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Individual, Parental, and Environmental Determinants of Diet Quality and Nutritional Status among Adolescents in Padang City, Indonesia

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ABSTRACT

Background: Understanding factors that influence adolescents' diet quality and nutritional status is essential, as this life stage shapes long-term health outcomes. Therefore, this study aimed to examine individual, parental, and environmental determinants that significantly predicted dietary quality and nutritional status among adolescents in Padang City, Indonesia.

Methods: A cross-sectional study involving 186 adolescents was conducted in Padang City, Indonesia. They were interviewed to assess individual, parental, and environmental determinants. Diet Quality Index for Adolescents (DQI-A) was used to assess dietary quality score and direct anthropometric measurements were performed to assess adolescent nutritional status. Multivariate analysis was applied to identify the most influential variable on DQI-A score (multivariate linear regression) and nutritional status (Multinomial logistic regression).

Results: Mean score of DQI-A was 43.7±6.4 and the majority of adolescent had normal nutritional status (65.6%). Diet quality was associated with parental determinants (paternal education) and environmental determinants (availability of healthy and unhealthy food at school, food accessibility and screen time) with β coefficient -5.37 to -5.70. Individual determinants (low physical activity) and parental determinants (maternal education) was associated with higher odds of being underweight with OR 11.04 and 12.98.

Conclusion: Dietary quality and nutritional status were shaped by the interaction of individual, parental and the environmental determinants rather than by a single factor. Therefore, comprehensive interventions are needed that simultaneously improve healthy food availability at school, strengthen parental nutritional knowledge, and promote healthier lifestyle behaviours among adolescents.

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Introduction

Adolescents are defined by the World Health Organization as individuals aged 10-19 years, while the Indonesian Ministry of Health classified adolescents as those aged 10–18 years (1, 2). Adolescence represents a pivotal stage of physical, psychological, and social development, characterized by rapid growth and increased nutritional demands, and serves as a critical period for establishing the foundation for long-term health and future wellbeing (1, 3). However, adolescents worldwide continue to face various nutritional challenges that may adversely impact their health and quality of life in future (4-6). Prioritizing adolescent health offers multiple benefits by improving their current wellbeing, fostering healthier lifestyle trajectories into adulthood, and enhancing future opportunities for the next generation (7).

Globally, adolescent under-nutrition remains a major public health concern, particularly in low- and middle-income countries. Recent estimates indicate that approximately 8% of adolescent girls (49 million) and 10% of adolescent boys (154 million) experienced nutritional deficiencies, reflecting persistent challenges in meeting dietary needs within this age group (8). In Indonesia, data from the 2018 Basic Health Research (Riskesdas) showed that among adolescents aged 16-18 years, the prevalence of nutritional status based on BMI-for-age was 1.4% as severely thin, 6.7% as thin, 9.5% as overweight, and 4.0% as obese; meanwhile, the 2023 Indonesian Health Survey (SKI) reported similar patterns with 1.7% severely thin, 6.6% thin, 8.8% overweight, and 3.3% obese (9, 10). The lack of substantial improvement between the two surveys indicates that thinness, overweight, and obesity remained unresolved nutritional problems, while the slight increase in severe thinness warrants particular attention. Data on adolescents in West Sumatra Province showed that in 2018, 1.84% were classified as severely thin, 7.6% as thin, 7.78% as overweight, and 3.72% as obese. In contrast, the 2023 Indonesian Health Survey (SKI) reported 2.9% severely thin, 6.9% thin, 7.1% overweight, and 2.4% obese adolescents (9, 10). Based on the comparison of these two datasets in West Sumatra Province, the prevalence of severe thinness has increased, while thinness and overweight remained above the public health threshold. Although obesity has declined, it still warrants monitoring due to its contribution to future non-communicable disease risk. These patterns underscore the need for more comprehensive nutritional interventions to improve the nutritional status of adolescents.

Adolescents tend to exhibit poor dietary patterns. Evidences from Southeast Asia showed that only 37.4% of adolescents consumed the five recommended food groups according to dietary guidelines; while nearly two-thirds (62.6%) regularly consumed sugar-sweetened beverages, and more than three-quarters (76.8%) consumed unhealthy or ultra-processed food (11). Diet quality served as an important measure of how well individuals adhered to dietary recommendations (12), reflecting overall food intake, nutrient interactions, and eating behaviours within a population context (13). A previous study indicated that adolescents generally had low diet quality, achieving only 23% of the maximum possible score (14), with the lowest scores observed in vegetable, fruit, and dairy consumption, alongside high intake of ultra-processed foods (14-16). Poor diet quality during adolescence has been linked to impaired growth and development at cellular level, increased risk of depression, reduced quality of life, lower academic achievement, and problems with concentration (17-19).

A variety of factors can influence adolescent diet quality and nutritional status. However, many previous studies have examined only one or two contributing factors, without accounting for the complex interactions among individual, family, and environmental influences. Therefore, this study adopted a more holistic approach to identify the determinants of diet quality and nutritional status among adolescents in Padang City, Indonesia. Padang City was selected as the study setting because it is one of the major urban areas in West Sumatra Indonesia with wide access to digital technology and fast food, both of which may influence adolescents' dietary patterns. Moreover, there are still limited researches examining the determinants of diet quality and nutritional status among adolescents in this region. The findings of this study are expected to provide a more comprehensive understanding of the contributing factors and to serve as an evidence base for policymakers and healthcare professionals in designing more effective, context-specific interventions to improve adolescent diet quality and nutritional status in Padang, Indonesia.

Materials and Methods

This cross-sectional study was conducted from September to October 2025 and enrolled adolescent students from junior and senior high schools located in Pauh District, Padang City, Indonesia. Pauh District was purposively selected as it is a rapidly developing area situated near a major higher education institution, Andalas University. Adolescents in this district have substantial exposure to fast food outlets, unhealthy snacks, and extensive use of digital technology, all of which may influence their dietary patterns and nutritional status. Adolescent students from three junior high schools and two senior high schools were selected using stratified random sampling with proportional allocation across grade levels.

Eligible students were randomly selected within each grade. Inclusion criteria included being enrolled during the data collection period, having the ability to understand and follow study instructions, willingness to participate, and provision of informed assent, with written informed consent obtained from their parents or guardians. Exclusion criteria included having physical condition that prevented reliable anthropometric measurements, or refusal to provide assent or parental/guardian consent. Participants with incomplete key data (24-hour recalls missing or missing anthropometric measurements) were also excluded from the primary analyses. Ethical approval was provided from Research Ethics Committee of the Faculty of Public Health, Universitas Andalas (No. B/113/UN16.12.D/PP/2025).

The minimum required sample size was calculated using the single-population proportion formula proposed by Lemeshow *et al.* (1990). The calculation assumed a 95% confidence level (95%CI) (Z=1.96), a precision level of 5% (d=0.05), and an estimated prevalence of 14% based on prior evidence of poor nutritional status (thinness and overweight) in adolescents (10). Using these parameters, the sample size was calculated as $n=Z^2 \times p(1-p)/d^2$, yielding a minimum of 184 participants. Accordingly, 200 students were initially recruited to account for potential nonresponse and incomplete data. However, 14 students provided only one day of 24-hour dietary recall and therefore; they did not meet the criteria for dietary assessment. As a result, these participants were excluded from the analysis, and the final analytic sample was 186 adolescents.

All subjects were interviewed by trained field enumerators (a minimum qualification of an associate degree in nutrition or final-year bachelor's students in nutrition) to assess subject characteristics, parental characteristics, and environmental characteristics. Subject characteristics included age, gender, smoking and alcohol consumption habits (self-reported current use: yes/no), pubertal status (using Tanner stage), and physical activity (using International Physical Activity Questionnaire/IPAQ). Parental characteristics were reported by the student and comprised father's and mother's highest educational attainment (categorized), history of parental non-communicable diseases (yes/no), parental smoking status (yes/no), and household size (number of household members). Environmental characteristics were measured by questionnaire items capturing food availability at home and school (presence/absence of specific healthy/unhealthy food items), food accessibility (using Food Insecurity Experience Scale), and average daily screen time (self-reported hours per day).

Diet quality data was assessed using Diet Quality Index for Adolescents (DQI-A) adjusted according to balanced diet guideline in Indonesia issued by the Ministry of Health, which emphasized dietary diversity, balanced consumption across major food groups, adequate water intake, and limitation of sugar, salt, and fat-rich foods (20). Dietary intake data were obtained from two non-consecutive 24-hour dietary recalls. Dietary recalls were conducted on different days to capture eating patterns on both weekdays and weekends, providing a more representative picture of usual intake. During the interview, trained enumerators used a portion-size photo book by Indonesia Ministry of Health, to help participants visualize and more accurately estimate the amount and types of foods they consumed. Food item reported in the 24-hour dietary recalls were subsequently classified into several food groups. In this study, the DQI-A score was calculated using nine food group including (i) water; (ii) carbohydrate; (iii) animal protein; (iv) plant protein; (v) vegetables; (vi) fruits; (vii) fat and oil; (viii) snacks and candy; and (ix) sugar drinks and juice. Groups 1-7 were classified as recommended food groups and group 8 and 9 were classified as non-recommended food groups (21, 22).

DQI-A emphasized three core principles of a healthy diet: diet quality (DQ), dietary diversity (DD), and dietary equilibrium (DE). Dietary quality in the DQI-A reflected the considered part of the "preference group" (such as whole-grain cereals, fresh fruit, and fish) given a score of 1. Items placed in the "intermediate group" (for example, white bread or minced meat) received a score of 0, while foods categorized as "low-nutrient, energy-dense" (including soft drinks, sweet snacks, and chicken nuggets) were given a score of -1. The dietary diversity component captured the range of different consumed foods and was calculated by assigning between 0 and 9 points depending on whether at least one serving from each recommended food group was eaten. Dietary equilibrium was scored by subtracting dietary adequacy (the percentage of the minimum recommended intake for each of the main food groups, capped at 1) and the dietary excess (the percentage of intake exceeding the upper level of the recommendation, capped at 1 and truncated to 0 when below 0).

All DQI-A component scores and the total index were expressed as percentages. Scores for dietary quality ranged from -100% to 100%, while both dietary diversity and dietary equilibrium ranged from 0% to 100%. The overall DQI-A score was obtained by averaging the three component scores.

This composite score ranged from -33% to 100%, with higher values indicating better diet quality. Scores were first calculated for each recall day, and an individual's final DQI-A score was derived from the mean of the two daily score.

Nutritional status was assessed through direct anthropometric measurements, including body weight using a calibrated digital scale and height using a microtoise. Body mass index (BMI)-for-age z-scores (BAZ) was calculated. Categories were defined as underweight (BAZ <−2 SD), normal weight (BAZ ≥−2 SD to ≤+1 SD), and overweight/obesity (BAZ >+1 SD). Nutritional status classification was based on the WHO Growth Reference for school-aged children and adolescents (5-19 years) (23).

Data analysis was performing using SPSS software (IBM SPSS Statistics for Windows, Version 21, Chicago, IL, USA). For descriptive analysis, continuous variables were assessed for distributional characteristics and reported as means and standard deviations, whereas categorical variables were described using frequencies and percentages. Associations between exposures (subjects, parental, and environmental factors) and outcomes (nutritional status categories and DQI-A score) were assessed using multivariable regression models. For continuous outcomes (DQI-A), linear regression was used; and for categorical nutritional status, multinomial logistic regression was used. Multivariate analysis was applied to identify the most influential variable on nutritional status categories and DQI-A score.

Results

The distribution of subjects based on their characteristics was presented in Table 1. Subjects were equally distributed by age as less than 15 years old and 15 years old or above. Majority of the subjects were female (57%), most of them were not smoking (84.4%), did not drink alcohol (98.4%), and had moderate physical activity (57.0%). A large proportion of parents had ≤9 years of education, and the average household size was 5 persons. More than half of the adolescents reported high availability of both healthy and unhealthy foods at home and at school, and most had high food accessibility. The mean screen time was 4.9±8.9 hours per day.

Based on dietary assessment, adolescents consumed most food groups below the recommended portions (Table 2). Average water intake (1279 mL/day) was notably lower than national guidelines. Consumption of vegetables (0.49 portions) and fruits (0.57 portions) was substantially below recommendations. Meanwhile, intake of carbohydrate sources (4.94 portions) and animal-based protein (3.42 portions) was closer to the suggested range.

Table 1: Distribution of adolescent characteristics in Padang City, Indonesia.[a]

Characteristics	n (%); mean±SD
Individual determinants	
Age	14.7±1.6
< 15 years	93 (50)
≥ 15 years	93 (50)
Gender	
Male	80 (43)
Female	106 (57)
Pocket Money	
< 6.01 USD	87 (46.8)
≥ 6.01 USD	99 (53.2)
Puberty Status	
Prepubertal	59 (31.7)
Pubertal	80 (43.0)
Postpubertal	47 (25.3)
Smoking	
Yes	29 (15.6)
No	157 (84.4)
Alcohol consumption	
Yes	3 (1.6)
No	183 (98.4)
Physical activity status	
Low	37 (19.9)
Moderate	106 (57.0)
High	43 (23.1)
Parental determinants	
Maternal education status	
≤9 years	162 (87.1)
>9 years	21 (11.3)
N/A	3 (1.6)
Paternal educational status	
≤9 years	150 (80.6)
>9 years	33 (17.7)
N/A	3 (1.6)
History of parental NCDs	
Yes	48 (25.8)
No	138 (74.2)
Parental smoking status	
Yes	140 (75.3)
No	46 (24.7)
Family size, person	5.0±1.2
≤4 person	62 (33.3)
>4 person	124 (66.7)
Environmental determinants	
Unhealthy food availability at home	
Less availability (< median)	77 (41.4)
More availability (≥ median)	109 (58.6)
Healthy food availability at home	
Less availability (< median)	82 (44.1)
More availability (≥ median)	104 (55.9)
Unhealthy food availability at school	
Less availability (< median)	67 (36.0)
More availability (≥ median)	119 (64.0)
Healthy food availability at school	
Less availability (< median)	79 (42.5)
More availability (≥ median)	107 (57.5)
Food accessibility	
Less accessibility (total score ≥4)	18 (9.7)
More accessibility (total score <4)	168 (90.3)
Screen time, hours	4.9±8.9
≥4 hours	98 (52.7)
<4 hours	88 (47.3)

NCDs: Noncommunicable diseases; SD: Standard deviation; [a]n=186

Table 2: Average of food consumption portion based on DQI-A adjusted according to balanced diet guideline among adolescent in Padang City, Indonesia.[a]

Food group	Recommended consumption (portion)	Weekday consumption (Mean±SD)	Weekend consumption (Mean±SD)	Average consumption (Mean±SD)
Recommended foods				
Water (mL)	2150-2300	1350.53±630.02	1207.98±600.07	1279.26±513.69
Carbohydrates sources	5-8	5.00±2.01	4.87±2.02	4.94±1.71
Animal-based protein	2-4	3.54±2.19	3.30±2.38	3.42±1.77
Plant-based protein	2-4	1.50±1.85	1.65±2.21	1.58±1.61
Vegetables	3-4	0.44±0.52	0.54±1.07	0.49±0.61
Fruits	2-3	0.47±1.15	0.67±1.42	0.57±0.98
Oil and fat	5-6	2.81±2.67	2.38±2.57	2.60±2.28
Non-recommended foods				
Snacks and candy (g)	<50	32.07±42.96	29.67±49.95	30.87±33.93
Sugared drinks and juice (mL)	<300	119.07±194.79	174.82±138.21	146.95±166.5

SD: Standard deviation; mL: Milliliter; g: Gram; [a]n=186.

For non-recommended items, average intakes of snacks (30.87 g/day) and sugary drinks (146.95 mL/day) remained within the limits but were still considerable. The mean of DQI-A score was

43.7±6.4. Score of each component of DQI-A was shown in Table 3.

Table 3: Diet Quality Index for Adolescent score adjusted according to balanced diet guideline among adolescent in Padang City, Indonesia.[a]

DQI-A component	Mean±SD
Dietary quality score	61.8±13.3
Dietary diversity score	64.1±10.5
Dietary equilibrium score	5.2±1.1
DQI-A score	43.7±6.4

DQI-A: Diet Quality Index for Adolescents; SD: Standard deviation; [a]n=186.

The majority of adolescents were classified as having normal nutritional status, with 63.7% of being males and 67.0% being females to fall into this category. As seen in Figure 1, underweight status was more common among males (15.0%) than females (6.6%), while overweight prevalence was slightly higher in females (26.4%) compared to males (21.3%). Overall, 10.2% of adolescents were underweight, 65.6% had normal nutritional status, and 24.2% were overweight.

Table 4 shows the findings from adjusted multivariable linear regression models, presenting the β-coefficients and 95%CI for each determinant. All models were adjusted for potential cofounders entered simultaneously using enter method. Several DQI-A components demonstrated significant associations with parental and environmental factors.

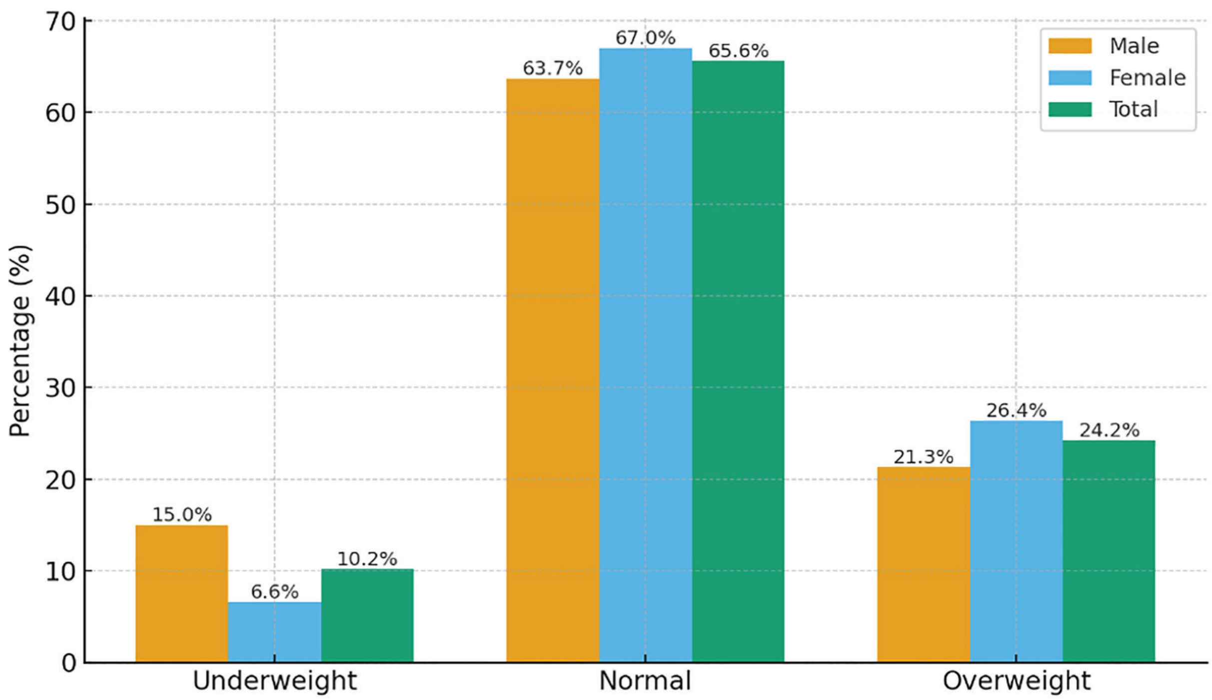

Figure 1: Distribution of nutritional status based on gender among adolescent in Padang City, Indonesia (n=186).

Table 4: Multivariate Linear Regression of each Determinants Predicting each DQI-A components among adolescent in Padang City, Indonesia.[a]

Determinants	Dietary quality score		Dietary diversity score		Dietary equilibrium score		DQI-A score	
	B (95% CI)	*P* value	B (95% CI)	*p* value	B (95% CI)	*p* value	B (95% CI)	*p* value
Individual's determinants								
Age	1.77 (-2.25 - 5.80)	0.386	-1.55 (-4.95 - 1.83)	0.366	0.05 (-0.32 - 0.42)	0.776	0.08 (-1.80 - 1.98)	0.926
Male	-0.66 (-5.12 - 3.78)	0.768	3.36 (-0.38 -7.12)	0.078	0.39 (-0.02 - 0.80)	0.064	1.03 (-1.06 - 3.13)	0.333
Pocket money <6.01 USD	1.97 (-1.86 - 5.81)	0.310	0.21 (-3.02 - 3.44)	0.897	-0.04 (-0.40 - 0.30)	0.785	0.71 (-1.09 - 2.52)	0.436
Prepuberty	-0.25 (-5.14 - 4.64)	0.919	0.23 (-3.88 -4.35)	0.910	0.14 (-0.30 - 0.60)	0.523	0.04 (-2.26 - 2.34)	0.971
Non smokers	3.59 (-2.31- 9.49)	0.232	3.34 (-1.63 - 8.31)	0.187	0.45 (-0.09 - 1.00)	0.104	2.46 (-0.32 - 5.24)	0.082
Non-alcohol	0.60 (-14.136 - 15.34)	0.935	3.15 (-9.26 -15.57)	0.616	0.47 (-0.89 - 1.84)	0.492	1.41 (-5.53 - 8.35)	0.689
Low physical activity	4.42 (-1.57 - 10.42)	0.147	-1.47 (-6.52 - 3.58)	0.566	0.11 (-0.44 - 0.67)	0.678	1.02 (-1.80 - 3.84)	0.476
Parental determinants								
≤9 years of paternal education	-4.51 (-10.75 - 1.72)	0.155	-5.70 (-10.96 - -0.44)	0.034[b]	-0.38 (-0.96 - 0.19)	0.193	-3.53 (-6.47 - -0.59)	0.019[b]
≤9 years maternal education	0.62 (-4.58 - 5.84)	0.812	1.15 (-3.24 -5.54)	0.606	0.14 (-0.34 - 0.62)	0.559	0.64 (-1.81 - 3.09)	0.607
No history of parental NCDs	-2.85 (-7.20 - 1.49)	0.197	0.44 (-3.22 - 4.108)	0.811	-0.11 (-0.51 - 0.29)	0.588	-0.84 (-2.89 - 1.20)	0.419
Non-smokers parents	-0.60 (-4.97 - 3.76)	0.784	-1.86 (-5.53 - 1.82)	0.320	0.06 (-0.34 - 0.46)	0.772	-0.80 (-2.86 - 1.25)	0.442
≤4 person family members	-1.72 (-5.63 - 2.18)	0.385	-0.87 (-4.17 - 2.41)	0.599	-0.01 (-0.37 - 0.34)	0.938	-0.87 (-2.71 - 0.97)	0.352
Environmental determinants								
Less availability healthy food at home	8.09 (4.19- 12.00)	0.425	3.47 (- 0.18 -6.76)	0.391	0.52 (- 0.16 - 2.89)	0.523	4.03 (-0.19 - 5.87	0.421
Less availability unhealthy food at home	1.90 (-1.94 - 5.76)	0.330	-1.78 (-5.02 - 1.46)	0.281	0.03 (-0.32 - 0.38)	0.869	0.05 (-1.76 - 1.86)	0.955
Less availability healthy food at school	-3.53 (-7.55 - 0.48)	0.084	-2.30 (-5.69 - 1.07)	0.180	-0.23 (-0.60 - 0.14)	0.219	-2.02 (-3.91 - -0.13)	0.036[b]
Less availability unhealthy food at school	4.39 (0.22 -8.55)	0.039[b]	-2.90 (-6.41 - 0.60)	0.104	-0.15 (-0.54 - 0.23)	0.426	0.44 (-1.51- 2.40)	0.656
Less food accessibility	-6.23 (-12.54 - 0.06	0.052	-5.01 (-10.33 - 0.29)	0.064	-0.79 (-1.38 - -0.21)	0.008[b]	-4.01 (-6.98 - -1.04)	0.008[b]
≥4 hours screen time	-3.91 (-7.80 - -0.02)	0.049[b]	-2.19 (-5.47 - 1.08)	0.188	-0.01 (-0.37 -0.35)	0.951	-2.04 (-3.87 - -0.20)	0.029[b]

DQI-A: Diet Quality Index for Adolescents; NCDs: Non-communicable diseases; [a]n=186; [b]p value <0.05.

Specifically, lower paternal education (≤9 years) was associated with reduced dietary diversity (Beta=−5.70; 95%CI: −10.96 to −0.44; *p*=0.034) and lower overall DQI-A scores (Beta=−3.53; 95%CI: −6.47 to −0.59; *p*=0.019). Limited availability of healthy foods at school was also linked to lower total DQI-A scores (Beta=−2.02; 95%CI: −3.91 to −0.13; *p*=0.036), whereas lower availability of unhealthy foods at school was associated with higher dietary quality scores (Beta=4.39; 95%CI: 0.22 to 8.55; *p*=0.039). In addition, reduced food accessibility was significantly related to lower dietary equilibrium (Beta=−0.79; 95%CI: −1.38 to −0.21; *p*=0.008) and lower DQI-A scores (Beta=−4.01; 95%CI: −6.98 to −1.04; *p*=0.008). Adolescents with screen time ≥ 4 hours per day also showed significantly lower dietary quality (Beta=−3.91; 95%CI: −7.80 to −0.02; *p*=0.049) and lower DQI-A scores (Beta=−2.04; 95%CI: −3.87 to −0.20; *p*=0.029) after controlling for confounders.

Table 5: Multinomial logistic regression of each Determinants Predicting Nutritional Status among adolescent in Padang City, Indonesia.[a]

Determinants	Nutritional status			
	Underweight		Overweight	
	OR (95%CI)	*p*	OR (95%CI)	*p*
Individual's determinants				
Age	0.34 (0.08-1.30)	0.117	1.00 (0.44-2.27)	0.992
Male	2.47 (0.52-11.74)	0.253	1.19 (0.47-2.97)	0.710
Pocket Money <6.01 USD	0.985 (0.27-3.47)	0.981	0.93 (0.42-2.03)	0.859
Prepuberty	3.19 (0.55-18.46)	0.194	0.94 (0.35-2.51)	0.913
Non smokers	0.41 (0.06-2.76)	0.366	2.07 (0.54-7.86)	0.283
Low physical activity	11.04 (1.83-66.65)	0.009[b]	0.66 (0.16-2.60)	0.555
Parental'determinants				
≤9 years of paternal education	0.55 (0.06-4.39)	0.573	4.46 (0.85-23.36)	0.077
≤9 years maternal education	12.98 (1.85-19.03)	0.045[b]	0.49 (0.18-1.36)	0.175
No history of parental NCDs	0.92 (0.21-3.95)	0.911	1.25 (0.52-2.98)	0.616
Non-smokers parents	1.32 (0.29-6.00)	0.715	1.48 (0.60-3.67)	0.392
≤ 4 person family members	0.57 (0.13-2.39)	0.446	1.76 (0.82-3.81)	0.146
Environmental determinants				
Less availability healthy food at home	3.07 (0.85-11.09)	0.087	1.18 (0.53-2.59)	0.680
Less availability unhealthy food at home	0.35 (0.10-1.26)	0.110	0.63 (0.28-1.40)	0.264
Less availability healthy food at school	1.06 (0.28-3.93)	0.925	0.85 (0.37-1.93)	0.699
Less availability unhealthy food at school	0.67 (0.16-2.72)	0.582	1.47 (0.63-3.42)	0.367
Less food accessibility	0.84 (0.12-5.78)	0.864	0.94 (0.27-3.25)	0.931
≥4 hours screen time	0.80 (0.23-2.79)	0.729	1.04 (0.47-2.29)	0.911

OR: Odds ratio; NCDs: Non-communicable diseases; [a]n=186; [b]*p* value <0.05; normal nutritional status as reference category of nutritional status.

Table 5 presents the results of adjusted multinomial logistic regression models examining determinants of nutritional status with normal nutritional status as reference category. After adjustment for potential confounders in the model, low physical activity was strongly associated with higher odds of being underweight (OR=11.04; 95%CI: 1.83–66.65; *p*=0.009). Maternal education of ≤9 years was also significantly associated with increased odds of underweight status (OR=12.98; 95%CI: 1.85–19.03; *p*=0.045). No significant associations were found for overweight status across any determinants included in the adjusted model.

Discussion

This present study examined individual, parental, and environmental determinants that significantly predicted dietary scores and nutritional status among adolescent in Padang City, Indonesia. Parental determinants and environmental determinants were found to be significant predictors of diet quality, however the individual determinants were found to be significant predictors of nutritional status. Diet quality scores were shown to provide a more reliable basis for predicting health outcomes than analyses that focus on single nutrients or specific foods (24). The total diet quality score in this study was lower than a previous study conducted among adolescents in urban areas of Aceh Province, but it was higher than the DQI-A scores reported in studies from West Java and Jakarta Province, Indonesia (22, 25, 26). However, the score would still considered low. Other studies from United Kingdom and Spain showed lower DQI-A than present study. Unfortunately, DQI-A data from Asian countries are limited, whereas studies from high-income countries have reported lower DQI-A scores than present study. These lower scores are largely attributed to the high consumption of non-recommended food group (e.g., snacks, candies, sugared beverages, and fruit juices) (27, 28).

The majority of adolescents in this study had a normal nutritional status. However, the proportion classified as overweight reached 24%, which is considerably higher than the national prevalence of overweight among Indonesian adolescents (10). This finding highlights the need for greater attention to overweight risk in this age group, as adolescence represents a critical period during which excess weight can track into adulthood and increase the risk of future metabolic complications (29, 30).

Among the parental determinants, both diet diversity score and DQI-A score were associated with paternal education level. Adolescents whose fathers had ≤9 years of schooling showed significantly lower diet diversity and DQI-A scores.

However, several studies have shown that maternal education could influence more substantially on adolescents' healthier dietary habits, as reflected in higher fruit and vegetable consumption and lower intake of soft drinks and unhealthy snacks (31, 32). Nonetheless, food-parenting practices of Latino fathers and their involvement in family meals have been linked to favourable dietary outcomes in adolescents, including increased fruit and vegetable intake and reduced consumption of sugar-sweetened beverages (33). The role of fathers in food-parenting behaviours, such as meal planning and food preparation may therefore positively influence adolescent dietary intake, although these effects are often examined alongside maternal influences.

Food availability at school was a significant predictor of diet quality. The findings showed that lower availability of healthy foods at school was inversely associated with DQI-A scores. In line with these findings, previous evidence demonstrated that improved visibility of healthy options in a smart school could significantly increase the students' consumption of coarse grains, fruits, seafood, and soy products, while decreasing intake of sweets, sugary drinks, and fast food, enhancing overall dietary habits (34). Less food accessibility was also inversely associated with dietary equilibrium score and DQI-A score. These findings can collectively suggest that strengthening the availability and accessibility of healthy foods within the school environment may serve as an effective strategy to promote healthier dietary patterns among adolescents (35).

A higher screen time was found to be significantly associated with a lower score of DQI-A. This finding was similar to another study that found low screen time to be associated with favourable nutritional behaviours and could significantly reduce the drinking of sweet beverages, and consumption of sweets and fast food (36). Moreover, previous evidences indicated that an increase in screen time and sedentary behaviours were associated with poorer dietary patterns among adolescents (37). These findings underscore the importance of reducing screen time as part of broader strategies to promote healthier eating habits and improve diet quality among adolescents.

Physical activity and maternal education were found to be significant predictors of nutritional status among adolescents. Present study showed that low physical activity was associated with an underweight status. This findings can explain previous cross-sectional studies revealing that adolescents with lower levels of physical activity were more likely to exhibit poorer physical fitness and lower BMI compared with their more active peers, indicating a potential link between low activity and underweight nutritional status in youth populations (38). In this study, low maternal educational level was significantly associated with underweight status. This finding aligns with a previous evidence showing that pupils with more highly educated mothers were less likely to be underweight (39). Furthermore, in resource-poor settings, low maternal educational level has consistently been linked to higher rates of underweight among adolescent girls, as it often coexists with socio-economic disadvantages such as food insecurity, limited nutrition knowledge, and suboptimal dietary practices (40).

It seems that this study highlighted the importance of a multidimensional approach in improving adolescent diet quality and nutritional status. Our findings demonstrated that individual, parental, and environmental determinants jointly shaped adolescents' nutritional outcomes, emphasizing that interventions targeting only one level may be insufficient. Limited food availability and accessibility, low physical activity, and lower parental education emerged as significant predictors that warrant attention. Given these findings, school-based nutrition programs should prioritize creating healthier food environments, while family-cantered strategies should aim to improve nutrition literacy among parents. In the individual level, promoting active lifestyles and especially reducing screen time, may support healthier growth patterns and improve dietary habits. Overall, integrated multilevel interventions that simultaneously address individual, parental, and environmental factors are needed to effectively improve adolescent nutrition and prevent both under-nutrition and poor diet quality. Future researches with larger and more diverse samples from similar socioeconomic settings in Indonesia and other low- and middle- income countries are needed to validate and extend these findings. Longitudinal studies and intervention-based designs are also recommended to better understand causal pathways and to evaluate the effectiveness of integrated strategies targeting individual, parental, and environmental determinants of adolescent dietary quality and nutritional status.

This study had several limitations that should be acknowledged. First, the cross-sectional design precludes causal inference between dietary quality, nutritional status, and their associated determinants. Second, dietary intake was assessed using two non-consecutive 24-hour dietary recalls, which may be subject to recall bias and may not fully capture habitual dietary intake despite efforts to include both weekday and weekend consumption. Third, although anthropometric measurements were conducted using standardized procedures, measurement error cannot be entirely ruled out. Finally, the study was conducted in a specific urban setting, which may limit the generalizability of the findings to adolescents in other regions or rural areas of Indonesia.

Conclusion

This study demonstrated that dietary quality and nutritional status were shaped by a complex interplay of individual, parental and environmental determinants rather than by a single factor. Limited access to healthy foods, lower physical activity, elevated screen time, and lower parental education were identified as key determinants. These findings emphasize the importance of developing comprehensive interventions to enhance healthy food availability at school, improve parental nutrition knowledge, and encourage healthier lifestyle behaviours among adolescents.

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Authors' Contribution

TPK: Conceptualization, funding acquisition, data curation, formal analysis, methodology, writing original draft, writing, review and editing. FA: Conceptualization, project administration, funding acquisition, methodology, writing, review and editing. IW: Data curation, project administration, writing, review and editing.

Conflict of Interest

The authors declare no conflict of interest.

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