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Relationship between nutritional status and myopia degree in adolescents at Prof. CPL USU Hospital

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ABSTRACT

Myopia is currently a major global public health problem causing significant vision loss and is a risk factor for more serious ocular conditions. Weight gain in adolescents has increased significantly in recent years due to lack of physical activity, increased caloric intake, and comfort in indoor environments. Weight gain is also the most common cause of dyslipidemia in adolescents. This is an observational analytic study with a cross sectional design. The study was conducted at Prof. CPL Universitas Sumatera Utara General Hospital from March 2023 until July 2023. Data analysis was carried out analytically and presented in the form of data tabulations. This study was attempted by 50 subjects with myopia who visited the Eye Polyclinic. Most of the subjects in this study were female, totaling 26 people (52%). The mean age of the subjects was 20.92 years with the youngest was 13 years old and the oldest was 24 years old. The mean height and weight measurements respectively were 1.63±0.1 m and 68.74±19.87 kg. Based on body mass index, most of the subjects were in normal cathegories accounted for 20 subjects (40%). Based on cholesterol levels, subjects with mild myopia showed a mean value of 206.84 mg/dL, those with moderate myopia had a mean of 190.94 mg/dL and severe myopia had a mean of 207.36 mg/d. Nutritional status have no significant correlation to the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara General Hospital.

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INTRODUCTION

Myopia is the most common refractive error and is currently a major public health problem of global concern because it causes significant reduction in vision and is a risk factor for more serious ocular conditions. Health problems due to myopia include an increase in complications that occur due to myopia, such as glaucoma, retinal detachment, and macular degeneration. Myopia with a higher degree carries a risk of more serious visual impairment and is a concern in the treatment of myopia in the future (Flitcroft et al., 2019; Resnikoff et al., 2019).

The prevalence of myopia continues to increase from year to year, which is estimated at 2.6 billion cases in 2020 and is projected to continue to increase to 3.36 billion cases in 2030 and reach half of the world's population in 2050. In the same year, It is estimated that 500 million people will suffer from severe myopia, which is an irreversible cause of blindness. The increasing prevalence of myopia throughout the world, especially in the younger generation in East Asia and Southeast Asia, has increased awareness, especially in the study of myopia, especially the risk factors that cause myopia and treatment of myopia. The COVID-19 pandemic that has occurred over the past few years, which has caused a reduction in outdoor physical activity for a long period of time, is also thought to have contributed to the increase in the incidence of myopia, especially in children and adolescents (Flitcroft et al., 2019; Resnikoff et al., 2019; WHO, 2022).

Several studies on myopia identify myopia as a condition that has multifactorial risk factors, including genetic and environmental factors. Published studies suggest that several influencing factors include offspring of parents with myopia, height, minimal outdoor activity, excessive close-up activity, body mass index and socioeconomic status (Kim et al., 2020). A study conducted in Korea found that obesity correlated with myopia

in children and adolescents. In this study, it was found that being overweight in women was correlated with severe myopia (S. Lee et al., 2022).

Weight gain in children and adolescents has increased significantly in recent years due to lack of physical activity, increased caloric intake, and comfort in indoor environments. Data from WHO in 2016 shows that 41 million children under the age of 5 years and 340 million teenagers are overweight and obese. Obesity in children and adolescents also cannot be avoided by disorders that occur due to being overweight, for example disorders of blood fat levels, abnormal blood pressure, increased blood sugar levels, and insulin resistance (Del Mar Bibiloni et al., 2016; S. Lee et al., 2022).

Increased body weight is also the most common cause of dyslipidemia in children and adolescents. In research conducted in Mexico, it was found that there was a 2-3 times greater risk of dyslipidemia in children and adolescents with myopia when compared with children and adolescents who had a normal BMI. A study in Singapore also found that higher blood cholesterol levels were also correlated with longer eyeball length, which is one of the factors causing myopia in children and adolescents. Studies conducted in France also concluded that there was a statistically significant correlation that consumption of saturated fat had implications for blood cholesterol levels and was correlated with axial length (Berticat et al., 2020; Bondyra-Wiśniewska et al., 2021; Del Mar Bibiloni et al., 2016; Gayatri & Veena, 2021).

Based on the data above, this study want to observe the relationship between nutritional status and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara General Hospital. The research is expected to give more insight into the topic discussed and hopefully become a reference for future relevant research.

METHOD

The study carried out was an observational analytical study with a cross sectional design. The aim of this study was to determine the relationship between nutritional status and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara General Hospital. The study was carried out at the Eye Clinic of Prof. CPL Universitas Sumatera Utara Hospital from March 2023 to July 2023.

The population in this study were all adolescents with myopia, who visited the Eye Clinic of Prof. CPL Universitas Sumatera Utara General Hospital from March 2023 to July 2023, who fulfill the the inclusion and exclusion criteria. All samples will undergo height and weight examination, refraction examination, ophthalmology examination, and blood examination at Prof. CPL Universitas Sumatera Utara General Hospital.

Data analysis is carried out analytically and presented in the form of tabulated data with the aim of describing research variables with categorical data presented in the form of a frequency distribution and describing research variables with numerical data, if the data is normally distributed then it is presented in the form of the average standard deviation or if the data is not normally distributed , then the data is presented in median (minimum-maximum) form. To determine the relationship between independent and dependent variables, the One Way ANOVA test is used if the data is normally distributed, and the Kruskal Walis test if the data is not normally distributed with a significance level of 5%.

RESULTS AND DISCUSSION

This study consisted of 50 subjects with myopia who visited the Eye Clinic of Prof CPL Universitas Sumatera Utara General Hospital. All subjects met the inclusion criteria. Subject characteristics are shown in full in table 1.

Most of the subjects in this study were female, totaling 26 subjects (52%). The average age of the subjects was 20.92 years with the youngest being 13 years old and the oldest being 24 years old.

The results of height and weight measurement were respectively 1.63 m (SD = 0.1 m) and 68.74 kg (SD = 19.87 kg). Based on nutritional status, the majority of subjects with normal nutritional status were 20 subjects (40%), overweight and obese each accounted to 15 subjects (30%).

Table 1. Characteristics of Research Subjects

Gender Characteristic	**n = 50**
Gender, n (%)	
Male	24 (48)
Female	26 (52)
Age, by year	
Mean (SD)	20,92 (3,05)
Median (Min – Max)	22 (13 – 24)
Height, m	

Mean (SD)	1,63 (0,1)
Median (Min – Max)	1,65 (1,28 – 1,8)
Weight, kg	
Mean (SD)	68,74 (19,87)
Median (Min – Max)	65 (40 – 130)
BMI, kg/m^2	
Mean (SD)	25,56 (5,67)
Median (Min – Max)	24,25 (17,7 – 42,2)
Normal	20 (40)
Overweight	15 (30)
Obesity	15 (30)
Cholesterol, mg/dl	
Mean (SD)	201,58 (29,91)
Median (Min – Mak)	194,5 (147 – 278)
Normal	31 (62)
Borderline	11 (22)
High	8 (16)
Visual Acuity (VA) OD, D	
Mean (SD)	-3,8 (2,26)
Median (Min – Max)	-3,75 (-8,50 – 0,5)
Visual Acuity (VA) OS, D	
Mean (SD)	-3,75 (2,3)
Median (Min – Max)	-,375 (-7,75 - -0,5)

Based on body weight, subjects with mild myopia had a mean of 70.26 kg, moderate myopia had a mean of 69 kg and severe myopia had a mean of 66.36 kg. By using the Kruskal Wallis test, it appears that there was no significant relationship between body weight and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.957).

Based on body height, subjects with mild myopia showed a mean of 1.65 m, those with moderate myopia a mean of 1.61 m and severe myopia a mean of 1.63 m. By using the Kruskal Wallis test, it appears that there was no significant relationship between height and degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.872).

Based on BMI, subjects with mild myopia showed a mean value of 25.56 kg/m2, those with moderate myopia a mean of 26.1 kg/m2 and severe myopia a mean of 24.96 kg/m2. By using the Kruskal Wallis test, it appears that there was no significant relationship between BMI and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.872).

Relationship between Body Weight, Height, BMI and Cholesterol Levels with Degree of Myopia In Adolescents at Prof. CPL Universitas Sumatera Utara Hospital

Table 2. shows the results of the analysis of relationship between Body Weight, Height, BMI and Cholesterol Levels with Degree of Myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital

Table 2. Relationship between Body Weight, Height, BMI and Cholesterol Levels with Degree of Myopia In Adolescents at Prof. CPL Universitas Sumatera Utara Hospital

Variable	Degree of Myopia	Mean (SD)	Median (Min-Max)	p
Weight, kg	Mild	70,26 (23,96)	65 (45 – 130)	0,957[a]
	Moderate	69 (19,3)	64 (40 – 107)	
	Severe	66,36 (15,02)	66 (46 – 98)	
Height, m	Mild	1,65 (0,08)	1,65 (1,52 – 1,8)	0,872[a]
	Moderate	1,61 (0,12)	1,65 (1,28 – 1,75)	
	Severe	1,63 (0,08)	1,65 (1,5 – 1,75)	
BMI, kg/m^2	Mild	25,56 (6,98)	23,2 (17,7-42,2)	0,651[a]
	Moderate	26,1 (4,75)	25 (18,4 – 34,9)	
	Severe	24,96 (5,02)	24,9 (18 – 36,4)	
Cholesterol, mg/dL	Mild	206,84 (32,34)	196 (160-278)	0,198[b]
	Moderate	190,94 (24,79)	192 (147-259)	
	Severe	207,36 (30,7)	203 (162-273)	

[a]Kruskal Wallis, [b]Oneway Anova

Based on body weight, subjects with mild myopia had a mean of 70.26 kg, moderate myopia had a mean of 69 kg and severe myopia had a mean of 66.36 kg. By using the Kruskal Wallis test, it appears that there was no significant relationship between body weight and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.957).

Based on body height, subjects with mild myopia showed a mean of 1.65 m, those with moderate myopia had a mean of 1.61 m and severe myopia had a mean of 1.63 m. By using the Kruskal Wallis test, it appears that there was no significant relationship between height and degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.872).

Based on BMI, subjects with mild myopia showed a mean value of 25.56 kg/m2, those with moderate myopia a mean of 26.1 kg/m2 and severe myopia a mean of 24.96 kg/m2. By using the Kruskal Wallis test, it appears that there was no significant relationship between BMI and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.872).

Based on cholesterol levels, subjects with mild myopia showed a mean value of 206.84 mg/dL, those with moderate myopia had a mean of 190.94 mg/dL and severe myopia had a mean of 207.36 mg/dL. By using the Oneway Anova test, it appeared that there was no significant relationship between cholesterol levels and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital (p=0.198).

Relationship between Nutritional Status and Degree of Myopia

Table 3. shows the results of the analysis of the relationship between nutritional status represented by body mass index and cholesterol levels and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital.

Tabel 3. Relationship between Nutritional Status and Degree of Myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital

Variable	Degree of Myopia			p
	Mild	Moderate	Severe	
Body Mass Index, n (%)				
Normal	9 (45)	5 (25)	6 (30)	0,823[a]
Overweight	4 (26,7)	7 (46,7)	4 (26,7)	
Obesity	6 (40)	5 (33,3)	4 (26,7)	
Cholesterol Level, n (%)				
Normal	11 (35,5)	14 (45,2)	6 (19,4)	0,713[a]
Borderline	4 (50)	2 (18,2)	5 (45,5)	
High	4 (50)	1 (12,5)	3 (37,5)	

[a]Kruskal Wallis

Based on nutritional status, the majority of subjects with normal nutrition showed mild myopia, accounted to 9 subjects (45%). In overweight subjects, most showed moderate myopia amounting to 7 subjects (46.7%) and in obese subjects, most of them showed mild myopia totaling 6 subjects (40%). The results of Kruskal Wallis test showed that there was no significant relationship between nutritional status and the degree of myopia (p=0.823).

Based on cholesterol levels, the majority of the 14 participants (45.2%) with normal cholesterol levels had intermediate myopia. Mild myopia totaled 4 persons in the majority of participants with borderline cholesterol levels and 4 people in the majority of subjects with high cholesterol levels. Myopia severity and cholesterol levels did not significantly correlate, according to analyses using the Kruskal Wallis test (p=0.713).

Based on BMI and choleresterol levels, correlation between nutritional status was evaluated. Both BMI and cholesterol levels revealed no statistically significant correlation with degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital, p=0.823 and p=0.713, respectively. From this result, this study concluded there was no statistically significant correlation between nutritional status and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara Hospital

Discussion

The study was conducted on 50 myopia subjects who visited the Eye Clinic of Prof. CPL Universitas Sumatera Utara General Hospital. The study aims to assess the relationship between nutritional status and the degree of myopia in adolescents at Prof. CPL Universitas Sumatera Utara General Hospital.

Based on gender, most of the subjects in the study were female. This is consistent with research conducted by Czepita et al in 2019 in Poland. Czepita found that the highest prevalence of myopia was found

in women compared to men, especially if the research sample was dominated by children aged 9 to 16 years. This is closely related to daily activities. Men tend to spend more time outside doing outdoor activities compared to women who spend time reading, writing or using computers (Czepita et al., 2019). Apart from that, there are also biological differences that can influence gender differences as explained by Krause et al who suspect that there are genetic factors and diet (KRAUSE et al., 1982). These results are also consistent with research conducted at Cicendo Hospital where the female gender dominates the patient demographic up to 64.1% (Juanarta, 2020).

In this study, the average age of the subjects was 20.92 years with the youngest being 13 years old and the oldest being 24 years old. This really depends on the study design but is quite consistent. In a larger study with more data such as that conducted by Verkicharla in 2020, it was found that the majority of patients seeking treatment were in the 11-15 year age range, followed by patients aged 16-20 years. It is quite rare to find myopia patients under the age of 5 years visiting the eye clinic. This is not much different from the results compared to the Caucasian race or the Chinese race. These results underline that apart from genetic and biological roles, there are social roles and activities in myopia progression (Verkicharla et al., 2020). These results are quite consistent with research conducted by Rahayu at the Bali Mandara Eye Hospital in 2018 where the research sample was predominantly aged 18 to 25 years. Rahayu's research is quite unique because it links age with the need for refractive surgery where the results show that many patients undergo corneal refractive surgery at reproductive age (Rahayu et al., 2020).

The results of height and weight measurements were respectively 1.63 m (SD = 0.1 m) and 68.74 kg (SD = 19.87 kg). Based on nutritional status, the majority of subjects with normal nutritional status were 20 subjects (40%), overweight and obese each amounting to 15 subjects (30%). Research by Huang et al in Taiwan in 2014 found patients with much lower body weight and height. This occurs as a result of Huang et al.'s population being dominated by children who are still attending elementary school (Huang et al., 2014). A number of population-based studies, particularly those involving young adults, have evaluated the impact of height on myopia and more research are examining this issue (D. C. Lee et al., 2018). The axial length and height of Chinese twins were found to be significantly correlated by Zhang et al. (D. C. Lee et al., 2018; Zhang et al., 2011). In addition, Sharma et al. found that in Chinese boys, but not in Chinese girls, height was negatively related to refractive error (taller kids were more myopic) (D. C. Lee et al., 2018; Sharma et al., 2010). Rosner et al.'s study from ages of 17 and 19 males did not discover any correlation between myopia and height (D. C. Lee et al., 2018; Rosner et al., 1995). Although the relationship between myopia and height is yet unknown, it may be explained by racial and demographic disparities.

In research based on nutritional status, the results of the study by Lee et al. (2022) with data from a nationally representative cross-sectional survey, the Korea National Health and Nutrition Examination Survey (KNHANES) VII conducted in 2016 to 2018 which examined whether obesity in childhood and adolescence was associated with myopia, compared with those who having normal weight, underweight, overweight, or obese did not show a significant chance of developing mild and moderate myopia, but the results showed a 3.77 times higher odds ratio than those with normal weight in developing mild myopia, higher among children and adolescents who are obese. In addition, even in women in the overweight category, they have an odds ratio 4.23 times higher than women with normal weight. According to previous research by Harrington et al. (2019), obesity in school children increased the risk of myopia by 2.7 times.

There is still some uncertainty regarding the precise cause-and-effect relationship between myopia and obesity. Despite the fact that obesity frequently results in a number of issues, myopia may also be influenced by insulin resistance. One of the most frequent metabolic abnormalities linked to obesity is insulin resistance. Insulin resistance is characterized by postprandial or fasting hyperglycemia, which is brought on by delayed initial insulin production and has been found to develop in 15% to 20% of children with obesity (Furushima et al., 1999; S. Lee et al., 2022). A study that involved people without diabetes found that this condition suppresses insulin secretion. Increased myopia due to hyperglycemia, which also causes to lens thickness and anterior pole shift (S. Lee et al., 2022; Sinha et al., 2002). Additionally, it is known that elevated blood insulin levels stimulate the release of insulin-like growth factor 1 (IGF-1), which encourages cell development and differentiation and causes the axial elongation that is a hallmark of myopia in the eye (Galvis et al., 2016; S. Lee et al., 2022).

A substantial link between cholesterol levels and myopia was not discovered in this research either. According to Bu and Wang (2017)'s study on the impact of cholesterol on myopia, there is a connection between high cholesterol and myopia, hence their findings are at odds with that research. To be more precise, if a person has high cholesterol compared to if they have normal cholesterol levels, their likelihood of getting myopia rises by 11%. Bu's study, on the other hand, focuses on diet, whereas the researchers' study is a cross-sectional investigation of blood cholesterol levels. This suggests that additional investigation into children's diets and their relationship to the prevalence of myopia may be necessary.

The study by Zheng et al. (2023) is more relevant that's shows inverse correlation between HDL levels and infant axial length was discovered, according to the findings. The association was rather faint, though, and

it was not significant.[26] The function of "GO/GROW" and "STOP" signals in regulating eye growth was made clear by Bertrand et al. (2006). The "GO/GROW" and "STOP" signals are hypothesized to start or inhibit the expansion of axial length, respectively. The "GO/GROW" signal is thought to speed up axial lengthening. Bertrand demonstrated that the role of apoA-I as a STOP signaling molecule was to suppress excessive ocular axial growth. According to the findings, apoA-I has a STOP profile in the retina and fibrous sclera, and its upregulation can prevent ocular axial elongation. It is believed that a transcriptional mechanism is how PPAR-agonists boost the expression of apoA-I, the primary protein in HDL lipoproteins. Numerous earlier studies verified that PPAR positively controls apoA-I (Bertrand et al., 2006). According to a study by Gervois et al. (2000), PPAR-activation induces hepatic apoA-I and apoA-II production, which raises plasma HDL cholesterol in people. Additionally, it has been shown that PPAR-D can activate the ATP-binding cassette transporter gene 1 (ABCA1), increasing the production of apoA-I and high-density lipoprotein. The findings from this investigation provide support for the hypothesis that apoA-I may be a common downstream target for PPAR (Gervois et al., 2000).

Genetic and environmental factors both have a role in the multifactorial condition known as myopia. Close up activities and less time outdoor are by far the best known environmental influences, even if few studies have found a causal association. Particularly, it is yet unknown if childhood or adolescent obesity causes children to develop myopia in adolescents and children (S. Lee et al., 2022). Based on demographic characteristics, it can be concluded that there is heterogeneity in myopia risk factors. Myopia etiologically has heterogeneous risk factors, with low levels of myopia likely originating from genetic factors that occur without exposure to risk factors. A large increase has occurred in students, driven by increased educational pressures combined with limited time spent outdoors. The increasing prevalence of high myopia has an unusual developmental pattern, with the increase in prevalence first appearing around age 11 years. This pattern suggests that the increase in the prevalence of high myopia is due to the development of myopia in children who become myopic at around 6 or 7 years old because the typical East Asian age-specific developmental rate will bring these children to the threshold of high myopia by 5 to 6 years (Rose et al., 2016). Excessive axial elongation of the eyeball is directly related to the severity of myopia (Sudhakar et al., 2020).

CONCLUSION

Although not very consistent, the results above show that there are still variations in research findings in previous research which can explain the results obtained in this study. So, it is worth underlining that further research is needed to understand this phenomenon better, especially in the productive age group. In fact, the expected association of height, weight, and obesity with myopia has not been consistently observed. A better diet has been associated with greater height and axial length, however, this does not appear to cause an increase in myopia due to the presence of strong ocular growth control mechanisms. International variations in mean height variations do not correlated in myopia prevalence. Likewise, international variations in the prevalence of people in the overweight and obese categories are not in line with the global distribution of myopia, and there is no data on countries with a high prevalence of myopia that are included in the list of the top 20 countries ranked by percentage of obesity.

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