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Comparing Visual Acuity amongst Preschool Children using HOTV Letter Chart and Broken Ring Chart

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Abstract

Background: Measuring visual acuity is a critical component of optometric examinations, particularly for preschool children. Accurate measurement of visual acuity in this age group is essential, as it helps assess their ability to see clearly. This study aimed to compare the visual acuity of preschool children aged 3 to 5 years using two different charts: the HOTV and Broken Ring charts.

Method: The study was conducted among 153 preschool children between the ages of 3 to 5 years (mean age 4.21 ±0.80 SD), in Ikpoba-Okha Local Government Area, Benin City, Edo State, Nigeria. The visual acuity of the participants was measured using both the HOTV and Broken Ring charts. Data analysis was performed using the Wilcoxon signed-rank test to evaluate statistical difference between variables.

Results: Mean visual acuity measured with the HOTV chart was -0.045 ± 0.202, while the mean visual acuity with the Broken Ring chart was 0.014 ± 0.223. The Wilcoxon Signed-rank test revealed a statistical difference between VA obtained with the two charts ($p<0.00001$). The study also found a statistically significant difference with age ($p= 0.0184$ and 0.003) for HOTV and Broken Ring charts respectively. However, there was no statistically significant difference between genders ($p = 0.749$ for HOTV chart and 0.447 for Broken Ring chart).

Conclusion: The findings suggest that preschool children produced more reliable visual acuity results with the HOTV letter chart compared to the Broken Ring chart. Therefore, it is crucial to consider the type of visual acuity chart used when assessing the vision of preschool children to ensure accuracy in measurement.

Key words: Preschool children; Visual acuity; HOTV Chart; Broken rings Charts; Optotype.

Introduction

Visual acuity plays a pivotal role in a child's development, influencing their social interactions, cognitive growth, motor skills, and spatial awareness [1]. Children with uncorrected visual impairments face significant challenges that can affect their academic performance and overall quality of life [2]. Refractive errors, which impact around 448 million children and adolescents, are a leading cause of visual impairment in young children [3]. In the United States, it is estimated that 7% of preschool-aged children remain undiagnosed with refractive errors, largely due to their limited ability to communicate vision problems [4]. Early visual acuity testing is therefore not merely a routine check but a crucial step toward ensuring that children receive timely interventions towards the treatment of visual problems [5].

To accurately assess visual acuity in pre-schoolers, several visual acuity charts have been developed. The Snellen chart, created in 1862, remains widely used, but its reliance on alphabetic letters makes it unsuitable for preliterate children [6]. Alternatives like the Lea Symbols, HOTV chart, and Broken Ring (Landolt C) chart have been introduced to overcome these limitations. The HOTV chart uses familiar letters (H, O, T, and V) that require minimal verbal communication [7], making it suitable for younger children. The Broken Ring chart, on the other hand, relies on a child's ability to identify gaps in circular optotypes, allowing for non-verbal assessment [8].

Both the HOTV and Broken Ring charts have advantages and limitations. The HOTV chart has proven useful in assessing visual acuity in preliterate children, offering accuracy comparable to standard letter charts [9]. However, it may give an advantage to older pre-schoolers familiar with letters [10]. In contrast, the Broken Ring chart, with its reliance on gap recognition, does not require familiarity with letters and is accessible to younger children or those with communication difficulties [11]. A drawback however, is that it may lack the sensitivity to detect subtle variations in visual acuity [12].

Hered et al compared the Lea Symbols and HOTV charts, concluding that both were effective for preschool vision screening, but the Lea Symbols chart had better testability rates, especially for 3-year-olds [13]. Moganeswari et al assessed the reliability, sensitivity, and specificity of various charts, finding HOTV to be the gold standard for visual acuity in preschool children, with Lea chart being a good alternative when HOTV was unavailable [14]. Lai et al compared the Landolt C (broken ring) and Tumbling E charts in preschool children and found that visual acuity improved with age, with the E chart showing superior results in younger children, but by ages 5-6, both charts yielded similar outcomes [15].

The existing literature on visual acuity measurement in preschool children provides extensive knowledge s into various assessment methods and chart types used in clinical practice and research. However, there are notable gaps that require further investigation. One key gap is the lack of studies directly comparing specific optotypes, particularly the HOTV letter chart and the broken ring chart. While many studies have assessed the overall efficacy and reliability of different charts, few have specifically compared the performance of these two charts.

This study aims to address this gap by comparing the effectiveness of the HOTV and broken ring charts in measuring visual acuity among pre-schoolers aged 3 to

5 years. By evaluating their precision, ease of use, and engagement with the children, this research seeks to provide valuable insights for improving early childhood vision screening practices.

Materials and Methods

Study Area

This research was conducted in Ikpoba-Okha Local Government Area, located in Benin City, Edo State, Nigeria. The study population comprised preschool children aged 3 to 5 years residing in this area.

Inclusion Criteria

Participants included preschool children whose parents or guardians provided consent, and children who were willing to participate in the visual acuity assessments.

Exclusion Criteria

1. Participants outside the age range of 3 to 5 years and residing outside Ikpoba-Okha Local Government Area.
2. Participants with any known visual impairments, eye diseases, or conditions that could affect visual acuity.
3. Participants who expressed clear refusal to participate or displayed significant discomfort during the visual acuity assessments.

Research Design

This was a cross-sectional observational study

Study materials

1. HOTV Letter Chart.
2. Broken Ring Chart.
3. Measuring tape to ensure standardized testing distances between the child and the charts.
4. Consent forms and information sheets.

Procedure

The procedure involved several key steps to create an optimal testing environment, facilitate participant understanding, and systematically record visual acuity measurements and observations. First, the testing environment was carefully prepared in a quiet, well-lit room to ensure clear visibility of the optotypes on both the HOTV letter chart and the Broken Ring chart. The setting was free from distractions to help maintain the focus of the preschool children during the assessments. Testing stations were set up within the designated room, with each station equipped with both the HOTV letter chart and the Broken Ring chart. These charts were securely placed at eye level for preschool children, ensuring consistent positioning across all stations. The distance between the child and the charts was accurately measured and maintained according to standardized testing procedures.

Before beginning the visual acuity assessments, a brief explanation of the process was provided to the children to familiarize them with the procedure. This introduction was designed to reduce anxiety, promote cooperation, and create a positive testing atmosphere. To minimize potential bias, the order in which the charts were presented was randomized for each child. The visual acuity assessments began with the child sitting at the predetermined testing distance. For each eye, the smallest identifiable line of optotypes on both the HOTV letter chart and the Broken Ring chart was recorded. Observations were made during the

assessment, documenting any hesitation, confusion, or ease in identifying specific letters or symbols.

Throughout the process, the children's engagement and cooperation levels were monitored using an observational checklist. Factors such as focus, signs of frustration or boredom, enthusiasm, or refusal to participate were systematically documented. This assessment helped ensure reliable data collection by evaluating each child's overall testing experience. Visual acuity results were recorded using the logMAR equivalence, ensuring standardized and accurate reporting of visual acuity measurements.

Before the commencement of the study, informed consent was obtained from the parents or guardian of all participants, and ethical approval for this study was granted by the Department of Optometry, Research and Ethics Committee at the University of Benin, with ethical approval number: EC/UBEN/LSC.OPT/24/091.

Statistical Analysis

The data collected was analyzed using SPSS version 22.0. Descriptive statistics, including mean and standard deviation was used to summarize features of the dataset, providing an overview of the central tendency and variability in visual acuity measurements from both the HOTV and Broken Ring charts. Inferential statistics, specifically the paired T-test, was used to compare visual acuity measurements between the two charts. Comparative analyses was also used to explore potential biases or limitations specific to each chart.

Results

Table 1 presents the demographic data of the participants. The study involved 153 participants, consisting of 76 males and 77 females, aged between 3 and 5 years. The mean age was 4.21 ± 0.80 years, with an age range of 2 years (3 to 5 years).

Table 1: Demographics data of the participants

Age	Male (n = 76)	Female (n = 77)	Total (%) (n = 153)
3	17 (22.4%)	19 (24.7%)	36 (23.5%)
4	22 (28.9%)	26 (33.8%)	48 (31.4%)
5	37 (48.7%)	32 (41.5%)	69 (45.1%)
Mean (±SD)	4.23 ± 0.84	4.16 ±0.75	4.21 ±0.80
Range	3 to 5 (2)	3 to 5 (2)	3 to 5 (2)

Figure 1 illustrates the distribution of logMAR visual acuity values obtained with the HOTV chart. The modal VA findings (51) were between -0.18 (6/4) and -0.04 (6/5).

Figure 2 shows the distribution of logMAR visual acuity values obtained with the Broken ring chart. The modal VA findings (58) were between -0.18 (6/4) and 0 (6/6).

Table 2 shows the descriptive statistics of visual acuity (VA) in logMAR for both charts. The mean VA was -0.0045 (equivalent to 6/5) for the HOTV chart and 0.014 (equivalent to 6/6) for the Broken Ring chart.

Table 2: Descriptive Statistics of Visual Acuity using both Charts

Visual Acuity Charts	HOTV Chart	Broken Ring
Mean ±SD (mm)	-0.045 ±0.202	0.014 ±0.223
25th Percentile(mm)	-0.18	-0.18
Median (mm)	-0.08	-0.08
75th Percentile (mm)	0	0
Standard Error of Mean	0.164	0.018
95% confidence (Lower, Upper)	-0.077 to -0.013	-0.021 to 0.0493

Table 3 reports the results of the Shapiro-Wilk normality test, which revealed that the data for all variables followed a non-parametric distribution (i.e., they were not normally distributed).

Table 3: Test of normality using the Shapiro-Wilk-test

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	Variables	Statistics	Sample size (n)	p-value
Charts	HOTV Chart	0.6954	153	<0.001
	Broken Rings Chart	0.7756	153	<0.001
Gender	Females	0.7575	77	<0.001
	Males	0.7273	76	<0.001
Age	3 years	0.7845	36	<0.001
	4 years	0.8005	48	<0.001
	5 years	0.7221	69	<0.001

Table 4 displays the results of the Wilcoxon signed-rank test, used to assess any significant differences in VA between the two charts. A significant difference was found between the two charts ($p < 0.05$).

Table 5 presents the Mann-Whitney U test results, which were used to determine any significant gender differences in VA values. The test showed no significant differences between males and females for both charts ($p > 0.05$).

Table 4: Wilcoxon Signed-rank Test Results

	Wilcoxon Signed-rank Test Results
Test Statistics (Z-value)	5.8648
Number of Pairs (N)	153
Median Difference	0.08
p-value	P < 0.00001
S-value	27.73
Effect size (r)	0.65
Null hypothesis	Rejected

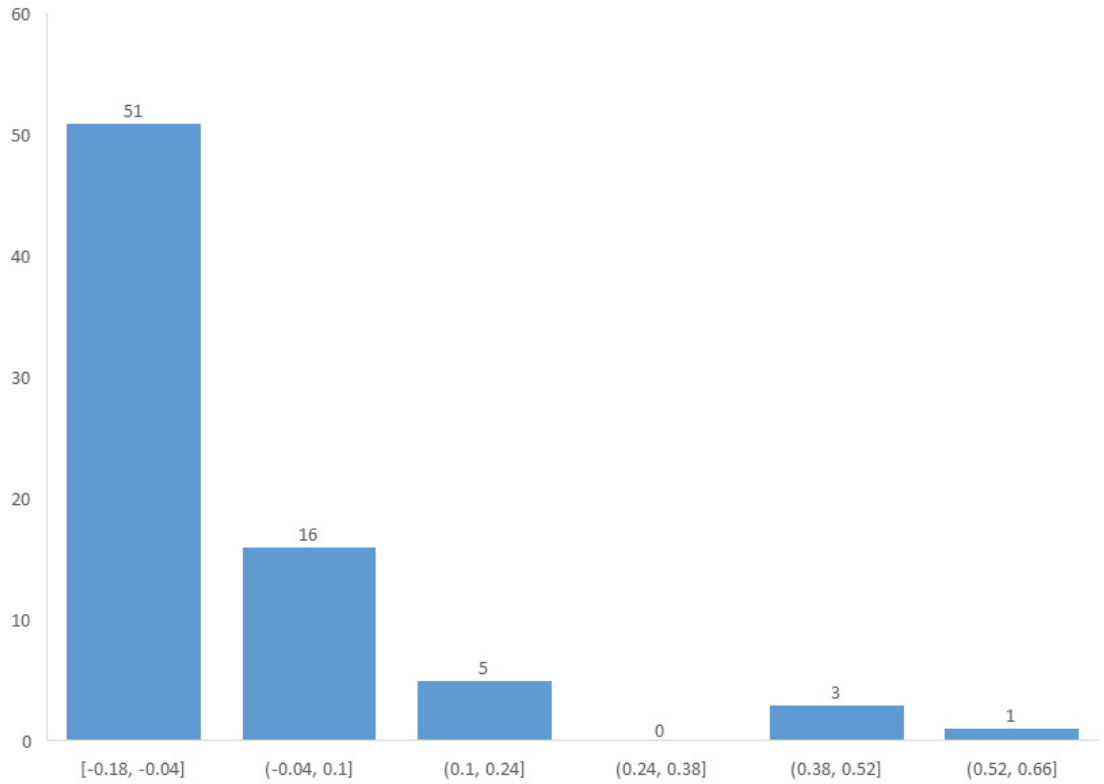

Figure 1: Distribution of VA taken with the HOTV Chart.

Table 6 shows the results of the Kruskal-Wallis test with a post-hoc Dunn test, revealing a significant age difference in VA measurements between the two charts ($p < 0.05$).

Table 5: Mann-Whitney U Test Results

Chart Type	Gender	N	U Statistics	p-value
HOTV Chart	Females	77	2836.5	0.749
	Males	76		
Broken Rings Chart	Females	77	2717	0.447
	Males	76		

Discussion

This study assessed visual acuity measurements using two different charts, the HOTV and Broken Ring charts, to determine if there are statistically significant differences between their effectiveness. Factors such as age and gender were also considered to assess their influence on visual acuity outcomes using the two charts.

The descriptive statistics revealed that the mean visual acuity was slightly better with the HOTV chart (-0.045 ± 0.202) compared to the Broken Ring chart (0.014 ± 0.223). Although the median and percentiles for visual acuity were similar between the two charts, the mean values suggested a potential differences. This finding aligns with the results of Moganeswari et al, which reported better reliability with the HOTV chart for visual acuity measurement in preschool children [14]. However, in contrast to both their results and those of the current study, Hered et al found that while both the Lea symbols and HOTV charts were effective for preschool screening, the Lea Symbols chart had higher testability rates, especially for 3-year-olds [13]. Although previous studies have compared the HOTV chart with other charts, direct comparisons cannot be

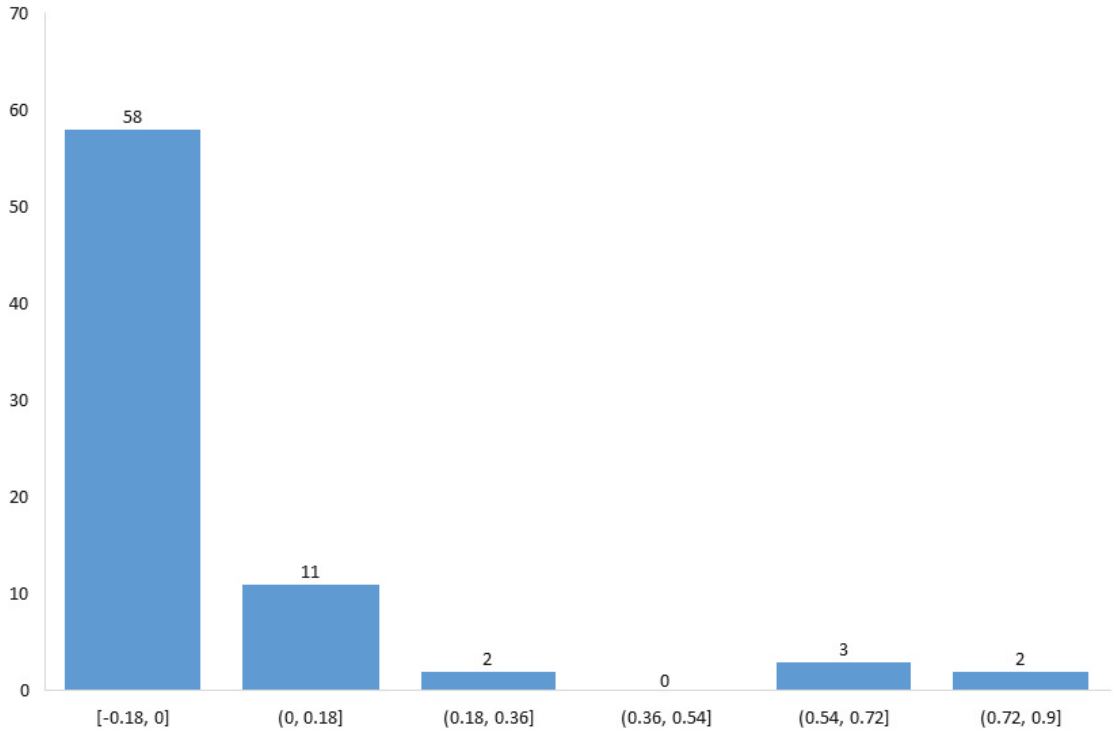

Figure 2: Distribution of VA taken with Broken Rings Chart

Table 6: Kruskal-Wallis Test with the Post-hoc Dunn's Test Result

Chart Type	Age	Rank Score	df	Alpha value	H statistics	Effect Size (η2)	p-value
HOTV	3 years	86.69	2		7.9864	0.04 (Small)	0.0184
	4 years	84.71					
	5 years	66.58					
Broken Ring	3 years	86.08	2	0.017	11.818	0.07	0.003
	4 years	89.13					
	5 years	63.83					

fully drawn with the current study, as we compared the HOTV chart with the broken ring chart, and no prior research has directly examined these two specific charts together.

To determine the most appropriate test to be conducted, test of normality was conducted to determine whether or not the data were normally distributed. This was done for both charts (HOTV and broken rings), for age and for gender. The results of showed a statistically significant deviation from normality across all points ($p < 0.001$), indicating that the data were non-parametric and do not follow the normal distribution. Based on the findings of the normality test, the most suitable statistical test to satisfy the objectives and hypotheses of the study was determined.

The Wilcoxon signed-rank test, used for comparing two paired samples, showed a significant difference in visual acuity measurements between the HOTV and Broken Ring charts ($p < 0.05$). The effect size ($r = 0.65$) further highlighted the practical importance of this difference

To explore gender differences, the Mann-Whitney U test was employed. It revealed no significant differences in visual acuity between males and females for either chart ($p > 0.05$). This is consistent with the findings of Osaiyuwu and Atuanya, which found no significant gender difference, but found a significant difference in both charts and age [16]. This implies that gender may not play a substantial role in determining visual acuity outcomes in preschool children when using these specific charts. To further support this study's findings, the work by Obajolowo et al., found no significant gender difference but found a significant difference in specificity across different age groups [17].

With regard to the influence of age on difference between the two charts, the Kruskal-Wallis test was used. The Kruskal-Wallis test with post-hoc Dunn's test showed significant differences in visual acuity measurements among different age groups ($p < 0.05$). Specifically, both charts demonstrated variations in visual acuity scores across different age groups. This suggests that age is a crucial factor to consider when interpreting visual acuity measurements in preschool children. The observed significant difference due to age is consistent with the findings of Lai et al.[15] which observed an improved visual acuity with age, particularly between ages 3-4 and 5-6 years. Similarly, Sanker found variations in visual acuity results between preschool children aged 3-4 years and 5-6 years [18]. These findings suggest that age-related developmental factors play a crucial role in shaping

visual acuity outcomes in preschool children, highlighting the importance of age-specific considerations in visual acuity assessments.

Overall, these findings highlight the importance of careful selection when choosing visual acuity measurement charts for preschool children. The broken ring chart may provide slightly different outcomes compared to the HOTV chart, which could have implications for clinical assessments and interventions. Additionally, age should be taken into account when interpreting visual acuity results in this population.

Conclusion

This study compared visual acuity measurements in preschool children using the HOTV letter chart and the broken ring chart, finding that the HOTV chart produced more reliable results. The study highlighted significant differences between the two charts and emphasizes the importance of selecting the right chart in clinical practice. While no significant gender differences were found, age was identified as an important factor affecting visual acuity, aligning with previous research. We recommend that clinicians should carefully select visual acuity charts based on design, age-appropriateness, and clinical context, as the study suggests both the HOTV letter chart and broken ring chart are effective but may vary in suitability. Establishing age-specific norms for visual acuity is crucial. This will aid in the creation of targeted screening protocols and interventions for preschool children.

Ethics approval and consent to participate:

Ethical approval for this study was obtained from the Research and Ethics Committee of the Department of Optometry, University of Benin, Benin-City, Edo State, Nigeria. All procedures performed in this study was in accordance with the Tenets of the Declaration of Helsinki for human subjects.

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Abbreviations: VA:Visual Acuity

References

1. Ghasemi Fard F, Mirzaie H, Hosseini SA, Riazi A, Ebadi A. Vision-related tasks in children with visual impairment: a multi-method study. Front Psychol. 2023;13;14:1180669. doi: 10.3389/fpsyg.2023.1180669.
2. Loh L, Prem-Senthil M, Constable PA. A systematic review of the impact of childhood vision impairment on reading and literacy in education. J Optom. 2024;17(2):100495. doi: 10.1016/j.optom.2023.100495.
3. Vision Atlas. Magnitude and Projections Child Eye Health [internet]. c2024 [cited: 2024 Sep 20]. Available from: https://www.iapb.org/learn/vision-atlas/magnitude-and-projections/child-eye-health/.
4. Gurung G, Gupta KK. Refractive Error among Children Visiting the Department of Paediatric Opthalmology of a Tertiary Eye Care Center. JNMA J Nepal Med Assoc. 2023;61(267):848-851. doi: 10.31729/jnma.8322.

5. Kabra S. Common Types of Vision Tests Related According To Age [internet]. 2024 [cited 2024 Sep 19]. Available from: https://skippereyeq.com/common-types-of-vision-tests-related-according-to-age/.

6. Wang YL, Wang JJ, Lou XC, Zou H, Zhao YE. Clinical usefulness of the baby vision test in young children and its correlation with the Snellen chart. Int J Ophthalmol. 2024;17(2):348-352. doi: 10.18240/ijo.2024.02.18.

7. Iwata Y. Developing a Novel Pediatric Eye Chart Assessing Visual Acuity by Minimum Separable Threshold. Children. 2024;11(4): 397.

8. Rashad MA, Abd Elaziz KM, Fawzy SM, Abdel Latif AAM, Abdel Latif MAM. Screening of Primary School Children for Amblyopia and Amblyogenic Factors in Central Cairo, Egypt. J Ophthalmol.;2018:8425319. doi: 10.1155/2018/8425319.

9. Chaplin PK, Bradford GE. A historical review of distance vision screening eye charts: what to toss, what to keep, and what to replace. NASN Sch Nurse. 2011;26(4):221-8. doi: 10.1177/1942602x11411094.

10. Bodack MI, Chung I, Krumholtz I. An analysis of vision screening data from New York City public schools. Optometry. 2010;81(9):476-84. doi: 10.1016/j.optm.2010.05.006.

11. Pointer JS. Recognition versus resolution: a comparison of visual acuity results using Two alternative test chart optotype. J Optom. 2008;1(2), 65-70.

12. Pishnamaz MR, Ostadimoghaddam H. Striped Circle Visual Acuity Chart; A Novel Visual Acuity Chart Based on the Landolt-C Chart. Med Hypothesis Discov Innov Ophthalmol. 2018;7(1):22-24.

13. Hered RW, Murphy S, Clancy M. Comparison of the HOTV and Lea Symbols charts for preschool vision screening. J Pediatr Ophthalmol Strabismus. 1997;34(1):24-8. doi: 10.3928/0191-3913-19970101-0.

14. Moganeswari D, Thomas J, Srinivasan K, Jacob GP. Test Re-Test Reliability and Validity of Different Visual Acuity and Stereoacuity Charts Used in Preschool Children. J Clin Diagn Res. 2015;9(11): NC01-5. doi: 10.7860/JCDR/2015/14407.6747.

15. Lai YH, Wang HZ, Hsu HT. Development of visual acuity in preschool children as measured with Landolt C and Tumbling E charts. J AAPOS. 2011;15(3):251-5. doi: 10.1016/j.jaapos.2011.03.010.

16. Osaiyuwu AB, Atuanya GN. Comparing visual acuity in preschool children using the Lea symbols and Sheridan Gardiner charts. Afri. Vis. Eye Health. 2015;74(1), 3.

17. Obajolowo TS, Olatunji FO, Ademola-Popoola, DS, Popoola, G. O. Performance of the Lea symbols chart for screening Nigerian children aged 3 to 5 years. Niger. J. Clin. Pract. 2020; 23(10):1381-1386.

18. Sanker N, Dhirani S, Bhakat P. Comparison of visual acuity results in preschool children with lea symbols and Bailey-Lovie E chart. Middle East Afr J Ophthalmol. 2013;(4):345-8. doi: 10.4103/0974-9233.120020.

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