EurAsian Journal of BioSciences
Eurasia J Biosci 13, 871-875 (2019)

Relationship between anthropometric parameters and dietary factors in refractive error in Indonesia

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Abstract

Background: Refractive error can be associated with nutrition status. This study aim to investigate the associations between anthropometric parameters and dietary factors in refractive error.

Material and Methods: Samples utilized were 252 eyes from 127 students between 13-17 years of age (mean 15 ± 0.67 y.o.). Seventy-five subjects were males and 52 were females. Subjects underwent visual acuity examination, noncycloplegic refraction, measurement of height and weight and each student was interviewed and filled out the semi-quantitative food frequency questionnaire (SQ-FFQ) to obtain daily nutrient intake.

Results: There was no significant association between age, weight, height, BMI and nutrient intake from SQ-FFQ (energy, protein, fat, carbohydrates, fibers, PUFA, cholesterol, vitamin A, carotene, vitamin E, vitamins B1, B2 and B6, folate, vitamin C, sodium, potassium, calcium, magnesium, phosphorus, iron and zinc) with SE ($r < 0.2$, $p > 0.005$).

Conclusion: In this study, there were no significant associations between anthropometric parameters and dietary factors with refractive error.

Keywords: anthropometric parameters, body mass index, dietary factors, food frequency questionnaire, height, NutriSurvey, refractive error, weight

Anandita NW, Aini N (2019) Relationship between anthropometric parameters and dietary factors in refractive error in Indonesia. Eurasia J Biosci 13: 871-875.

BACKGROUND

In Indonesia, vision impairment caused by refractive error has a prevalence of 22.1% (Indra et al. 2017). Myopia was recognized as the most common type of refractive error, with the highest incidence among the young population (14-16 years old) and some studies reveal a rising prevalence over the past two decades (Jobke et al. 2008). On the other hand, 10% of 66 million school-aged children (5-19 years old) suffered refractive error with a low rate wearing corrective lens (12.5% of refractive error group). This condition negatively affects the development of intelligence and learning processes in children, which can lead to lack of creativity and productivity in the workforce (Indra et al. 2017, WHO 2014).

Although it is well known that the refractive status of the eye is dominantly controlled by genetic factors, there is evidence that nutritional factors also have an effect. Halasa and Mclaren (1964) as well as Graham and Gray (1963) showed that marasmus, premature birth and starving increased the incidents of myopia.

Improved nutrition in the last two decades in China, since economic reforms in 1998, is believed to have caused height increase compared with children born in the previous years. This condition raised the theory that along with the growth process, high posture is associated with increasing axial length of the eye (Abhishek et al. 2010).

In contrast, Cordain et al. performed an evolutionary analysis of the causes of myopia that appears in juveniles, and they suggested that hyperinsulinemia contributes to axial elongation of patients with myopia due to interference with the retinoid receptor pathway. Specifically, this study revealed that food consumption with high glycemic index (GI), especially in advanced economic countries, is associated with deregulation of eye growth control. Implicitly, it can be concluded that patients with myopia will be taller, heavier and have a greater body mass index (McLaren and Halasa 1964).

During this time, there has been no research in Indonesia that links refractive error with nutritional status through anthropometric measures and dietary factors. This study aimed to investigate associations between anthropometric parameters and dietary factors with refractive errors in school-aged children.

Received: March 2019
Accepted: June 2019
Printed: July 2019

MATERIALS AND METHODS

This research is categorized as observational, analytic research, in which cross-sectional research design with anthropometry and nutritional intake as independent variables and refractive error as the dependent variable are assessed simultaneously at one time. This study was conducted from January until March 2015. The subjects of this study were ninth grade students (2015-2016 academic year) at Junior High School (JHS) Satu Atap Lesanpuro Malang who are still active and willing to follow this research.

There were two criteria categorized as exclusion criteria in this research, i.e subject refused to be the object of this research and subject had systemic disease(s) that would significantly affect the examination of height and weight such as Anasarca edema, marfan syndrome, eye disorders that may affect the refractive status such as congenital anomalies, glaucoma, intraocular inflammation, as well as anterior and posterior segment abnormalities.

Both eyes of the subjects of this study were examined for visual acuity alternately using the Snellen chart from 6 m (20 feet) away from the test subject. If the subject did not reach 20/20, the examination was checked by the pinhole. If the subject could see the chart clearer with pinhole, correction with positive, negative or cylindrical spherical lens was performed until the subject reaches visual acuity of 20/20. This examination is able to determine the refractive status of the subject, whether they have myopia, hypermetropia, astigmatism or emmetropia.

The weight and height of subjects were checked using measuring instruments that were previously prepared. The resulted data were input into the WHO AnthroPlus software to determine nutritional status.

Dietary data or dietary intake was obtained by the following steps: design of 24-hour recall questionnaire, interview using 24-hour recall of the subject (random in one class) to know student dietary intake in the last 24 hours, the obtained 24-hour recall data were entered in Excel to list all food ingredients and their portions consumed by students. Based on the data portion consumed by the student, the value of the 25th, 50th and 75th percentiles was determined to specify the size of the portion that will be used for data retrieval in the semi-quantitative food frequency questionnaire (SQ-FFQ) for all respondents. All foodstuffs and portions (small, medium and large) were included in the SQ-FFQ questionnaire. SQ-FFQ data were input into NutriSurvey software (2007) using the Indonesian food database to get the averages of student food intake.

RESULTS

The present study selected 252 eyes from 127 patients (two eyes were excluded because there was OD chorioretinitis and OS papillary atrophy with suspected traumatic optic neuropathy). The number of subjects was 76 males (60%) and 51 female (40%) students from Junior High School Satu Atap Lesanpuro Malang (**Fig. 1**).

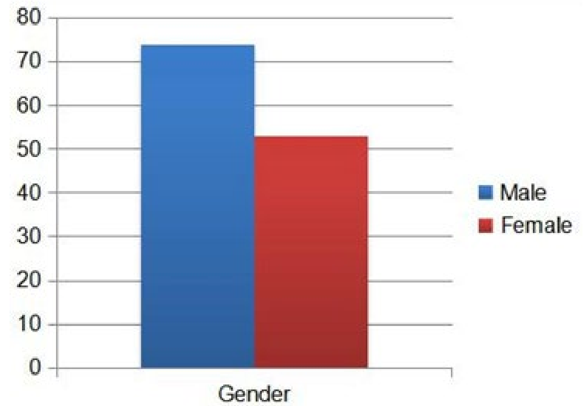

Fig. 1. Subject distribution according to gender

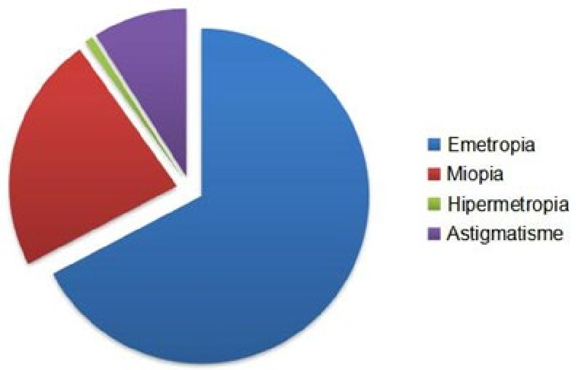

Fig. 2. The distribution of refractive error in each sample

The mean age of all study subjects was 15 ± 0.67 years old, the youngest was 13 years 7 months old and the oldest was 17 years 7 months old. Figure 2 shows the distribution of refractory status in each sample. Most students had a refractory status of emmetropia, 169 eyes (67%), the second most was myopia in 59 eyes (23%), astigmatism in 23 eyes (9%) and hypermetropia in two eyes (0.8%). There was 25 males (33%) and 23 females (45%) students with refractive error (**Fig. 2**).

This study showed that the mean visual acuity was 0.83 (right eye) and 0.85 (left eye). The mean amount of right eye correction was -0.4 D and -0.33 D for the left eye. The mean of height in all student was 154.3 cm, the mean of body weight was 48.2 kg and the mean value for BMI was 18.36 kg/m2. The mean value for body weight, height, and BMI in male students was 157.4 cm, 55.5 kg, and 17.6 kg/m2, respectively. While the mean value for weight, height, and BMI in female students was 149.8 cm, 42 kg, and 19.5 kg/m2. Based on the anthropometric examination, the numbers of students with stunting, overweight, or obesity were 33 children (26%), 13 children (11%) and seven children (6%), respectively.

Table 1. Correlation results between anthropometric parameters and nutrients with SE

Variable	r	Significance
Age	-0.007	0.917
Body weight	-0.060	0.347
Height	-0.060	0.345
BMI value	0.008	0.899
Energy (kcal)	-0.003	0.968
Protein	0.057	0.365
Fat	0.027	0.672
Carbohydrate	-0.034	0.588
Fiber	-0.059	0.349
PUFA	0.082	0.196
Cholesterol	0.063	0.317
Vit. A	0.034	0.588
Carotene	0.001	0.986
Vit. E	-0.020	0.753
Vit. B1	0.016	0.805
Vit. B2	0.045	0.475
Vit. B6	-0.033	0.605
Folic Acid	0.024	0.710
Vit. C	-0.033	0.606
Sodium	0.038	0.545
Potasium	0.026	0.687
Calcium	0.050	0.428
Magnesium	0.059	0.353
Phosphorus	0.058	0.363
Iron	0.061	0.335
Zinc	0.041	0.512

This study used a semi-quantitative questionnaire comprised of 55 food items. Based on questionnaire results by NutriSurvey software, the mean of daily nutrition intake consumed by each child included 2946 kcal of energy, 105.4 grams of protein, 55 grams of fat, 505 grams of carbohydrates, 17.55 grams of fiber, 16.3 grams of PUFA, 375.1 mg of cholesterol, 6770.1 µg of vitamin A, 0.36 mg of carotene, 7.28 mg of vitamin E, 1.35 mg of vitamin B1, 1.75 mg of vitamin B2, 2.34 mg of vitamin B6, 348.4 µg of folic acid, 136.7 mg of vitamin C, 1092.7 mg of sodium, 9263 mg of sodium, 1559.9 mg of calcium, 902.4 mg of magnesium, 1683 mg of phosphorus, 28.4 mg of iron and 8 mg of zinc.

The obtained data were analyzed using a normality test with Kolmogorov-Smirnov and then correlation tests. Kolmogorov-Smirnov results for body weight, height, BMI, energy intake, protein, fat, carbohydrate, fiber, PUFA, cholesterol, vitamin A, carotene, vitamin E, vitamin B1, vitamin B2, vitamin B6, folic acid, vitamin C, sodium, potassium, calcium, magnesium, phosphorus, iron and zinc showed significance less than α (0.05). These results indicated that the data distribution was not normal. Thus, the data did not meet the normality assumption, and so Spearman correlation test was used.

Based on **Table 1**, the correlation between age, body weight, height and BMI with SE had a Spearman correlation coefficient value of < 0.20. According to Arikunto (2010), correlation values in the range from 0.00-0.20 are classified as low correlation. Thus, it can be concluded that the relationship was very weak and not significant (p-value > 0.05). Similar results were obtained for the relationship between food intake variables protein, fat, carbohydrate, fiber, PUFA, cholesterol, vitamin A, carotene, vitamin E, vitamin B1, vitamin B2, vitamin B6, folic acid, vitamin C, sodium, potassium, calcium, magnesium, phosphorus, iron, and zinc.

Based on **Table 2**, the regression test showed that the equation used to determine the effect of height on SE value was:

$$Y = -1.094 + 0.005 X + ei$$

This equation has a significance value of 0.414, greater than α (0.05), which means there was not a significant effect on height and SE value. As seen in **Table 1**, the effect of the height parameter was not significant and positive to SE value. An increase in height would not increase the SE value, supported by regression test results of no significant effect.

The effect of height increase on the SE value was 0.003 (R2), which means that 0.3% of SE value was influenced by height while 99.7 % was influenced by other factors. The significance value of body weight, BMI, and several nutrition intake variables was also greater than α (0.05), which means that there were no significant effects of these variables on the SE value. There were no significant differences between myopia and non-myopia based on weight, height, BMI value, energy, protein, fat, carbohydrate, fiber, PUFA, and cholesterol level.

Based on **Table 3**, the significance value of each variable was greater than α (0.05), which means that

Table 1. Simple linear regression analysis results

Parameter		Coeff.	T Value	Sig	F	Sig	R	R^2
Body Weight	Const.	-0.365	-2.121	0.035	0.314	0.576	0.035	0.001
	BW	0.000	0.560	0.576				
Body Length	Const.	-1.094	-1.230	0.220	0.669	0.414	0.052	0.003
	BL	0.005	0.818	0.414				
BMI	Const.	-0.365	-1.152	0.250	7.51×10^{-5}	0.993	0.001	0.000
	BMI	-1.34×10^{-4}	-0.009	0.993				
Protein	Const.	-0.402	-3.880	0.000	0.148	0.700	0.024	0.001
	Protein	3.46×10^{-4}	0.385	0.700				
Fat	Const.	-0.389	-3.952	0.000	0.062	0.804	0.016	0.000
	Fat	2.41×10^{-4}	0.248	0.804				
Carbo-hydrate	Const.	-0.375	-3.744	0.000	0.062	0.934	0.005	0.000
	Carbo	1.72×10^{-5}	0.083	0.934				
PUFA	Const.	-0.372	-6.791	0.000	0.074	0.786	0.017	0.000
	PUFA	1.66×10^{-4}	0.271	0.786				
Cholesterol	Const.	-0.444	-5.739	0.000	1.787	0.182	0.084	0.007
	Cholesterol	1.32×10^{-4}	1.337	0.182				

Table 3. The average difference between stunting and normal group based on measured parameters (SE OD and SE OS)

Variable	Groups	Mean	St.Dev	Stat Value	Significance	Note
SE	Stunting	0.2065	0.51798	-1.833	0.067	Not Significant
	Normal	-0.4313	0.92451			

Table 4. The average differences between normal group and overweight group based on SE OD dan SE OS variables

Variable	Groups	Mean	St.Dev	Stat Value	Significance	Note
SE	Normal	-0.3774	0.84805	-1.330	0.7417	Not Significant
	Over weight	-0.3304	0.79337			

there were no significant differences between stunting and normal group (non-stunting) based on SE OD and SE OS variables.

Based on **Table 4**, the significance value in each variable was greater than α (0.05), which means that there were no significant differences between overweight and normal groups based on SE OD and SE OS variables.

DISCUSSION

In this study, we observed a spherical equivalent sample of myopia in 47 subjects, while 80 subjects had non-myopia (hypermetropia and emmetropia). This study showed that there were no significant correlations between weight, height, BMI or food intake and there were no influences between body weight, height, BMI and food intake on SE value.

This study also examined the relationship between myopia and non-myopia group with anthropometric status and food intake. The results showed that there was no significant difference between myopia and non-myopia in body weight, height, and BMI parameters. Furthermore, this study also found that there were no significant differences in SE value between stunting and non-stunting groups, and also between overweight and obesity with normal BMI.

Rafat et al. (2013) observed a correlation between anthropometric factors in myopia and non-myopia children between the ages of 7-9 years. The number of myopia group was 169 children and the non-myopia group was 180 children. This research found that the mean of weight, height, and BMI in all subject were 31.6 ± 8.1 kg, 132.3 ± 7.5 cm and 17.8 ± 3.2 kg/m2, respectively. In the myopia group, there were 54 overweight subjects and 45 subjects were overweight in the control group. Thus, myopic children were more obese than the control group (Gardiner 1956).

The relationship between height and the myopic condition has been examined in several studies, especially in young adults. Recent studies found that there was a significant difference between height and an axial length of the eye in twin children in China. Another study reported that height is inversely proportional to the refractive error in boys, but no differences were found in girls. On the contrary, another study found that there was no difference between height and myopia in 106,926 Israeli military men (aged 17-19 years) (Gardiner 1958).

Another study also found that there was no significant correlation between anthropometry variables (height, body weight, and BMI) with myopia in 23,616 men in South Korea. Research in Finland found that men with myopia 1.9 cm were higher than non-myopia men. A study in Denmark revealed that myopia patients of 0.8 cm were higher than emmetropia and hypermetropia 0.2 cm were lower than emmetropia. Most research studies have shown that higher correlation between axial length of eye and height, but not always correlated with myopia parameters. A possible reason is emmetropization is achieved primarily by adjusting the correlation between corneal flattening and eye length (Gardiner 1958).

Our research used a semi-quantitative questionnaire to examine the relationship between dietary factors and refractive errors. This questionnaire determined the nutrition status in the study population. In this study, we compared the FFQ results consisting of 55 food type questions between two groups, myopia, and non-myopia. Mann-Whitney test showed that there were no differences between the two groups in nutrition intake such as calories (energy), protein, fat, carbohydrate, fiber, PUFA, cholesterol, vitamin A, carotene, vitamin E, vitamin B1, vitamin B2, vitamin B6, folic acid, vitamin C, sodium, potassium, calcium, magnesium, phosphorus, iron and zinc.

Lim et al. (2010) found that the intake of saturated fat and cholesterol was correlated with a longer axial length of the eye, but not correlated with myopia (spherical equivalent). Saturated fat is known as an insulin antagonist and contributes to the occurrence of insulin resistance, which supports the hyperinsulinemia theory of Cordain. However, this effect is relatively small, since the difference between the axial length of the eye in the lowest and highest quartile groups of saturated fat intake was only about 0.30 mm and its association with SE and myopia diagnosis was also not seen. The ambiguity factors that may affect the study were also not investigated (Lim et al. 2010).

CONCLUSION

This study found that there were no significant associations between anthropometric parameters (body weight, height, and BMI) and dietary factors (nutrition intake) with a refractive error by correlation and regression analyses.

ACKNOWLEDGEMENTS

All Author thank to the 42nd Indonesian Ophthalmologist Association (IOA) Annual Meeting.

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