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Original Article

Visual acuity assessment of preschool children in the inner city area in Jakarta

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Abstract

Background Visual acuity (VA) assessment is an important ocular examination to identify children with vision problems. Such early identification allows for early intervention to prevent childhood blindness.

Objective To describe and compare VA measurements in preschool children using two different visual acuity charts.

Methods This cross-sectional study in children aged 36-60 months was done in a low-income area in the Central Jakarta District as a collaboration between Department of Ophthalmology and Department of Child Health, Universitas Indonesia Medical School/ Dr. Cipto Mangunkusumo Hospital, Jakarta. All children underwent visual acuity examinations using Lea symbols and Tumbling E charts. The VA results from two charts were analyzed with Bland-Altman plot for limits of agreement. Statistical analyses were performed to determine the differences between vision charts.

Results A total of 113 children enrolled, but only 38 children completed the examinations. The mean age of subjects was 50.5 (SD 6.4) months. Overall, subjects' mean VA was 0.29 (SD 0.18) for Lea symbols and 0.37 (SD 0.14) for Tumbling E. The mean difference of VA between Lea symbols and Tumbling E was 0.07 (SD 0.22) logMAR units, with upper and lower limits of agreement at 0.36 and 0.51, respectively. There was no statistical difference in VA score using Lea symbols and Tumbling-E based on gender and age.

Conclusion Most preschool children in our study have normal visual acuity. Lea symbols and Tumbling E chart are comparable and can be used to efficiently measure VA in preschool children. **[Paediatr Indones. 2021;62:1-6; DOI: 10.14238/pi62.1.2022.1-6**].

Keywords: *visual acuity assessment; preschool children; Lea symbols; Tumbling E chart*

In preschool children, visual acuity measurements can be a laborious process due to uncooperative behavior and various levels of cognitive functions. However, identifying vision problems when they are most amenable to correction may prevent lifetime visual function impairment.[1] Therefore, numerous charts have been devised for pediatric visual acuity measurements. There are two types of charts, either using letter optotypes, such as in HOTV, Landolt C, and Tumbling E (E-chart), or using picture optotypes, as in Lea symbols.[2]

The Lea symbols chart was the first logMAR-based chart that was well-accepted for pediatric visual acuity tests. It consists of three symbols (apple, square, and house) which have several crucial differing features from the fourth symbol, a circle.[3] Several considerations should be made when using Tumbling E, another logMAR-based chart, as a visual test chart in children. The most concerning factor is the underdeveloped spatial orientation, the skill needed to differentiate

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up-down-right-left, in preschool children.4 Thus, we aimed to compare visual acuity measurements using Lea symbols and Tumbling-E in preschool children.

Methods

This cross-sectional study was conducted in children aged 36-60 months in an urban, low-income area of the Central Jakarta District. This study was done as a collaboration between Department of Ophthalmology and Department of Child Health, Universitas Indonesia Medical School/Dr. Cipto Mangunkusumo Hospital, Jakarta. A cluster random sampling technique was used to choose the location. Children with strabismus, developmental delay, attention deficit, or any ocular diseases on examination were excluded from the study. Data were collected by trained optometrists. The Ethics Committee of the Universitas Indonesia Medical School approved this study. Informed written consent was also obtained from parents or guardians before commencement of the study.

For VA assessments, the chart was positioned at the child's eye level, with the subject in a standing or sitting position, three meters from the chart. Visual acuity examinations were performed unilaterally, beginning with the right eye followed by the left eye. The Lea symbols and Tumbling-E charts were introduced to the children beforehand.

For the Lea symbols examination, children were asked to point to the same picture/symbol on the recognition card as the one the examiner pointed to on the examination chart. If the first four symbols in one line were identified correctly, the examiner moved to the next line. The test was continued until the child was unable to identify at least four symbols in one line. Visual acuity was documented based on the last line that was successfully identified.[5]

For the Tumbling E test, the child was asked to point his/her fingers in the direction of the "legs" of the letter E or was requested to rotate the recognition card, which had been placed in front of the child, to copy the direction of the E "legs" pointed to by the examiner. The test was continued until the child could not correctly identify at least half of the directions of the letter E in one line. Visual acuity was documented based on the last line that was successfully identified.[5]

In conjunction with the VA tests, anterior segment evaluations were performed with a penlight to look for any ocular diseases that would hinder the VA result. Furthermore, posterior segment evaluation was performed using a direct ophthalmoscope through the undilated pupil to look for any posterior abnormalities that may obscure the visual axis.

Demographic data were presented in categorical variables; visual acuity data were presented in numerical variables, using the standardized LogMAR units. An additional assessment was made to divide those with normal visual acuity and those with a suspicious refractive abnormality, according to their age, based on pediatric VA nomogram, according to Bell *et al.*[6] (**Table 1**).

The *SPSS version 23 software* (SPSS, Chicago, IL, USA) was used for data analysis, and P values <0.05 were regarded as statistically significant. The Shapiro-Wilk test was used to assess data normality. Since data were not normally distributed, various non-parametric methods were used. The Wilcoxon signed-rank test was used to determine the differences, and the Bland-Altman plot was used to analyze the agreement between the Lea symbols and Tumbling E results. Mann-Whitney and Fisher's exact test were used to analyze for correlations between visual acuity and age group, gender, as well as other possible risk factors.

Results

Table 1. Normal visual acuity based on age (months)[7]

Age, months	Normal visual acuity	
	Feet (meters)	LogMAR acuity
30-35	20/60 (6/20) or better	0.52 or better
36-47	20/50 (6/15) or better	0.40 or better
48-59	20/40 (6/12) or better	0.30 or better
60-72	20/30 (6/10) or better	0.22 or better

There were 133 children aged 36 months to 60 months who fulfilled the study criteria, of whom 73 children (54.89%) were recruited based on their cooperation level. Nonetheless, 45.20% of children were not able to complete the Tumbling E test, and 2.73% of children were not able to complete the Lea symbols test (**Table 2**). Thus, only 38 children capable of completing both examinations were included in this study.

The mean age of the study population was 50.5

(SD 6.4) months. The mean visual acuity was 0.29 (SD 0.18) for Lea symbols and 0.37 (SD 0.14) for Tumbling E. Visual acuity (VA) comparison of the test results revealed that more than half of subjects had a better VA according to their Lea symbols examination (**Table 3**). The prevalence of children with low VA, suspected to be due to refractive problems was slightly lower then using the Lea symbols examination (**Table 4**) compared to the Tumbling E test. In line with the other results, the majority of subjects with an unmatched VA category (different Lea symbols and Tumbling E VA categories) had normal VA in the Lea symbols examination (**Table 5**).

The mean difference in VA between Lea symbols and Tumbling E was 0.07 (SD 0.22) logMAR units, with upper and lower limits of agreement at 0.36 and 0.51, respectively (**Figure 1**). Lea symbols and Tumbling E chart are comparable and can be used to efficiently measure VA in preschool children. Mann-Whitney test revealed no significant differences in mean and median VA scores among the age and gender groups (**Tables 6** and **7**). Furthermore, Wilcoxon signed-rank test indicated that the mean VA score using Lea symbols was not significantly different from the mean Tumbling E VA score, according to age group (**Table 8**).

Subjects underwent further evaluation of possible risk factors related to VA. **Table 9** shows subjects' clinical characteristics and VA categories. None of the factors was significantly associated with low VA in our study (P>0.05).

Discussion

Table 2. Successful use of the two visual examinations, categorized by age groups (n=73)

Age groups, n	Lea symbols and Tumbling E, n	Lea symbols only, n	Tumbling E only, n	Total, n(%)
36-47 months	15	18	1	34 (46.6)
48-59 months	22	14	1	37 (50.7)
60-71 months	1	1	0	2 (2.7)
Total, n(%)	38 (52.0)	33 (45.2)	2 (2.8)	73

Table 3. Compatibility of Lea symbols and Tumbling E VA results (n=38)

Visual acuity comparison	Frequency, n
Same VA by both charts	6
Better VA by Lea symbols	21
Better VA by Tumbling E	11

Table 4. Number of children with low and normal VA, according to Lea symbols and Tumbling E tests (n=38)

Visual acuity category,n	Lea symbols	Tumbling E
Normal	30	25
Low	8	13

Table 5. Compatibility of VA result category between charts (n=38)

Compatibility	Frequency
Matched VA category	21
Unmatched VA category	
Normal VA by Lea symbols	6
Normal VA by Tumbling E	11

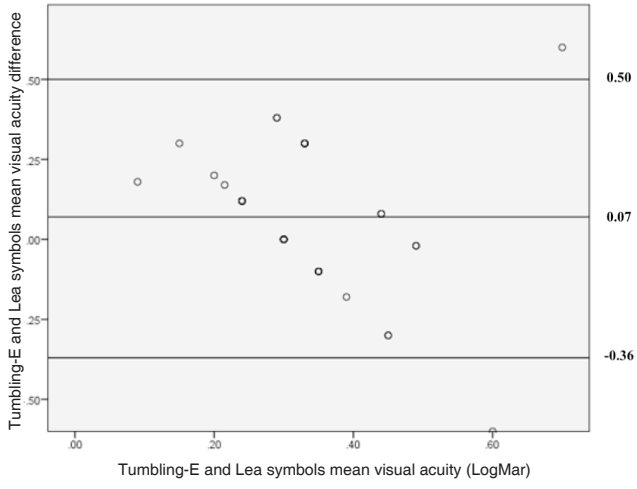

Figure 1. Bland-Altman plot of Tumbling E and Lea symbols

Table 6. Visual acuity comparison between children aged 36-47 months and 48-59 months (n=37)

Age, months	Lea symbols		Tumbling E	
	Mean (SD)	Median (range)	Mean (SD)	Median (range)
36-47	0.28 (0.17)	0.30 (0.00-0.60)	0.38 (0.19)	0.30 (0.18-1.00)
48-59	0.31 (0.19)	0.24 (0.10-0.90)	0.37 (0.09)	0.30 (0.30-0.48)
P value[a]	0.949		0.483	

[a]Mann-Whitney test

Table 7. Visual acuity comparison between gender (n=38)

Gender	Lea symbols		Tumbling E	
	Mean (SD)	Median (range)	Mean (SD)	Median (range)
Male	0.30 (0.17)	0.30 (0.00-0.60)	0.38 (0.18)	0.30 (0.18-1.00)
Female	0.29 (0.20)	0.18 (0.00-0.90)	0.35 (0.08)	0.30 (0.30-0.48)
P value*	0.944		0.570	

*Mann-Whitney test

Table 8. Visual acuity comparison of Lea symbols and Tumbling E, by age group (n=37)

Age (months)	Mean rank		P value[a]
	Lea symbols	Tumbling E	
36-47	7.56	5.75	0.115
48-59	10.91	7.29	0.131

[a]Wilcoxon signed-rank test

Table 9. Subjects' clinical characteristics and VA result categories (n=38)

Clinical characteristics	Lea symbols			Tumbling E chart		
	Normal VA	Low VA	P value*	Normal VA	Low VA	P value*
Nutritional status						
Normal	23	7		21	9	
Underweight	5	1	1.000	3	3	0.354
Overweight	1	0		0	1	
Obes3	1	0		1	0	
Body stature						
Normal	23	7	0.660	21	9	0.407
Short	7	1		4	4	
Head circumference						
Normal	21	6	1.000	19	8	0.457
Microcephaly	9	2		6	5	

*Fisher's exact test

Lea symbols and Tumbling E are both logMAR-based charts. Such charts are specifically designed with a logarithmic scale, providing a constant ratio progression of optotype size and proportional spacing related to the optotype size. The logarithmic scale is combined with the same number of optotypes in each row, in order to standardize the visual task per row. Thus, every optotype can be counted as 0.2 logMAR, and every row can be counted as 1.0 logMAR.[3,8]

In our study, more than 42.3% (33) of children could not accomplish the Tumbling-E test, with a slightly higher percentage of failure in the 36-47 months group compared to the 48-59 months group (54.5% and 38.9%, respectively). On the other hand, only one child in each group, or less than 5%, could not perform the Lea symbols test. An underdeveloped spatial orientation in children younger than five years

might be the biggest contributing factor for being unable to complete the Tumbling E test.[4,9] In our study, underdevelopment of spatial orientation was the main reason for their inability to understand instructions for the Tumbling E test. A lower percentage of failure in the older group, 48-59 months, can be attributed to the visual maturation process.[2] Almost every other study also found that preschool children tended to be more cooperative with Lea symbols.[1,11,14] However, a 2017 study found a 5-11% better testability rate with Tumbling E in children aged 3-4 years compared to previous studies which was hypothetically connected with stimulation of spatial orientation through a smartphone.[4] We had no evidence of this hypothesis in our study because our subjects were from lower income families so their exposure to smartphones was limited.

A previous study concluded that Lea symbols yielded higher VA scores than the Snellen E-chart, which might be attributed to the higher accuracy of the LogMAR-based chart.[9] Another study showed that the Lea symbols chart gave a one-line higher VA score than the Bailey-Lovie chart, which presumably was a result of a lower chance of correctly guessing in the Bailey-Lovie chart (10% versus 25%).[11] In our study, both Lea symbols and Tumbling E are LogMAR charts with four optotypes, which reduced the bias in those two previous studies.

We found that Lea symbols yielded better VA scores in all groups. Further evaluation revealed that there were no significant VA differences between each age group nor each gender, which meant that every child who understood the instruction could accomplish the test. A study also recommended Lea symbols as the preferred tool for VA examination for children older than 30 months, due to the high repeatability score.[12] Lea symbol has also been suggested by the VIP study, considering the good testability and between-test agreement.[9] In addition, a previous study showed a poor specificity of Tumbling E compared to Lea symbols (15% *vs*. 56%, respectively), which may lead to over referral.[13]

There was no significant mean difference between tests in the same age group and gender. In contrast, a study found a statistically significant difference in VA result in children aged 3-4 years when comparing Lea symbols and Bailey-Lovie E. Hence, they suggested using Lea symbols to examine children aged 3-4 years, while charts could be used interchangeably in older children.[14]

A study in South Africa showed a positive correlation between insufficient dietary intake, especially protein, fruits, and vegetables, with low VA. On the other hand, the intake of carbohydrates as the primary energy source did not affect VA.[15] In our study, we found no correlation between nutritional status and low VA, which must be interpreted with caution due to the small number of participants.

A limitation of this study was the lack of a sampling technique, as all participants were from one inner city area. Also, the best-corrected visual acuity (BCVA) was not quantified in our study, and as a result, we cannot conclude which chart gave more accurate results. However, the inferences drawn from this study can be used for a more extensive study, involving the urban area and examining BCVA to fill the existing gaps.

In conclusion, most preschool children in this study have normal visual acuity. Preschool children tend to be more cooperative with Lea symbols than Tumbling E. However, for children who can accomplish both tests, the Tumbling E chart is comparable to the Lea symbols chart.

Conflict of Interest

None declared.

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