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Relationship Between Dietary Diversity Score (DDS) and Macronutrient Adequacy Intake with Thinness among Students at SDN 1 Karangmulyan Lebak Regency in 2025

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Abstract. Lack of nutrients in Indonesia is still a problem in various age groups, including school-age children. Thinness in school-age children occurs due to a lack of food diversity and macronutrient intake. Thinness can lead to a cyclical effect of malnutrition in later life. Lebak Regency is the district with the 2nd highest number of severe underweight cases in Banten Province in 2016, and Banten is the province with the highest thinness cases in Java Island in 2018 and 2023. This study aims to determine the relationship of thinness based on the Dietary Diversity Score (DDS), macronutrient adequacy, child characteristics (age, gender), maternal characteristics (gestational age, maternal age at pregnancy), sociodemographic characteristics (parental income, father's education, mother's education) parental factors (father's and mother's education), history of infectious disease and exclusive breastfeeding. This study uses secondary data and a cross-sectional study design with a sample of 137 students taken using the purposive sampling method. The study was conducted through quantitative analysis with univariate, bivariate, with chi-square tests, and multivariate with logistic regression. 20.5% of students were thin and had severe thinness. There is a significant relationship between dietary diversity score OR 2,582 (95%CI: 1,082-6,163) and adequacy of fat intake OR 3,638 (95%CI: 1,010-13,10) with thinness. Adequacy of fat intake is the dominant factor in thinness..

Keywords: Dietary Diversity Score (DDS), Adequacy of fat intake, Students, Thinness, Lebak Regency

INTRODUCTION

School-age period is a developmental stage that can be divided into two phases: *middle childhood* (ages 5–10 years) and *pre-adolescence*, which typically occurs between ages 9–11 years for girls and 10–12 years for boys [1]. This period is often referred to as the latent phase, during which children's height and weight increase, although the rate of growth is relatively stable. However, they enter adolescence, body weight may increase by up to 50% compared to their weight during childhood [2].

Adequate nutrition in early life is crucial, as thinness during this period can delay sexual maturation and hinder physical growth [3]. This condition may lead to a cyclical intergenerational pattern of thinness [4,5,6], and contribute to reduced productivity in adulthood [7].

Globally, numerous studies have been conducted on childhood thinness, primarily focusing on children under the age of five, while school-aged children remain relatively underrepresented in research [8]. In 2021, a systematic review was conducted to examine the nutritional status of school-aged children and adolescents (aged 5–19 years) as reported in studies from low- and middle-income countries (LMICs) worldwide [9]. According to this review, the highest prevalence rates of stunting, thinness, and underweight were reported in the Democratic Republic of the Congo (61.0% among 203 primary school children aged

7–17 years) [10], Ethiopia (58.3% among 211 adolescent girls with a mean age of 14 years) [11], and Nigeria (95.7% among 139 primary school children aged 5–15 years) [12].

In Indonesia, the prevalence of thinness among children aged 5–12 years has fluctuated over the past decade. In 2013, the prevalence was 11.2% [13], decreasing to 10.4% in 2016, and further to 9.2% in 2018 [14]. However, according to the latest data from the 2023 Indonesian Health Survey, the prevalence of thinness and severe thinness among children aged 5–12 years increased to 11%. A lower prevalence was reported among adolescents aged 13–15 years, with 7.6% affected by thinness. Notably, children living in rural areas contributed more to the prevalence of thinness compared to those living in urban areas [15].

In Banten Province, the prevalence of thinness among children aged 5–12 years was 13.1%, which is higher than the national average in 2023 and also exceeds the rates reported in other provinces on Java Island, including DKI Jakarta (9.7%), West Java (9.8%), Central Java (10.4%), Yogyakarta Special Region (10.0%), and East Java (9.7%) [15]. This prevalence is consistent with Banten's 2018 data, where the province recorded the highest thinness rate on Java Island at 10.1% [14].

Lebak Regency, located in Banten Province, has shown concerning records, ranking second highest in severe malnutrition cases among children under five in 2016, and second lowest in school-age children's health screening coverage at the provincial level, with only 79.71% coverage [16]. Unresolved cases of malnutrition during early childhood are closely associated with thinness during school age [17]. SDN 01 Karangmulyan is one of 28 public elementary schools located in Cihara Subdistrict, Lebak Regency.

In Indonesia, particularly in rural areas, dietary diversity across all age groups remained inadequate in 2018, with most individuals failing to meet the recommended intake levels for energy and protein. Average daily energy intake from tubers was 66 kcal, from animal-source foods (meat, fish, poultry, milk, eggs) 187 kcal, from oily fruits/seeds 30 kcal, from legumes 55 kcal, and from vegetables and fruits 49 kcal. These values are below the ideal energy intake recommendations: 120 kcal from tubers, 240 kcal from animal-source foods, 60 kcal from oily fruits/seeds, 100 kcal from legumes, and 120 kcal from vegetables and fruits. Animal protein intake (16.6 g/day) also fell short of the ideal intake recommended by the 2012 National Workshop on Food and Nutrition (WNPG), which is 22 g/day [16], and was notably lower than plant-based protein intake, which averaged 43.26 g/day.

Dietary Diversity Score (DDS) is an index commonly used to assess dietary diversity at the individual level across all age groups, as well as at the household level, and serves as a proxy indicator for micronutrient adequacy [18]. However, several studies have demonstrated that DDS can also be used as an indicator to predict macronutrient adequacy in children [19,20,21], as well as nutritional status among children [22]. DDS is directly associated with total energy intake [22] and the energy density of foods (kilocalories per gram of food weight) [23]. A more diverse DDS is associated with higher diet quality and improved nutrient adequacy [24]. Recent studies in India have found that the Nutrient Adequacy Ratio (NAR) increases proportionally with higher DDS, which has been linked to increases in body mass index (BMI) [19]. Conversely, several clinical trials have shown that low DDS is associated with decreased dietary energy density, resulting in significant weight loss [22].

METHODS

This study is a cross-sectional analysis utilizing secondary data from a primary study entitled *"Factors Associated with Helminth Infections among Students of SDN 1 Karangmulyan, Cihara Subdistrict, Lebak Regency, 2020,"* conducted from September to October 2020. The study population consisted of all students enrolled at SDN 1 Karangmulyan, Lebak Regency, totaling 151 students. A sample of 137 students was selected using purposive sampling based on the inclusion criterion of having a Body Mass Index-for-Age (BMI/Age) z-score between <-3 SD and 1 SD. The secondary data analysis was carried out in Jakarta between May and July 2021.

The data collected included student characteristics, family characteristics, socio-demographic information, dietary habits, anemia and helminth infection status, Clean and Healthy Living Behavior (PHBS) data, individual and household food consumption data, and dietary intake data obtained through a 24-hour food recall. The dependent variable in this study was undernutrition status (thinness and severe thinness). The independent variables included Dietary Diversity Score (DDS), energy adequacy, carbohydrate adequacy, protein adequacy, fat adequacy, student's age, sex, maternal age at the time of pregnancy, gestational age at birth, history of exclusive breastfeeding, history of recurrent symptoms of acute respiratory infections (ARI) and diarrhea, father's educational level, mother's educational level, and total household income

2.1 Nutritional Status (thinness and severely thinness)

Nutritional status was determined using Body Mass Index-for-Age (BMI/Age), categorized into "Thinness" (z-score <-3 SD to <-2 SD) and "normal nutrition" (z-score -2 SD to +1 SD) [25].

2.2 Dietary Diversity Score (DDS)

Dietary Diversity Score (DDS) was calculated based on the number of food groups consumed over a 24-hour period, using nine predefined food group categories [17]. DDS was categorized as "low diversity" (DDS <4) and "high diversity" (DDS ≥4) [26,27,28].

2.3 Macronutrient adequacy

In this study, macronutrient adequacy—including adequacy of energy, carbohydrates, protein, and fat—was assessed using the Nutrient Adequacy Ratio (NAR), calculated by dividing the total intake by the recommended daily intake based on the 2019 Indonesian Recommended Dietary Allowances (AKG 2019) [33]. NAR values were categorized as "inadequate" (NAR <1) and "adequate" (NAR ≥1) [25,29,30,31].

2.4 Age and Sex

Age and sex were included as variables, with age categorized into "6–9 years" and "10–12 years," and sex categorized as "male" and "female" [32].

2.5 Maternal Characteristics

Maternal characteristics included maternal age at the time of pregnancy, categorized as "at risk" (<20 years and >35 years) and "not at risk" (20–35 years). Gestational age at birth was classified as "preterm" (<37 weeks) and "full term" (≥37 weeks) [7].

2.6 History of exclusive breastfeeding

This Data was categorized as "non-exclusive breastfeeding" and "exclusive breastfeeding." History of recurrent symptoms of acute respiratory infections (ARI) and diarrhea was classified as "present" and "absent."

2.7 History of ISPA and diarrhea

History of recurrent symptoms of ISPA and diarrhea was categorized as "with history" and "without history."

2.7 Family Characteristics

Both paternal and maternal education levels were categorized as "low" (no formal education to junior high school completion) and "high" (senior high school to higher education). Total household income was classified as "low" (< IDR 2,710,000) and "high" (≥ IDR 2,710,000).

2.8 Data Analysis

Data analysis in this study included univariate analysis to describe the distribution of dependent and independent variables, followed by bivariate analysis using the *chi-square test*. Multivariate analysis was conducted using *multiple logistic regression.*

RESULTS AND DISCUSSION

2.1 Distribution of Students by Nutritional Status (BMI-for-Age), Age and Sex Characteristics, Dietary Diversity Score (DDS), Macronutrient Adequacy, Maternal Characteristics, History of Exclusive Breastfeeding and Infectious Diseases, and Family Characteristics

Based on the analysis presented in Table 1, of the 151 students, 20.5% were classified as Thinness (thinness and severe thinness), 9.3% as overweight or obese, and 70.2% as having normal nutritional status. For further analysis, the study focused on students with thinness (20.5%) and normal nutritional status (70.2%). This research showed that students aged 10–12 years accounted for 48.9%, which was slightly lower than those aged 6–9 years (51.1%). Male students made up 50.4% of the sample, while female students accounted for 49.6%. The proportion of students with low dietary diversity (46%) was lower than those with high dietary diversity (54%). All students consumed foods from the cereal, root, and tuber group. However, vegetable and fruit consumption remained low: only 16.1% consumed vitamin A-rich vegetables and fruits, 23.4% consumed dark green leafy vegetables, 27.7% consumed vegetables in general, and only 5.8% consumed fruits.

Table 1. Distribution of Students by Determinants of Thinness

Variable	n	%	Variable	n	%
Nutritional Status			***Dietary Diversity Score* (DDS)**		
Thinness			Low diversity	63	46.0
and severe thinness	31	20.5	High diversity	74	54.0
Normal	106	70.2			
			Maternal age of pregnancy		
Students Characteristic			At Risk	39	28.5
Age			Not at risk	98	71.5
6-9 years	70	51.1			
10-12 years	67	48.9	**Gestasional Age**		
			Preterm	3	2.2
Sex			Aterm	134	97.8
Male	69	50.4			

Female	68	49.6	***History of exclusive breastfeeding***		
			No	82	59.9
Macronutrient Adequacy			Yes	55	40.1
Energy					
Adequate	18	13.1	**History of ISPA**		
			Yes	25	18.2
In-adequate	119	86.9	No	112	81.8
			History of Diarrhea		
Protein			Pernah ada riwayat	48	35.0
Adequate	39	28.5	Tidak pernah	89	65.0
In-adequate	98	71.5			
			Father's Education Level		
Fat			Low Education	105	76.6
Adequate	42	30.7	High Education	32	23.4
In-adequate	95	69.3	**Mothers Education Level**		
			Low Education	125	91.2
Carbohydrate			High Education	12	8.8
Adequate	38	27.7			
Inadequate	99	72.3	**Family's Income**		
			< Rp 2.710.000	110	80.3
			≥ Rp 2.710.000	27	19.7

The distribution of students based on macronutrient adequacy showed that the median total caloric intake was 1,279 kcal, with a median protein intake of 35.7 grams, fat intake of 46.2 grams, and carbohydrate intake of 171.3 grams. Based on the adequacy ratios, 86.9% of students had inadequate energy intake, 71.5% had inadequate protein intake, 69.3% had inadequate fat intake, and 72.3% had inadequate carbohydrate intake. Based on maternal characteristics and exclusive breastfeeding history, 28.5% of students were conceived by mothers aged below 20 years or above 36 years. Additionally, 2.2% of students were born preterm (gestational age less than 37 weeks). Meanwhile, the distribution of students based on exclusive breastfeeding history and infectious diseases showed that the proportion of students who were not exclusively breastfed was higher (59.9%) than those who were exclusively breastfed. Additionally, 18.2% of students had a history of acute respiratory infection (ARI) symptoms, and 35% had a history of recurrent diarrhea. The results of distribution of students based on family characteristics included father's education level, mother's education level, and total household income. A greater proportion of students had fathers with a low level of education (76.6%) compared to those with a higher education level. Similarly, 91.2% of students had mothers with a low level of education. In addition, 80.3% of students came from households with a low total income (< IDR 2,710,000), which is below the regional minimum wage for Lebak Regency.

2.2 Association Between Student Characteristics (Age and Sex), Maternal Characteristic, history of exclusive breastfeeding and Infectious disease, and family characteristics with Thineess

The proportion of thinness aged 6–9 years (24.3%) was higher than that of students aged 10–12 years (20.9%). Similarly, the proportion of Thinness male students (26.5%) was higher compared to female students (18.8%). However, bivariate analysis showed no significant association between age (p-value = 0.787) and sex (p-value = 0.388) with thinness. The distribution of students based on maternal characteristics and exclusive breastfeeding history showed that 28.5% of students were born to mothers who were either younger than 20 years or older than 36 years at the time of pregnancy. Additionally, 2.2% of the students were born prematurely (before 37 weeks of gestation).

Regarding exclusive breastfeeding and infectious disease history, the proportion of students who were not exclusively breastfed was higher (59.9%) than those who were exclusively breastfed. Furthermore, 18.2% of students had a history of acute respiratory infection (ARI) symptoms, and 35% had experienced recurrent diarrhea. The distribution of students based on family characteristics, including parental education and total household income, revealed that 76.6% of students had fathers with a low level of education, while 91.2% had mothers with a low level of education. Moreover, 80.3% of students came from households with a total income below IDR 2,710,000, which is less than the regional minimum wage in Lebak Regency.

The bivariate analysis of exclusive breastfeeding history and thinness status revealed that 25.5% of thinness students had not been exclusively breastfed, compared to 20.7% of those who had. There was no statistically significant association between exclusive breastfeeding history and thinness. Among students with a history of acute respiratory infection (ARI) symptoms, 24.0% were thinness versus 22.3% of those without such a history. In the case of recurrent diarrhea, 29.2% of students with a history of diarrhea were Thinness, compared to 19.1% of those without. Chi-square tests indicated no significant relationships between thinness status and exclusive breastfeeding history (p = 0.660), ARI history (p = 1.000), or recurrent diarrhea (p = 0.259).

The analysis of family characteristics showed that the proportion of Thinness students whose fathers had a low level of education was 21.0%, which was lower than the proportion among those whose fathers had a higher education level (28.6%). Similarly, 21.6% of Thinness students had mothers with a low level of education, while 33.3% had mothers with a higher level of education. Furthermore, the proportion of Thinness students from households with a total income below IDR 2,710,000 was 23.6%, compared to 18.5% from households with higher income (≥ IDR 2,710,000). However, no statistically significant associations were found between thinness status and father's education level (p-value = 0.543), mother's education level (p-value = 0.468), or total household income (p-value = 0.754).

Table 2. Summary of Bivariate Analysis Results

Variabel	Gizi Kurang		Gizi Baik		Total		*P-value*	OR	CI 95%
	n	%	n	%	n	%			
Dietary Diversity Score									
Low diversity	20	31.7	43	68.3	63	100	0.032*	2.66	1.16 - 6.11
High diversity	11	14.9	63	85.1	74	100			
Energy Intake									
Adequate	30	25.2	89	74.8	119	100	0.074	5.07	0.73 - 44.9
In-adequate	1	5.6	17	94.4	18	100			
Protein Intake									
Adequate	23	23.5	75	76.5	99	100	0.883	1.18	0.48 - 2.94
In-adequate	8	20.5	31	79.5	38	100			
Fat Intake									
Adequate	27	28.4	68	71.6	98	100	0.027*	3.77	1.22 – 11.59
In-adequate	4	9.5	38	90.5	39	100			
Carbiohydrat Intake									
Adequate	25	25.3	74	74.7	99	100	0.339	1.80	0.67 - 4.81
In-adequate	6	15.8	32	84.2	38	100			
Age									
6-9 Years	17	24.3	53	75.7	70	100	0.787	1.21	0.54 - 2.71
10-12 Years	14	20.9	53	79.1	67	100			
Sex									
Male	18	26.5	50	73.5	68	100	0.388	1.55	0.69 - 3.48

Female	13	18.8	56	81.2	69	100			
Maternal Age									
<20 dan >35 years (risk)	10	25.6	29	74.4	39	100	0.760	1.26	0.53 - 3.00
20-35 years (no risk)	21	21.4	77	78.6	98	100			
Gestasional Age									
Preterm	0	0	3	100	3	100	1.000	1.30	1.19 - 1.42
Aterm	31	23.1	103	76.9	134	100			
Exclusive Breastfeeding									
No	14	25.5	41	74.5	55	100	0,660	1.30	0.58 - 2.93
Exclusive breastfeeding	17	20.7	65	79.3	82	100			
History of ISPA									
Yes	6	24.0	19	76.0	3	100	1.000	1.09	0.39 - 3.04
No	25	22.3	87	77.7	148	100			
History of diarrhea									
Yes	14	29.2	34	70.8	53	100	0.259	1.74	0.77 - 3.94
No	17	19.1	72	80.9	98	100			
Father's Education Level									
Low Education	22	21.0	83	79.0	105	100	0.543	0.67	0.27 - 1.67
High Education	9	28.1	23	71.9	32	100			
Mother's Education Level									
Low Education	27	21.6	98	78.4	125	100	0.468	0.55	0.15 - 1.96
High Education	4	33.3	8	66.7	12	100			
Family's Income									
<2.710.000	26	23.6	84	76.4	110	100	0.754	1.36	0.46 - 3.95
≥2.710.000	5	18.5	22	81.5	27	100			

2.3 Association Between Macronutrient Adequacy and Thinness

The analysis presented in Table 2 shows that the proportion of Thinness students with inadequate energy intake was 25.2%, compared to 5.6% among those with adequate energy intake. The proportion of Thinness students with inadequate protein intake (23.5%) was slightly higher than those with adequate protein intake (20.5%). Regarding fat intake, 27.6% of students with inadequate fat intake were Thinness, whereas only 10.3% of students with adequate fat intake were Thinness. For carbohydrate intake, 25.3% of students with inadequate carbohydrate intake were Thinness, while 15.8% of those with adequate intake fell into the Thinness category. Further analysis indicated no statistically significant association between thinness and adequacy of energy intake (p-value = 0.074), protein intake (p-value = 0.883), or carbohydrate intake (p-value = 0.339). In contrast, fat intake adequacy was significantly associated with thinness status (p-value = 0.027), with an odds ratio (OR) of 3.77 (95% CI: 1.22–11.59). This suggests that students with inadequate fat intake were 3.8 times more likely to be Thinness than those with adequate fat intake.

2.4 Fat Intake Adequacy as a Dominant Factor Associated with Thinness

The results of the multivariate analysis presented in Table 3 indicate that two variables were significantly associated with thinness status: Dietary Diversity Score (DDS) and fat intake adequacy. The analysis showed that students with a DDS < 4, indicating a low dietary diversity, were 2.6 times more likely to be Thinness compared to those with a DDS ≥ 4 (OR = 2.582; 95% CI: 1.082–6.163), after controlling for energy intake adequacy, fat intake adequacy, protein intake adequacy, carbohydrate intake adequacy, and history of recurrent diarrhea. Among all variables analyzed, inadequate fat intake emerged as the most dominant factor associated with thinness in this study.

The multivariate analysis revealed an odds ratio (OR) of 3.638 (95% CI: 1.010–13.10) for fat intake adequacy in relation to thinness. This indicates that students with inadequate fat intake were 3.6 times more likely to be Thinness compared to those with adequate fat intake, after adjusting for Dietary Diversity Score, energy intake adequacy, protein intake adequacy, carbohydrate intake adequacy, and history of recurrent diarrhea. Inadequate fat intake was identified as the most dominant determinant of thinness in this study.

Table 3. Final Multivariate Model of Determinants of Thinness

Variabel	B	*p-value*	OR	95% CI
Dietary Diversity Score (DDS)	0.949	0.033*	2.582	1.082 – 6.163
Kecukupan Asupan Energi	1.234	0.291	3.436	0.348 – 33.90
Kecukupan Asupan protein	-0.803	0.170	0.448	0.142 – 1.409
Kecukupan Asupan lemak	1.291	0.048*	3.638	1.010 – 13.10
Kecukupan Asupan karbohidrat	0.407	0.484	1.502	0.481 – 4.688
Riwayat Diare Berulang	0.483	0.278	1.621	0.677 – 3.882

In this study, students with adequate fat intake typically consumed at least one portion of animal-based protein from poultry or meat, such as chicken or beef, per day. Additionally, the method of food preparation significantly influenced fat adequacy. Students with adequate fat intake frequently consumed 1–2 pieces of deep-fried foods or foods prepared with coconut milk, such as fried chicken, fried rice, coconut rice (*nasi uduk*), vegetable fritters (*bakwan*), *cilung*, fried or omelet-style eggs, and others. These foods contain considerably higher levels of saturated fatty acids (SAFA) compared to foods that are boiled or steamed, such as chicken cooked in soup, sautéed, or grilled. Analysis of food recall data using the NutriSurvey application showed that different cooking methods significantly affected SAFA content, which in turn was closely associated with students' fat intake. For example, when students consumed poultry such as chicken, the meat in its raw or minimally processed form contained higher levels of monounsaturated fatty acids (MUFA) compared to SAFA and polyunsaturated fatty acids (PUFA). However, once the chicken was deep-fried, its nutritional composition shifted, resulting in significantly higher SAFA content than MUFA. SAFA levels were found to increase up to fourfold when the food was fried and prepared with coconut milk.

The findings of this study are supported by research conducted among children in Taiwan, which demonstrated a significant association between dietary cholesterol intake from total fat and Body Mass Index-for-Age (BMI/Age), with a correlation coefficient of r = 0.333. Adequate fat intake not only contributes to the energy density of the diet but also plays an essential role in the absorption of fat-soluble vitamins and essential fatty acids (EFAs) [32]. Similarly, studies conducted in Vietnam and neighboring countries reported comparable findings regarding the consequences of an imbalanced, low-fat diet [32]. Since fat provides more energy (9 kcal per gram compared to 4 kcal per gram for carbohydrates and protein), low fat intake may lead to insufficient energy consumption and deficiencies in fat-soluble vitamins [22].

Total fat intake includes various types of fatty acids that are closely linked to body composition, namely monounsaturated fatty acids (MUFA), saturated fatty acids (SAFA), and polyunsaturated fatty acids (PUFA) [33]. A study conducted in the United States found that increased intake of total fat, SFA, MUFA, myristic acid, palmitic acid, and stearic acid was associated with an increase in Body Mass Index (BMI) [34]. In contrast, PUFA consumption has been linked to a reduction in adiposity due to metabolic changes that promote fatty acid oxidation [35]. Among different types of fatty acids, the degree of saturation influences the rate of fatty acid oxidation [36]. MUFA intake, particularly oleic acid, has been associated with reduced adipose fat deposition, whereas SAFA is strongly linked to increased adipose and visceral fat accumulation, as well as obesity [33]. MUFA intake also stimulates increased fatty acid oxidation, contributing to higher total energy expenditure, which may help reduce body weight and BMI [37]. Higher plasma levels of total n-3 polyunsaturated fatty acids (PUFAs) have been associated with reductions in body mass index (BMI), waist circumference, and hip circumference among individuals ranging from normal weight to obese [37]. Moreover, increased oxidation of unsaturated fatty acids has been linked to decreased body fat mass [36].

2.5 Correlation of Dietary Diversity Score with Thinness

As shown in Table 2, the proportion of Thinness students with low dietary diversity (31.7%) was higher than that of Thinness students with high dietary diversity (14.9%). The chi-square test revealed a p-value of 0.032 and an odds ratio (OR) of 2.66, indicating a statistically significant association between Dietary Diversity Score (DDS) and thinness. Students who consumed less diverse types of food were 2.66 times more likely to be Thinness compared to those with more diverse diets.

In this study, the Dietary Diversity Score (DDS) was significantly lower among Thinness boys compared to boys with normal weight. Only 15.1% of Thinness boys consumed food from more than four food groups—namely cereals, legumes and pulses, meat/fish/poultry, and vitamin A-rich fruits and vegetables—compared to their counterparts whose diets were less diverse. Thinness children consumed significantly lower amounts of vitamin A-rich vegetables and fruits (e.g., carrots, bananas, chayote, mangoes, papaya), other vegetables (e.g., bean sprouts, long beans, cabbage), other fruits (e.g., oranges, guava, salak, mangosteen, melon), dairy products (powdered milk, cheese), fish (e.g., mackerel, carp, salted fish), meat (beef, organ meats, meatballs)/poultry (chicken), legumes and seeds (tempeh and tofu), eggs, and fats/coconut milk. This contributed to significantly reduced intake of total energy, protein, fat, and key micronutrients such as vitamins A and C.

Interestingly, the study also found that the consumption of dark green leafy vegetables—such as spinach, cassava leaves, mustard greens, and water spinach—acted as a protective factor for good nutritional status. Students who did not consume dark green leafy vegetables were more likely not to be Thinness and were more likely to have normal nutritional status (p-value = 0.04, OR = 0.36; 95% CI: 0.15–0.88). These findings are consistent with studies showing that higher DDS is associated with healthier food choices and improved nutrient density, including greater intake of fruits, vegetables, and whole grains [10]. Higher DDS has also been linked to lower BMI due to increased intake of dietary fiber, vitamin C, and calcium, all of which are associated with low energy density diets and inversely related to obesity [19,20,40].

The results of this study align with several other studies indicating that more diverse diets are associated with better diet quality and nutrient adequacy in Iran and various other countries [22,39,40]. Similar research also found that adolescents with low DDS had lower BMI-for-age z-scores compared to those with higher dietary diversity [18]. A recent study conducted among school-aged children in Southern Ethiopia reported that only 27.5% met the minimum DDS, and children living in urban areas were 65% less likely to be Thinness than those in rural settings. Urban children were also twice as likely to achieve adequate dietary diversity compared to their rural counterparts [41]. A study conducted in the Mayuge and Iganga districts found that low DDS scores were associated with decreased nutritional status [42]. Greater dietary diversity reflects better access to a wide variety of foods and, therefore, greater food and nutrient intake, which positively influences nutritional status [43].

CONCLUSIONS

The prevalence of students with thinness was 20.5%. There were no statistically significant associations between thinness status and energy intake adequacy, carbohydrate intake adequacy, protein intake adequacy, age, sex, maternal age during pregnancy, gestational age at birth, history of exclusive breastfeeding, history of respiratory tract infections, recurrent diarrhea, father's education level, mother's education level, or total household income. However, Dietary Diversity Score (DDS) and fat intake adequacy were significantly associated with thinness. Among the associated factors, inadequate fat intake was identified as the most dominant determinant of thinness among students.

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