners OR pediatric OR pediatric
3.	1 OR 2	
4.	MeSH	Schools [MeSH] OR School Health Services [MeSH]
5.	Free text	School OR schools OR preschool OR preschools OR school-based OR educational intervention
6.	4 OR 5	
7.	3 AND 6	
Intervention		
8.	MeSH	Vision Tests [MeSH]
9.	Free Text	Eye screening OR eye tests OR vision screening OR vision tests
10.	8 OR 9	
Outcome		
11.	MeSH	Refractive Errors [MeSH] OR Eyeglasses [MeSH]
12.	Free text	Refractive Errors OR Refractive error OR eyeglasses OR spectacles OR vision deficit OR visual acuity OR Myopia OR Hyperopia OR Aniseikonia OR Anisometropia OR Astigmatism
13.	11 OR 12	
14.	7 AND 10 AND 13	
15.	Filter	("deprived countries" OR "deprived country" OR "deprived nation" OR "deprived nations" OR "deprived population" OR "deprived populations" OR "deprived world" OR "developing countries" OR "developing country" OR "developing economies" OR "developing economy" OR "developing nation" OR "developing nations" OR "developing population" OR "developing populations" OR "developing world" OR "lami countries" OR "lami country" OR "less developed countries" OR "less developed country" OR "less developed economies" OR "less developed economy" OR "less developed nation" OR "less developed nations" OR "less developed population" OR "less developed populations" OR "less developed world" OR "lesser developed countries" OR "lesser developed country" OR "lesser developed economies" OR "lesser developed economy" OR "lesser developed nation" OR "lesser developed nations" OR "lesser

		developed population" OR "lesser developed populations" OR "lesser developed world" OR "LMIC" OR "LMICS" OR "low gdp" OR "low gnp" OR "low gross domestic" OR "low gross national" OR "low income countries" OR "low income country" OR "low income economies" OR "low income economy" OR "low income nation" OR "low income nations" OR "low income population" OR "low income populations" OR "lower gdp" OR "lower gnp" OR "lower gross domestic" OR "lower gross national" OR "lower income countries" OR "lower income country" OR "lower income economies" OR "lower income economy" OR "lower income nation" OR "lower income nations" OR "lower income population" OR "lower income populations" OR "Middle-income countries" OR "middle income country" OR "middle income economies" OR "middle income economy" OR "middle income nation" OR "middle income nations" OR "middle income population" OR "middle income populations" OR "poor countries" OR "poor country" OR "Poor Economies" OR "Poor Economy" OR "poor nation" OR "poor nations" OR "poor population" OR "poor populations" OR "poor world" OR "poorer countries" OR "poorer country" OR "Poorer Economies" OR "Poorer Economy" OR "poorer nation" OR "poorer nations" OR "poorer population" OR "poorer populations" OR "poorer world" OR "third world" OR "transitional countries" OR "transitional country" OR "Transitional Economies" OR "Transitional Economy" OR "under developed countries" OR "under developed country" OR "under developed economies" OR "under developed economy" OR "under developed nation" OR "under developed nations" OR "under developed population" OR "under developed populations" OR "under developed world" OR "under served countries" OR "under served country" OR "under served nation" OR "under served nations" OR "under served population" OR "under served populations" OR "under served world" OR "underdeveloped countries" OR "underdeveloped country" OR "underdeveloped economies" OR "underdeveloped economy" OR "underdeveloped nation" OR "underdeveloped nations" OR "underdeveloped population" OR "underdeveloped populations" OR "underdeveloped world" OR "underserved countries" OR "underserved country" OR "underserved nation" OR "underserved nations" OR "underserved population" OR "underserved populations" OR "underserved world") OR (Afghanistan OR Albania OR Algeria OR “American Samoa” OR Angola OR Armenia OR Azerbaijan OR Bangladesh OR Belarus OR Byelarus OR Belorussia OR Belize OR Benin OR Bhutan OR Bolivia OR Bosnia OR Botswana OR Brazil OR Bulgaria OR Burma OR “Burkina Faso” OR Burundi OR “Cabo Verde” OR “Cape verde” OR Cambodia OR Cameroon OR “Central African Republic” OR Chad OR China OR Colombia OR Comoros OR Comores OR Comoro OR Congo OR “Costa Rica” OR “Côte d'Ivoire” OR Cuba OR Djibouti OR Dominica OR “Dominican Republic” OR Ecuador OR Egypt OR “El Salvador” OR Eritrea OR Ethiopia OR Fiji OR Gabon OR Gambia OR Gaza OR “Georgia Republic” OR Georgian OR Ghana OR Grenada OR Grenadines OR Guatemala OR Guinea OR “Guinea Bisau” OR Guyana OR Haiti OR Herzegovina OR Hercegovina OR Honduras OR India OR Indonesia OR Iran OR Iraq OR Jamaica OR Jordan OR Kazakhstan OR Kenya OR Kiribati OR Korea OR Kosovo OR Kyrgyz OR Kirghizia OR Kirghiz OR Kirgizstan OR Kyrgyzstan OR “Lao PDR” OR Laos OR Lebanon OR Lesotho OR Liberia OR Libya OR Macedonia OR Madagascar OR Malawi OR Malay OR Malaya OR Malaysia OR Maldives OR Mali OR “Marshall Islands” OR Mauritania OR Mauritius OR Mexico OR Micronesia OR Moldova OR Mongolia OR Montenegro OR Morocco OR Mozambique OR Myanmar OR Namibia OR Nepal OR Nicaragua OR Niger OR Nigeria OR Pakistan OR Palau OR Panama OR

		“Papua New Guinea” OR Paraguay OR Peru OR Philippines OR Phillippines OR Philipines OR Philippines OR Principe OR Romania OR Rwanda OR Ruanda OR Samoa OR “Sao Tome” OR Senegal OR Serbia OR “Sierra Leone” OR “Solomon Islands” OR Somalia OR “South Africa” OR “South Sudan” OR “Sri Lanka” OR “St Lucia” OR “St Vincent” OR Sudan OR Suriham OR Suriname OR Swaziland OR Syria OR “Syrian Arab Republic” OR Tajikistan OR Tadzhikistan OR Tadjikistan OR Tadzhik OR Tanzania OR Thailand OR Timor OR Togo OR Tonga OR Tunisia OR Turkey OR Turkmen OR Turkmenistan OR Tuvalu OR Uganda OR Ukraine OR Uzbek OR Uzbekistan OR Vanuatu OR Vietnam OR “West Bank” OR Yemen OR Zambia OR Zimbabwe)
16.	14 AND 15	

5.2 Data Extraction and Assessment Form (EPOC)

DATA EXTRACTION TOOL

Review title or ID

Study ID *(surname of first author and year first full report of study was published e.g. Smith 2001)*

Report IDs of other reports of this study *(e.g. duplicate publications, follow-up studies)*

Notes:

1.0 GENERAL INFORMATION	**Date form completed**	
	Name/ID of person extracting data	
	Study Title	
	Author(s)	
	Year	
	Trial Registration Number	
	Reference details	
	Report author contact details	
	Publication type *(e.g. full report, abstract, letter)*	
	Study funding source *(including the role of funders)*	
	Possible conflicts of interest *(for study authors)*	
	Notes:	

2.0 ELIGIBILITY	**Study Characteristics**	**Review Inclusion Criteria** *(Insert inclusion criteria for each characteristic as defined in the Protocol)*	**Yes/ No / Unclear**	**Location in text** *(pg & ¶/fig/table)*
	Type of study	Randomized trial		
		Non-randomised trial		
		Controlled before-after study • Contemporaneous data collection • At least 2 intervention and 2 control clusters		
		Interrupted time series OR Repeated measures study • At least 3 time points before and 3 after the intervention • Clearly defined intervention point		
		Other design (specify):		
	Participants			

2.0 ELIGIBILITY	**Study Characteristics**	**Review Inclusion Criteria** *(Insert inclusion criteria for each characteristic as defined in the Protocol)*		**Yes/ No / Unclear**	**Location in text** *(pg & ¶/fig/table)*
	Types of intervention				
	Types of outcome measures	Primary	Secondary		
	Decision:				
	Reason for exclusion				
	Notes:				

3.0 POPULATION AND SETTING	**Population description** *(from which study participants are drawn)*	**Description** *Include comparative information for each group (i.e. intervention and controls) if available*	**Location in text** *(pg & ¶/fig/table)*
	Study Period		
	Setting *(including location and social context)*		

3.0 POPULATION AND SETTING	**Population description** *(from which study participants are drawn)*	**Description** *Include comparative information for each group (i.e. intervention and controls) if available*	**Location in text** *(pg & ¶/fig/table)*
	Inclusion criteria		
	Exclusion criteria		
	Method/s of recruitment of participants		

4.0 METHODS		**Descriptions as stated in report/paper**	**Location in text** *(pg & ¶/fig/table)*
	1. **Aim of the study**		

	Design *(e.g. parallel, crossover, non-RCT)*		
	Unit of allocation *(by individuals, cluster/ groups or body parts)*		
	Start date		
	End date		
	Duration of participation *(from recruitment to last follow-up)*		
	Notes:		

5.0 PARTICIPANTS	Country				Location in text
	Setting				
	Baseline Characteristics				
			Mean	**Range**	
		Age			

		Gender	**Males**		**Females**	**Total Number**
			Number (n)	Proportion (%)	Number (n)	Proportion (%)
		Ethnic Group	**African**		**Non-African**	
			Number (n)	Proportion (%)	Number (n)	Proportion (%)
	Control Group (write it)	Age	**Mean**		**Range**	
		Gender	**Males**		**Females**	**Total Number**
			Number (n)	Proportion (%)	Number (n)	Proportion (%)
		Ethnic Group	**African**		**Non-African**	
			Number (n)	Proportion (%)	Number (n)	Proportion (%)
	Total no. randomized (Participants in Intervention and Control Group)	Age	**Mean**		**Range**	
		Gender	**Males (%)**		**Females (%)**	**Total No.**
			Number (n)	Proportion (%)	Number (n)	Proportion (%)
		Ethnic Group	**African**		**Non-African**	
			Number (n)	Proportion (%)	Number (n)	Proportion (%)
	Clusters (If applicable)					

	Participants Inclusion Criteria					
	Participants Exclusion Criteria					
	Pre-treatment					
	Baseline imbalances					
	Withdrawals and exclusions					
	Subgroups measured					
	Subgroups reported					
6.0 INTERVENTION	Intervention	Number Randomized	Number followed-Up	Number Reviewed	Description of Intervention	

Intervention Received by Both Groups/Co-interventions				
Outcome (Period)	**Primary**		**Secondary**	
Duration of Treatment/Intervention				
Provision of intervention *(e.g. no., profession, training, ethnicity, etc. if relevant)*				
Economic variables *(i.e. intervention cost, changes in other costs as a result of intervention)*				
7.0 OUTCOMES	Primary Outcome	Time Point Measured	Start of Intervention	End of Intervention
		Time Point Reported	Start of Intervention	End of Intervention

		Outcome definition	Desirable	Undesirable
	Secondary Outcome 1	Time Point Measured	Start of Intervention	End of Intervention
		Time Point Reported	Start of Intervention	End of Intervention
		Outcome definition	Desirable	Undesirable
	Secondary Outcome 2	Time Point Measured	Start of Intervention	End of Intervention
		Time Point Reported	Start of Intervention	End of Intervention
		Outcome definition	Desirable	Undesirable
	Person measuring/ reporting Outcome			
	Unit of Measurement *(if relevant)*	Primary Outcome	Secondary Outcome 1	Secondary Outcome 2
		Proportion (%)		
	Validation of Outcome Tool *(If applicable)*	Yes	No	Unclear
	Note			

8.0 RESULT	Outcome	Intervention group (With 95% CI)	Controls (With 95% CI)	Comparative Risk (With 95% CI)
	Proportion of Children with uncorrected/ under corrected refractive error **At Baseline**			
	Proportion of Children with uncorrected/under corrected refractive error **At 3 month Follow-up**			
	Proportion of Children with uncorrected/ under corrected refractive error **At 6 month follow-up**			
	Proportion of Children with uncorrected /under corrected refractive errors			

	Beyond 6 month Follow-up			
	The proportion of children wearing spectacles **At Baseline**			
	The proportion of children wearing spectacles **At 3 Month Follow-up**			
	Proportion of children wearing spectacles **At 6 Month Follow-up**			
	Proportion of children wearing spectacles **Beyond 6-month Follow-up**			
	Reported adverse effect of school Screening programmes **(Assessed at any**			

	the point in the study)			
	Reported cost-effectiveness of school vision screening programs **(Assessed at any point in the study**			
	Reported Effect of the Vision screening program on academic performance **(Assessed at any point in the study)**			
	Reported effect of vision screening method on the effectiveness of school screening program **(Assessed at any point in the study**			

<table>
<tr><td rowspan="9"></td><td rowspan="3">Number of missing participants and reasons
(if applicable)</td><td colspan="6">Intervention Group</td><td colspan="2">Comparator</td></tr>
<tr><td>No.</td><td colspan="5">Reason</td><td>No.</td><td>Reason</td></tr>
<tr><td></td><td colspan="5"></td><td></td><td></td></tr>
<tr><td rowspan="2">No. participants moved from other group and reasons
(*if applicable)*</td><td>No</td><td colspan="5">Reason</td><td>No</td><td></td></tr>
<tr><td></td><td colspan="5"></td><td></td><td></td></tr>
<tr><td>Any other results reported</td><td colspan="6"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">Statistical methods used and appropriatenes s of these methods</td><td colspan="3">Statistical Method Used</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td colspan="3">Method Appropriate</td><td>Yes</td><td colspan="2"></td><td>No</td><td>Unclear</td></tr>
<tr><td>Notes</td><td colspan="6"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">**9.0 APPLICABILITY**</td><td>Have important populations been excluded from the study?</td><td colspan="2">Yes</td><td></td><td>No</td><td></td><td colspan="2">Unclear</td><td></td></tr>
<tr><td>Is the intervention likely to be aimed at disadvantaged</td><td colspan="2">Yes</td><td></td><td>No</td><td></td><td colspan="2">Unclear</td><td></td></tr>
</table>

	groups?							
	Does the study directly address the review question?	Yes		No		Unclear		
	Notes							

10.0 OTHER INFORMATION	Key conclusions of study authors	
	References to other relevant studies	
	Correspondence required for further study information *(what and from whom)*	
	Further study information requested ***(from whom, what and when)***	
	Correspondence received *(from whom, what*	

	and when)	

5.3a HOY et al (2012) Risk of Bias Tool for Prevalence Studies

Name of author(s):

Year of publication:

Study title:

Risk of Bias Item	**Risk of bias level**
External Validity	
1. Was the study's target population a close representation of the national population in relation to relevant variables, e.g. age, sex, occupation?	
2. Was the sampling frame a true or close representation of the target population?	
3. Was some form of random selection used to select the sample, OR, was a census undertaken?	
4. Was the likelihood of non-response bias minimal?	
Internal Validity	

5. Were data collected directly from the subjects (as opposed to a proxy)?	
6. Was an acceptable case definition used in the study?	
7. Was the study instrument that measured the parameter of interest (e.g. prevalence) shown to have reliability and validity (if necessary)?	
8. Was the same mode of data collection used for all subjects?	
9. Was the length of the shortest prevalence period for the parameter of interest appropriate?	
10.. ere the numerator(s) and denominator(s) for the parameter of interest appropriate?	
Summary item on the overall risk of study bias: LOW RISK OF BIAS: 8 or more "yes" answers. Further research is very unlikely to change our confidence in the estimate. MODERATE RISK OF BIAS: 6 to 7 "yes" answers. Further research is likely to have an important impact on our confidence in the estimate and may change the estimate.	

HIGH RISK OF BIAS: 5 or fewer "yes" answers. Further research is very likely to have an important impact on our confidence in the estimate and is likely to change the estimate.	

5.3b Assessment of risk of bias for randomized control trials

Risk	**Reviewers' Judgement**	**Support for Judgement**	Location in Text
Random Sequence Generation (Selection bias)			
Allocation Concealment (Selection bias)			
Blinding of participants and personnel (Performance Bias)			
Blinding of outcome assessment			

(Detection bias)			
Incomplete outcome data (Attrition bias)			
Selective reporting (Reporting Bias)			

5.4 Preferred reporting items for systematic reviews and meta-analysis (PRISMA) checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	45-46
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	47-48
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	48

METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	12
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	49
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	50
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	115
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in a systematic review, and, if applicable, included in the meta-analysis).	51-52
Data collection process	10	Describe the method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	52-53
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	52
Risk of bias in individual studies	12	Describe methods used for assessing the risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	53
Summary measures	13	State the principal summary measures (e.g., risk ratio, the difference in means).	54
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	54-55

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of the risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	53

Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	53
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	56
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	58-63
Risk of bias within studies	19	Present data on the risk of bias of each study and, if available, any outcome-level assessment (see item 12).	63-70
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	71-86
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	71-78
Risk of bias across studies	22	Present results of any assessment of the risk of bias across studies (see Item 15).	63-70
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	53
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	86-88
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	88-89
Conclusions	26	Provide a general interpretation of the results in the context of other evidence and implications for future research.	91-92
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., the supply of data); the role of funders for the systematic review.	N/A

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

5.5 Plos one manuscript guide

Manuscript Organization

Manuscripts should be organized as follows. Instructions for each element appear below the list.

Beginning section	*The following elements are required, in order:* ➤ Title page: List title, authors, and affiliations as first page of manuscript ➤ Abstract ➤ Introduction
Middle section	*The following elements can be renamed as needed and presented in any order:* ➤ Materials and Methods ➤ Results ➤ Discussion ➤ Conclusions (optional)
Ending section	*The following elements are required, in order:* ➤ Acknowledgments ➤ References ➤ Supporting information captions (if applicable)
Other elements	➤ Figure captions are inserted immediately after the first paragraph in which the figure is cited. Figure files are uploaded separately. ➤ Tables are inserted immediately after the first paragraph in which they are cited. ➤ Supporting information files are uploaded separately.