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RESEARCH ARTICLE

Screening for Visual Impairment in Preschool Children: Development of a Protocol

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ABSTRACT:

BACKGROUND: Preschool vision screening (PVS) has been recommended as a cost-effective method to differentiate children with vision impairments. The primary aim of vision screening children at preschool is to reduce the prevalence of amblyopia by referring them while the condition is still amenable to treatment. If the visual deficit is not corrected during the period of visual development, it is likely to be permanent and cannot be rectified later. It is estimated that 5% to 6% of all preschool children have some form of vision defect that might require treatment or follow up, emphasizing the need for preschool vision screening and comprehensive eye care.

OBJECTIVE: To develop a protocol for screening visual impairment in preschool children aged 3 to 5 years

MATERIAL AND METHOD: The permission for conducting the study was obtained from the Institutional Research Committee. Subsequently, the permission was obtained from the Head of the Department for carrying out the study in the Outpatient Department of Ophthalmology. The screening tests had to be validated, and visual acuity measurement was the most used test across nations. Hence, the sample size calculation was determined using the formula 4pq/d2 /prevalence where “p” was the sensitivity of visual acuity chart and “d” was the precision level. Any validated tool must have at least 70% sensitivity.

RESULT: Titmus stereo fly test had high sensitivity but poor specificity. Frisby and Randot preschool had good sensitivity and moderate specificity to screen vision impairment. AUC was moderate. Stereo acuity charts were good screening but moderate diagnostic tools. Plusoptix A09 had moderate sensitivity and specificity for spherical and cylindrical refractive errors compared to vision and stereo charts AUC was also poor. Plusoptix A09 showed better sensitivity for cylindrical values.

CONCLUSION: The stereo acuity charts exhibited good sensitivity and moderate specificity making them good screening but moderate diagnostic tools. Plusoptix A09 had moderate sensitivity and specificity for visual impairment screening compared to visual acuity and stereo charts. Good agreement was observed between Lea and HOTV, Lea and E and HOTV and E vision charts.

KEYWORDS: Preschool vision screening, Visual impairment, Positive Predictive value, Plusopitix A09 and Visual acuity charts

Introduction

Vision assessment in children is a major aspect towards preventive health. Preschool screening is advocated over school vision screening as it is the critical frame to intervention. Timely childhood screening is widely endorsed for avoidable and correctable vision deficits. Amblyopia, squint, and refractive errors are the commonly encountered ocular disorders in childhood.[1]

Preschool Vision Screening and its relevance

Preschool vision screening (PVS) has been recommended as a cost-effective method to differentiate children with vision impairments. The primary aim of vision screening children at preschool is to reduce the prevalence of amblyopia by referring them while the condition is still amenable to treatment. If the visual deficit is not corrected during the period of visual development,

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it is likely to be permanent and cannot be rectified later. It is estimated that 5% to 6% of all preschool children have some form of vision defect that might require treatment or follow up, emphasizing the need for preschool vision screening and comprehensive eye care.[2] PVS had been suggested by the American Academy of Ophthalmology (AAO), American Academy of Paediatrics (AAP), American Association of Paediatric Ophthalmology and Strabismus (AAPOS), American Optometric Association (AOA), American Association of Certified Orthoptists and United States Preventive Services Task Force (USPSTF).[3]

The definition of normal vision varies with age and the diagnostic tests used. It is hence difficult to state the accurate prevalence of vision impairment in pre-schoolers. Preschool vision screening programmes were developed based on the experimental data in animals which advocated that early treatment of visual disorders was more effective than treatment later in life. Amblyopia and its risk factors are the main causes of vision impairment in preschool age group.[1] As children with amblyopia are asymptomatic, they are seldom brought for consultation lest associated with other ocular problems. Vision screening in children are primarily aimed at detecting non strabismic amblyopia. Non strabismic amblyopia occurs frequently due to refractive errors or media opacities. Distorted visual acuity as a result of refractive errors, strabismus or media opacities could become a substantial burden on the affected child.[4] To be left with one eye that has a visual acuity of 20/40 or less might result in reduced stereo acuity, failure to procure a driving license upsetting his or her job choices in future. Parents usually express regret that if only the problem was detected earlier, appropriate intervention could have been initiated. Such sentiments can have impact on the family life for years to come.[5]

AIM AND OBJECTIVES

Aim:

Development of a protocol for screening visual impairment in preschool children

Objectives:

- ➢ To develop a protocol for screening visual impairment in preschool children aged 3 to 5 years
- ➢ To validate the
- Visual acuity charts (Lea symbol, HOTV and E charts)
- Stereo acuity charts (Frisby, Randot preschool and Titmus stereo fly test)
- Photo refractor (Plusoptix A09) for screening visual impairment in 3 to 5 years old children

MATERIAL AND METHODS

Study Design: Cross-sectional

Study Participants: Pre-school children

Study setting: Outpatient department of Ophthalmology

The permission for conducting the study was obtained from the Institutional Research Committee. Subsequently, the permission was obtained from the Head of the Department for carrying out the study in the Outpatient Department of Ophthalmology.

The screening tests had to be validated, and visual acuity measurement was the most used test across nations. Hence, the sample size calculation was determined using the formula 4pq/d2 /prevalence where “p” was the sensitivity of visual acuity chart and “d” was the precision level. Any validated tool must have at least 70% sensitivity. Anticipating 70% sensitivity[6,7] for the visual acuity charts to pick up visual impairment with 5% precision and taking 6% as the prevalence of visual impairment[8] in the pre-schoolers, the minimum sample size needed for the study was determined to be 90 visually impaired and 90 normal eyes.

Development of a screening protocol for visual impairment

A systemic search of research articles was conducted. The search was conducted in search engines and data bases such as Pubmed, Google Scholar, Embase, Scopus, Science direct, Hinari, Medline, Web of Science, CINAHL and Global Health to find out pertinent articles published in English language. The literature search was done using key words including preverbal children, preschool children, toddlers, vision screening, preschool, amblyopia, visual deficit, visual impairment, prevalence, refractive error, vision, charts, stereo acuity, and photo refractor. All manuscripts considered relevant to the subject were scrutinised. In the end, we narrowed down to 20 articles published between 2010-2015. Their titles and abstracts were assessed and the full texts were downloaded and reviewed.

Validation of the protocol with the screened participants

A brief history was obtained from the parents/guardian. Torch light examination was performed before commencing the screening tests. A single investigator did all the enrolment, performed all the tests up to squint assessments. Dry refraction was done and acceptance attempted only for children who were co-operative. The order of presentation of the visual and stereo acuity charts was generated using a random number table to reduce the observer bias. Comprehensive eye examination was taken as the gold standard for final diagnosis.

Visual acuity measurement

Distance visual acuity examination was performed at 3 meters or 10 feet. The charts employed were Lea symbol chart, HOTV chart and E chart. All were log MAR charts designed for 3-meter distance to maintain uniformity and comparability. Each chart had 5 optotypes (symbols/letters) in each line and all the lines had same optotypes arranged in random sequence. Lea symbol chart had pictures of square, house, circle, and apple. HOTV had letters H, T, O and V. E chart had orientations of letter E in 4 directions like right, left, up and down. All charts had only 4 different optotypes and were positioned at the eye level of children while measuring visual acuity.

The subject had to match each optotype to that in the lap/flash card or recognize verbally. For Tumbling E, the participant was trained to point in any of the four different orientations or use the lap card. For Lea symbol chart, other names for the pictures were acceptable if the child was consistently using them. A pretest was done and the child's ability to identify the symbols/letters was checked binocularly by bringing the chart at a close by distance. Once the child could recognize all the optotypes, monocular testing was performed. A butterfly pattern occluder was used to interest the child and to ensure proper occlusion of the fellow eye before taking vision. Right eye was tested first followed by left eye in all children. Precaution was taken not to cover the surrounding optotypes when assessing visual acuity with the charts. Four out of 5 optotypes had to be correctly identified to proceed to the next smallest optotype. The visual acuity was noted down as the smallest optotype size which the child recognized. The visual acuity range was from 1.0 to 0.0 log MAR (3/30 to 3/3 or 20/200 to 20/20). Testing distance was maintained throughout the procedure. The child was not allowed to move closer to the chart to identify the symbols/letters. All visual acuity measurement were done in normal room illumination.

Measurement with Plusoptix A09

Plusoptix A09 was positioned at a distance of 1.20 meter (3.3 feet) away from the child at the eye level. Fixation target of the instrument was a smiley face which lighted automatically and a warble sound was produced on pressing the button. This enhanced to draw the attention of the child when the readings were taken. The instrument was moved forward until green circles were observed around the pupil and another warble sound was heard. The binocular measurements were taken automatically at this distance (1metre) and displayed on the monitor. "Measurements completed" was shown on the left side of the screen. The readings were checked twice. It was ensured that the child's attention was not drawn towards the monitor. If the screen showed as "measurement aborted" the testing distance was rechecked, the room illumination reduced and the pupil brightness was tested. If binocular measurements were not obtained again, the investigator recorded measurements uniocularly. The readings displayed on the monitor were spherical, cylindrical or spherocylindrical refractive error values in diopters (D), Inter pupillary distance in millimeters (mm) and pupil diameters in mm. All the readings were noted down.

Squint Assessment tests

The tests like extra ocular motility (EOM), smooth pursuits, Hirschberg test and cover tests were performed. If the child had squint, Krimsky test was done to measure the deviation for near and distance. It was documented in prism diopters.

Anterior segment examination

A Slit Lamp Bio microscope was used to assess the health of anterior segment structures of the eye.

Cycloplegic refraction and posterior segment evaluation

The homide 2% drops (homatropine hydro bromide) were administered in each eye, one drop each after every 10 minutes (2 times) to ensure maximum cycloplegic effect. One more drop was instilled after 30 minutes if pupil size was less than 6mm or pupillary light reflex was present. Cycloplegic refraction was performed after noting the pupillary light reaction and the net value estimated by an experienced optometrist. Retinal evaluation was done after cycloplegic refraction. Cycloplegic refraction was considered as the gold standard for the refractive measurements.

RESULT

The participants were recruited from the Out Patient Department of Ophthalmology, over an 18-month period. A total of 110 children were approached for the study. Only 90 participants were suitable according to the inclusion criteria and were enrolled for the study.

Table 1: Age and gender distribution of the participants enrolled

Age (years)	Male No (%)	Female No (%)	Total No (%)
3	09 (10)	12 (13)	21 (23)
4	18 (20)	16 (18)	34 (38)
5	21 (23)	14 (16)	35 (39)
Total	48 (53)	42 (47)	90 (100)

Out of 90 subjects 48 were male while 42 were female subjects. Total 35 subjects were from the 5 years of age group and 34 subjects belong to 4 years of age group while only 23 patients were registered under 3 year age group.

Table 2: Descriptive data of the different study variables

Study variables	median	(Q1,Q3)
Visual Acuity (log MAR) (n=180)		
Lea symbol chart	**0.29**	**(0.1,0.6)**
HOTV chart	**0.25**	**(0.1,0.6)**
E chart	**0.30**	**(0.1,0.7)**
Stereo acuity (sec of arc) (n=90)		
Frisby cards	**150**	**(55,600)**
Titmus stereo fly test	**400**	**(100,800)**
Randot preschool test	**200**	**(60,800)**
Study variables (n=90)	**Mean**	**SD**
Age (months)	**50.2**	**9.7**
Interpupillary Distance (mm)	**52.6**	**5.01**
Pupil Diameter (mm)	**5.98**	**0.79**

The median best corrected visual acuity in log MAR was 0.29 (0.1, 0.6) with Lea symbol chart. Aided near vision was recorded with N notation chart or lea symbol near vision chart depending on the co-operation of the child. It was possible to record near vision in 95.6% (172 eyes).

Table 3: Validation of the developed protocol for visual impairment screening

Screening tests	Sensitivity (95% CI)	Specificity (95% CI)	PPV (%)	NPV (%)	AUC (95% CI)
Visual acuity charts (n=180)					
Lea Symbol	87.9 (84.9,92.9)	97.8 (93.9,99.9)	97.1	88.1	0.980 (0.960,0.995)
HOTV	88.2 (83.1,91.4)	97.7 (95.8,99.5)	97.3	88.6	0.980 (0.959,0.995)
Stereo acuity charts (n=90)					
Frisby	67.2 (60.8,72.6)	64.4 (56.8,70.6)	62.7	71.9	0.733 (0.641,0.823)
Titmus stereo fly	87.5 (84.4,92.5)	39.6 (33.4,46.8)	55.0	82.5	0.639 (0.536,0.740)
Randot preschool	73.2 (68.6,79.6)	56.1 (49.8,62.2)	58	70.4	0.704 (0.606,0.797)
Pluspotix A09 (n=126)					
Sphere	57 (49.2,63.0)	52.8 (45.9,58.9)	55.1	53.5	0.553 (0.466,0.636)
Cylinder	62.9 (55.6,69.2)	65 (56.9,71.1)	65.6	60.9	0.663 (0.584,0.745)

Among the screening tests employed, Lea symbol and HOTV chart had excellent sensitivity and specificity to pick up a visually impaired eye. AUC was also high making them good screening and diagnostic tools as shown in the Table 3. Titmus stereo fly test had high sensitivity but poor specificity. Frisby and Randot preschool had good sensitivity and moderate specificity to screen vision impairment. AUC was moderate. Stereo acuity charts were good screening but moderate diagnostic tools. Plusoptix A09 had moderate sensitivity and specificity for spherical and cylindrical refractive errors compared to vision and stereo charts AUC was also poor. Plusoptix A09 showed better sensitivity for cylindrical values.

DISCUSSION

Our study created a screening protocol for preschoolers based on a thorough literature evaluation. Lea symbol, HOTV, and E charts were the screening tests used to measure visual acuity. For assessing stereo acuity, use the Frisby, Randot preschool, and Titmus stereo fly test, as well as the Plusoptix A09. The next step was a thorough eye test. For a definitive diagnosis, a thorough eye examination was considered the gold standard.

In children ages 0 to 5 years old, Bloomberg et al.[9] suggested that the integration of Plusoptix photo screener and cover or stereo test could increase the sensitivity for identifying amblyogenic risk factors. The findings of Bloomberg et al. are not supported by the findings of our study. The study's retrospective design and diverse age group could be the causes.

For children older than three years old, Silbert and colleagues found that a normal Plusoptix result in conjunction with normal ocular alignment tests and visual acuity had a 98% negative predictive value for ocular anomalies, including major refractive problems.[10] We calculated kappa for various combinations of visual acuity, stereoacuity, and Plusoptix and discovered that it was consistently less than 0.5. The results of Silbert et al. do not agree with the conclusions of our investigation. It can be a result of the various population demographics and diagnostic standards.

In a kindergarten for 4- to 5-year-old children, qualified individuals devised a screening protocol for amblyopia using Lea symbols charts, ocular alignment, motility assessment, and TNO random dot test. The protocol's sensitivity, specificity, PPV, and NPV values were 89.3%, 93.1%, 83.3%, and 97.5%, respectively.[11] We are unable to comment on the protocol because the diagnostic standards, screening procedures, and study population used varied.

Children aged 3, 4, and 5 were used to determine the HOTV and Lea chart's sensitivity. According to their findings, the Lea symbol chart's sensitivities for detecting amblyopia, refractive error, and strabismus (VIP targeted vision diseases) in this age group are 83%, 83%, and 78%, respectively. For children aged 3, 4, and 5, the HOTV test had sensitivity values of 57%, 80%, and 82%, respectively. With both charts, the specificity was set at close to 90% across all age groups. In the various age groups, there were no statistically significant differences between the two visual acuity charts.[12]

The sensitivity indicated with preschool visual acuity charts, however, varies widely. This might be as a result of the variety of the study's locations, screening staff, and diagnostic conditions. Moreover, the literature does not contain a comparison between 3 charts for the same participant group.

The Lea symbol chart's sensitivity and specificity for detecting a lack of visual acuity were 78% and 93%, respectively, according to Bertuzzi and colleagues. The Lea sign was proposed by the authors as a cheap, quick, and easy instrument for a widespread eye examination of infants between the ages of 38 and 54 months.[13] In superior specificity relative to sensitivity of the Lea visual acuity chart, the current investigation validated the conclusions of Bertuzzi et al. For both trials, visual impairment served as the basis for the diagnosis.

The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the Titmus stereo fly test in screening strabismus were reported as 83.1%, 83.3%, 77.8%, and 87.5%, respectively, by Ancona and coworkers.[14] In a screening setup, Farvardin and colleagues reported that the sensitivity of the TNO, Titmus, and Randot tests was 55.5%, 48.4%, and 44.4%. He emphasized how different the stereo tests used were across research.[15] According to Ohlsson et al., the sensitivities of the Randot E, Titmus, and TNO stereo tests for detecting amblyopia were 36%, 38%, and 46%, respectively.[16] The sensitivities reported in the published literature range widely. This can be because of various diagnostic standards and screening protocols.

CONCLUSION

Visual impairment is common in childhood. Although early intervention is important for the prevention or treatment of visual impairment, treatment of certain refractive errors in children. A validated protocol for screening visual impairment in children aged 3 to 5 years was developed. The visual acuity charts demonstrated very high sensitivity and specificity for screening visual impairment in 3- to 5-year-old children. The stereo acuity charts exhibited good sensitivity and moderate specificity making them good screening but moderate diagnostic tools. Plusoptix A09 had moderate sensitivity and specificity for visual impairment screening compared to visual acuity and stereo charts. Good agreement was observed between Lea and HOTV, Lea and E and HOTV and E vision charts. Therefore, they could be used interchangeably for vision screening of 3- to 5-year-olds.

REFERENCES

1. Atowa UC, Wajuihian SO, Hansraj R. A review of paediatric vision screening protocols and guidelines. Int J Ophthalmol. 2019 Jul 18;12(7):1194-1201.
2. Evans JR, Morjaria P, Powell C. Vision screening for correctable visual acuity deficits in school-age children and adolescents. Cochrane Database Syst Rev. 2018 Feb 15;2(2):CD005023.
3. Jullien S. Vision screening in newborns and early childhood. BMC Pediatr. 2021 Sep 8;21(Suppl 1):306.
4. Peters HB, Blum HL, Betman JW, Johnson F, Fellows V., Jr The Orinda vision study. Am J Optom Arch Ame Acad Optom. 1959;36(9):455–469.
5. Amigo G, McCarthy A, Pye D. Visual characteristics of an underprivileged group of Australian children. Aust J Optom. 1979;59(6):188–197.
6. Omar R, Hussin DA, Knight VF. Comparison of Lea symbol chart and Sheridian Gardiner chart in assessing vision screening among preschool children :a Malaysian perspective.J Med Assoc Thai 2012;95(3):412-7.
7. Schmidt P1, Maguire M, Dobson V, Quinn G, Ciner E, Cyert L, et al. Comparison of preschool vision screening tests as administered by Licensed Eye care Professionals in the Vision in Preschoolers Study. Ophthalmology. 2004;111(4):637-50.
8. Carlton J, Karnon J, Murray CC, Smith KJ, Marr J. The clinical effectiveness and cost effectiveness of screening programmes for amblyopia and strabismus in children upto the age of 4-5 years:a systematic review and economic evaluation. Health Technology Assessment 2008;12(25):21-39.
9. Bloomberg JD, Suh DW. The accuracy of the PlusoptiX A08 photoscreener in detecting risk factors for amblyopia in central Iowa .J AAPOS. 2013;17(3):301-4.
10. Silbert DI, Matta NS, Andersen K. Plusoptix photoscreening may replace cycloplegic examination in select pediatric ophthalmology patients. J AAPOS. 2013;17(2):163-5.
11. Casas-Llera P, Ortega P, Rubio, Santos V, Prieto MJ, Alio JL.Validation of a school-based amblyopia screening protocol in a kindergarten population. Eur J Ophthalmol. 2016; 26(5):505-9.
12. Cyert L, Schmidt P, Maguire M, Moore B, Dobson V, Quinn G. Threshold visual acuity testing of preschool children using the crowded HOTV and Lea Symbols acuity tests J AAPOS. 2003;7(6):396-9.
13. Bertuzi F, Orsoni JG, Porta MR, Paliaga GP, Migilor S. Sensitivity and specificity of a visual acuity screening protocol performed with the Lea symbols 15 - line folding distance chart in preschool children. Acta Ophthalmol Scand 2006;84(6):807-11.
14. Ancona C, Stoppani M, Odazio V, La Spina C, Corradetti G, Bandello F.Stereo tests as a screening tool for strabismus: which is the best choice? Clin Ophthalmol. 2014 ;8:2221-7.
15. Farvardin M, Afarid M. Evaluation of stereo tests for screening of amblyopia. IRCMJ. 2007;9:80-85.
16. Ohlsson J, Villareal G, Abrahamsson M, Cavazos H, Sjostrom A,. Sjostrand J, et al. Screening merits of the Lang II, Frisby, Randot, Titmus, and TNO stereotests.J AAPOS. 2001;5(5):316-22.