Original Article

Refractive Error and Anisometropia in Down Syndrome: A Cross-Sectional Study in A Tertiary Hospital

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ABSTRACT

Purpose: To determine the frequency of refractive errors and the magnitude of anisometropia in children with Down syndrome (DS) across different age groups.

Study Design: Cross-sectional study.

Place and Duration of Study: Ophthalmology Clinic at Ngoerah General Hospital from January 2024 to September 2024.

Methods: A total of 53 DS children were included in the study. Refractive errors were recorded from the latest control visit, with measurements taken from fully dilated pupils. The highest recorded hypermetropic value, as well as the lowest myopic and cylindrical values from both eyes, were used for analysis. Continuous variables were reported as mean ± standard deviation (SD), and categorical variables were reported as frequencies and percentages. Refractive errors were compared between preschool (<6 years) and school-age (≥6 years) groups using the Mann-Whitney test, with p-values <0.05 considered statistically significant.

Results: Out of 53 DS children, 85% had refractive errors. The most common refractive error was myopia (37.7%), followed by hypermetropia (28.3%) and astigmatism (18.9%). Among the 35 children in the school-age group (≥6 years), 45.7% had myopia and 22.8% had hypermetropia, whereas among the 18 children under 5 years of age, 38.9% had hypermetropia. A significant difference in the spherical equivalent between the two age groups was observed ($p < 0.05$). Anisometropia was present in 19% of participants, with 15% exhibiting a low degree of anisometropia.

Conclusion: The high prevalence of refractive errors in DS children and the tendency toward myopia in primary school-aged children support an age-dependent myopic shift.

Keywords: Anisometropia, Down Syndrome, Refractive Errors.

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INTRODUCTION

Down syndrome (DS), caused by trisomy 21, has a global incidence of 1 in 1,000–1,100 births, with Indonesia's prevalence increasing from 0.12% in 2010 to 0.13% in 2013.[1] Children with DS often experience visual impairments,[2] with refractive errors occurring more frequently and exhibiting greater variability than in non-DS individuals.[3-6] Anisometropia is also common, with previous studies reporting highly variable prevalence rates (19.4%–43%).[4,5] This study investigates refractive errors and anisometropia in DS children across different age groups to support early eye care guidelines.[7]

METHODS

This study was a cross-sectional study conducted from January 2024 to September 2024, involving all paediatric patients with DS who visited the eye clinic at Ngoerah General Hospital. The study was conducted under the principles outlined in the Declaration of

Helsinki. Ethical approval was obtained from the Research Ethics Committee of the Faculty of Medicine, Udayana University, under ethical clearance (**0994/UN14.2.2.VII.14/LT/2024).**

A total of 53 DS children were included in the study, either referred by the paediatric department or self-referred via an examination flyer distributed by Persatuan Orang Tua Anak dengan Down Syndrome (POTADS, Association of Parents of Children with Down Syndrome) Bali and Kuncup Bunga Foundations. The sample size was calculated using the formula for estimating proportions in a finite population, requiring a minimum of 41 subjects. Due to the limited population of children with DS, a total sampling approach was employed to ensure comprehensive data collection.

The inclusion criteria encompassed all DS children who were willing to undergo a complete eye examination, including an anterior segment examination and refraction assessment with cycloplegic agents. Exclusion criteria included children who were uncooperative during the examination and those whose parents or guardians did not consent to a complete eye examination, specifically the application of cycloplegic eye drops. Parents or guardians provided signed informed consent and an agreement letter before evaluation.

The instruments used for data collection included visual acuity assessments with the Snellen chart, LEA card, or Cardiff card, depending on the child's level of cooperation, age, and cognitive ability. The refractive examination was conducted using an autorefractor-keratometer and/or streak retinoscopy. The anterior segment examination was performed using a portable slit lamp or a flashlight with a loupe.

Refractive error was expressed as the spherical equivalent (SE), calculated as the spherical value plus half the cylindrical value. Refractive status was classified as either emmetropia or ametropia (refractive error). Streak retinoscopy was primarily used for children with limited cooperation. The streak retinoscopy examination was performed after cycloplegic dilation using three drops of cyclopentolate, administered 15 minutes apart in both eyes. If sufficient pupillary dilation was not achieved, an additional drop of 0.5% tropicamide was applied to both eyes. In cooperative DS children, auto-refractometry and subjective refraction were conducted after cyclopentolate instillation.

Refractive status was categorized as emmetropia when SE was >-1.00 diopters (D) and <+2.00D, myopia when SE ≤-1.00D, hypermetropia when SE ≥+2.00D, and astigmatism when the cylindrical value was greater than the spherical value, with a magnitude greater than 1.00D. Refractive error data were recorded from the latest control visit, with measurements taken from fully dilated pupils. The highest recorded hypermetropic value, as well as the lowest myopic and cylindrical values from both eyes, were used for analysis.

Anisometropia was defined as a refractive difference of greater than 1.00D between the two eyes. It was further classified based on severity, with low anisometropia ranging from 1.00-2.00D, high anisometropia from 2.00-6.00D, and remarkably high anisometropia if greater than 6.00D.

Continuous variables were reported as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Refractive errors were compared between preschool (<6 years) and school-age (≥6 years) groups using the Mann-Whitney test, with p-values <0.05 considered statistically significant. Analyses were conducted using IBM SPSS (Statistical Package for the Social Sciences) version 27.

RESULTS

A total of 54 DS children aged 1–18 years (mean age 8.39 ± 5.39 years) participated in this study, with 53 children completing all examinations. The gender distribution was balanced, with 52.8%being male participants. The spherical equivalent of the right eye was -2.20 ± 4.72 D, while that of the left eye was -1.77 ± 4.72 D.

The most common refractive error was myopia (37.7%), followed by hypermetropia (28.3%) and astigmatism (18.9%). Among the 20 children with myopia, moderate myopia (SE 2.00-6.00D) was observed in 9 children, while severe myopia (SE >-6.00D) was present in 10 children, accounting for 50% of the myopic cases.

Among the 35 children in the school-age group (≥6 years), 45.7% had myopia and 22.8% had hypermetropia. In contrast, among the 18 children in the pre-school age group (<6 years), 38.9% had hypermetropia. The spherical equivalent between the pre-school (<6 years) and school-age (≥6 years) groups was found to be significantly different ($p<0.05$) based on Mann-Whitney U analysis.

Table 1: *Demographic and refractive error distribution of the study population (n=53).*

Characteristics	N	(%)
Age (years, mean ± SD)	8.39 ± 5.39	
Gender (n)		
Male	25	(47.2)
Female	28	(52.8)
History of Prematurity		
Yes	4	(7.5)
No	49	(92.5)
History of Birth		
Vaginal Birth	29	(54.7)
Sectio Caesarean	24	(45.3)
Mother's Age during Pregnancy(years)		
≤35	30	(56.7)
>35	23	(43.3)
Spherical Equivalent (Diopters, mean ± SD)		
Right Eye	-2.2 ± 4.72	
Left Eye	-1.77 ± 4.72	
Refractive Error		
Myopia	20	(37.7)
Hypermetropia	15	(28.3)
Astigmatism	10	(18.9)
Emmetropia	8	(15.1)
Anisometropia	10	(18.9)
Low	8	(15.1)
High	2	(3.8)

Table 2: *Refractive Errors by Age Group.*

Refractive Error	Age Group (years) n (%) = 45		
	0-5	6-13	≥14
Myopia	4 (28.6)	12 (54.5)	4 (45)
Hypermetropia	7 (50)	7 (31.8)	1 (10)
Astigmatism	3 (21.4)	3 (13.7)	4 (45)
Total	14	22	9

Table 3: *Distribution of Anisometropia Types by Age Group.*

Anisometropia	Age Group (years) n (%) = 10		
	0-5	6-13	≥14
Myopia	1 (50)	3 (50)	1 (50)
Hypermetropia	1 (50)	2 (33.3)	0 (0)
Astigmatism	0 (0)	1 (16.7)	1 (50)

Table 4: *Mean Spherical Equivalent by Age Group.*

Age Group (years)	<6	≥6	p
Mean spherical equivalent	33.64	23.59	0.025*

*Mann-Whitney U test showed a difference in spherical equivalent results between pre-school age and school age with p <0.05.

Anisometropia was present in 10 children (19%), with 8 children (15%) exhibiting a low degree, and 2 children having severe anisometropia. Among the anisometropic cases, 50% were associated with myopia, while only 3 children had hypermetropia.

DISCUSSION

Refractive errors were observed in approximately 85% of DS cases, with 58.5%occuringin school-age children. According to the data from the International Agency for the Prevention of Blindness (IAPB) in 2021, 55% of school-age children with DS had refractive errors, compared to only 4.5% in the general population.[8]Refractive errors in DS are attributed to differences in visual development compared to children with typical growth and development, particularly in accommodation ability. The process of emmetropization in early life differs in DS, as existing refractive errors tend to persist rather than resolve, particularly hypermetropia and oblique astigmatism.[9] According to another study, refractive errors were more common in children older than six years, with an increasing prevalence as age advances.[10]

In this study, myopia was the most prevalent refractive error. These findings align with previous DS studies in Asia, such as those by Horio *et al*., Terai in Japan, and Kim *et al*., in Korea, which reported a trend towards myopia with increasing age.[3,4,9] However, other studies in Asia have shown contrasting results, indicating a higher prevalence of hypermetropia and astigmatism in DS children.[2,10-11] To the best of our knowledge, this is the first study to report myopia trends in Balinese children with DS.

Among school-age children, nearly half had myopia. In healthy, non-DS children, refractive errors typically shift towards myopia with age.[12-13] In contrast, DS children are more frequently found to have hypermetropia, likely due to a defective or delayed emmetropization process.[5,10] The results of this study suggest that refractive errors in DS children exhibit an age-dependent myopic shift.

Hypermetropia was the most prevalent in the 0-5 years age group. Studies by Terai *et al*, and Kim similarly found that hypermetropia was more common in infants with DS but tended to shift towards myopia during adolescence.[3,11] This finding may be explained by the natural occurrence of hypermetropia in young children, which typically decreases with age due to emmetropization. In early life, the mean refractive error in DS children does not significantly differ from that of the general population; however, in DS children, refractive errors tend to worsen with age, due

to the failure of the emmetropization.[5,10]

Previous studies have reported hypermetropia in 20-40% of DS children under 18 years of age, with hypermetropia being more common than myopia.[8,10,11,14-17] Other studies have documented an even higher prevalence of hypermetropia, exceeding 60%.[2,7,18-20]

Astigmatism prevalence has been reported to vary significantly across studies, ranging from less than 10%,[16,21] to 20–30%,[10,12,17,18,22] around 45%,[18,20,22] and up to 60%.[2,6,7,8,15,19] Study in Italy by Valentini *et al*, reported astigmatism as the most common refractive error in DS. In contrast, this study found astigmatism to be the least common refractive error, affecting approximately 19% of participants.[10] The variation in the reported prevalence may be due to differences in classification or grouping criteria for astigmatism.

Anisometropia was observed in 19% of cases in this study, with the highest prevalence in children aged 6–13 years. Typically, anisometropia is more common at birth but decreases by age two due to the process of emmetropization and the development of binocular vision. However, the prevalence of anisometropia increases again during childhood and adolescence as myopia progresses.[23] When anisometropia persists beyond three years of age, it is likely to result in amblyopia. Since amblyopia is common in DS children and near vision difficulties caused by hypermetropia can contribute to learning disabilities, hypermetropia should be addressed by clinicians. Special attention is also required in cases of severe myopia and astigmatism.[2]

The limitation of this study is that it did not assess accommodation, despite the well-documented impaired accommodation in DS children. Additionally, although the study included a wide age range, the distribution was not balanced across age groups. Future research should aim to include a more evenly distributed sample across different age groups to better represent the relationship between refractive errors and age development.

CONCLUSION

The findings of this study highlight the high prevalence of refractive errors in DS, with 19% being affected by anisometropia. Early detection of refractive errors, particularly in children with special needs, can significantly improve their quality of life, as well as that of their caregivers. The data obtained in this study can serve as a foundation for developing eye health screening programs specifically tailored to children with DS.

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Patient's Consent: Researchers followed the guide lines 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 **(0995/UN14.2.2VII.14/LT/2024)**.

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