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Associations Among Nutrition Knowledge, Dietary Patterns, and Nutritional Status in West Likupang Adolescents

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ABSTRACT

Adolescence is a critical period for establishing healthy dietary practices. Understanding nutrition knowledge, dietary patterns, and nutritional status can inform school-based nutrition education that incorporates locally available foods. This study examined the associations among nutrition knowledge, dietary patterns, and nutritional status among adolescents in West Likupang, North Minahasa Regency, to inform the development of Zimbalok, a balanced nutrition education approach integrating local foods, menu planning, balanced-plate guidance, and practical food preparation. A cross-sectional analysis was conducted using questionnaire and anthropometric data from 65 seventh-grade students aged 12–15 years at SMP Negeri 2 Likupang Barat. Nutrition knowledge and dietary patterns were assessed using questionnaires, while nutritional status was evaluated using body mass index-for-age (BMI-for-age) and height-for-age. Data were analyzed using descriptive statistics and Chi-square tests, with statistical significance set at *p* < 0.05. Most participants were 13 years old (80.0%) and male (58.5%). Poor nutrition knowledge and poor dietary patterns were observed in 66.2% and 44.6% of participants, respectively. Based on BMI-for-age, 83.1% had normal nutritional status, 9.2% had thinness, 4.6% had severe thinness, and 3.1% were overweight. Height-for-age assessments indicated that 15.4% were short and 3.1% were severely short. Nutrition knowledge was significantly associated with dietary patterns (*p* = 0.002). Dietary patterns were also significantly associated with height-for-age (*p* = 0.004) and BMI-for-age (*p* = 0.006), whereas nutrition knowledge was not significantly associated with either anthropometric indicator (*p* = 0.174 and *p* = 0.476, respectively). These findings highlight the need for nutrition education that integrates practical dietary skills and locally available foods, providing preliminary evidence to inform Zimbalok development. However, the cross-sectional design does not establish causal relationships or demonstrate the effectiveness of Zimbalok.

INTRODUCTION

Adolescence is a critical developmental period characterized by rapid biological, psychological, cognitive, and social changes [1]. During this stage, nutritional requirements increase to support growth, tissue development, hormonal maturation, and increasing physical activity. At the same time, adolescents gradually develop greater autonomy in determining what, when, and where they eat. Food choices can therefore be influenced not only by nutritional needs but also by taste preferences, peer influence, family practices, school food environments, food availability, affordability, and exposure to commercial food marketing [2,3]. These characteristics make adolescence an important period for establishing sustainable dietary behaviors. Nutrition education at this stage should

consequently move beyond the transfer of information and include opportunities to develop practical food skills, self-efficacy, decision-making capacity, and supportive social environments [4].

The nutritional challenges experienced during adolescence are increasingly complex because undernutrition and excess weight can coexist within the same population [5]. Globally, the burden of malnutrition among school-age children and adolescents has shifted toward a combination of thinness, overweight, obesity, and micronutrient deficiencies. The World Health Organization has reported substantial numbers of children and adolescents aged 5–19 years affected by overweight, obesity, and thinness, demonstrating that adolescent nutrition cannot be approached solely from the perspective of undernutrition. In Indonesia, the situation is similarly characterized by a triple burden. UNICEF reports that approximately one in two school-age children and adolescents consumes at least one sugary drink daily, more than 95% do not consume sufficient fruits and vegetables, and more than half of adolescents do not achieve adequate physical activity. These dietary and lifestyle conditions create an environment in which nutritional problems may persist or develop during adolescence [6,7].

The Indonesian context is particularly important because nutritional problems during adolescence may have consequences extending into adulthood and subsequent generations [1]. Recent national evidence summarized by UNICEF from the 2023 Indonesia Health Survey indicates that among adolescents aged 13–15 years, 7.6% were thin and 16.2% were overweight or obese. These conditions occur alongside continuing concerns regarding micronutrient deficiencies and other forms of undernutrition [8]. The coexistence of nutritional problems illustrates that adolescents require interventions capable of promoting adequate, diverse, and balanced diets rather than interventions focused exclusively on weight reduction or prevention of undernutrition. School-based programs are particularly relevant because schools provide repeated contact with adolescents and can integrate nutrition education into social interaction, practical learning, and the school food environment **[6,9]**.

The situation is also relevant in the setting of West Likupang, North Minahasa, where adolescents live within a local food environment that provides opportunities for using locally available foods as part of balanced diets. Nevertheless, availability of food does not necessarily translate into appropriate dietary practices. Understanding students' nutrition knowledge, dietary patterns, and anthropometric status is therefore necessary to identify educational needs and guide the selection of locally relevant learning activities. Normal BMI-for-age alone may not adequately represent the range of nutrition-related needs within a school population; dietary practices and height-for-age also warrant consideration. An assessment of these complementary indicators can provide a foundation for planning nutrition education that addresses both knowledge and practical dietary behavior **[10,11]**. However, the relationships among these variables in the participating school need to be examined before educational priorities can be defined.

A further issue is the relationship between nutrition knowledge, dietary behavior, and nutritional status. Knowledge is commonly regarded as an important precursor of healthy food choices; however, knowledge alone does not necessarily produce behavioral change. A systematic review involving children and adolescents found inconsistent associations between nutrition knowledge and dietary practices, indicating that other factors such as lifestyle, peers, parents, education, occupation, and the food environment may influence whether knowledge is translated into behavior [12,13]. School-based nutrition education has demonstrated potential to influence adolescent dietary behavior, particularly when interventions use multiple strategies and provide opportunities for active participation.

A systematic review of controlled school-based nutrition interventions found that most included studies using behavioral theories reported favorable changes in consumption of at least two food groups, with Social Cognitive Theory being the most frequently used theoretical framework. A meta-analysis of school-based food and nutrition education similarly found evidence of improvement in adolescent food consumption [14,15]. In Indonesia, a cluster randomized controlled study in Makassar demonstrated that a three-month multistrategy nutrition education intervention improved breakfast-related attitudes, self-efficacy, breakfast frequency, and nutrient intake. Another randomized trial in Makassar used 12 weekly 75-minute sessions based on Social Cognitive Theory and reported improvements in BMI z-score, waist circumference, snacking behavior, and self-efficacy among overweight adolescents. These findings support the importance of repeated, behavior-oriented education rather than one-way information delivery [16]. Nevertheless, evidence from these intervention studies does not establish the effectiveness of Zimbalok, and their session schedules should not be interpreted as characteristics of the Zimbalok program. The present analysis instead addresses the local descriptive and associational evidence needed to inform its development.

The present study reports a cross-sectional analysis of nutrition knowledge, dietary patterns, and nutritional status to inform the development of Zimbalok, a locally contextualized approach to balanced nutrition education. The proposed educational approach combines balanced nutrition principles with local food utilization through menu planning, Isi Piringku (Indonesia's balanced-plate guidance), preparation of healthy meals and packed lunches, use of the school environment as a food-related learning resource, and presentation of local food products. These components describe the educational framework; their delivery, duration, frequency, and effectiveness are not evaluated in the present analysis. The study's contribution lies in examining nutrition-related needs and associations within a coastal/rural school setting to guide the contextual adaptation of these activities. Specifically, the study aims to describe nutrition knowledge, dietary patterns, BMI-for-age, and height-for-age among seventh-grade students at SMP Negeri 2 Likupang Barat and to examine associations among these variables. It was hypothesized that nutrition knowledge would be associated with dietary patterns and that dietary patterns would be associated with BMI-for-age and height-for-age nutritional

status. The findings are intended to inform educational priorities and subsequent program evaluation, while recognizing that cross-sectional associations cannot establish temporal ordering, causal pathways, or intervention effectiveness.

METHODS

Study design

This study used an analytical cross-sectional design to examine associations among nutrition knowledge, dietary patterns, and nutritional status among seventh-grade students at SMP Negeri 2 Likupang Barat, North Minahasa Regency, Indonesia. The analysis included 65 students from two parallel classes. Nutrition knowledge and dietary patterns were assessed using questionnaires, while nutritional status was assessed using body mass index-for-age and height-for-age. The two classes constituted the study sample and were not analyzed as intervention and comparison groups.

The present analysis examined the available measurements without evaluating changes over time. Descriptive statistics were used to summarize participant characteristics and study variables, and associations between categorical variables were examined using Chi-square tests. The study was intended to provide evidence to inform the development of balanced nutrition education based on locally available foods (Zimbalok). It did not evaluate the effectiveness of Zimbalok, and the cross-sectional design does not permit conclusions about temporal relationships or causality.

Study setting and period

The study was conducted at SMP Negeri 2 Likupang Barat, located on Jalan Trans Bumbune-Sonsilo, Desa Bumbune, Kecamatan Likupang Barat, Kabupaten Minahasa Utara, Sulawesi Utara, Indonesia. The school served as the setting for questionnaire administration and anthropometric assessment. Data collection took place from May to July 2026.

Population and participants

The target population consisted of all students in grades VII–IX at the study school, totaling 169 students. The accessible population for the present analysis comprised seventh-grade students from two parallel classes. The study sample comprised 65 seventh-grade students from two parallel classes: Class VII-A with 33 students and Class VII-B with 32 students. Participants were aged 12–15 years. Students from both classes were included in a single cross-sectional sample; no intervention or comparison-group allocation was used in the present analysis.

The sample size was determined by the available seventh-grade study sample rather than a priori statistical power calculation. All 65 participants were included in the present analysis. Consequently, the sample size should not be interpreted as demonstrating adequate power to detect all associations of interest, particularly those involving nutritional status categories with few

participants. Nonsignificant findings were therefore interpreted as insufficient evidence of an association rather than evidence that no association existed.

Sampling and group allocation

The sample was selected from seventh-grade students participating in the research program. The original protocol described a matching approach between the two groups based on school status, student age, parental education, and parental occupation. Because the final report does not explicitly document the allocation sequence or identify which class was designated as intervention and control, the present manuscript does not assign an intervention label to either class without supporting documentation.

For a fully CONSORT Extension for Non-randomized Trials/TREND-compliant intervention report, the final manuscript should include the allocation process, number assessed for eligibility, number allocated to each group, number receiving the intended intervention, follow-up, and number analyzed.

Intervention framework

Zimbalok refers to a balanced nutrition education approach based on locally available foods. Its educational framework encompasses balanced nutrition knowledge, menu planning, Isi Piringku (Indonesia's balanced-plate guidance), preparation of balanced packed meals through Isi Bekalku, utilization of the school environment as a food-related learning resource, and presentation of local food products. These components provide a practical context for connecting nutrition knowledge with everyday food choices.

In the present cross-sectional study, Zimbalok served as the educational context informing the assessment of nutrition knowledge, dietary patterns, and nutritional status. Intervention delivery, session frequency, session duration, total program duration, and implementation fidelity were not evaluated in this analysis. The findings are intended to inform the selection and refinement of educational components for subsequent implementation and prospective evaluation; they do not establish the effectiveness of Zimbalok.

Variables and measurements

The primary variables available for analysis were nutrition knowledge, dietary pattern, BMI-for-age, and height-for-age. Participant characteristics included age, sex, parental education, and parental occupation. Nutrition knowledge was assessed using a 25-item questionnaire. Each correct response received a score of 1 and each incorrect response received a score of 0. Knowledge was categorized as good when the percentage score was 56–100% and poor when it was below 56%. Dietary pattern was assessed using a 20-item questionnaire. Correct responses were scored 1 and incorrect responses 0. A dietary pattern was classified as good when the score was ≥60% and poor when it was <60%. Anthropometric measurements included body weight and height. BMI-for-age was

classified using age- and sex-specific WHO growth standards, with severe thinness defined as a z-score <−3 SD, thinness as −3 to <−2 SD, normal as −2 to +1 SD, overweight as >+1 to +2 SD, and obesity as >+2 SD. Height-for-age was classified as very short below −3 SD, short from −3 to <−2 SD, normal from −2 to +3 SD, and tall at ≥+3 SD.

Data collection

Data collection included administration of the nutrition knowledge and dietary pattern questionnaires and anthropometric assessment. The research report states that the first stage involved collection of demographic characteristics, nutrition knowledge, dietary pattern, and nutritional status. The available report does not provide sufficient documentation to reconstruct individual pretest and posttest measurements.

Data quality control

Questionnaire data were subjected to editing, coding, and data entry before statistical analysis. Anthropometric measurements were recorded and categorized according to the relevant growth reference. Quality control was limited to the procedures documented in the available research report; assessor training, duplicate anthropometric measurements, and additional verification procedures could not be confirmed.

The dataset was analyzed within a cross-sectional framework. Chi-square tests were used to examine associations between categorical variables, rather than changes over time or intervention effects. No paired pretest–posttest analyses or comparisons between intervention and control groups were performed. Details of the statistical procedures are presented in the Statistical analysis subsection.

Statistical analysis

Descriptive statistics were used to summarize participant characteristics, nutrition knowledge, dietary patterns, and nutritional status. Categorical variables were presented as frequencies and percentages. Bivariate associations among nutrition knowledge, dietary patterns, BMI-for-age, and height-for-age were examined using Chi-square tests, with statistical significance set at $p<0.05$.

All analyses were conducted on the combined cross-sectional sample of 65 students. No intervention-group comparisons or pretest–posttest analyses were performed. Multivariable adjustment was not undertaken; therefore, the reported associations were unadjusted and potentially influenced by confounding factors, including age, sex, parental education, and parental occupation. Findings were interpreted as exploratory associations without inferring temporal relationships or causality.

Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable national standards for health research involving human participants. Ethical approval was obtained from the Health Research Ethics Committee of the Health Polytechnic of the Ministry of

Health Manado (Poltekkes Kemenkes Manado), under approval number DP.04.03/FXXX.28/428/2026. Permission to conduct the study was also obtained from the relevant education authority and participating school before participating recruitment.

RESULTS

Table 1. Sociodemographic characteristics of participants

Characteristic	n	%
Age (years)		
12	1	1.5
13	52	80.0
14	11	16.9
15	1	1.5
Sex		
Male	38	58.5
Female	27	41.5
Head of family education		
Primary school	17	26.2
Junior secondary school	28	43.1
Senior secondary school	20	30.8
Head of family occupation		
Laborer	4	6.2
Fisherman	13	20.0
Trader	1	1.5
Farmer	38	58.5
Private employee	9	13.8

A total of 65 seventh-grade students were included in the available dataset. Most participants were 13 years old (80.0%) and male (58.5%). The educational background of heads of families was predominantly junior secondary school (43.1%), followed by senior secondary school (30.8%) and primary school (26.2%). Most heads of families worked as farmers (58.5%), followed by fishermen (20.0%), private-sector employees (13.8%), laborers (6.2%), and traders (1.5%).

Table 2. Anthropometric characteristics of participants

Variable	n	%
Weight (kg)		
20–29.9	4	6.2
30–39.9	21	32.3
40–49.9	33	50.8
50–59.9	4	6.2
60–69.9	3	4.6
Height (cm)		
130–139.9	2	3.1
140–149.9	20	30.8
150–159.9	35	53.8
160–169.9	8	12.3

Body weight was predominantly within the 40–49.9 kg range (50.8%), while height was predominantly 150–159.9 cm (53.8%).

Table 3. Nutritional status based on BMI-for-age and height-for-age

Nutritional status	n	%
BMI-for-age		
Overweight	2	3.1
Normal	54	83.1
Thinness	6	9.2
Severe thinness	3	4.6
Height-for-age		
Normal	53	81.5
Short	10	15.4
Very short	2	3.1

Based on BMI-for-age, most participants were classified as normal (83.1%). Nevertheless, 9.2% were thin and 4.6% were severely thin, while 3.1% were overweight. Based on height-for-age, 81.5% were normal, 15.4% were short, and 3.1% were very short.

Table 4. Associations among study variables

Independent variable	Outcome	p-value
Age	BMI-for-age	0.691
Age	Height-for-age	0.715
Nutrition knowledge	BMI-for-age	0.476
Nutrition knowledge	Height-for-age	0.174
Dietary pattern	BMI-for-age	0.006
Dietary pattern	Height-for-age	0.004
Nutrition knowledge	Dietary pattern	0.002

Age was not significantly associated with BMI-for-age nutritional status (p=0.691) or height-for-age (p=0.715). Nutrition knowledge was not significantly associated with height-for-age (p=0.174) or BMI-for-age nutritional status (p=0.476). In contrast, dietary pattern was significantly associated with both height-for-age (p=0.004) and BMI-for-age nutritional status (p=0.006). Nutrition knowledge was also significantly associated with dietary pattern (p=0.002). Among participants with poor nutrition knowledge, 11 students (25.6%) were classified as short/very short, compared with 1 student (4.5%) among those with good nutrition knowledge. However, this difference did not reach statistical significance.

DISCUSSION

This cross-sectional study examined associations among nutrition knowledge, dietary patterns, and nutritional status among adolescents in West Likupang. Poor nutrition knowledge was identified in 66.2% of participants, and 44.6% had poor dietary patterns. Although most participants had normal BMI-for-age, thinness, severe thinness, and short stature were also observed. Nutrition knowledge was significantly associated with dietary pattern, while dietary pattern was significantly associated with both BMI-for-age and height-for-age. Nutrition knowledge was not significantly associated with

either anthropometric indicator. These findings describe unadjusted relationships within the study sample; they do not demonstrate that knowledge influences nutritional status through dietary behavior or that nutrition education improves these outcomes. Nevertheless, they identify nutrition-related needs that may inform school-based educational planning. The relevance of addressing these needs is consistent with the recognition of adolescence as an important period for nutrition, growth, and development [17].

The association between nutrition knowledge and dietary patterns suggests that these dimensions are related within the participating school population. However, the analysis does not establish whether greater knowledge preceded dietary practices, whether existing food practices contributed to knowledge, or whether both reflected shared family and environmental influences. Thakur and Mathur reported inconsistent relationships between nutrition knowledge and dietary behavior among children and adolescents, highlighting the limitations of knowledge alone as an explanation for food choices [18]. The present findings should therefore be interpreted as evidence of an association rather than confirmation of a knowledge-to-behavior mechanism. Educational planning may reasonably address both nutrition information and practical food skills, while recognizing that affordability, availability, family practices, and peer influences may affect students' opportunities to apply what they know [19].

Dietary pattern was significantly associated with BMI-for-age and height-for-age. These results indicate differences in the distribution of anthropometric categories across dietary-pattern categories, but the reported p-values alone do not establish the direction, magnitude, or clinical importance of those differences. Dietary practices may be relevant to nutritional status because food consumption contributes to energy and nutrient availability. However, the dietary-pattern questionnaire does not provide a direct quantitative assessment of energy or nutrient intake, and its categories should not be interpreted as demonstrating specific nutrient deficiencies or excesses. Nutritional status also reflects interacting biological, socioeconomic, and environmental conditions. Evidence concerning adolescent food environments supports consideration of these broader influences when interpreting relationships between dietary behavior and anthropometric outcomes [20].

The absence of statistically significant associations between nutrition knowledge and BMI-for-age or height-for-age requires cautious interpretation. It does not demonstrate that nutrition knowledge is unrelated to nutritional status, particularly given the small sample and the limited numbers of participants in some anthropometric categories. Knowledge and anthropometry also represent different dimensions of nutrition: questionnaire responses describe participants' knowledge at assessment, whereas anthropometric indicators reflect accumulated growth and body composition. Current knowledge and reported dietary practices may not represent the conditions that shaped earlier growth, which is particularly relevant when interpreting height-for-age. Thus, the findings do

not establish either the presence or absence of an indirect relationship between knowledge and anthropometric status. Such a relationship would require appropriately designed longitudinal research and explicit assessment of potential mediating and confounding factors [21,22].

Social Cognitive Theory offers a conceptual perspective for considering the coexistence of personal, behavioral, and environmental influences on adolescent eating practices. Within this perspective, knowledge is one potential influence alongside self-efficacy, social support, and opportunities to obtain and prepare food. However, these theoretical constructs were not directly assessed in the present study, and the findings cannot be regarded as a test of the theory. Previous school-based intervention reviews provide a separate evidence base for considering education that includes behavioral skills and environmental support. Their intervention findings help contextualize possible educational responses to the needs identified here, but they do not validate a causal explanation for the present cross-sectional associations [23].

School-based intervention research also provides useful context for future program development. Indriasari et al. reported improvements in breakfast-related outcomes following a multistrategy nutrition education intervention among Indonesian adolescents. Other Indonesian evidence has reported improvements in nutrition knowledge and selected dietary behaviors following multicomponent programs. These studies differ from the present research because they evaluated changes following an intervention, whereas this study assessed associations within a cross-sectional sample. Consequently, their findings should not be presented as confirmation that Zimbalok produced the observed knowledge, dietary-pattern, or anthropometric distributions. They instead provide a rationale for subsequently evaluating whether an educational program adapted to the local setting can improve clearly specified outcomes [22].

Several limitations should be considered. First, the cross-sectional design prevents determination of temporal ordering and permits reverse causation. Second, all associations were bivariate and unadjusted; potential confounding by sex, age, parental education, parental occupation, socioeconomic circumstances, pubertal maturation, physical activity, and health conditions was not controlled. Third, the sample comprised 65 students from two classes in a single school, limiting generalizability. No a priori sample-size calculation was available, and sparse anthropometric categories may reduce statistical precision and affect the suitability of Chi-square approximations. Fourth, questionnaire-based assessment is susceptible to reporting and classification errors. Finally, p-values without corresponding effect estimates and confidence intervals provide limited information about association strength and precision. Age was not significantly associated with either anthropometric indicator, but the concentration of participants at age 13 years limited age variation; chronological age also does not fully represent biological maturation. Future studies should recruit a larger and more diverse sample, report association estimates with confidence intervals, use methods

appropriate for sparse categorical data, and adjust for prespecified confounders. Longitudinal research would help clarify temporal relationships, while a separately designed prospective intervention study would be needed to evaluate Zimbalok effectiveness.

CONCLUSION

Poor nutrition knowledge and suboptimal dietary patterns were common among adolescents in the study sample, alongside thinness and short stature in a minority of participants. Nutrition knowledge was associated with dietary patterns but not significantly associated with BMI-for-age or height-for-age. Dietary patterns were associated with both anthropometric indicators. These findings represent unadjusted cross-sectional associations and do not establish temporal relationships or causality.

The findings may inform school-based nutrition education priorities, including balanced nutrition knowledge, practical food-selection skills, and locally available foods. They provide a needs-assessment rationale for considering approaches such as Zimbalok, but do not demonstrate program effectiveness. Future research should assess these associations using larger samples and adjustment for potential confounders, while any evaluation of Zimbalok should use a separate prospective intervention design.

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CONFLICT OF INTEREST

The authors declare no conflict of interest related to this study.

DATA AVAILABILITY

The dataset generated during the study is subject to institutional and ethical restrictions. The availability of individual-level pretest and posttest data should be determined according to the approved research protocol and institutional data-sharing policy.

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