ORIGINAL PAPERS

Myopia Prevalence and its Correlation with Demographic Characteristics Before the COVID-19 Pandemic among Acehnese School Children (6-19 years) in Indonesia

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Abstract

The prevalence of myopia in school-age children has increased dramatically year by year. Myopia is an impact on academic achievement, and blindness, and increases the economic burden. The research objective was to analyze the prevalence of myopia and its relationship with demographic characteristics (age and gender) in school-age children. This study was a cross-sectional design. The respondents were male (M), female (F), and school-age children (aged 6-19 years). The total subjects were 1171 school students, Elementary Schools (n=661; M=326, F=335), Junior High Schools (n=307; M=138, F=169), and High Schools (n=203; M=84, F=119). Data analysis was descriptive and chi-square tests (p<0.05). We found that the prevalence of myopia in school-age children was 14.61%. The highest rate of myopia is at the age of 19 years, girls (15.73%) more than boys (13.32%), in the late adolescent group (23.53%) more than the early adolescent group (18.75%), and childhood age (9.32%). Myopia in high school-age children (23.15%) was more than in junior high school students (20.85%), and elementary school students (9.07%). There was a relationship between age (p<0.001*), age group (p<0.001*), and school level (p<0.001*), but otherwise, there was no association between gender (p=0.24) with myopia in school-age children. In conclusion: myopia prevalence is highest at the age of 19 years, a group of late teens, high school, and females more than males. Myopia is associated with age among Acehnese school children (6-19 years) in Indonesian, so that's why we recommend performing visual acuity tests routinely.

Keywords: refractive errors, myopia, school children, Acehnese, Indonesia.

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INTRODUCTION

Refractive error (ametropia) in school-age children is one of the global public health problems today[1–3]. In Indonesia, refractive error is the eye health problem that occupied the first rank[4]. Myopia is one of the refractive errors that affect vision disorders and complications such as blindness[2,5]. The prevalence of myopia is varied in different populations, ethnicities, and regions[5]. The prevalence of myopia in children is higher in the urban population and ethnic Chinese[5,6]. The prevalence of myopia is higher in Asian populations (60%) compared to Europe (45%), while the lowest prevalence is in Africa and South America, which is around 10%[2,6,7].

The prevalence of myopia is increasing year by year[1,2,8]. It is predicted that some 1.4 billion people in the world have myopia in 2000 and this number will rise sharply to around 4.8 billion people by 2050[7]. It is estimated that approximately 24.7% of Indonesia's population is refraction disorder, and its prevalence in school-age children is 10% of the total 66 million children in Indonesia[4]. Grzybowski et al reported that the prevalence of myopia in school-age children (ages 6-19 years) in Indonesia reached 32.68% and at the age above 21 years is 48.1%[5,7]. A study in Iran in 2016, reported that as many as 14.3% of children aged 5-12 years were myopia[9]. The results of a study in children aged 5-7 years in Spain found that the prevalence of myopia was 16% in 2016 and increased to 20% in 2017[10].

Myopia risk factors are complex, whereas the etiology is associated with genetic and environmental factors such as reading habits at a close distance, lack of exercise, and lack of outdoor activities, but it is certainly unclear[3–5,8]. Myopia is increased in children who have risk factors such as: close reading habits (reading distance <25 cm) or doing work at close range (writing, watching television), a history of parents with myopia, lack of sleep, less time outside the room, duration of gadget usage, low light exposure, living in urban environments, lack of exercise, ethnicity, vitamins, lifestyle, digital screen time, and use of LED lights[4,5,7–12]. Changes in lifestyle and age have been implicated in the increased prevalence of risk factors for myopia in the world[1].

Myopia in children is not only an impact on economic burdens but also has an impact on declining levels of children's intelligence, disruption of social activities, and even psychological aspects[10,13]. Myopia is the leading cause of permanent blindness in children and adolescents, but myopia can be prevented[14,15]. Children with refractive errors require fast and precise handling so that they can be corrected visual acuity, but otherwise uncorrected refractive disorders will provide effects such as blindness, interruption in work, social disruption, and others[11,16]. Periodic eye examinations are needed for school-age children to detect refractive errors that can provide fast and precise handling.

Data on the prevalence of refractive errors, including myopia, and the association with demographic characteristics (age and gender) in Indonesian school children (6-19 years) are not yet known. Studies on the prevalence of refractive error in Indonesian school children had done only focused on a school-age group such as only primary school students[17] or just in junior high school students,[18] as well as they also did not analyze the relationship between age and gender with a prevalence of refraction errors. This study was different from the two studies because we analyzed the prevalence of myopia and its relationship with several demographic factors by comparing different age groups of students from 3 levels of school (elementary school, junior high school, and senior high school).

This research has not been done much in the world. Research on the relationship between myopia and age has been done in only 5 countries in the world: Brazil, China, India, Poland, and Saudi Arabia, while the relationship between myopia and gender has been carried out in 4 countries in the world such as China, Columbia, India, and Saudi Arabia[7]. Therefore, we conducted this study to analyze the prevalence of myopia and its relationship with age and gender in Indonesian school children (aged 6-19 years) at all levels of school level from elementary school, junior high school, and high school. This study focused solely on myopia and was conducted before the COVID-19 pandemic. This study is expected to serve as a resource for all stakeholders (students, parents, schools, and the government) in the prevention of myopia through regular and periodic eye health examinations to reduce myopia morbidity. More research that examines various risk factors for myopia is required to aid in the prevention of myopia in schoolchildren (6–19 years).

METHODS

Study design, Population and the subject of the study
This study was conducted as an observational study with a cross-sectional design. The purpose of the study was to analyze the prevalence of myopia in school-age

children in Banda Aceh, Aceh Province, Indonesia. The study also analyzed the prevalence of myopia concerning demographic characteristics such as age, gender, and school level (elementary, junior high, and high school). The research was carried out at four different locations: elementary schools at 54 and 35 Banda Aceh, junior high school, and high school at Darul Ehsan, Siem Village, Banda Aceh, Aceh Province, Indonesia from January to April 2016. Refraction testing was done during the school day as well as during breaks so that it did not interfere with class time.

Students from elementary, junior high, and senior high schools in Banda Aceh, Indonesia, were included as subject research. Subject inclusion criteria were school age (6-19 years), male, female, and willing to be examined. The inclusion criteria were unhealthy. The ages are classified according to the Ministry of Health of the Republic of Indonesia's age group categories: childhood (5–11 years), early adolescence (12–16 years), and late adolescence (17–25 years). Total sampling was used for sample collection, so all populations were respondents and research samples. After obtaining permission from each student's parents, the principal, and the homeroom teacher, refraction is checked. All of the students present during the refraction examination were motivated to find out more about refraction.

Refraction examination and statistical analysis
The research data was obtained from the refraction examination results of the respondents. Snellen charts were used to measure refraction. Refractions Refractionists perform the examination, which is then analyzed by an ophthalmologist. An ophthalmologist will prescribe a diagnosis of myopia and other refractive errors. Data on age and gender were obtained during the respondent's anamnesis. To analyze research data, descriptive and correlational methods are used. The descriptive analysis results are presented in the form of images and tables. The correlational analysis ($p<0.05$) used the chi-square correlation test to investigate the relationship between myopia and demographic characteristics (gender, age, and school level).

Ethical considerations
The implementation of this study was licensed by the Faculty of Medicine at Syiah Kuala University in Banda Aceh. Examination of refraction students has obtained written permission from the principal. All subjects who volunteered were asked to sign a written consent. All junior high school and senior high school students signed written informed consent, while informed consent for elementary students was signed by each homeroom teacher.

RESULTS

Characteristics of Subject
The study results regarding the characteristics of the subjects are as shown in Table 1. The number of subjects in all school-age groups is more girls than boys. The number of research subjects in each group was different, and the highest number of subjects was in the elementary school group, as in Table 1.

Table 1. Characteristics of respondents by gender

School	Gender		Amount
	Boys	Girls	
Elementary School	326	335	661
Junior High School	138	169	307
Senior High School	84	119	203
Total	548	623	1171

Table 2 shows that the data analysis regarding the characteristics of the study respondents was based on age and school level. The mean age of students from the elementary school, junior high school, and senior high school is seen in Table 2. The age of subjects based on the school level is divided into three groups: elementary school age, junior high school age, and senior high school age. The minimum age for primary school children was 6 years old (n=120 students), and the maximum age was 14 years old (n=1 student). The minimum age for junior high school children was 11 years with a total of 14 children. The minimum age for high school-age subjects was the age of 14 years (n= 19 students) and the maximum age was 19 years (n=3 students).

Table 2. Characteristics of the sample based on age

School	Age			
	Average	SD	Minimum	Maximum
Elementary School	8.43	1.79	6	14
Junior High School	12.81	0.94	11	16
Senior High School	15.50	1.00	14	19

Relationship between myopia with gender

Table 3 illustrates the number of students with myopia and emmetropia in school-age children by gender. The results showed that the number of students with a diagnosis of myopia in girls (15.73%) was higher than in boys (13.32%), but the prevalence rate of myopia in girls and boys was not statistically significant (p>0.05). These results indicate that there is no significant difference in the number of Myopia between girls and boys in school-age children.

Table 3. Relationship between refractive errors with gender in school-age children

Gender	Diagnosis		Total	p-value
	Emmetropia (Σ)	Myopia (Σ)		
Boy	475	73	548	0.244
Girl	525	98	623	
Total	1000	171	1171	

The relationship between myopia and age

The greatest number of school-age children with a diagnosis of myopia was 13 years old (n=26 students), and the least was 18 years old (n=1 students). This table illustrates that the number of students with myopia is 171 from a total of 1171 students. We found that the percentage of myopia in school-age children (aged between 6-19 years) amounted to 14.61%. We also analyzed the relationship between myopia prevalence and age group categories according to the Ministry of Health of the Republic of Indonesia. Subjects were divided into 3 groups: childhood (6-10 years), early adolescents (11-15 years), and late adolescents (16-19 years), as shown in Table 4.

Table 4. Relationship between Myopia and age in school-age children

Age	Diagnosis		Total	p-value
	Emmetropia Σ (%)	Myopia Σ (%)		
Childhood	594 (90.68)	62 (9.32)	656	
Early adolescence	390 (81.25)	104 (18.75)	494	0.001*
Late adolescence	16 (76.47)	5 (23.53)	21	
Total	1.000 (85.39)	171 (14.61)	1.171	

Table 4 illustrates that the highest number of students with myopia is in the early adolescent age group, but on the contrary is the result of analysis based on percentages showing that the highest number of students with a diagnosis of myopia is in the late Teens age group of 23.53%. As many as 5 out of 16 late adolescents were diagnosed with myopia. Subsequently has followed by early adolescents as many as 18.75% of students are diagnosed with myopia. The lowest number was in childhood, which was 9.32%. The results of the chi-square analysis are shown in Table 4. This table illustrates that there is a relationship (p=0.001*) between the age group and myopia in school-age children. Myopia is increased with increasing age.

The relationship between myopia and school levels

The highest percentage of students with myopia were high school students (Table 5). Table 5 shows that there was a relationship between the school level and the occurrence of myopia in school-age children (p=0.001*). The number of Myopia progressively increased with age (p=0.001*) in school-age children.

Table 5. Relationship between myopia and school level in school-age children

School	Diagnosis		Total	p-value
	Emmetropia Σ (%)	Myopia Σ (%)		
Elementary School	601 (90.93)	60 (9.07)	661	
Junior High School	243 (79.15)	64 (20.85%)	307	0.001*
Senior High School	156 (76.85)	47 (23.15%)	203	
Total	1.000 (85.39)	171 (14.61)	1.171	

The relationship between myopia and gender in school-age children can be seen in Table 6. This table indicates that although the number of Myopia in girls

Table 6. Relationships between Myopia and gender in elementary, junior and high school students

School	Gender	Diagnosis		Total	p-value
		Emmetropia (Σ)	Myopia (Σ)		
Elementary	Boys	298	28	326	0.666
	Girls	303	32	335	
Total		**601**	**60**	**661**	
Junior High School	Boys	114	24	138	0.178
	Girls	129	40	169	
Total		**243**	**64**	**307**	
Senior High School	Boys	63	21	84	0.600
	Girls	93	26	119	
Total		**156**	**47**	**203**	

is more than in boys at all levels of school, the correlation analysis showed that there was no relationship between gender and myopia in students of elementary school (p=0.66), junior high school (p=0.178), and high school (p=0.600) in Banda Aceh, Indonesia.

DISCUSSION

Myopia, a refractive error, is the leading cause of visual impairment and the second-leading cause of vision loss in almost every country[16,19]. The prevalence of myopia is increasing worldwide and it is estimated that the prevalence of myopia will increase from around 1406 million in 2000 to 4758 million people or will be 7.5 times more in 2050[16,19]. Based on data from the World Health Organization (WHO) states that the prevalence of myopia is increasing year by year[20]. The prevalence of myopia in 2010 was 1914 million (28%), then in 2020 increased to 2584 million (33%), in 2030 increased to 3337 million (40%), estimated in 2040 will increase to 4156 million (46%), and in 2050 reached 4949 million (52%)[8,20]. Myopia caused about 101 million people to become blind in 2010[16]. Myopia has also burdened the economy and is estimated to cost around 202 billion US dollars annually[19,21]. Myopia in school-age children has an impact on academic achievement[22].

Myopia is not only a serious health problem in school-age children in Indonesia but also in several countries in the world. Myopia is also a serious eye health problem in China because its prevalence rate has increased sharply over the past 15 years[14]. The highest prevalence of myopia is in China and its incidence increases with age[23]. A study conducted for one year in China stated that as many as 33.6% of first-grade children and 54% of grade 7 students had myopia[24]. Research results also mention that as much as 90% of Chinese teenagers and young adults are diagnosed with myopia[25]. Another study stated that 94.9% of undergraduate students and 96.9% of graduate students in China were myopia[26]. Research carried out for 15 years from 2001 to 2015 in China reported that the prevalence of myopia in middle school-age children increased from 79.5% to 87.7%[14].

A study in Hong Kong also said that the prevalence of myopia in children in Hong Kong is higher than in Western countries[27]. The prevalence of myopia in school-age children in Hong Kong is 36.7%[15]. A study of school-age children (5-17 years) in India reported that the prevalence of myopia was 7.48% of the total

of 1,029 students, the prevalence in women (8.2%) was higher than that of men (6.68%)[28]. The prevalence of myopia in India is lower than the findings in our research, while gender is in line with the results of our research which also found that there was no correlation between gender and myopia but the prevalence of myopia in boys is more than in girls[27]. A study in Saudi Arabia reported that the prevalence of myopia in medical students was 44.4%, women (46.8%) more than men (36.7%)[29].

The prevalence of myopia increases with age[22,30]. Age is positively related to myopia in children.[27] More than half (54.52%) of children over 11 years are diagnosed with myopia[27]. We also found that the highest prevalence of myopia was at the age of 19 years (66.66%). Research conducted on junior high school students in Bandung, Indonesia reported that as many as 18.39% of children with refractive disorders, about 94.38% of myopia and 5.62% of astigmatism, more girls (73.7%) than men (26.3%)[18]. Research on elementary school students in Jakarta found that refractive error of about 51.46% and the highest is myopia[17]. Research in Korea also mentions that myopia increases with age[31]. In late adolescence, girls are twice as likely to experience myopia compared to boys[32]. We also report that myopia is more common in the late adolescent age group and girls.

In this study, myopia risk factors are associated with age and gender therefore, this research can be continued by analyzing other risk factors that are associated with myopia. Some other risk factors of myopia are activity outside the home, ethnicity (East Asia had the highest prevalence), and a history of parents with myopia[32–34]. Children who live in cities have a 2.6 times risk of experiencing myopia compared to those who live in rural areas[32]. Uncorrected myopia is a major problem of major eye health in school-age children in almost all countries, including in the world including in Indonesia. School age up to the age of 20 years is a good period for the growth and development of the eye[28]. Myopia results in physical health disorders, vision impairment, myopia retinopathy, cataracts, choroid neovascularization, myopia glaucoma, myopia macular degeneration, blindness, and retinal detachment[5,20,23,24].

In conclusion, the prevalence of myopia in school-age children in Banda Aceh Indonesia was 14.61%. The highest percentage of myopia is in students with the age of 19 years, high school, and girls more than in boys. There was a relationship between age and school level with myopia. There was no correlation between

gender and myopia in school-age children. Education and eye examinations should be done regularly for the community, including school-age children, including for school-age children to maintain eye health.

CONFLICT OF INTEREST

This study's authors all stated that there was no conflict of interest. Furthermore, there was no conflict of interest between the author and the university in terms of the study's research and publication.

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