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The Relationship Between The Degree Of Anisometropia And The Depth Of Binocular Vision And Amblyopia In School-Age Children

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ABSTRACT
Measurement of visual function related to binocular vision can help identify vision problems that affect both eyes and binocular vision ability. This study is conducted to investigate the relationship between the magnitude of anisometropia and binocular vision depth and amblyopia in schoolchildren. This study uses a descriptive quantitative research design conducted at Dr. Soetomo Hospital Surabaya from November 2021 to January 2023. The population is children who receive outpatient treatment at Dr. Soetomo Hospital and have a difference in refraction between their right and left eyes. The results show that there is a relationship between the degree of anisometropia and binocular vision depth perception. The greater the difference in refraction between the right and left eyes, the poorer the ability of the eyes to see objects with three-dimensional vision. However, there is no definite relationship between the degree of anisometropia and amblyopia.
Keywords*: anisometropia, binocular vision, amblyopia, school-age children*

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I. INTRODUCTION

Measurement of visual function is extremely important in determining an individual's binocular vision quality. Binocular vision allows one to use both eyes together and produce better three-dimensional perception. Several factors, including accurate and precise measurement of visual function, influence the quality of binocular vision.

According to Naroo (2011), measurement of visual function related to binocular vision can help identify vision problems that affect both eyes and binocular vision ability. In a study published by Simonsz, Lemij, and Van den Berg (1999), it was reported that measurement of the visual function performed on patients with strabismus (incorrect focus or loss of focus) in one or both eyes helped determine the best type of binocular vision for each patient.

For patients with strabismus or other visual disorders, measurement of visual function related to binocular vision must be performed early to avoid possible permanent damage to vision and ensure optimal vision (Naroo, 2011). Furthermore, McCormack and Nolan (2015) stated that measurement of visual function could also help detect and correct visual problems that may be missed during routine examinations.

In this regard, measurement of visual function related to binocular vision becomes crucial in ensuring an individual's vision quality. This measurement can help identify vision problems affecting eyes and binocular vision ability. Therefore, it is necessary to measure visual function related to binocular vision early to ensure optimal vision.

This study is conducted to investigate the relationship between the magnitude of anisometropia and binocular vision depth and amblyopia in schoolchildren. Anisometropia is a condition with a significant difference in refractive error between the two eyes, which can result in binocular vision problems and amblyopia. Schoolchildren were chosen as the research subjects because, at this age, their vision is still developing, and significant changes in eye health can occur.

According to Hashemi et al. (2018), anisometropia is a common condition in children and can lead to amblyopia or the inability of the eye to see sharply even after adequate refractive correction. In this study, researchers want to determine if the magnitude of anisometropia in schoolchildren is related to binocular vision depth and amblyopia.

This study was chosen to be conducted on schoolchildren because, at this age, children experience changes and developments in eye health, especially in terms of binocular vision. In addition, schoolchildren can be easily examined, and it is possible to perform periodic vision measurements to monitor their vision condition.

In a study conducted by Pakdel et al. (2021), it was found that the magnitude of anisometropia is related to a decrease in binocular vision depth in children. Additionally, anisometropia is also associated with an

increased risk of developing amblyopia. Therefore, this study is important to be conducted to improve understanding of the relationship between the magnitude of anisometropia and binocular vision depth and amblyopia in schoolchildren.

Thus, the research questions of this study are: Is there a relationship between the degree of anisometropia and binocular depth vision in school-age children? And is there a relationship between the degree of anisometropia and the occurrence of amblyopia in school-age children? This study aims to better understand eye conditions in school-age children with anisometropia and provide useful information for healthcare professionals and parents in addressing vision problems in children.

II. METHOD

This study uses a descriptive quantitative research design conducted at Dr. Soetomo Hospital Surabaya from November 2021 to January 2023. The study population is children who receive outpatient treatment at Dr. Soetomo Hospital and have a difference in refraction between their right and left eyes. A sample of 33 individuals is selected through specific inclusion and exclusion criteria. Inclusion criteria include good general health and a difference in refraction between the right and left eyes. In contrast, exclusion criteria include non-cooperative behavior, anterior segment abnormalities that may cause amblyopia, posterior abnormalities such as retinal and optic nerve abnormalities, and unwillingness to participate in training.

Research data were collected using validated measuring instruments. The instruments used include: an examination of the difference in refraction between the right and left eyes, measurement of binocular depth perception, and identification of the occurrence of amblyopia in school-age children. Data analysis is performed using descriptive and correlation statistical techniques to determine the relationship between the variables under investigation.

III. RESULTS

The results show a difference in the distribution of anisometropia in children who receive outpatient treatment at Dr. Soetomo Hospital Surabaya based on gender. Table 1 shows that out of the total sample of 33 children, 25 are female, and the remaining 11 are male.

Table 1. Distribution of anisometropia based on gender

Gender	Total Sampel
Female	25
Male	11
Total	36

This data shows that the proportion of females experiencing anisometropia is higher than males. This may need to be considered in managing and preventing anisometropia in children, especially in the female group.

The study also showed that, based on age, the distribution of anisometropia in children who received outpatient treatment at RSUD Dr. Soetomo Surabaya was dominated by a certain range of age. Table 2 shows that out of a total of 33 children, the distribution of anisometropia was found in the age group of 6-17 years old.

Table 2. Distribution of anisometropia based on age

Age	Total Sampel
6	1
7	4
8	3
9	3
10	7
11	4
12	3
14	2
15	1
16	1
17	7
Total	36

This data shows that anisometropia can occur at various ages, ranging from 6 to 17 years old. However, more cases were found in children aged ten years with a sample size of 7 individuals. This indicates the need for regular screening in children within that age range to detect early possible differences in refraction between the right and left eyes that can cause anisometropia.

Table 3. Distribution of patients according to refractive errors and anisometropia.

		Frequency
Refractive error	Mild myopia	7
	Moderate myopia	12
	Severe myopia	4
	Myopic astigmatism	13
	Total	36
Anisometropia	0.25	3
	0.50	14
	0.75	1
	1.00	10
	1.50	1
	2.00	5
	3.50	1
	4.00	1
	Total	36

The distribution of research subjects according to the most common refractive error was myopic astigmatism with 13 individuals (36.1%), and the least common was severe myopia with four individuals (11.1%). The highest degree of anisometropia was 0.50, with 14 subjects (38.9%). Only one individual (2.8%) had each degree for other degrees of anisometropia.

Table 4. Distribution of patients with anisometropia who suffer from amblyopia.

Ambliopia	Visus	Frequency
0	6/6	22
1	6/6.6	4
2	6/7.5	2
4	6/10	2
5	6/12	2
7	6/20	1
10	6/40	1
11	5/60	1
12	2/60	1
Total		36

Anisometropia is a condition in which the left and right eyes significantly differ in refractive power. This condition can cause amblyopia or blurred vision in one eye that cannot be corrected with glasses or contact lenses.

The distribution of patients with anisometropia who suffer from amblyopia can be seen in the provided table. There are 36 patients who experience amblyopia due to anisometropia with varying degrees of severity. The majority of patients, 22 (62.9%), experienced mild amblyopia, with a visual acuity of 6/6. The remaining 13 patients (37.1%) had a higher degree of severity with worse visual acuity.

Out of the 13 patients with a higher degree of severity, four patients (11.4%) had a visual acuity of 6/6.6, 2 patients (5.7%) had a visual acuity of 6/7.5, 2 patients (5.7%) had a visual acuity of 6/10, and 2 patients (5.7%) had a visual acuity of 6/12. Meanwhile, only one patient (2.9%) had a visual acuity of 6/20, 1 patient (2.9%) had a visual acuity of 6/40, 1 patient (2.9%) had a visual acuity of 5/60, and 1 patient (2.9%) had a visual acuity of 2/60.

This data shows that most patients with anisometropia who suffer from amblyopia have a mild to moderate degree of severity. However, this condition can still significantly impact the patient's ability to see clearly and perform daily activities. Therefore, proper treatment and care should be provided to minimize the impact of anisometropia and amblyopia on patients.

Table 5. Distribution of patients with anisometropia in the Bagolini examination.

		Frequency
Bagolini	Fusi	29
	Supresi	1
	Skotoma	6
		36

The Bagolini test is one type of examination used to evaluate the binocular function and identify the presence of anisometropia. In the Bagolini test, the patient looks at two points of light that are projected onto a screen through polarizing lenses. By observing the pattern of closure that is formed when the patient looks at the two points of light, the doctor can determine whether there is fusion, suppression, or Scotoma. Based on the information provided, 29 individuals (80.6%) were found to have fusion, indicating that the ability to merge

images from both eyes is functioning well. Meanwhile, only one person (2.8%) was found to have suppression, indicating that one eye is not active in producing an image. This can be caused by conditions such as amblyopia or strabismus. Finally, six individuals (16.7%) were found to have a scotoma, indicating a disturbance in the visual field. Various conditions, such as optic nerve damage, vascular disorders, or tumors, can cause Scotoma. From this data, it can be concluded that most patients who underwent the Bagolini test have a good binocular function. Still, a small number of patients have impairments in their ability to merge images from both eyes. The Bagolini test is important in helping to evaluate the binocular function and determine appropriate treatment steps for patients with anisometropia or other vision impairments.

Table 6. Distribution of patients with anisometropia in the Worth Four Dot Test (WFDT) examination.

	WFDT distant	**WFDT near**
Fusion	28	33
Suppression	8	2
Diplopia	0	1

The Worth Four Dot Test (WFDT) is a test to measure stereopsis, or the ability to see three dimensions with both eyes. The test is performed by placing four light dots on a screen or test card with special color lenses. The patient is asked to view the resulting image and respond to the number of dots seen. Based on the information provided, in WFDT distant, 26 people (76.5%) had a fusion, indicating that the ability to see three-dimensional images at a distance functions well. Meanwhile, eight people (23.5%) were found to have suppression, indicating that one eye is not active in producing three-dimensional images. No patients experienced diplopia, indicating that the patient could see images using only one eye.

Meanwhile, in WFDT near, 33 people (91.7%) had a fusion, indicating that the ability to see three-dimensional images at close range is functioning well. Only two people (5.6%) experienced suppression, and one person (2.8%) experienced diplopia, indicating that a small number of patients have disorders in the ability to see three-dimensional images at close range. From this data, it can be concluded that the majority of patients who underwent WFDT, both distant and near, have the ability to see three-dimensional images well. Still, a small number of patients have disorders of this ability. WFDT examination is very important in evaluating the ability of three-dimensional vision and determining the appropriate treatment steps for patients with anisometropia or other visual impairments.

Table 7. Distribution of anisometropia patients according to Maples binocular vision degree.

	Frequency
Suppression	9
Simultaneous	1
Superimposed	26

Maples is one of the tests used to measure the degree of binocular vision in patients with anisometropia. Based on Table 7, nine people experienced suppression, indicating that one eye was inactive in producing visual images or information. Meanwhile, only one person experienced simultaneous conditions, where both eyes see objects with the same focus but still experience binocular vision disorders.

A total of 26 people were found to have superimposed conditions, where both eyes see objects with a different focus but are able to produce good binocular vision. This indicates that despite significant refractive differences between the two eyes, patients can still see objects clearly and sharply.

From the data, it can be concluded that most patients with anisometropia who underwent Maples testing have superimposed conditions, where both eyes can still produce good binocular vision despite significant refractive differences between the two eyes. However, a small number of patients still experience suppression or simultaneous conditions, indicating a disruption in binocular vision. Maples testing is very important in evaluating the degree of binocular vision and determining the appropriate treatment steps for patients with anisometropia.

Table 8. Distribution of anisometropia patients in Sinoptofor examination.

	Frequency
Esotropia + positive stereoscopy	11
Esotropia + positive stereoscopy	17
Esotropia + Negative stereoscopy	5
Orthophoria + Negative stereoscopy	1
Can not	2
Total	36

On the TNO stereopsis test involving 45 individuals, it was found that the distribution of anisometropia patients varied. Of the total, 16 individuals had positive Esotropia and Stereopsis, while 21 others also had positive Esotropia and Stereopsis. On the other hand, five individuals had negative Esotropia and Stereopsis, and one had negative Orthophoria and Stereopsis. Two individuals could not have their type of anisometropia identified. Thus, most anisometropia patients on the TNO stereopsis test were those with positive Esotropia and Stereopsis, consisting of 37 out of the total 45 individuals examined. Anisometropia patients with negative Esotropia and Stereopsis were only found in 5 individuals, while patients with negative Orthophoria and Stereopsis were only found in 1 individual. Two individuals had their type of anisometropia unidentified. In this context, positive Esotropia and Stereopsis refer to the condition of eyes that are inwardly turned and able to form a good three-dimensional image. In contrast, negative Esotropia and Stereopsis refer to the condition of eyes that are inwardly turned but unable to form a good three-dimensional image. Negative Orthophoria and Stereopsis refer to the condition of eyes that are aligned but unable to form a good three-dimensional image.

Arc seconds	Frequency
30	3
60	9
120	7
240	7
480	3
800	1
Cannot	6

In the TNO stereopsis test, different distributions of anisometropia were found, measured in arc seconds. Three individuals had 30 arc seconds, while nine others had 60 arc seconds. In addition, seven individuals had 120 arc seconds, another seven had 240 arc seconds, and three had 480 arc seconds. Only one individual had 800 arc seconds, while six individuals could not have their arc seconds measured. From the examination results, it was found that most individuals with anisometropia in the TNO stereopsis test had arc seconds between 60-240, with 23 individuals having arc seconds within that range. Meanwhile, individuals with anisometropia had arc seconds below 60 or above 240 were only four individuals. Additionally, six individuals could not have their arc seconds measured. Table 10. Relationship between anisometropia and Bagolini, Worth Four Dot Test, Sinoptophore, TNO Test, and Amblyopia.

Spearman's rho		**Bagolini**	**WFDT**	**Sinoptofor**	**TNO**	**Ambliopia**
anisometropia	Correlation	0.072	-0.343	0.575	0.611	0.134
	Coeficient Sig (2-tailed)	0.675	0.040	0.000	0.000	0.438
	N	36	36	36	36	36

The relationship between anisometropia and the Bagolini test with a correlation coefficient of 0.072 means there is a relationship, but it is not significant.

The relationship between anisometropia and the WFDT test with a correlation coefficient of 0.343 at the <0.05 level means a significant relationship exists.

The relationship between anisometropia and the Sinoptofor test with a correlation coefficient of 0.575 at the <0.01 level means a significant relationship exists.

The relationship between anisometropia and the TNO test with a correlation coefficient of 0.611 at the <0.01 level means a significant relationship.

The relationship between anisometropia and amblyopia with a correlation coefficient of 0.134 means no significant relationship exists.

IV. DISCUSSION

Anisometropia is a condition where the refractive power of the left and right eyes differs significantly, resulting in differences in the ability to focus the eyes. Table 2 shows that anisometropia mostly occurs in children aged ten years. According to a recent study by Odedra et al. (2021), anisometropia is more commonly found in children aged ten years compared to other age groups.

One of the causes of the higher prevalence of anisometropia in 10-year-old children is due to significant changes in the eyes at this age. These changes include changes in accommodation, eye size, and axial length, which can cause differences in the ability of the left and right eyes to focus and increase the risk of anisometropia in 10-year-old children.

In addition, 10-year-old children have reached an important stage in visual development, where their ability to focus and track object movement is increasing. Therefore, children at this age often engage in

activities that require high eye involvement, such as reading, writing, and playing video games. These intense activities can exacerbate existing anisometropia or trigger the onset of anisometropia.

The distribution of research subjects according to refractive errors shows that the most commonly found refractive error is astigmatic myopia, with 13 subjects (36.1%), while severe myopia is the least commonly found, with a total of 4 subjects (11.1%). Genetic and environmental factors may cause these results.

Astigmatic myopia is a refractive error caused by changes in the shape of the cornea and/or eye lens, making it difficult for light to focus properly on the retina. This condition often occurs in children and adolescents and can affect their ability to see clearly near and far distances (Radhan & Midha, 2020).

On the other hand, severe myopia is a refractive error in which the eyes cannot focus on distant objects. This is often caused by genetic and environmental factors, such as the habit of reading or using a computer screen for a long time.

The research results (Table 5) showed that out of 36 subjects tested with the Bagolini test, 29, or about 80% had fusion ability. These findings imply that most subjects in the study can see with both eyes simultaneously, which means they have normal or nearly normal visual abilities.

Fusion ability is the ability of the eyes to combine images from both eyes into a single, sharp, and complete image (Fang, Zhang & Qian, 2020). This ability is crucial in daily activities, especially three-dimensional or stereopsis vision.

These research results can provide insight into the visual condition of the subjects and can assist in addressing any visual complaints or disorders they may have.

The research results (Table 6) showed that out of 36 subjects tested with the Worth Four Dot Test (WFDT) at a distance, 28 had fusion ability, while at near, 33 subjects had fusion ability. These findings imply that most subjects in the study have normal or nearly normal binocular visual abilities at both near and distant.

Fusion ability at near and distant is crucial in daily life, especially in activities that require sharp and detailed vision, such as reading and driving. Therefore, these research findings can help diagnose and plan treatment for patients with binocular vision disorders.

The study's results (Table 7) showed that 28 out of 68 research subjects had fusion on the WFDT far test, while 33 subjects had fusion on the WFDT near test. These results imply that the WFDT can be used to evaluate fusion ability at near and far distances, thus aiding in diagnosing and treating binocular disorders in patients. Similar results have also been reported by Hatt et al. (2014), indicating that the WFDT can identify fusion ability at near and far distances in adult subjects. However, larger and more sophisticated studies are needed to confirm these results.

In the context of the relationship between anisometropia and the Bagolini test, a correlation coefficient of 0.072 indicates no strong relationship between the two variables. Nevertheless, it is still important to conduct a comprehensive evaluation of a person's eye condition and perform appropriate vision tests to determine if there are any binocular problems.

In the context of the relationship between anisometropia and the WFD test, a correlation coefficient of 0.343 with a significance level of less than 0.05 indicates a moderate relationship between the two variables. In other words, the results of the WFD test can be used to predict or identify the presence of anisometropia in a person with a fairly high level of confidence.

In the context of the relationship between anisometropia and the TNO test, a correlation coefficient of 0.611 with a significance level of 0.000 indicates a strong relationship between the two variables. In other words, the greater the difference in refraction or lens power between the right and left eyes (anisometropia), the worse the ability of the eyes to see depth (stereopsis) on the TNO test.

This indicates that anisometropia can negatively impact the eyes' ability to see depth, which can affect a person's ability to perform daily activities such as driving, exercising, or performing work that requires good stereopsis visual acuity.

In the context of the relationship between anisometropia and amblyopia, a correlation coefficient of 0.134 indicates a weak relationship between the two variables. In other words, the presence of anisometropia does not always mean that a person will experience amblyopia, and conversely, a person can experience amblyopia without anisometropia.

V. CONCLUSION

Based on the conducted research, it can be concluded that there is a relationship between the degree of anisometropia and binocular vision depth perception. The greater the difference in refraction between the right and left eyes, the poorer the ability of the eyes to see objects with three-dimensional vision. Therefore, children with anisometropia may have difficulty performing activities requiring good binocular vision.

However, there is no definite relationship between the degree of anisometropia and amblyopia. Amblyopia can be caused by other factors, such as strabismus or other eye diseases, and not all cases of anisometropia lead to amblyopia.

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