Journal of Multidisciplinary Healthcare Dovepress

Open Access Full Text Article ORIGINAL RESEARCH

Vision Screening and Detection of Ocular Abnormalities in School Children by Teachers in Jordan

Yazan Gammoh[1], Bruce D Moore[2]

[1]Department of Optometry Science, Al-Ahliyya Amman University, Amman, Jordan; [2]Department of Pediatric Studies, New England College of Optometry, Boston, MA, USA

Correspondence: Yazan Gammoh, Department of Optometry Science, Al-Ahliyya Amman University, P.O. Box 121, Amman, 19328, Jordan, Email y.gammoh@ammanu.edu.jo

Purpose: To evaluate the accuracy of vision screening and detection of ocular abnormalities conducted by teachers in school children in Jordan compared with vision testing by optometrists and ocular disease identification by ophthalmologists.

Methods: A non-random, purposive sampling strategy where 6-year-old and 15-year-old school children from three schools in Amman, Jordan were included. Twenty-two teachers were trained to conduct visual acuity screening using the 0.2 logMAR line of the distance visual acuity (DVA) chart at 10 feet and near visual acuity (NVA) chart at 16 inches, in addition to detecting ocular abnormalities. An optometrist assessed the visual acuity and conducted objective and subjective refraction, while an ophthalmologist examined the ocular health of all children.

Results: A total of 542 children (51% female) were included in the study, of which 47% were 6 years old and 53% were 15 years old. Teacher screening had sensitivities of 76.92% for DVA, 68% for NVA, and 37.50% for abnormality detection. The specificities of DVA, NVA, and ocular abnormalities were 98.22%, 98.48%, and 99.24%, respectively. The positive predictive value for DVA, NVA, and ocular abnormalities were 83.33%, 99.00%, and 60%, respectively. The negative predictive value for each procedure was 98.22% for DVA, 98.48% for NVA, and 98.12% for ocular abnormalities.

Conclusion: Teachers were able to conduct vision screening with a high level of accuracy compared to the gold standard of testing by optometrists, which would be useful for the early detection and referral of refractive errors in school children. However, they were unable to detect ocular abnormalities compared with the gold standard for disease identification by ophthalmologists. Further training and monitoring, or different training approaches should be implemented to enable teachers to identify ocular abnormalities at acceptable levels.

Keywords: teachers, refractive error, school children, eye disorders, Jordan

Introduction

The World Report on Vision, released by the World Health Organization (WHO) has identified uncorrected refractive errors (URE) as one of the main causes of preventable vision impairment.[1] Globally, over 70 million children suffer from vision impairment due to URE,[2] with a consequent effect on their education, quality of life, and future career choices.[3]

Vision screening including visual acuity assessment and detection of ocular abnormalities is recommended for school children as as per the WHO.[4] School eye health programs have been identified as cost-efficient and effective methods for the early detection of URE and ocular abnormalities.[2] School screenings usually involve non-healthcare personnel such as teachers and community workers in coordination with eye care professionals such as optometrists and ophthalmologists.[5–7] Nevertheless, vision screenings for school children are mainly addressed in high-income countries,[6,7] with inconsistent outcomes in low- and middle-income countries.[8]

Jordan is a middle-income country in the Eastern Mediterranean Region (EMR) according to the WHO geographic distribution.[9] The prevalence of childhood visual impairment in EMR is 11.57%, with the leading causes being uncorrected

Received: 15 August 2024
Accepted: 31 October 2024
Published: 5 November 2024

refractive error and amblyopia.[10] URE, particularly myopia, continues to be a significant contributor to preventable vision impairment in EMR, as is the case in many other countries.[11]

Limited scholarly evidence exists on the prevalence of refractive errors in Jordanian children, with discrepancies in the reported prevalence due to inconsistencies in the definition of refractive errors, variations in charts used for visual acuity screening, or different personnel conducting screening.[12,13] Although the optometrist-to-population ratio in Jordan exceeds the WHO recommendations,[14] which would allow optometrists to provide vision screenings in schools, their practice patterns are limited to optical centers, ophthalmic clinics, and ophthalmic departments within hospitals.[15] Thus, there is a need for alternative personnel such as teachers to provide vision screenings in schools as teachers spend a substantial amount of time with children. In addition, they know how to work with their students and get their students to perform well compared to most other potential job categories of screeners.[16,17]

This study aimed to assess the accuracy of vision and ocular health screening among school children conducted by teachers in Jordan. In addition, this study provides insight into the distribution of refractive error among school children in Jordan.

Material and Methods

A cross-sectional study was conducted between November 2023 and April 2024, where school children from three schools in Amman, Jordan underwent vision screening conducted by school teachers, which was followed by a comprehensive vision and eye health examination by licensed optometrists and ophthalmologists. A convenience sampling method was adopted in which schools close to the (AAU) campus were approached to reduce the cost of transportation and ensure the safety of the participants. The university campus is conveniently located near a refugee camp (low-income), a middle-income town where several ethnicities live, and a high-income district that allows for the choice of three schools.

The tenets of the Declaration of Helsinki were followed and ethical approval was obtained from the AAU Scientific Research Ethics Committee (IRB: AAU/2/10/2022-2023). Approvals were obtained from the school principals, and the teachers provided written informed consent. Parents and/or guardians of the students provided consent to allow their children to participate. Only students in the first grade (age of 6 years) and ninth grade (age of 15 years) were included in the study, as myopia is expected to start around the age of 6 years, with early adult-onset myopia occurring at the age of 15 years.[18,19]

A total of 22 teachers participated in a one-day training on eye health vision screening conducted by licensed optometrists and ophthalmologists. To ensure cultural relevance and avoid language barriers, the Arabic language was used, and photos included in the training were obtained from previous screening campaigns conducted by the trainers. Each teacher was given a screening kit that contained the following: HOTV logMAR distance (10 feet), near (16 in) visual acuity chart, occluder, and measuring tape with a mark set at ten feet. A pointing card was also included to allow nonverbal children to identify the shape of letters.[16,20] The above charts have been recommended to be used as per the World Health Organization, which prompted their use in the current study.[20]

The training of the teachers included the following procedures and desired outcomes:

1. The teacher asked the child about their ocular complaints and conducted an external observation to detect any sign of eye redness, “deviating eyes”, and white optical media. If the teacher suspected any symptoms or signs, they would put a note and referred the patient to an ophthalmologist.
2. A spot was marked on the floor set at ten feet from the distance visual acuity chart, which was hung in a way that would allow its height to be adjusted according to the child’s height.
3. Testing was always performed for the right eye first, followed by the left eye. Both eyes were tested.
4. The untested eye was occluded using an occluder and testing was conducted while the child wore spectacles, if any.
5. The child would have considered to “pass” the test if they were able to read at least three letters from the 0.2logMAR line.
6. If the child was unable to read three letters at the 0.2logMAR line, they were recorded as “fail” in the record sheet.

7. For near visual acuity, the child was asked to hold the reading card at 16 in, and a cord was attached to the card to ensure a proper testing distance. The child was asked to wear spectacles, if any, and read the 0.2 logMAR line with both eyes open. The pass/fail criteria were the same as distance visual acuity.[16,20]

The ophthalmologist conducted an eye health examination immediately after the screening, which was performed by the teachers to address any urgent medical eye condition. Visual acuity assessment and cycloplegic objective and subjective refraction were conducted either on the same day or one week later. Parents/guardians were notified through the school administration of their child's condition and were then provided with spectacles through local optical stores based on the prescription given by the ophthalmologist.

Child records were stored in a secure facility and only data from complete records were included in the data analysis. Anonymized data were entered into Microsoft Excel Spreadsheets, and data analysis was performed using SPSS software version 25 (IBM Corporation, Armonk, NY, USA). Statistical significance was set at P value less than 0.05.

Results

A total of 542 students were included in the analysis out of 586 students who were examined during the data collection phase (92.5% inclusion rate). Table 1 shows the demographic characteristics of the study population. In terms of age and sex distribution for the 51 children who wore spectacles, 30 girls (59%) and 21 boys (41%) wore spectacles, 28 children (55%) were 6 years old, and 23 children (45%) were 15 years old. Table 2 details the refractive error distribution in the student population based on the spherical equivalent of refraction (SER) obtained from the cycloplegic subjective refraction. Myopia was defined as SER of less than −0.50 diopters (D). Hyperopia was defined as SER > +0.50D.[21,22] Children were identified as having astigmatism if the cylindrical (CYL) component of the refractive error was −0.75D or more.[21] As hyperopia and astigmatism can be defined at more than one level, further classification was also included.[23–25]

Table 3 shows the SER distribution obtained from the cycloplegic objective refraction. There was no statistically significant difference between the right and left eyes (p=0.41); thus, data from the right eye only are shown for the other

Table 1 Demographics of the School Students (n=542)

Variable	Category	Number	Percentage
Gender	Boys	264	49%
	Girls	278	51%
Age (years)	6	256	47%
	15	286	53%
Grade	One	256	47%
	Nine	286	53%
School type	High-income	116	21%
	Middle-Income	165	30%
	Low-income	261	49%
Child wearing spectacles?	Yes	51	9%
	No	491	91%
Parents wearing spectacles?	Yes	18	3%
	No	524	97%

Table 2 Refractive Error Profile of the School Students

Variable	Whole Sample (n=542)	6-Years Old (n=256)	15-Years Old (n=286)
Emmetropia (SER between +0.50 and −0.50 D)	27%	26%	37%
Myopia (SER less than −0.50 D)	11%	8%	18%
Hyperopia (SER greater than +0.50 D)	61%	66%	45%
Hyperopia (SER greater than +1.00D)	35%	54%	21%
Hyperopia (SER greater than +2.00D)	7%	11%	4%
Astigmatism (CYL of −0.50 D or more)	49%	50%	48%
Astigmatism (CYL of −0.75 D or more)	30%	30%	30%
Astigmatism (CYL of −1.00 D or more)	23%	23%	23%
Astigmatism (CYL of −1.50 D or more)	2%	2%	1%
Astigmatism (CYL of −2.00 D or more)	0.4%	0.3%	0.3%

Abbreviations: SER, spherical equivalent of refraction; CYL, cylinder; D, diopter.

Table 3 Distribution of the Spherical Equivalent of Refraction (SER), Measured in Diopters, for the Sample Population

Variable	Mean	Standard Deviation	Minimum	Maximum	95% Confidence Interval	P*
Right eye	+0.76	1.06	−2.75	+6.00	0.67–0.85	0.41
Left eye	+0.81	1.09	−2.50	+6.00	0.72–0.92	
Boys	+0.86	1.06	−2.50	+6.00	0.74–0.99	0.02*
Girls	+0.66	1.05	−2.75	+3.50	0.54–0.78	
6-years old	+0.97	1.19	−2.75	+6.00	0.83–1.12	<0.001*
15-years old	+0.57	0.89	−2.50	+4.75	0.47–0.67	

Notes: *Significance level set at less than 0.05.

demographics. Statistically significant differences were observed between boys and girls (p=0.02), and between 6-years old and 15-years-old children (p<0.001).

A total of 22 teachers participated in the vision screening, with 12 teachers (54%) from low-income schools and the rest split equally between middle-income schools (n=5, 23%) and high-income schools (n=5, 23%). An average of 25 students (± 11.77) were screened per teacher, with a range of 6 to 63 students. An optometrist and ophthalmologist then conducted comprehensive eye health and vision examinations. The average visual acuity at distance was 0.10 logMAR on average for both the right eye and the left eye (p=0.65). The average presenting distance visual acuity was 0.10 logMAR (95% confidence interval: 0.09–0.11). The binocular near visual acuity was 0.12 logMAR (95% confidence interval: 0.11–0.13). Table 4 details the sensitivity, specificity, positive and negative predictive values, and reliability indicators for assessment among teachers, optometrists, and ophthalmologists. In addition, the kappa scores for each assessment were noted.

Table 5 details the number of students who were prescribed spectacles (22%), medicine (1.66%), or referred for further assessment and management (1.29%). Out of the seven students who were referred, five (71%) were diagnosed with accommodative esotropia, and two (29%) were diagnosed with esotropia in the right eye.

Table 4 Sensitivity, Specificity, Predictive Values and Reliability Indicators for Vision Screening and Identification of Ocular Abnormalities as Obtained by Teachers and Optometrists and Ophthalmologists (Whole Sample, n=542; 6-Year-Old, n=256; 15-Year-Old, n=286)

Variable	Distance Visual Acuity	Near Visual Acuity	Disease/Abnormality Identified
True positive	Whole sample: 6% 6-year-old: 10% 15-year-old: 2%	Whole sample: 3% 6-year-old: 3% 15-year-old: 3%	Whole sample: 1% 6-year-old: 2% 15-year-old: 0%
True negative	Whole sample: 91% 6-year-old: 87% 15-year-old: 96%	Whole sample: 95% 6-year-old: 96% 15-year-old: 95%	Whole sample: 96% 6-year-old: 94% 15-year-old: 99%
False positive	Whole sample: 1% 6-year-old: 1% 15-year-old: 0%	Whole sample: 0% 6-year-old: 0% 15-year-old: 0%	Whole sample: 1% 6-year-old: 1.5% 15-year-old: 0%
False negative	Whole sample: 2% 6-year-old: 1% 15-year-old: 2%	Whole sample: 2% 6-year-old: 2% 15-year-old: n= 2%	Whole sample: 2% 6-year-old: 3% 15-year-old: 1%
Sensitivity	Whole sample: 76.92% 6-year-old: 89.29% 15-year-old: 45.45%	Whole sample: 68.00% 6-year-old: 70.00% 15-year-old: 60.00%	Whole sample: 37.50% 6-year-old: 41.67% 15-year-old: 25.00%
Specificity	Whole sample: 98.22% 6-year-old: 98.67% 15-year-old: 97.86%	Whole sample: 98.48% 6-year-old: 98.80% 15-year-old: 97.84%	Whole sample: 99.24% 6-year-old: 98.36% 15-year-old: 100%
Positive predictive value	Whole sample: 83.33% 6-year-old: 80.65% 15-year-old: 100%	Whole sample: 99.00% 6-year-old: 99.00% 15-year-old: 99.00%	Whole sample: 60.00% 6-year-old: 55.56% 15-year-old: 100%
Negative predictive value	Whole sample: 98.22% 6-year-old: 98.67% 15-year-old: 97.86%	Whole sample: 98.48% 6-year-old: 98.80% 15-year-old: 97.84%	Whole sample: 98.12% 6-year-old: 97.17% 15-year-old: 98.95%
Kappa Score	Whole sample: 0.84* 6-year-old: 0.83* 15-year-old:0.62*	Whole sample: 0.80* 6-year-old: 0.82* 15-year-old:0.56*	Whole sample: 0.45* 6-year-old: 0.45* 15-year-old: 0.40*

Notes: *p less than 0.001.

Table 5 Demographic Characteristics of the Students Who Were Prescribed Spectacles, Medicine or Referred (n=542)

Category/Variable	Spectacles Prescribed (n=118, 22% of the Sample)	Medicine Prescribed (n=9, 1.66% of the Sample)	Referral (n=7, 1.29%)
6-years old	n=90, 76%	n=9, 100%	n=3, 43%
15-years old	n=28, 24%	n=0, 0%	n=4, 57%
Boys	n=61, 52%	n=6, 67%	n=4, 57%
Girls	n=57, 48%	n=3, 33%	n=3, 43%
High Income	n=13, 11%	n=1, 11%	n=1, 14%
Middle Income	n=27, 23%	n=1, 11%	n=2, 29%
Low Income	n=78, 66%	n=7, 78%	n=4, 57%

Discussion

Good vision is essential for school children to achieve acceptable academic performance and a good quality of life, with a detrimental effect on their adulthood as uncorrected refractive errors such as hyperopia my lead to the development of amblyopia.[3,26,27] Several studies have investigated the accuracy and efficacy of various personnel to conduct vision screening including optometrists,[28] teachers,[29] and older school students.[30] Teachers-led school screening seem to be a cost-effective approach compared to optometrist-led assessment with a similar level of accuracy.[29] Vision screening by teachers is also useful as children spend a substantial amount of time in schools with their teachers which would eliminate the factor of fear from 'strangers' conducting vision screening.[31] This study was designed to assess the validity of school children's vision screening as there is a lack of scholarly evidence on the accuracy of vision screening by teachers in Jordan.

This study assessed the accuracy of teachers in measuring distance visual acuity (DVA), near visual acuity (NVA), and the detection of ocular abnormalities. Among the children screened, teacher screening had a sensitivity of 76.92% for DVA, 68% for NVA, and 37.50% for abnormality detection. The visual acuity sensitivity results correlated favorably with previous studies conducted in various parts of the world.[6–8,16,17,28,29,32] The current study is unique in reporting the sensitivity of detecting ocular abnormalities, as few studies have reported ocular diseases as identified by teachers.[17,33] The low sensitivity of detecting ocular abnormalities warrants a different approach to training teachers in disease detection. Lower sensitivity for the three parameters was observed in the 15-year-old cohort than in the 6-year-old group. This is an interesting finding, as the analysis of student eye-care behavior shows variations according to age.[34] Another aspect could be the adoption of a HOTV chart, which is usually recommended for younger children.[5] The choice of HOTV for both age groups was because of its availability, which has reduced the cost of attaining other age-appropriate charts, and ease of use, which simplified the training offered to the teachers. Future training and screening programmes in Jordan should adopt age-recommended screening charts.[5] It would be interesting to investigate the perception of children regarding vision screening and engage them in the screening process to ensure higher accuracy rates. In addition, there is a possibility of engaging them in screening younger children, as student-led screening has been shown to be effective and cost-efficient.[30]

The specificities of DVA, NVA, and ocular abnormalities were 98.22%, 98.48%, and 99.24%, respectively. This indicates that the teachers were able to identify children with normal ocular and visual status with a high level of accuracy. The positive predictive value for DVA, NVA, and ocular abnormalities were 83.33%, 99.00%, and 60%, respectively. This means that a high number of children who were flagged by the teachers as failing the screening had vision abnormalities. The negative predictive value for each procedure was 98.22% for DVA, 98.48% for NVA, and 98.12% for ocular abnormalities. This indicates that most of the children identified as having a normal visual status had no visual issues. The Kappa score for distance visual acuity was 0.84 ($p<0.001$) indicating an almost perfect agreement between the teachers' and optometrists' distance visual acuity tests.[35] A kappa score of 0.8 ($p<0.001$) was obtained for near visual acuity, indicating substantial agreement between the optometrists' and teachers' near visual acuity tests.[35] On the other hand, kappa value for identification of abnormalities was only 0.45 ($p<0.001$), indicating a moderate agreement between teachers' identification of abnormalities and diseased identified by the ophthalmologist.[35] These findings are in agreement with reports from other countries that support the call to enable teachers to conduct vision screening in schools.[6–8,16,17,28,29]

A case history study conducted at the beginning of the survey showed that only 9% of the children wore spectacles for refractive error correction. However, refraction conducted by eye care professionals revealed a substantial level of uncorrected refractive error, where 8% of the 6-year-old children were found to be myopic, doubling (18%) in 15-year-old children. This finding is consistent with the available literature regarding the prevalence of myopia in children.[12,13,36,37] Astigmatism of at least −0.75 D cylinder was found in almost a third of the children (30% for both age groups), which is in agreement with the reported astigmatism in similar age groups.[23] It is also worth noting that 36.8% of adults in Jordan have astigmatism of at least −0.75 D cylinder.[21] Clinically significant hyperopia (≥+2.00 D)[24] was found in 11% of the 6-year-old children and 4% of the 15-year-old children, which is in alignment with available literature.[25] Uncorrected hyperopia may lead to amblyopia and irreversible vision impairment; thus it was useful to detect clinically significant hyperopia.[38] The number of children who wore spectacles increased from 9% prior to screening to 22% once all children received either correction for the first time or replacement of spectacles due to inaccurate prescription or broken spectacles. This is of utmost importance as it is expected to support children's academic performance.[39]

The strength of this study is the adoption of international guidelines for vision screening in school children.[5,8] This would allow for reliable reporting of screening outcomes and comparison with evidence on vision screening by teachers available in the literature.[6–8,16,17,28,29,32] Furthermore, the definition of refractive errors aligns with the definitions used for adults in Jordan,[21] and the most common definitions in the literature.[18,19,22–25] Furthermore, the use of cycloplegia, though additional time, effort, and precautions, allowed for accurate reporting of refractive errors.[22–25]

The main limitation of this study was the purposive sampling technique. The choice of 6-years old children was to detect juvenile myopia onset,[18] and late-onset myopia.[18,19] This is important because the prevalence of myopia among adults in Jordan exceeds 50% of the adult population, which requires early detection to mitigate its progression.[21,36] However, this created a limitation in understanding the ability of teachers to screen school teachers of other ages, given that the sensitivity of vision screening was lower for 15-year old students compared for 6-year old children. In addition, it limited the ability to detect hyperopia and other amblyogenic factors, as early detection of amblyopia is necessary for successful management.[40–42] Future screening efforts are recommended for children under the age of 9 years to detect hyperopia and other amblyogenic factors.[40–42]

Conclusion

This study aimed to assess the accuracy of vision screening and detection of ocular abnormalities in school children by teachers in Jordan. Screening was conducted according to scholarly evidence and World Health Organization (WHO) guidelines on vision and eye screening. Furthermore, the refractive error is the most widely accepted definition in the literature. Teachers were able to conduct vision screening at a high level of accuracy compared to the gold standard of testing by optometrists, which would be useful for the early detection and referral of refractive errors in school children. However, they were unable to detect ocular abnormalities compared with the gold standard for disease identification by ophthalmologists. Further training and monitoring, or different training approaches should be implemented to enable teachers to identify ocular abnormalities at acceptable levels.

Funding

This research was supported by a research grant (grant number: VOSHINT-RES-04-2023) from Volunteer Optometric Services to Humanity/International (VOSH/International). The sponsor had no involvement in any of the stages from study design to submission of the paper for publication.

Disclosure

The authors report no conflicts of interest in this work.

References

1. World Health Organization. *World Report on Vision*. Geneva: World Health Organization; 2019. Licence: CC BY-NC-SA 3.0 IGO.
2. Burton MJ, Ramke J, Marques AP, et al. The Lancet Global Health Commission on Global Eye Health: vision beyond 2020. *Lancet Glob Health*. 2021;9(4):e489–e551. doi:10.1016/S2214-109X(20)30488-5
3. Richter LM, Daelmans B, Lombardi J, et al. Investing in the foundation of sustainable development: pathways to scale up for early childhood development. *Lancet*. 2017;389(10064):103–118. doi:10.1016/S0140-6736(16)31698-1
4. World Health Organization. *Package of Eye Care Interventions*. Geneva: World Health Organization; 2022. Licence: CC BY-NC-SA 3.0 IGO.
5. World Health Organization. *WHO Guideline on School Health Services*. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.
6. Logan NS, Gilmartin B. School vision screening, ages 5–16 years: the evidence-base for content, provision and efficacy. *Ophthalmic Physiol Opt*. 2004;24(6):481–492. doi:10.1111/j.1475-1313.2004.00247.x
7. Sabri K, Easterbrook B, Khosla N, Davis C, Farrokhyar F. Paediatric vision screening by non-healthcare volunteers: evidence based practices. *BMC Med Educ*. 2019;19(1):65. doi:10.1186/s12909-019-1498-x
8. Harvey AA, Morjaria P, Tousignant B. Priorities in school eye health in low and middle-income countries a scoping review. *Eye*. 2024;38 (11):1988–2002. doi:10.1038/s41433-024-03032-1
9. World Health Organization Regional Office for the Eastern Mediterranean. Available from: http://www.emro.who.int/countries.html. Accessed July 19, 2024.
10. Alrasheed S. Systematic review and meta-analysis of childhood visual impairment in the Eastern Mediterranean Region. *East Mediterr Health J*. 2023;29(6):482–490. doi:10.26719/emhj.23.020
11. Kahloun R, Khairallah M, Resnikoff S, et al. Prevalence and causes of vision loss in North Africa and Middle East in 2015: magnitude, temporal trends and projections. *Br J Ophthalmol*. 2019;103(7):863–870. doi:10.1136/bjophthalmol-2018-312068
12. Khader YS, Batayha WQ, Abdul-Aziz SM, Al-Shiekh-Khalil MI. Prevalence and risk indicators of myopia among schoolchildren in Amman, Jordan. *East Mediterr Health J*. 2006;12(3–4):434–439.

13. Khatatbeh AE, Othman EF, Alalawneh AM, et al. Ocular and Dental Causes of Headaches Among School-Age Children in Jordan: a Retrospective Study. *Cureus*. 2021;13(6):e15623. doi:10.7759/cureus.15623
14. Gammoh Y, Moodley V. Situation analysis of optometric education in the Eastern Mediterranean Region. *East Mediterr Health J*. 2023;29 (3):170–176. doi:10.26719/emhj.23.019
15. Okasheh-Otoom A, Gammoh Y, Otoum M, Naqaweh A. The Scope of Optometry Practice in Jordan. *Optom Vis Sci*. 2022;99(1):35–44. doi:10.1097/OPX.0000000000001823
16. Tobi P, Ibrahim N, Bedell A, Khan I, Jolley E, Schmidt E. Assessing the prevalence of refractive errors and accuracy of vision screening by schoolteachers in Liberia. *Int Health*. 2022;14(Suppl 1):i41–i48. doi:10.1093/inthealth/ihab085
17. Aniemeka DI, Ezeanosike E, Ogbonnaya CE, et al. Effectiveness of teachers in the detection of eye disorders among primary school children in Abakaliki Metropolis, Ebonyi State Nigeria. *Ann Ib Postgrad Med*. 2023;21(3):20–26.
18. Grosvenor T. A review and a suggested classification system for myopia on the basis of age-related prevalence and age of onset. *Am J Optom Physiol Opt*. 1987;64(7):545–554. doi:10.1097/00006324-198707000-00012
19. Bullimore MA, Lee SS, Schmid KL, et al. IMI-Onset and Progression of Myopia in Young Adults. *Invest Ophthalmol Vis Sci*. 2023;64(6):2. doi:10.1167/iovs.64.6.2
20. World Health Organization. *Vision and Eye Screening Implementation Handbook*. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO.
21. Mallen EA, Gammoh Y, Al-Bdour M, Sayegh FN. Refractive error and ocular biometry in Jordanian adults. *Ophthalmic Physiol Opt*. 2005;25 (4):302–309. doi:10.1111/j.1475-1313.2005.00306.x
22. Flitcroft DI, He M, Jonas JB, et al. IMI - Defining and Classifying Myopia: a Proposed Set of Standards for Clinical and Epidemiologic Studies. *Invest Ophthalmol Vis Sci*. 2019;60(3):M20–M30. doi:10.1167/iovs.18-25957
23. Hashemi H, Asharlous A, Khabazkhoob M, Yekta A, Emamian MH, Fotouhi A. The profile of astigmatism in 6–12-year-old children in Iran. *J Optom*. 2021;14(1):58–68. doi:10.1016/j.optom.2020.03.004
24. Mavi S, Massie J, Chan VF, Morjaria P. Hyperopia: a practical introduction. *Community Eye Health*. 2024;37(122):12–13.
25. Castagno VD, Fassa AG, Carret ML, Vilela MA, Meucci RD. Hyperopia: a meta-analysis of prevalence and a review of associated factors among school-aged children. *BMC Ophthalmol*. 2014;14(1):163. doi:10.1186/1471-2415-14-163
26. Hark LA, Thau A, Nutaitis A, et al. Impact of eyeglasses on academic performance in primary school children. *Can J Ophthalmol*. 2020;55 (1):52–57. doi:10.1016/j.jcjo.2019.07.011
27. Davidson S, Quinn GE. The impact of pediatric vision disorders in adulthood. *Pediatrics*. 2011;127(2):334–339. doi:10.1542/peds.2010-1911
28. Wang L, Congdon N, Hogg RE, et al. The cost-effectiveness of alternative vision screening models among preschool children in rural China. *Acta Ophthalmol*. 2019;97(3):e419–e425. doi:10.1111/aos.13954
29. Paudel P, Kovai V, Naduvilath T, Phuong HT, Ho SM, Giap NV. Validity of Teacher-Based Vision Screening and Factors Associated with the Accuracy of Vision Screening in Vietnamese Children. *Ophthalmic Epidemiol*. 2016;23(1):63–68. doi:10.3109/09286586.2015.1082602
30. Bhattarai D, Gnyawali S, Silwal A, et al. Student-led screening of school children for refractive error correction. *Ophthalmic Epidemiol*. 2018;25 (2):133–139. doi:10.1080/09286586.2017.1371767
31. Habiba U, Ormsby GM, Butt ZA, Afghani T, Asif M. Knowledge and practices of teachers associated with eye health of primary school children in Rawalpindi Pakistan. *Taiwan J Ophthalmol*. 2017;7(1):28–33. doi:10.4103/tjo.tjo_11_17
32. OstadiMoghaddam H, Fotouhi A, Hashemi H, et al. Validity of vision screening tests by teachers among school children in Mashhad, Iran. *Ophthalmic Epidemiol*. 2012;19(3):166–171. doi:10.3109/09286586.2011.602503
33. Panda L, Das T, Nayak S, et al. Tribal Odisha Eye Disease Study (TOES # 2) Rayagada school screening program: efficacy of multistage screening of school teachers in detection of impaired vision and other ocular anomalies. *Clin Ophthalmol*. 2018;12:1181–1187. doi:10.2147/OPTH.S161417
34. Li M, Wang W, Zhu B, Tan X. A Latent Class Analysis of Student Eye Care Behavior: evidence From a Sample of 6–17 Years Old in China. *Front Public Health*. 2022;10:914592. doi:10.3389/fpubh.2022.914592
35. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159–174. doi:10.2307/2529310
36. Alrasheed SH, Alghamdi W. Systematic review and meta-analysis of the prevalence of myopia among school-age children in the Eastern Mediterranean Region. *East Mediterr Health J*. 2024;30(4):312–322. doi:10.26719/2024.30.4.312
37. Cao H, Cao X, Cao Z, Zhang L, Han Y, Guo C. The prevalence and causes of pediatric uncorrected refractive error: pooled data from population studies for Global Burden of Disease (GBD) sub-regions. *PLoS One*. 2022;17(7):e0268800. doi:10.1371/journal.pone.0268800
38. Pascual M, Huang J, Maguire MG, et al. Risk factors for amblyopia in the vision in preschoolers study. *Ophthalmology*. 2014;121(3):622–9.e1. doi:10.1016/j.ophtha.2013.08.040
39. Alvarez-Peregrina C, Sánchez-Tena MÁ, Andreu-Vázquez C, Villa-Collar C. Visual Health and Academic Performance in School-Aged Children. *Int J Environ Res Public Health*. 2020;17(7):2346. doi:10.3390/ijerph17072346
40. Ciner EB, Kulp MT, Pistilli M, et al. Associations between visual function and magnitude of refractive error for emmetropic to moderately hyperopic 4- and 5-year-old children in the Vision in Preschoolers - Hyperopia in Preschoolers Study. *Ophthalmic Physiol Opt*. 2021;41 (3):553–564. doi:10.1111/opo.12810
41. Kulp MT, Ciner E, Ying GS, et al. Vision Screening, Vision Disorders, and Impacts of Hyperopia in Young Children: outcomes of the Vision in Preschoolers (VIP) and Vision in Preschoolers - Hyperopia in Preschoolers (VIP-Hip) Studies. *Asia Pac J Ophthalmol*. 2022;11(1):52–58. doi:10.1097/APO.0000000000000483
42. Janti SS, Alluri VM, Kolavai RR, Mali K, Eereti S, Kamble B. Prevalence of Amblyogenic Risk Factors Among School Children in India Using the Spot Vision Screener. *Cureus*. 2024;16(8):e66977. doi:10.7759/cureus.66977