Priorities in school eye health in low and middle-income countries
A scoping review

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Abstract

School eye health (SEH) has been on the global agenda for many years, and there is mounting evidence available to support that school-based visual screenings are one of the most effective and cost-efficient interventions to reach children over five years old. A scoping review was conducted in MEDLINE, Web of Science, PubMed and CINHAL between February - June 2023 to identify current priorities in recent literature on school eye health in low- and middle-income countries (LMICs). Selection of relevant publications was performed with Covidence, and the main findings were classified according to the WHO Health Promoting Schools framework (HPS). A total of 95 articles were included: cross-sectional studies (n = 55), randomized controlled trials (n = 7), qualitative research (n = 7) and others. Results demonstrate that multi-level action is required to implement sustainable and integrated school eye health programmes in low and middle-income countries. The main priorities identified in this review are: standardised and rigorous protocols; cost-effective workforce; provision of suitable spectacles; compliance to spectacle wear; efficient health promotion interventions; parents and community engagement; integration of programmes in school health; inter-sectoral, government owned programmes with long-term financing schemes. Even though many challenges remain, the continuous production of quality data such as the ones presented in this review will help governments and other stakeholders to build evidence-based, comprehensive, integrated and context-adapted programmes and deliver quality eye care services to children all over the world.

The search was conducted in MEDLINE, Web of Science, PubMed and CINHAL and the main search terms were: school setting, eye health, school-aged children, LMICs. Complete search strategy in presented in appendix 1.

Introduction

Access to quality eye care is essential to achieve the United Nations' Sustainable Development Goals(1). Nevertheless, 2.2 billion people suffer from visual impairment (VI), with 90% of them living in low and middle-income countries (LIMCs) (1). Vision loss can have a significant impact on education outcomes and life opportunities, but even so, approximately 70.2 million children under 14 years old are visually impaired or blind, mostly from uncorrected refractive errors (1). Specific data on school-going children is limited but global estimates evaluate that 448 million children present a significant refractive error (2).

One of the most effective and cost-efficient interventions to deliver eyecare to children is through school-based eye health programmes (SEHP)(1) This model is traditionally driven by non-governmental organizations (NGOs) and consists of outreach teams that visit schools, screen for children presenting reduced visual acuity (VA) and provide spectacles or referrals for advanced or specialist clinical care. While most agree that these interventions are important, there is no consensus on the optimal selection of tests or personnel to conduct screenings, and practices still vary widely, especially in limited resources settings (3, 4). Since 2016, many guidelines have been published to guide governments and organizations in planning, implementing and evaluating sustainable school-based initiatives such as the International Agency for Prevention of Blindness School Eye Health (SEH) guidelines for LMICs(5). However, the global context has changed since the publication of these guidelines, namely with the COVID-19 pandemic but also with recent developments in global eye health such as the official integration of eye health in the UN's universal health coverage objectives.

Therefore, this scoping review aims to identify new evidence published relative to SEH initiatives and identify topics to prioritize in future SEH programmes for LMICs.

Methodology

We developed a scoping review protocol in accordance with JBI methodology for scoping reviews (6) and the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (7). The protocol was not published *a priori*. The research question was: *What are the best practices in school eye health initiatives for children from low-middle income countries in recent publications since the release of IAPB's guideline in 2016?* With the assistance of a biomedical research librarian from *Université de Montréal*, we developed a search strategy based on the main search terms: school setting, eye health, school-aged children and LMICs. Complete search strategy in presented in appendix 1. The search was carried in four online databases, respectively MEDLINE®, Web of Science™ , PubMed® and CINHAL between February and June 2023. The main concept of the search, school-eye health initiatives, has been described as follows by Burton *et al.* (1): comprehensive school-based programmes that include screening approaches to identify children with vision impairment, spectacle provision, health education, promotion, and support inclusive education for children with vision impairment. All search results were imported in Covidence software (Veritas Health Innovation, Melbourne, Australia) and duplicates were automatically removed. References were included when conducted in LMICs based on World Bank's classification for the year 2023 (8), in school settings, with a population of schoolchildren aged 5-17years old, and published in English since 2016. A public health optometrist (AH) performed screening of title, abstract, and full text, with the support of an optometry professor (BT) when there was uncertainty on eligibility. We included only primary studies, but manual search of references in relevant systematic

reviews and meta-analysis provided additional records. Editorials, advanced clinical studies, epidemiological studies, and those conducted in disability schools were excluded. Studies on refractive errors were included if associated with preventable risk factors.

Based on the main topics emerging from the initial search, specific research questions were formulated: What are the new topics that can be found in recent literature on SEH? What national, local and school levels policies facilitate integration and scalability of SEH programmes? What are the best practices to promote SEH in school settings that lead to better compliance? Which protocols, techniques, and technologies result in better outcomes?

We therefore extracted the main outcomes of all the selected studies, but also screening protocols details such as visual acuity cut-off, refractive error definitions and charts used. We subsequently sorted results according to the Health Promoting Schools framework (HPS) (9). This framework, first introduced by the WHO in 1995 and updated in 2021, 'provides a resource to education systems to foster health and well-being through stronger governance'(9). It is an ecological model that proposes integration of school health services in a multi-level approach. The eight global standards of HPS defined by the WHO were adapted to school eye health with themes from literature, as shown in Figure 1. These concepts are very well aligned with the integrated approach suggest by the WHO and IAPB in the current guidelines for school eye health programmes (5, 10). Indeed, school-based vision screening are direct health services, but all the other components are required to ensure the delivery of sustainable, comprehensive, and effective school eye health programmes.

Results

A total of 7633 studies were retrieved from database searches and eight additional records were added through footnote chasing, as presented in the PRISMA flowchart (Figure 2). After the selection process, 95 publications were included, sorted by main theme, and summarized in Table 1. Almost half of the articles were from India (n = 44; 46.3%), others being mostly from Africa (n = 36.5; 38.4%) and Asia (n = 14.5; 15.3%). Most of the publications were cross-sectional studies (n = 55), with a few randomised experimental studies (n = 7), qualitative research (n = 7), economic evaluation (n = 5) and other designs (n = 21).

Figure 3 shows the volume of publications for each HPS theme. The school health service delivery is the main theme discussed in the selected studies.

School-based screenings

More than half of the selected studies focused on delivery components of school-based visual screenings (n = 50), such as protocols and techniques (n = 9), new technologies (n = 9), workforce (n = 12) and outcomes (n = 20).

Screening protocols

There is a multitude of school-based vision screening protocols described in recent studies, ranging from basic visual acuity assessment to comprehensive examinations by eye care professionals, some even including opportunistic screening for vitamin A deficiency (11) . Large variations were noted between studies with regards to visual acuity cut-offs, charts used and refractive error definitions, making comparison of outcomes challenging (see Table 2). Almost half of the selected studies used 6/12 as a cut-off, but most used 6/9, and these were mainly in India.

Disparities are documented even within countries, as demonstrated in a survey from Nigeria where 100% of the optometrists doing vision screening were including VA and ocular health assessment, 71.4% tested near vision, 35.7% evaluated for strabismus and only 14.2% did a refraction with retinoscopy or an autorefractor (12). While distance VA assessment alone has been shown to be inefficient for screening, the addition of retinoscopy significantly increases the accuracy of screenings but requires skilled screeners (13). Instrument-based screenings using portable focometers or autorefractors are easier to use but less accurate (14, 15). Similarly, noncycloplegic refraction is known to underestimate hyperopia and overestimate myopia in school-aged children (15), but the gold standard of cycloplegic refraction is not practical in school settings due to the parents' consent and side effects of the drops (16, 17). Non-cycloplegic spectacle correction was not greater than the clinically tolerable level of 0.5D in a study by Khurana (16), thus, it is suggested that non-cycloplegic refractions can be accepted if there are social, economic or logistical constraints. However, children should be referred for cycloplegic refraction when presenting with high levels of myopia, hyperopia or binocular vision issues (16, 17).

Rigorous and standardized protocols were described in a few studies. A structured protocol based on the WHO recommendations for Primary Eye Care in Africa has successfully been tested in Kenya, showing that it can be transferred to school settings (19). Also, at least three programmes (16, 17, 18) were based on the Refractive Error Study in Children (RESC) protocol, published in 2000. Similarly, multi-stage screenings are largely documented in India, being a time- and cost-effective model in low-resources settings, with its effective use of skilled human resources (20). The large-scale REACH programme includes an initial screening by

teachers with vision assessment, +1.50 lens test, torch light examination and colour vision for boys in graders 8-12. A detailed examination is provided to identified children the same day, on-site by an optometrist, with a retinoscopy, subjective refraction, cover test, torch light and direct ophthalmoscopy when needed. Children needing further evaluation were then referred to tertiary services. A 6-months unannounced visit is organized to monitor compliance and an annual follow-up cycle is planned. All data is registered in digital records, allowing monitoring progress and facilitating management. This standardized protocol has been implemented in more than 10,000 schools across five states in India and more than 2,000,000 children 5-18 years old underwent screening (21). An economic evaluation of this programme has shown that costs were low even with this comprehensive model (22).

Lastly, timing of screenings has been mentioned by few authors as an important issue to consider when organizing SEHP as seasonal variations may affect the screening's coverage (23, 24).

Technology

Many new technologies for school-based screening have been evaluated recently, aiming to improve efficiency of programmes. However, evidence is not very robust for most of them.

Different photoscreeners have been compared to subjective or cycloplegic refractions, with overall limited results. In fact, self-adjustable spectacles have been compared to cycloplegic refraction with clinically significative differences in two studies (25, 26). Similarly, the Welch Allyn Spot Vision Screener™ (Skaneateles Falls, USA) overestimated hyperopia and underestimated myopia but overall refraction values were considered acceptable for a screening test. Being

more portable than a traditional photorefractor, it can act as a guide for subjective correction, but not a replacement for retinoscopy (27). Other authors have explored the PlusOptix A09 (Nuremberg, Germany), the most commonly used screening tool for paediatric populations (28). The portable vision screener showed a minimal time for screening a child (4 seconds) and better cost-effectiveness compared to other photoscreeners and Mohindra, but variable validity (28-30).

Validity of smartphone fundus photographs that capture the undilated Bruckner's reflex has also been assessed to detect ocular morbidities. Photographs has shown good validity when researchers agreed on interpretation, but lower validity when disagreement (13% of photographs). Moreover, 13% of children have been excluded of the study due to poor quality of photographs (31).

Lastly, few studies evaluated Peek Vision, an app-based package developed to optimize outcomes of school-based screenings. There has been a significant improvement in referral rates with the Peek school eye health system (32), but no difference in spectacle wear at 3-4 months follow-up with the health education intervention (33). It has also been shown that Peek Acuity can be successfully used by teachers but had a higher rate of false positive than standard screening (32).

Therefore, while these technologies are promising, more evidence from LMICs will be needed.

Workforce

Twelve of the selected studies evaluated human resources performing school-based vision screenings, most of them involving teachers as screeners.

Conducting vision screenings is generally accepted by teachers, eye care professionals and parents (34-37). Vision screening by teacher is less costly than alternative primary eye care models (38) and shows overall good outcomes, especially with older children (18, 20, 39, 40). However, validity of screenings by teachers is variable when compared to eye care professionals as shown in Table 3a (18, 20, 39-44). Challenges reported by teachers in Pakistan include lack of training, heavy workload and lack of time (45). Therefore, authors recommend support of teachers with ongoing motivation, sufficient and standardized training, annual refresher courses, written guidelines, and supervision (20, 40, 45, 46). Strong monitoring and quality assurances are also needed to improve quality of screenings by teachers and limit potential workload of qualified eye care teams (42, 43). Interestingly, teachers in Zanzibar had better validity in screenings when vision screenings were integrated with a nutrition programme compared to vision screening only (23).

Some authors recently compared validity of alternative screeners such as community health workers (CHW) (44, 47), vision technicians (46) or allied health trainees (19), and obtained overall better outcomes than teachers (see Table 3b). This suggests that community-level workers may be more efficient primary screeners (46). However, they also showed a lack of training, shortage of available workforce and reduced access to transport in Malawi (34).

Lastly, student-led screenings in Nepal have been shown to be a cost-effective model for countries with limited financial resources (48), but it is not an effective approach according to eye care professionals in Pakistan (45).

Outcomes

The ultimate outcome for vision screening is to achieve better educational outcomes through good vision. In fact, children with uncorrected refractive errors have significantly lower academic results than normal-sighted children (49), and children with adequate correction have better academic results after wearing spectacles (50).

Nevertheless, spectacle rate at follow ups are generally low, ranging from 0% (51) to 65.9% (52). Better compliance rates are reported with children presenting myopia and when they notice a vision improvement with their spectacles (51-55). Indeed, students with initial VA worse than 6/18 in the better eye were almost three times more likely to be wearing their spectacles than those with better presenting VA (56). Another study in India demonstrated that spectacle use increase by 10% with refractive errors over 0.75D (55). Correlations between better compliance and other factors were generally not consistent from one study to the other, except for parents wearing spectacles and those with higher education (51, 53, 57, 58).

Broken and lost frames are the main factors mentioned by children for non-spectacle use, in addition to lack of frame measurements and consequential discomfort (23, 24, 26, 41, 51-55, 58-61). Indeed, large variations between facial and frames measurements are reported, and 8% of selected children in India were wearing adult frames at follow-up (55, 62). Moreover, Indian students mentioned that they expected trendy, stylish and resistant spectacles, so providing proper quality frames adapted to children and following their preferences when choosing frames has been suggested to improve compliance after school screenings (24, 55, 61, 63). Ready-made spectacles can be a cost-effective and acceptable alternative to custom-made spectacles, with similar spectacle wear rates and symptoms of discomfort than custom-made spectacles (56), and potential cost-savings for national programmes (38, 64). Respectively 86.0% and 86.7% of children in India and Ghana were eligible to ‘ready-to-clip’ spectacles (56, 65).

Additionally, stakeholders often cited concerns about spectacle affordability (24, 34, 59, 61, 66-68). In fact, unmet needs and spectacle coverage rate was found to be significantly lower in low-income families in multiple settings and out-of-pocket payments may limit access to eye care (68-70). Therefore, financial input from the community, in the form of health insurance or other support, is required to ensure equity in spectacle provisions (59, 68). An economic evaluation by Burnett *et al*. showed that a tier pricing structure based on capacity to pay could improve equity to access quality frames and decrease the dependence on external funding (59). A public-private partnership with local eye clinics is another suggested model for providing subsidised spectacles to children after school vision screening when costs are prohibitive, leading to better compliance rates (52). Indeed, free spectacles have been shown to be beneficial when delivered directly in school, with a majority of parents feeling good about them when they are of good quality (59, 61).

Logistics and geographic issues were also mentioned as significant barriers to compliance, namely due to misunderstanding of referral letters, restricted time off from work and transport to clinics limit access to the required follow-ups in rural regions (34, 59, 66, 67). Lastly, parents' disapproval and friends teasing are other frequently cited reasons for non-wear of spectacles, as discussed in the next section.

<u>Socio-emotional and physical environments</u>

The HPS framework stipulates that schools should provide favourable social and physical environments for school-based health services (9). Despite this recommendation, social stigma is still one of the main barriers to spectacle wear cited by students. When asked about non-wear of spectacles, they frequently mention fear, teasing, peer pressure and family disapproval (23,

34, 41, 51, 54, 57, 59, 61, 71, 72). Parents also demonstrate negative perceptions towards spectacles, such as not believing that their child needs correction, being concerned by the risk of dependency, of potential damage to their child's eyes, a lack of trust in modern medicine or apprehensions towards marriage prospects (23, 24, 34, 41, 54, 55, 57, 59, 61, 66, 67, 73). Nevertheless, most parents agree that school screenings and eye care services are important, so authors agree that these concerns should be assessed through eye health education, better training, and parents' counselling in order to improve SEH programmes outcomes.

Similarly, physical environments are not always adequate either to students' needs, as shown in three studies. In Chennai, 21% of classrooms had a distance visual demand over a 6/9 visual acuity (VA) equivalent, meaning that children who pass screening at that threshold may suffer from visual stress (74). In Nigeria, 9.4% of children did not meet the required visual acuity to meet the classroom demands (75). Additionally, near visual demand is greater for children who read at a very close distance (25cm), therefore increasing the risk for asthenopia (74-76). Authors recommend that school authorities should be aware of those constraints and should accommodate visually impaired children (74, 75).

Finally, few studies assessed the visual impact of online classes, especially during COVID-19. No causal link has been shown between home confinement, digital use and with myopia progression during that specific period (77, 78). However, increased use of digital device has been associated with eyestrain and dry eyes (76, 79-81). Considering that online education and digital tools may remain in schools, preventive interventions such as adequate refractive error correction, sufficient ambient lighting and limiting screen time is suggested by Gupta to reduce asthenopia for schoolchildren (81).

School curriculum

According to the WHO, health promoting schools should encourage health literacy by integrating health education in school curricula. In fact, many studies reported significant gaps in students' (23, 82, 83) and teachers' (37, 84) knowledge on eye health, which are associated with non-compliance in spectacle wear after screenings. In Ethiopia, only 55% of teachers had good knowledge and favourable attitude towards eye health and refractive errors (37). While levels were higher in Ghana (60%-75%), only 39% of respondents thought that eye problems could lead to poor academic performance (35).

Even so, most of the eye health promotion activities included in selected studies were limited to education of students and parents on importance of spectacle wear. Comprehensive health promotion activities can however lead to improved knowledge on eye health (85, 86). In Tanzania, students trained as vision champions improved their community's eye health knowledge by sharing eye health messages to their families and neighbours (87). Eye care service utilization also increased significantly after a one-week eye health promotion in Vietnam, with the proportion of children reporting to have had an eye check-up going from 63.3% before the intervention up to 84.7% after the health promotion activities (85). However, this intervention did not lead to a significant increase of spectacle compliance rates, similarly to results obtained after close follow-ups by ophthalmologists in Nepal (57). Better outcomes on spectacle wear and compliance to referral were found in India with a 23-step protocol based on frames and fit, education and motivation (88). The intervention was based on barriers and solutions described by local stakeholders, and required continuous planning and follow-up, but ultimately led to a change of behaviour from the students, teachers, and parents (88). Additional strategies were

suggested in the literature to promote eye health message and raise community awareness, such as integration of eye health messages in school curriculum (36, 61, 82-84), teachers' follow-ups to parents (26), workshops on eye health and use of social and mainstream media (36, 37, 42, 68, 89).

Finally, new eye health education messages that are mentioned in recent literature focus mainly on myopia prevention. In fact, 12 of the selected studies associated myopia prevalence with behavioural risk factors such as near work, limited outdoor activities, time spent in front of TV, computer games, mobile exposure and type of schooling (77, 78, 90-99). However, results are very inconsistent, and no causal link could be established in either of these cross-sectional studies, even though stronger associations were found between myopia prevalence, reduced outdoor activities and prolonged near work (77, 78, 91, 92, 94-99). According to these authors, parents should be informed of risk factors and school curricula should promote a healthy balance between classroom time and time spent outdoors (78, 92, 96-99).

Community partnerships

Active engagement from parents and local communities are essential to implement health promoting schools (9). Many publications showed the significant influence that community members, and particularly parents, can have in service uptake and adherence to treatments after SEH interventions (67, 100). Many authors agree that parents should also be educated and counselled about the benefits of wearing spectacles, and maybe even by being present during vision screening activities (24, 66, 67, 72, 89).

Interventions based on community participation and co-creation were described through the development of locally relevant interventions and eye health promotion material in Tanzania,

India, and Vietnam (21, 85, 88, 100-102). For example, a co-creation workshop engaging key stakeholders in Zanzibar demonstrated that broadcasting songs/music containing eye health messages through a local radio station was a locally relevant, well-accepted and cost-efficient way to improve awareness (101).

Collaboration with local eye care providers is also recommend to ensure continuous eye health services in the community after the school screenings (12, 68). However, school screenings can lead to a subsequent overload for local centres as demonstrated in Chan 2017, where a community-based health promotion activity in Zanzibar increased the number of patients at the local vision centre by 417% (87).

Interestingly, two publications mentioned the lack of coverage for children who are not attending school. (42, 103). Authors noted very high absenteeism rates in some regions (up to 31.8% in rural India) and suggested that stakeholders reflect on how to reach those out-of-school children, potentially with community-based platforms (42, 103).

School governance and leadership

The WHO's HPS framework mentions that strong school governance and leadership is required to create a solid link between the school leaders, local communities, and governmental instances. None of the selected articles specifically focused on governance, but seven studies mentioned that engaging students and teachers in screening activities is a powerful strategy for programme implementation (23, 24, 45, 51, 61, 86, 100). In fact, teachers are more dedicated when supported by enabling environments with sufficient training and incentives, leading to better implementation and compliance amongst children after screenings (23, 45, 51, 61).

Therefore, teachers' personal motivation, interests and commitments should be considered when selecting them for vision screenings (45).

Similarly, students' empowerment in child-to-child approaches has been effective to improve children's awareness and attitude towards visual impairment in a small-scale community-based initiative in Nigeria (86). Show-casting compliant children as role models has also been mentioned as a solution to improve compliance in India (24).

School policies

Integration of school-based health services in school policies is a key factor for sustainability of programmes (9), and is discussed in recent literature on school eye health. In fact, pairing SEH with existing school health activities such as feeding programmes can be more efficient and cost-effective than an isolated, vertical SEHP model, as shown in a project in Zanzibar (23, 104). This integrated approach minimizes costs through inter-sectoral collaboration in key activities such as stakeholders' mobilization and training (38, 104). Moreover, this model showed better outcomes in eye health screening coverage, follow-up rate and spectacle-wear rate (23), and allowed partnerships with local primary health care to ensure a continuum of eye care services beyond initial screenings (19, 21).

Government policies

Lastly, the WHO advocates for long-term commitments and clear governmental policies through its HPS objectives (9). Seven studies specifically focused on national integration and scaling of SEH programmes, with examples from Malawi, India, and Zambia (12, 34, 38, 68, 100, 102, 105). One of the key factors for scaling SEHP reported in those publications is

collaboration between NGOs, ministry of health and ministry of education (34, 100). Ownership of the programme by the government is also crucial to ensure full support through funding and human resources allocation and lead to sustainable programmes, considering that durable initiatives will not be possible if only relying on NGO's funding (34, 100). Economic evaluations demonstrated that the delivery of the school-based vision screening programmes at scale was affordable for governments in Cambodia and Ghana, and that government-subsidized spectacles through social health insurance could be a potential long-term solution (38, 105). Therefore, advocacy for policy changes and continuous efforts for capacity strengthening are also essential. Local stakeholders in Eswatini, Malawi and Zambia mentioned that eye health is not always a priority compared to others health disciplines and lack of data can be a challenge for advocacy, planning and budgeting interventions (34, 38, 68, 100).

At an operational level, large-scale SEH programmes are feasible due to key components such as community engagement, co-designed model of care for a context-adapted, comprehensive protocol, and rigorous programme monitoring and evaluation (102). However, lack of clear frameworks, legislation and policies to structure eye health practices and inefficient pathways between schools and health services have been barriers to programme delivery in low resources settings (12, 34, 68, 100, 102). In fact, 14.3% of Nigerian optometrists have to organize outreaches by themselves, which limits the frequency of vision screening (12).

To summarize, main priorities from in recent literature are identified in Figure 4.

Discussion

This study provides updated data and identifies current priorities for stakeholders involved in school eye health programmes. Publications were analysed through the WHO's Health-Promoting Schools framework, an ecological approach for durable and integrated programmes conducted in school settings. Results demonstrate the complexity of effective school-based health services such as vision screenings and illustrate the many challenges to overcome in order to achieve sustainable initiatives embedded in effective eye care services pathways. Main priorities identified throughout in this work are protocols, compliance to spectacle wear, human resources, national integration and financing. These findings are concordant with other systematic reviews on the topic published in the past years (3, 4, 106, 107).

First of all, findings in his study demonstrated a wide disparity in school-eye health programmes delivery. While multi-stage screenings have been largely implemented in India, basic protocols restricted to distance VA assessment and ocular health assessment are described in most LMICs. In fact, limited resources, equipment, and support can restrain implementation of standardized, comprehensive protocols with routine examinations (3, 4, 106, 107).

Discrepancies around the visual acuity threshold used for school-based screenings is one of the most significant aspect of protocols that can impact programmes' delivery, and stakeholders should reflect on it wisely when planning SEHP. In fact, almost half of programmes in selected studies currently use 6/12 as VA cut-off, in accordance with the WHO's recommended indicator for distance vision coverage (eREC) (108). This indicator is important for standardisation and limits the cost of programmes by reducing the rate of false positives. Moreover, better spectacles wear rates are obtained with children presenting significant

refractive errors and lower initial VA due to an increased perceived benefit.(107, 109). However, this threshold might fail to identify children with small refractive errors, which can be critical in some classrooms with high visual demands, poor lighting, and low contrast blackboards. Consequently, global paediatric guidelines advocate for 6/9 considering children's excellent visual potential (2, 110). Recent recommendations on myopia prevention also include full correction of myopia to reduce its progression (111). Therefore, 6/9 should be aimed for in regions with increasing myopia prevalence to allow early identification and management of children at risk, but 6/12 can be an acceptable option when resources are limited. Additionally, other tests should be considered to detect hyperopia, a refractive error that does not affect distance vision but is associated with lower academic performance. (112)

Variability in charts used, and prescribing criteria are other aspects which impact significatively programme delivery. Global guidelines provide specific prescription criteria and encourage the use of age-appropriated, validated log MAR charts to ensure rigorous and comparable outcomes (5, 110). Also, while many new technologies have been developed recently to facilitate screenings, more evidence is needed before replacing current techniques.

Secondly, results in this review have shown a significant interest for outcomes of school-based screenings, mainly compliance to spectacle wear. It is understandably a concern for stakeholders considering that poor compliance may reduce the cost-effectiveness of programmes and leave many children with suboptimal vision that can potentially limit their educational potential (22, 112-114). Spectacle wear is generally low at follow-ups in the selected studies, and reasons for non-compliance vary largely between settings, enhancing the need for strong monitoring and evaluation. Context-specific data is also required to understand local

socio-cultural factors leading to non-wear of spectacle, and findings should be taken into consideration when developing locally-adapted eye health education material (109). Health promotions activities should also include community participation, leadership from students, and teachers, and involve parents in order to reduce social stigma, gaps in knowledge and negative attitudes towards eye care (107, 109). Moreover, integration of eye health in school curriculum is suggested to increase eye health literacy(107), and should now include myopia prevention advice considering its rapid increase in prevalence in schoolchildren (1, 111, 115). In fact, while evidence in selected studies was inconsistent, global guidelines recommend to reduce close reading distance, take frequent breaks while reading and spend a minimum of two hours per day outdoors (111, 115, 116).

Other significant factors for non-compliance to spectacle wear are broken or lost spectacles, discomfort, dislike of frame and peer teasing/bullying. This highlights the need for provision of quality spectacles after screenings, with frames suitable for children features and corresponding to their liking. An acceptable and cost-efficient solution for most children is ready-made spectacles, but they need to be prescribed in accordance with guidelines (107, 114, 117). Moreover, programme-makers need to ensure continuous access to eye care providers in order to replace spectacles when required (107, 109). Collaboration with local professionals and efficient pathways of care are therefore essential for integrated and sustainable programmes.

Lack of human resources is another significant challenge for SEHP delivery in LMICs (4), and evaluation of different screeners for their sensitivity and specificity is a major topic discussed in the literature. As mentioned previously, teachers are currently key actors in school-based visual screenings due their proximity with children. In fact, initial screenings by teachers are

accurate and cost-effective when trained correctly, in accordance with results from other systematics reviews (4, 107). Yet, their work overload, insufficient training, and lack of time may lead to variable results and debatable validity. Low specificity (high rates of false positives) result in unnecessary re-examinations of normal children, increasing programmes' costs and overburden for local eye care providers and parents. Conversely, low sensitivity (high rates of false negatives) can be very problematic as visually impaired children may be missed and compromise the quality of the programme (42, 43). Therefore, selection of motivated teachers, strong support, annual refresher course, supervision and monitoring is required to ensure quality of screenings by teachers. However, other community-level health workers can conduct school-based screenings, as recommended in the WHO's eye care competency framework (118). In fact, community-level health workers showed better overall validity in school screenings, and while no selected publications demonstrated the validity of nurses in this study, Burnett *et al*. demonstrated that they can be a practical and cost-effective workforce to carry preventive and health promotion work (4, 107). Teachers can be involved in many other aspects of school eye health programmes, such as scheduling referrals and communicating outcomes to the school-based community (107).

Finally, few publications focused on policy level challenges such as integration of school eye health in other school health interventions, scaling of programmes and long-term financing and sustainability. In fact, other systematic reviews reported that political and socio-economic issues such as lack of financing, human resources and infrastructures limit the capacity of LMICs to implement and deliver mass school-based vision and eye health screenings (4, 106, 107). Currently, most programmes are vertical, isolated, and NGO-driven, and multi-level collaboration

518 is required to develop and successfully scale-up SEH programmes. Pairing with other school
519 health programmes can be envisaged to share financial and human resources (107). Moreover,
520 government ownership and collaboration between ministries of Health, Education and even
521 Finance are essential to support long-term sustainable initiatives with adequate financial and
522 human resources. In fact, cost of services and spectacles is a major barrier to eye care coverage
523 and compliance after SEHPs, especially for low-income families (107). According to Evans *et*
524 *al.,* school-screening programmes which provide free spectacles have better outcomes at follow-
525 ups than those that do not (114). Therefore, financial schemes such as national insurance plans
526 or cross-subsidization should be considered to limit out-of-pockets payments for parents,
527 improve equity to eye care and reduce dependency on NGOs. *Burnett et al*. mentioned that
528 inclusion of eye health in governmental strategic plans and health budgets are key political
529 determinants for SEH programmes, even if close partnerships with NGOs are sometimes
530 necessary for additional support (107). However, prioritisation of eye care at national levels may
531 remain a challenge (106) and context-specific, quality data are required to advocate for policy
532 changes. Efficient referral pathways, clear frameworks, legislation, and standardised guidelines
533 are also needed by local eye care professionals to structure their practice and facilitate scaling
534 of SEH programmes.
535
536 **Limitations**
537 This study has many limitations. First, only one reviewer (AH) performed most of the
538 article selection and data extraction, and no critical appraisal of quality has been done on
539 selected articles. Secondly, it is important to note that volume of research may not be
540 representative of stakeholders' real priorities, and abundant publications on compliance and

myopia may only result from simpler study designs. By opposition, economic evaluation and sustainability assessment are complex designs that requires significant resources and may not be possible to conduct in every setting. Priorities also vary widely between middle-income and lower-income settings, where resources and eye care delivery systems may be much more limited. Resource mapping is therefore an important step in planning programmes to ensure protocols adapted available workforce.

Moreover, this work focused on school-going children. However, neonatal, infant and preschool visual screenings are also important to consider to detect congenital and early-onset ocular problems (4). Similarly, most selected studies focused on refractive errors, but it is important to recognize that refractive error may not be the most prevalent condition in all countries, as ocular diseases such as allergies and trachoma may be a concern for children in some LMICs (10). Also, despite a search in four databases, none of the retained articles came from LMICs in Latin or South America, limiting the representativeness of the results.

Interestingly, there is no major gender inequalities reported in selected studies. However, recent global studies demonstrated that girls have a higher burden from refractive disorders due in part by a lack of access to health care for girls and gender-based barriers within parental-decision making (107, 119). Gender-specific policies is therefore recommended when designing SEHPs (107, 119). Reaching out-of-school children and those with disabilities should also be taken in consideration during planning (107).

Conclusion

School eye health initiatives have the potential to improve life of millions of children globally, especially in LMIC. This scoping review demonstrates that multi-level and multi-sectoral

action is required to implement sustainable and integrated school eye health programmes in low and middle-income countries. Based on the Health Promoting Schools framework, the main priorities identified in this review have highlighted the need for:

1. Rigorous and standardised protocols based on available human and financial resources, with strong monitoring and evaluation
2. In-depth understanding of local barriers to spectacle wear in order to provide suitable spectacles that correspond to children's liking and comfort
3. Creation of locally adapted eye health education material and health promotion activities based on leadership and participation
4. Inclusion of eye health and myopia prevention in school curricula
5. Strong partnerships with other school health programmes, communities and local eye care providers for integrated pathways of care
6. Government involvement and intersectoral collaboration between ministries for long-term national plans, with support from NGOs when needed
7. Advocacy for priorisation of eye care in national plans, including standardised guidelines, legislation and frameworks for eye care providers

Even if many challenges remain, the continuous production of quality data such as the ones presented in this review will help governments and other stakeholders to build evidence-based, comprehensive, integrated and context-adapted programmes and deliver quality eye care services to children all over the world.

Conflict of Interest

The authors declare no conflict of interest.

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Author contribution statement

AH was responsible for designing the search protocol, conducting the search, screen for eligible studies, extracted relevant results, sorted and analysed data. She wrote the first draft and created tables and figures.

BT reviewed and edited the search protocol, advised when ambiguity arose during screening and reviewed and edited all drafts of the manuscript

PM PY reviewed and edited the search protocol and all drafts of the manuscript

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Titles and legends to figures and tables

Figure 1 : WHO's Health-Promoting Schools framework adapted to school-eye health*
**adapted from World Health Organization. Health Promoting Schools (2021) (9)*

Figure 2 : PRISMA chart for school-eye health scoping review

Figure 3 : Number of selected publications sorted by HPS main themes
Legend : SEHP : school eye health programs
M&E : monitoring and evaluation
VA : visual acuity
RE : refractive error

Figure 4 : Priorities in school-eye health for low-middle income countries

Table 1 : Characteristics of selected studies
Legend : HPS : Health Promoting School framework

Table 2 : Characteristics of school-based visual screenings

Table 3 : Reported validity of screeners in selected studies
3a. Validity of teachers
3b. Validity of other screeners