Original Article

Visual Acuity and Refractive Errors in Toddlers

PJO – Official Journal of Ophthalmological Society of Pakistan

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ABSTRACT

Purpose: Uncorrected refractive error is the leading cause of visual impairment in children worldwide, especially in this digital era. The purpose of this study was to examine toddlers' visual acuity (VA) and refractive errors in several playgroups and kindergartens in Makassar and Gowa, Indonesia.

Study Design: Descriptive cross-sectional study.

Place and Duration of Study: Four Playgroups and Kindergartens in Makassar and Gowa, Indonesia from July 2023 to August 2023.

Methods: The subjects of this study were 245 playgroup and kindergarten students. An ophthalmologist and an experienced optometrist examined visual acuity and refractive errors of the subjects using Kay Picture test linear crowded book and a Retinoscope, respectively. The data were analyzed using the One-Way ANOVA test and the Chi-square test.

Results: Thirty-four children out of 245 (13.87%) had decreased visual acuity. One subject had myopia (2.9%), 21 had simple myopic astigmatism (61.8%), seven had compound myopic astigmatism (20.6%), three had compound hyperopic astigmatism (8.8%), and two subjects had mixed astigmatism (5.9%).Males had higher prevalence of decreased visual acuity as compared to females. There was no significant difference in visual acuity of different age and gender (p=0.437; p=0.312).

Conclusion: The prevalence of reduced visual acuity in children aged two to six years was 13.87%. The most frequently encountered refractive error was simple myopic astigmatism, accounting for 61.8% of cases.

Key Words: Visual acuity, Refractive error, Myopia, Astigmatism.

How to Cite this Article: Rimayanti U, Hasan NAW, Jamaluddin SRW, Fitrah M, Syauqad M. Visual Acuity and Refractive Errors in Toddlers. 2025;41(1):40-45. **Doi: 10.36351/pjo.v41i1.1897**

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Received: July 16, 2024
Revised: December 17, 2024
Accepted: December 27, 2024

INTRODUCTION

Refractive errors and cataracts are the leading causes of visual impairment.[1] According to the World Health Organization, in 2023, approximately 2.2 billion individuals were affected by visual impairment, including both nearsightedness and farsightedness.[1] Nineteen million individuals were below the age of 15 and 12 million of them suffered from refractive error.[1,2]

Refractive errors are not limited to adults and school-age children; they can also occur in younger age groups. This finding is consistent with the report by Pan CW et al, which shows that 66.8% of 5667 preschool children, aged 3 to 6 years from 2011 to 2012 in Yuhuatai District, China, had uncorrected refractive errors.[3] Further insight into the prevalence of refractive errors in children is provided by the Li et al, study, indicating that among 7,166 children, 1,407 (19.6%) had refractive errors.[4]

The State of the World's Children report highlighted that nearly every aspect of millions of children's lives worldwide now involves digital

technology.[5] The prevalence of digital device utilization among preschool-aged children is 95.9%, with a predominant reliance on smartphones/gadgets (94.2%).[6] This fact indicates the possibility of shift of diminished visual acuity and refractive errors into the younger age group. Furthermore, digital-based educational frameworks and current parental attitudes show an increased permissiveness toward gadget usage. The decline in visual acuity (VA) and the presence of refractive errors may also impact a child's academic performance. Therefore, examining VA and conducting refractive error screenings are essential for the early detection of visual impairments in children and for implementing early interventions to prevent childhood blindness.[7] Based on these considerations, this study investigates VA and different kinds of refractive errors in several playgroups and kindergartens in Makassar and Gowa, Indonesia.

METHODS

This descriptive cross-sectional study was conducted from July 2023 to August 2023, at four playgroups and kindergartens in Makassar and Gowa, Indonesia. The subjects were recruited through purposive sampling which included students whose parents signed the written informed consent before examination. The exclusion criteria were children with congenital eye diseases, a history of eye surgery, and non-cooperative children. According to the Issac and Michael table, from a population of 2,253 subjects, the minimum required sample size with a 10% error rate is 241 subjects.[8] A total of 245 playgroup and kindergarten students were selected as the subjects of this study, ensuring a robust and representative sample.

An ophthalmologist examined the VA of the children using the Kay Picture Test Linear Crowded Book. The normative data for visual acuity was based on previous studies.[9,10] An experienced optometrist performed dry retinoscopy (Professional Streak Retinoscope, Keeler, UK). The procedure of retinoscopy is according to Enaholo et al, (2023).[11] All examinations were performed at the school.

The demographic variables were analyzed and reported as percentage, mean, and standard deviation. The relationships between variables were analyzed using the One-Way ANOVA test and the Chi-square test. A statistically significant p-value was set as <0.05. All the data were analyzed using Statistical Package for the Social Sciences (SPSS) version 25.

The procedures adhered to the tenets of the Declaration of Helsinki, and their use was approved by the Ethics Committee of UIN Alauddin University Makassar, Indonesia (No: E.011/KEPK/FKIK/I/2023).

RESULTS

Most of the children were five years old (69%) and children of two years of age were least represented, comprising of only two individuals (1.6%). Gender distribution showed male predominance (53.5%). Age distribution is shown in Figure 1.

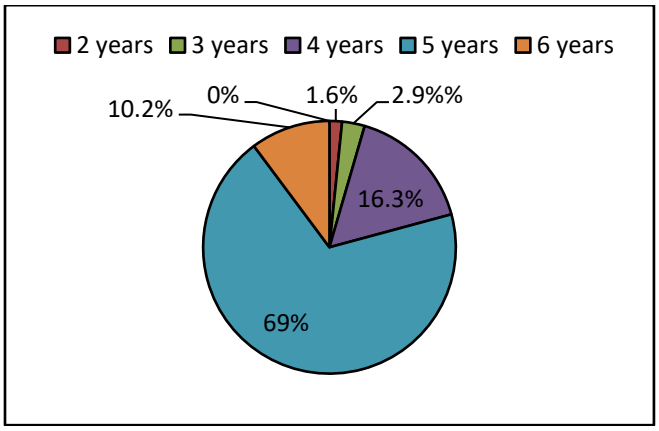

Figure 1: Age distribution among the studied sample.

Table 1 shows that 34 subjects (13.87%) had decreased visual acuity (VA). The majority of subjects experiencing a decline in VA were five years old (76.5%), with the fewest cases observed in subjects aged four years (2.9%). Males exhibited a higher prevalence of decreased VA compared to females. However, there were no significant differences in VA decline based on age or gender (p = 0.437; p = 0.312).

Table 1:*Number of Children with Decreased Visual Acuity.*

Subject Characteristics	Results (n=34)	*p**
Age		0.437
4 years	1 (2.9%)	
5 years	26 (76.5%)	
6 years	7 (20.6%)	
Gender		0.312
Male	20 (58.8%)	
Female	14 (41.2%)	

*One-Way ANOVA test

Table 2 shows the average visual acuity (Mean ±

Standard Deviation) of the children. There were no significant differences between age and gender in the average visual acuity (p= 0.477; p=0.322).

Table 2: *Mean±Standard Deviation of Visual acuity Based on Age and Gender.*

Subject Characteristics (n = 34)	Visual Acuity LE	Visual Acuity RE	*p**
Age			
4 years	0.602 ± 0.251	0.636 ± 0.265	0.477
5 years	0.594 ± 0.163	0.626 ± 0.178	
6 years	0.615 ± 0.219	0.776 ± 0.137	
Gender			
Male	0.576 ± 0.141	0.679 ± 0.148	0.322
Female	0.616 ± 0.220	0.638 ± 0.229	

VA = Visual Acuity; *RE* = Right Eye; *LE* = Left Eye
*Chi-square test

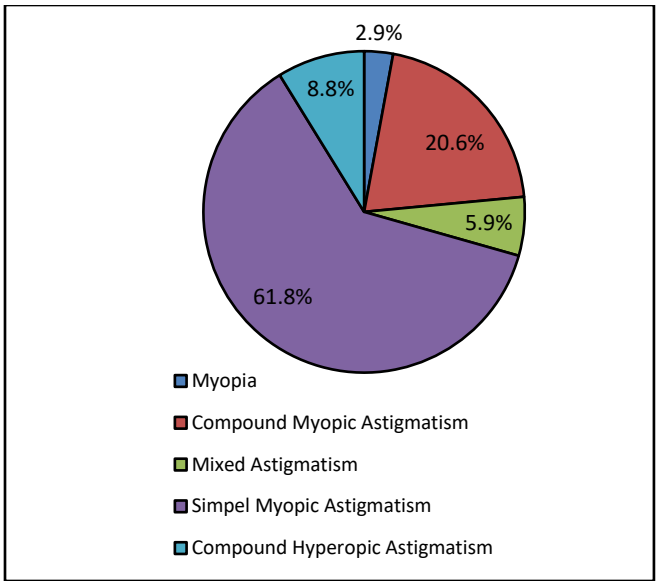

Figure 2: Distribution of Refractive Error.

Most prevalent refractive error was simple myopic astigmatism (61.8%), while the least encountered was myopia (2.9%). Figure 2 depicts the details.

Table 3 indicates no statistically significant differences between age and gender regarding the type of refractive errors (p= 0.920; p=0.448).

Table 3: *Distribution of Subject Characteristics and Refractive Errors.*

Parameter	Number of Subjects (Percentage)	P*
4 years old		
- Simple Myopic Astigmatism	5 (14.70%)	0.920
- Compound Myopic Astigmatism	3 (8.82%)	
5 years old		
- Myopia	1 (2.94%)	
- Simple Myopic Astigmatism	11 (32.35%)	
- Compound Myopic Astigmatism	6 (17.64%)	
- Compound Hyperopic Astigmatism	1(2.94%)	
- Mixed Astigmatism	1(2.94%)	
6 years old		
- Simple Myopic Astigmatism	5 (14.7%)	
- Compound Myopic Astigmatism	1 (2.94%)	
Male		
- Myopia	0 (0%)	
- Simple Myopic Astigmatism	10 (29.41%)	
- Compound Myopic Astigmatism	3 (8.82%)	
- Compound Hyperopic Astigmatism	1 (2.94%)	
- Mixed Astigmatism	0 (0%)	0.448
Female		
- Myopia	1 (2.94%)	
- Simple Myopic Astigmatism	11 (32,35%)	
- Compound Myopic Astigmatism	7 (20.58%)	
- Mixed Astigmatism	1 (2.94%)	

*Chi-square test

DISCUSSION

We found that most children showing decreased visual acuity or refractive errors were in the 5-year age group. Age and activity play a significant role in the occurrence of refractive errors. These errors are more prevalent during growth periods, as a child's age is closely related to an increased demand for visual activities.[12] This preference for refractive errors during developmental phases aligns with existing literature, as evidenced by the study conducted by Lie et al., which noted that decreased visual acuity most frequently occurs in children aged five years.[4]

Our study found that children aged 4 years had the lowest prevalence of decreased visual acuity. Notably, this finding aligns with the study conducted by Olusanya et al., which highlighted that the age group of 1-5 years experiences the lowest incidence of refractive errors.[2]

There was no significant correlation between age and the decline in visual acuity which was similar to the reports of Friedman DS et al.[13] Although there is higher prevalence of myopia in general population, 3 to 5-year-old children did not have a higher rate of refractive error.[14] However, myopia prevalence was markedly increased after 6 years of age.[15,16]

This study revealed no significant difference between gender and the decline in visual acuity. This finding was consistent with the study by Wen et al., which indicated no significant difference in the prevalence of refractive errors based on gender.[17] However, there were more males with refractive errors and this observation aligned with Paudel et al., who reported that refractive errors were more prevalent in males than females.[18] Conversely, this contradicted the findings of the National Institute of Eye Health[19] and Li et al.[4], stating that females were more prone to refractive errors than males. The higher risk of refractive errors in females may be associated with earlier puberty onset in females, leading to earlier increases in eye axial length development.[20] The variation in near-vision activities may contribute to these differences, as females typically engage in more close-up tasks, while males tend to participate in more outdoor activities.

French et al, stated that children with low to moderate levels of outdoor activity have a higher risk of developing myopia compared to those with high levels of outdoor activity.[21] Engaging in outdoor activities promotes a broader field of view, relaxes accommodation, and stimulates dopamine release, which helps inhibit excessive eye growth.[22]

Physical activities and sufficient exposure to sunlight outdoors can prevent axial elongation of the eyeball and mitigate visual acuity impairment.[23] Outdoor light has a higher intensity than indoor light. UVB radiation can stimulate vitamin D production, contributing to collagen formation (a significant component of the sclera) and preventing muscle hypertrophy.[22,24]

The most frequent refractive error found in this study was simple myopic astigmatism. This finding is similar to that reported by Li et al.[4], which stated that astigmatism was the most frequently encountered refractive error, followed by myopia and hyperopia. Astigmatism can be hereditary, manifesting at birth or later in life, and may worsen or improve with age. It can also occur as a result of eye surgery or trauma.[19]

Another hypothesis proposed a relationship between astigmatism and myopia, suggesting that uncorrected astigmatism may cause uncoordinated eye growth, potentially leading to the development of myopia.[25] The second most common refractive error was compound myopic astigmatism.

This study indicates that myopia was the least common refractive error. This finding, which aligns with the study by Lan et al,[16] has significant implications for understanding and addressing myopia prevalence. Environmental factors, including near work, education, outdoor activities, and economic status, influenced myopia. It is suspected that children in developed countries are more prone to myopia.

This study found no significant correlation between gender and refractive errors (myopia, hyperopia, astigmatism), consistent with findings by Wen et al.[17] Other studies also supported the absence of a significant relationship between gender and refractive errors (astigmatism, myopia).[16]

The limitations of this study include the adoption of a cross-sectional subject selection method and the utilization of dry retinoscopy. The choice of dry retinoscopy was influenced by parental reluctance to subject their children to cycloplegic testing. In addition, the results of this study cannot be generalized.

CONCLUSION

This study determined that the prevalence of reduced

visual acuity in children aged two to six was 13.87%. The most frequently encountered refractive error was simple myopic astigmatism, accounting for 61.8% of cases.

Funding: This study was supported by the fund of School of Medicine, Universitas Islam Negeri Alauddin Makassar.

Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(E.011/KEPK/FKIK/I/2023)**.

ACKNOWLEDGMENT

Nurhira Abdul Kadir, MD, from the University of Wollongong, New South Wales, Australia, edited the English language.

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Sri Rezki Wahdania Jamaluddin; *Medical practitioner: Manuscript preparation, Manuscript editing, Manuscript review.*

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