Prevalence and Predictors of Double Burden of Malnutrition and Nutrient Inadequacy among Thai Adolescents: A Cross-Sectional Study

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Abstract: The double burden of malnutrition and nutrient inadequacy, characterized by the coexistence of underweight or excess body weight, is increasingly prevalent among adolescents in low- and middle-income countries, including Thailand. This study aimed to determine the prevalence of this double burden and to identify sociodemographic predictors of nutrient inadequacy among Thai secondary school adolescents. This cross-sectional survey was conducted in one province of Southern Thailand with 1,205 students, aged 13–18 years. Sociodemographic data were collected through a self-administered questionnaire. Nutritional status was assessed using World Health Organization Body mass index-for-age z-scores, while dietary intake was measured through 24-hour dietary recalls. Nutrient adequacy was evaluated according to the Thai Recommended Dietary Intakes. Chi-square tests and multiple binary logistic regression analyses were applied to examine associations between sociodemographic variables and nutrient inadequacy.

Results showed the prevalence of thinness and excess body weight was 24.2% and 23.1%, respectively. Inadequate intake of calcium, vitamin C, zinc, selenium, and magnesium exceeded 95% in all groups. Predictors of nutrient inadequacy included breakfast skipping, large family size, male gender, younger age, and physical inactivity. The findings highlight that Thai adolescents face widespread micronutrient deficiencies regardless of weight status. School and community-based interventions tailored to age and gender are needed to address the double burden of malnutrition by collaborating with school health educators to improve screening, nutritional knowledge, advocate for school food policies, and foster healthy environments.

Keywords: Adolescents, Dietary intake, Malnutrition, Nutrient inadequacy, Nutrition, Thailand

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Introduction

Adolescence is a critical life stage marked by rapid growth, increased nutritional requirements, and the development of long-term health habits. Nutritional status has a significant influence on physical, cognitive, and psychosocial development, as a foundation for future health outcomes.[1,2] In recent decades, malnutrition among adolescents has emerged as a complex and dual-faceted public health challenge in many low- and

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middle-income countries, including Thailand.[3] The double burden of malnutrition (DBM) is the co-occurrence of undernutrition (thinness and micronutrient deficiencies) and overnutrition (overweight and obesity) within individuals, households, or populations.[4] This condition is increasingly observed among adolescents with experience of nutrient inadequacy regardless of body weight status. The major drivers include the nutrition transition, characterized by increased availability of energy-dense processed foods, reduced physical activity, and persistent socioeconomic disparities. These factors contribute to an imbalance of excess energy intake alongside insufficient intake of essential micronutrients.[5,6] DBM also heightens risks for non-communicable diseases (NCDs) such as diabetes and cardiovascular disease, as stunting reduces metabolic capacity while being overweight increases metabolic load.[7]

To address these challenges, the Thai government has implemented nutrition-related policies, such as the sugar-sweetened beverage tax, to reduce consumption and improve awareness of healthy lifestyle choices.[8] Nutrition remains pivotal for adolescents' development, influencing pubertal maturation, height velocity, body composition, and brain and immune function.[9] Imbalances in macronutrient intake—particularly excessive carbohydrate, protein, and fat consumption—can increase the risk of obesity. In contrast, inadequate intake of calcium, vitamin D, iron, folate, and magnesium undermines bone health, cognition, blood volume, and lean body mass, delays the onset of menstruation, and affects immunity.[10,11]

Globally, systematic reviews report DBM prevalence ranging from 1% to 35.4%.[12] Country-level data show variation, including 4.0% in Nigeria,[13] 26.2% in China,[14] and 48.3% in Malaysia.[15] In Thailand, the 2021 Global School-based Student Health Survey (GSHS) reported thinness, overweight, and obesity prevalence at 8.2%, 19.1%, and 6.8%, respectively.[16] Regional disparities exist, with Southern provinces such as Nakhon Si Thammarat showing a higher prevalence of adolescent malnutrition, shaped by diverse geography (mountains, lowlands, coastal areas) and dietary practices influenced by local products and socioeconomic conditions.[17] Prior studies demonstrate that adolescents' diets are often inadequate in energy, carbohydrates, protein, and fat,[18-21] while excessive intakes of saturated fat[21] and sugar[18] are typical. Micronutrient inadequacies are widespread, with insufficient intake of vitamin A, B1, B2, C, calcium, magnesium, iron, folate, and zinc.[14,18-22] Conversely, sodium intake typically exceeds recommendations.[18] These inadequacies are closely linked to social determinants of health (SDH), such as gender, age, family size, and modifiable behaviors, including breakfast skipping and physical inactivity.[13,23,24]

Within Southern Thailand, this province is the most populous, presenting a unique dietary environment shaped by geography, food culture, and socioeconomic diversity. Despite growing recognition of DBM, few studies in Thailand have comprehensively examined the intersection of thinness, excess body weight, nutrient inadequacy, and SDH predictors.[5,17] Existing evidence emphasizes behavioral risk factors such as breakfast skipping, physical inactivity, and household size. Still, such evidence lacks robust dietary recall analysis integrated within anthropometric and SDH frameworks.[13,25,26] Moreover, current evidence remains fragmented and limited in understanding how DBM and nutrient inadequacy co-occur and which SDH factors most strongly predict adolescent nutrition outcomes. This study aimed to determine the prevalence of DBM and inadequate nutrient intake, and to identify SDH factors and nutrient inadequacy among Thai secondary school adolescents.

Literature Review and Conceptual Framework

The double burden of malnutrition (DBM) refers to the coexistence of undernutrition, such as wasting, stunting, and micronutrient deficiencies, and overnutrition, such as overweight, obesity, or diet-related NCDs.[4] It manifests at three levels: at the individual level, as when obesity coexists with nutritional anemia or micronutrient deficiencies; at the household level, when family members experience different forms of malnutrition; and at the population level, when communities simultaneously face undernutrition and overnutrition.[4,12] This study focused on the individual level of DBM among Thai adolescents.

Globally, systematic reviews show a growing prevalence of DBM, with rates ranging from 1% to 35% and disproportionately affecting low- and middle-income countries.[12] At the individual level, the coexistence of overweight or obesity with stunting ranges from 0.4% to 79.8%, while the co-occurrence with micronutrient deficiencies ranges from 1.0% to 94.0%.[27] Studies report specific prevalence rates of adolescent DBM at 4.0% in Nigeria,[13] 26.2% in China,[14] and 48.3% in Malaysia.[15] In Thailand, national surveys confirm the dual challenge: the 2021 GSHS documented 8.2% thinness, 19.1% overweight, and 6.8% obesity, with higher rates among males than females.[16] These data highlight DBM as both a global and national priority.

Three overlapping transitions shape the etiology of DBM. The nutrition transition reflects dietary shifts toward high-energy, ultra-processed foods. The epidemiological transition involves rising rates of NCDs alongside declining infectious diseases. The demographic transition reshapes population structures and increases life expectancies. Together, these transitions have reshaped adolescents' diets, marked by higher consumption of simple carbohydrates, fats, and salt, often at low cost and broad accessibility.[3,4] Such patterns fuel obesity and NCDs while simultaneously failing to provide adequate micronutrients. Research shows clear macronutrient and micronutrient inadequacies among adolescents worldwide. Excessive intakes of sugar and fat are linked to obesity, while deficiencies in protein, iron, folate, calcium, and vitamins A, B, and C compromise physical growth, cognition, and immune function.[14,17-22] In Thailand, studies show similar dietary imbalances, with fat consumed in excess of recommendations, while low vitamin A, iron, and calcium intake.[6] Regional studies confirm that adolescents in Southern Thailand often consume diets low in micronutrients, with local food availability insufficient to offset broader nutrition transition effects.[17]

DBM is also closely shaped by the social determinants of health. Gender differences influence dietary patterns, with males consuming more energy-dense foods and having higher DBM prevalence than females.[13] Physical inactivity contributes to being overweight and obesity,[23,26] while breakfast skipping is linked to inadequate intakes of vitamins A, B1, B2, C, calcium, iron, potassium, and zinc.[23] The other SDH factors, such as age, family size, and socioeconomic resources, further limited food consumption availability and dietary quality.[13,28] Collectively, these factors interact to shape adolescents' nutritional outcomes.

Guided by the SDH framework, this study considers three levels of influence: social position (gender, grade point average, family size, and daily pocket money), biological factors (age and stage of adolescence), and individual behaviors (breakfast skipping, smoking, physical activity, and sedentary lifestyle).[29] This framework reveals how structural and behavioral factors influence both nutrient inadequacy and DBM. It highlights the need for health promotion strategies in schools and communities, focusing not only on diet and physical activity but also on addressing upstream determinants such as household resources and educational support.[28,30]

Although international evidence from Malaysia, China, and Nigeria has identified key predictors of DBM, studies in Thailand remain limited. Most Thai studies have assessed malnutrition through anthropometry alone, with few using detailed dietary recall methods to evaluate both macro- and micronutrient adequacy.[17,31] Consequently, there is insufficient understanding of how DBM coexists with nutrient inadequacy and how SDH factors contribute to these outcomes. This study addressed this gap by examining DBM and nutrient inadequacy among adolescents using comprehensive dietary recall methods integrated with an SDH framework.

Study Aim, Research Questions, and Hypotheses

This study aimed to determine the prevalence of DBM and nutrient inadequacy, and to identify SDH predictors of nutrient inadequacy among Thai secondary school adolescents. The study addressed the following research questions: 1) What is the prevalence of thinness and excess body weight among Thai adolescents? 2) What is the prevalence of nutrient inadequacy—defined as nutrient intake below 60% of the Thai Recommended Dietary Intake (RDI)—among adolescents with thinness and excess body weight? and 3) What SDH factors are associated with DBM and nutrient inadequacy in this population?

We hypothesized that social position factors (e.g., GPA, gender, family size, and daily pocket money), biological factors (e.g., age group), and individual behaviors (e.g., smoking, exercise frequency, sedentary behavior, and breakfast intake) are significantly associated with DBM and nutrient inadequacy among Thai adolescents.

Methods

Design: This study employed a descriptive cross-sectional design and is reported here according to the STROBE guidelines for cross-sectional studies.

Sample and Setting: The study was conducted between June and August 2020 in one province, which is the largest province of Southern Thailand, a region with diverse socioeconomic and cultural contexts. To ensure geographic and socioeconomic representation, three districts were purposively selected.

The study population consisted of adolescents aged 13-18 years, enrolled in grades 7-12. The required sample size of 1,092 was calculated using a malnutrition prevalence of 43.4% from prior studies,[17] with a 95% confidence level and 3% margin of error. To account for possible non-response, 20% was added, yielding a target of 1,310 students. A total of 1,205 students participated, giving a response rate of 91.9%.

A multi-stage stratified random sampling technique was used: 1) School selection: The largest public secondary school in each district was selected to represent variation in urbanicity and socioeconomic background; 2) Classroom selection: Within each grade level, classrooms were chosen proportionally to their enrollment size; and 3) Student selection: from each selected classroom, participants were randomly chosen using a student roster. On the day of the survey, additional randomization was carried out to finalize the participant list. This clarified process ensured both proportional representation and randomization, enhancing methodological rigor.

Inclusion criteria were full-time students in the first semester of the 2020 academic year, aged 13-18 years, and able to provide informed consent. Written consent was obtained from both adolescents and their parents or legal guardians. Exclusion criteria included chronic illness, physical disability, or injury that could affect dietary intake or nutritional status.

Ethical Considerations: This study adhered to ethical guidelines and received approval from the Human Research Ethics Committee (HREC) of Walailak University (Approval No. WUEC-20-352-01). Written informed consents were obtained from both 13-18-year-old students and their parents or legal guardians. They were assured of confidentiality and informed of their right to withdraw from the study at any time without consequence.

Instruments:

The Demographic Characteristics Form: A structured, self-administered questionnaire was developed based on a literature review and validated by a panel of nutrition and nursing experts. The instrument captured the following: Social position variables: gender, GPA (< 3.0 vs. ≥ 3.0), daily pocket money (< 100 THB/US$ 3.15 vs. ≥ 100 THB/

US$ 3.15), and family size (< 5 vs. ≥ 5 members), Biological factors: age group (13–15 vs. 16–18 years), and Individual behaviors: smoking, breakfast consumption, exercise frequency, and sedentary activity.

Anthropometric Assessment: Anthropometric data (height and weight) were collected following a standardized protocol across all three districts. Measurements were conducted by trained research assistants under the supervision of nutritionists. Equipment: A calibrated digital scale (Tanita, accuracy 0.1 kg) and a stadiometer (accuracy 0.1 cm) were used. Calibration: Equipment was checked daily, with scales recalibrated weekly by laboratory officers. Procedure: Students were measured barefoot and in light clothing. Each measurement was taken twice; if discrepancies exceeded 0.1 kg or 0.1 cm, a third measurement was taken and the average recorded. Body mass index-for-age z-scores (BAZ) were calculated using WHO AnthroPlus software for individuals aged 5–19 years. Nutritional status categories were: thinness (BAZ < 2 SD), normal weight (BAZ −2 SD to +1 SD), and excess body weight (BAZ > +1 SD, including overweight and obesity).[32]

Dietary Assessment and Nutrient Intake Analysis: Dietary intake was assessed using three non-consecutive 24-hour dietary recalls (two weekdays and one weekend day), following the multiple-pass method to improve recall accuracy;[33] 1) A quick list of all foods and beverages consumed; 2) Probing for commonly forgotten items (snacks, fruits, drinks); 3) Recording time, place, and occasion of each meal; 4) Detailed descriptions, portion sizes (using household measures, food models, and photo aids), and preparation methods; and 5) Final review to capture omissions. Strategies to minimize recall bias included interviewer training, use of visual portion-size aids, probing for snacks/beverages, and conducting recalls on both weekdays and weekends to capture variation.

Nutrient intake data were analyzed using INMUCAL-Nutrient V.4.0 software, developed by the Institute of Nutrition, Mahidol University. Nutrient intake assessment included energy, macronutrients (such as carbohydrates, protein, and fat), and micronutrients (including vitamins A, B1, B2, C, calcium, iron, zinc, selenium, magnesium, and sodium). Nutrient adequacy was evaluated against Thai Dietary Reference Intakes (DRIs), stratified by sex and age. To evaluate nutrient adequacy, this study used the Recommended Daily Intake (RDI) as a reference instead of the Estimated Average Requirement (EAR) due to limitations in EAR data for Thai adolescents.[34] The tolerable upper intake levels (ULs) were used as a reference for sodium and sugar intake to ensure that no excessive consumption posed a health risk.[34] Nutrient inadequacy was defined as intake < 60% of the RDI. For sodium and sugar, excessive intake was defined as intake exceeding the ULs.

Data Analysis: Descriptive statistics summarized participant characteristics. Continuous variables were presented as means and 95% confidence intervals (CI), while categorical data were reported as frequencies and percentages. Associations between SDH factors and nutritional status were tested with a chi-square test. To identify predictors of nutrient inadequacy, multivariate binary logistic regression was performed separately for thin and excess body weight groups, yielding adjusted odds ratios (AORs) with 95% CIs. Significance was set at $p < 0.05$. Assumptions of logistic regression (independence, absence of multicollinearity, linearity in the logit) were verified. Analyses were conducted using SPSS.

Results

Participant characteristics and nutritional status

A total of 1,205 adolescents participated, of whom 65.9% were female and 34.1% were male. Based on BMI-for-age z-scores, 24.2% were classified as thin, 23.1% as having excess body weight (EBW, overweight or obese), and 52.7% as normal weight. **Table 1** presents the distribution of nutritional status by SDH variables. A significant association was found between gender and nutritional status (χ^2 = 11.275, p = 0.004), with males exhibiting higher rates of both thinness and EBW, while females were more frequently of normal weight. Other SDH factors, such as GPA, family size, and pocket money, were not statistically significant. However, trends suggested a higher thinness among adolescents from larger families and greater EBW among those who skipped breakfast.

Table 1. Social determinants of health factors according to nutritional status using the Chi-square test (n = 1205)

Variables	Total N (%)	Thin N (%)	Normal N (%)	EBW N (%)	χ^2	p-value
Gender	1,205				11.275	0.004
Male	411 (34.1)	113 (27.5)	189 (46.0)	109 (26.5)		
Female	794 (65.9)	178 (22.4)	446 (56.2)	170 (21.4)		
Age groups (years)	1,205				1.177	0.555
Younger (13-15)	675 (56.0)	159 (23.6)	352 (52.1)	164 (24.3)		
Older (16-18)	530 (44.0)	132 (24.9)	283 (53.4)	115 (21.7)		
GPA	1,037				0.736	0.692
< 3.00	351 (33.8)	89 (25.3)	180 (51.3)	82 (23.4)		
≥ 3.00	686 (66.2)	165 (24.1)	371 (54.1)	150 (21.8)		
Family size	1,195				1.174	0.556
Small < 5 persons	974 (81.5)	230 (23.6)	513 (52.7)	231 (23.7)		
Large ≥ 5 persons	221 (18.5)	58 (26.3)	117 (52.9)	46 (20.8)		
Daily pocket money	1,170				2.675	0.262
<100 THB/US$ 3.15	391 (33.4)	83 (21.2)	216 (55.3)	92 (23.5)		
≥ 100 THB/US$ 3.15	779 (66.6)	199 (25.5)	404 (51.9)	176 (22.6)		
Smoking	1,205				1.977	0.372
No	1082 (89.8)	255 (23.6)	574 (53.0)	253 (23.4)		
Yes	123 (10.2)	36 (29.3)	61 (49.6)	26 (21.1)		
Exercise frequency	1,205				2.485	0.647
None	216 (17.9)	57 (26.4)	111 (51.4)	48 (22.2)		
< 3 days/week	96 (8.0)	27 (28.1)	45 (46.9)	24 (25.0)		
≥ 3 days/week	893 (74.1)	207 (23.2)	479 (53.6)	207 (23.2)		
Sedentary behavior	1,184				4.938	0.294
None	131 (11.0)	34 (26.0)	70 (53.4)	27 (20.6)		
< 3 days/week	698 (59.0)	156 (22.4)	380 (54.4)	162 (23.2)		
≥ 3 days/week	355 (30.0)	99 (27.9)	173 (48.7)	83 (23.4)		
Breakfast intake	1,191				4.027	0.402
None	96 (8.1)	17 (17.7)	51 (53.1)	28 (29.2)		
< 3 days/week	612 (51.4)	157 (25.6)	320 (52.3)	135 (22.1)		
≥ 3 days/week	483 (40.5)	116 (24.0)	255 (52.8)	112 (23.2)		

Note. EBW = Excess body weight, GPA = Grade point average

Macronutrient and micronutrient intake

As shown in **Table 2,** mean energy and macronutrient intakes were below Thai RDIs across groups. Thin adolescents reported slightly higher intakes than EBW peers. For example, thin males consumed a mean of 1,421.1 kcal (95% CI: 1,328.6–1,513.4), compared to 1,191.5 kcal (95% CI: 1,117.2–1,265.9) in EBW males. Carbohydrate intake excluded sugars, and fat intake without saturated fatty acids (SFA). Thin adolescents had higher mean carbohydrate (163.1 g in males vs. 135.2 g in EBW males) and protein intake (69.1 g vs. 60.4 g, respectively). Micronutrient intakes were consistently below recommendations, particularly calcium (356.6–379.3 mg among thin vs. 309.5–322.2 mg among EBW adolescents) and vitamin C (17.1–25.9 mg). Mean sodium intake exceeded 2,000 mg/day in all groups.

Table 2. Mean and 95% CI of nutrient intake by gender and nutritional status (n = 570)

Nutrient intake	Thin (n = 291)		Excess body weight (n = 279)	
	Male (n = 113)	Female (n =178)	Male (n = 109)	Female (n = 170)
Macronutrients				
Energy (kcal)	1,421.1 (1,328.6, 1,513.4)	1,352.8 (1,290.9, 1,414.7)	1,191.5 (1,117.2, 1,265.9)	1,198.0 (1,132.2, 1,263.9)
Carbohydrates (g)	163.1 (154.0, 172.1)	160.4 (153.5, 167.2)	135.2 (126.3, 144.1)	136.9 (130.3, 143.6)
Protein (g)	69.1 (63.7, 74.7)	64.7 (61.4, 67.9)	60.4 (56.4, 64.4)	60.4 (56.3, 64.6)
Fat (g)	54.7 (49.5, 59.8)	50.3 (46.6, 53.9)	45.5 (41.8, 49.1)	45.4 (41.8, 48.9)
Sugar (g)	26.7 (22.4, 31.1)	35.3 (31.6, 38.9)	20.6 (17.1, 23.9)	27.4 (24.0, 30.7)
SFA (g)	14.5 (12.7, 16.2)	14.8 (13.1, 16.4)	12.0 (10.9, 13.2)	12.5 (11.2, 13.8)
Micronutrients				
Vitamin A (mg)	436.4 (321.1, 551.7)	731.7 (553.7, 909.6)	559.1 (386.2, 731.9)	635.5 (481.9, 789.2)
Vitamin B1 (mg)	1.4 (1.2, 1.7)	1.5 (1.3, 1.7)	1.1 (0.9, 1.3)	1.2 (1.0, 1.3)
Vitamin B2 (mg)	1.0 (0.8, 1.1)	1.1 (0.9, 1.2)	0.9 (0.8, 1.0)	0.9 (0.8, 1.0)
Vitamin C (mg)	17.9 (13.8, 21.9)	25.9 (21.8, 30.1)	17.1 (13.6, 20.6)	24.3 (19.2, 29.5)
Calcium (mg)	356.6 (311.2, 401.9)	379.3 (347.4, 411.1)	322.2 (281.5, 362.9)	309.5 (281.1, 337.8)
Iron (mg)	7.5 (6.9, 8.2)	8.5 (8.0, 8.9)	6.9 (3.2, 7.6)	6.8 (6.3, 7.3)
Zinc (mg)	4.3 (3.9, 4.7)	4.5 (4.2, 4.8)	3.8 (3.5, 4.1)	3.9 (3.7, 4.2)
Selenium (mg)	47.4 (41.2, 53.6)	38.8 (35.3, 42.4)	40.8 (35.6, 45.9)	36.2 (33.0, 39.2)
Magnesium (mg)	31.1 (26.9, 35.4)	31.9 (28.8, 34.9)	28.3 (24.3, 32.3)	31.7 (28.7, 34.8)
Sodium (mg)	2,482.2 (2,205.2, 2,759.2)	2,532.2 (2,368.7, 2,695.5)	2,135.5 (1,914.8, 2,356.3)	2,212.8 (2,035.7, 2,389.8)

Note: SFA = Saturated fatty acids; Carbohydrate without total sugars; Fat without SFA

Prevalence of nutrient inadequacy

Nutrient inadequacy was widespread (**Table 3**). Over 95% of adolescents, regardless of nutritional status, consumed inadequate levels of calcium, vitamin C, zinc, selenium, and magnesium. Protein inadequacy was more prevalent among EBW adolescents (41.6%) than among thin adolescents (25.4%). Excess sodium intake (> UL) was reported in 61.5% of thin and 50.2% of EBW adolescents.

Table 3. Prevalence of nutrient inadequacy by nutritional status (n = 570)

Nutrient inadequacy	RDI	UL	Thin % inadequacy	EBW % inadequacy
Macronutrients				
Energy (kcal)	1,860	–	89.7	95.0
Carbohydrates (g)	209	–	84.9	92.8
Protein (g)	51.0	–	25.4	41.6
Fat (g)	51.7	–	59.5	72.4
Sugar (g)	–	24.0	55.3	40.9
Saturated fatty acids (g)	–	20.7	15.5	9.0
Micronutrients				
Vitamin A (mg)	600	–	71.5	74.6
Vitamin B1 (mg)	1.0	–	51.9	57.0
Vitamin B2 (mg)	1.0	–	59.1	66.3
Vitamin C (mg)	80.0	–	95.9	97.1
Calcium (mg)	1,000	–	98.6	99.3
Iron (mg)	11.0	–	80.8	91.4
Zinc (mg)	9.8	–	98.6	99.3
Selenium (mg)	400	–	100.0	100.0
Magnesium (mg)	220.0	–	100.0	100.0
Sodium (mg)	–	2,000	61.5	50.2

Note. RDI = Recommended daily intake; UL = Tolerable upper intake level; EBW = Excess body weight; Inadequacy refers to < 60% of RDI or > UL

Predictors of nutrient inadequacy

Multiple logistic regression analyses were conducted separately for thin and EBW adolescents, with all model assumptions met. Results are presented in **Table 4**. In the thin group, adolescents from larger families (≥ 5 members) were more likely to have inadequate protein intake (AOR = 0.43, 95% CI: 0.20–0.92, p = 0.028) and vitamin B1 intake (AOR = 0.47, 95% CI: 0.24–0.91, p = 0.027). Breakfast skipping was a strong predictor of multiple inadequacies, including protein (AOR = 0.25, 95% CI: 0.11–0.57, p = 0.001), fat (AOR = 0.14, 95% CI: 0.03–0.72, p = 0.018), and vitamin B2 intake (AOR = 0.16, 95% CI: 0.03–0.83, p = 0.029). Males were more likely to have inadequate vitamin A intake (AOR = 0.28, 95% CI: 0.13–0.59, p = 0.001) and excess sugar intake (AOR = 0.39, 95% CI: 0.21–0.73, p = 0.003).

In the EBW group, younger age (13–15 years) predicted inadequate protein intake (AOR = 0.50, 95% CI: 0.28–0.91, p = 0.022) and iron intake (AOR = 0.27, 95% CI: 0.09–0.76, p = 0.014).

Lower GPA (< 3.00) had significantly higher odds of protein inadequacy (AOR = 0.49, 95% CI: 0.26–0.93, p = 0.029). Breakfast skipping was associated with carbohydrate inadequacy (AOR = 0.33, 95% CI: 0.11–0.99, p = 0.048), while physical inactivity predicted excessive sugar intake (AOR = 0.26, 95% CI: 0.12–0.77, p = 0.014). Unexpectedly, smoking was inversely associated with excess sodium intake (AOR = 0.18, 95% CI: 0.05–0.65, p = 0.009).

Table 4. Social determinants of health, predictors of nutrient inadequacy in thin and EBW adolescents using multiple binary logistic regression (n = 1,205)

Predictor	Nutrient inadequacy	AOR (95% CI)	p-value
Thin group			
Family size ≥ 5	Protein	0.43 (0.20–0.92)	0.028
	Vitamin B1	0.47 (0.24–0.91)	0.027
Male gender	Vitamin A	0.28 (0.13–0.59)	0.001
	Excess sugar	0.39 (0.21–0.73)	0.003
Breakfast skipping	Protein	0.25 (0.11–0.57)	0.001
	Fat	0.14 (0.03–0.72)	0.018
	Vitamin B2	0.16 (0.03–0.83)	0.029
EBW group			
Younger age	Protein	0.50 (0.28–0.91)	0.022
	Iron	0.27 (0.09–0.76)	0.014
GPA < 3.00	Protein	0.49 (0.26–0.93)	0.029
Breakfast skipping	Carbohydrate	0.33 (0.11–0.99)	0.048
Physical inactivity	Excess sugar	0.26 (0.12–0.77)	0.014
Smoking	Excess sodium	0.18 (0.05–0.65)	0.009

Note. AOR = Adjusted odds ratio, EBW = Excess body weight, GPA = Grade point average; Independent variables: gender, age groups, GPA, family size, daily pocket money, smoking, exercise frequency, sedentary behavior, and breakfast intake

Discussion

Prevalence of thinness and excess body weight

This study identified a marked double burden of malnutrition (DBM) among Thai adolescents, with 24.2% classified as thin and 23.1% as having excess body weight (EBW). These prevalence rates are higher than those of the Thailand Global School-based Student Health Survey (GSHS), which documented 8.2% thinness, 19.1% overweight, and 6.8% obesity.[16] Comparatively, our findings also exceed those reported in China (thinness 5.0%; overweight 15.4%; obesity 11.0%),[14] Malaysia (thinness 12.7%; overweight 15.0%; obesity 14.8%),[15] and Nigeria (thinness 13.5%; overweight 11.4%; obesity 4.0%).[13] These findings underscore the urgency of addressing DBM as both undernutrition and overnutrition threaten adolescent growth trajectories, academic performance, and long-term health outcomes.

Macronutrient and micronutrient inadequacy

Widespread inadequacies in nutrient intake were found across both thin and EBW adolescents. More than 95% of participants were consuming insufficient levels to meet the recommended intake for calcium, vitamin C, zinc, selenium, and magnesium. Energy inadequacy was prevalent, and protein inadequacy was higher in EBW adolescents (41.6%) compared to thin adolescents (25.4%). Excessive sodium intake was also observed in 61.5% of thin and 50.2% of EBW adolescents. These findings reflect a hallmark of intraindividual DBM, whereby adolescents simultaneously consume energy-dense foods high in refined sugars and fats but fail to meet micronutrient requirements, resulting in poor dietary quality.[4,14,23] Notably, our categorization of nutrients clarified that carbohydrate intake without total sugars and fat intake without saturated fatty acids (SFA) ensured transparency and comparability with other studies.

SDH predictors of nutrient inadequacy

The binary logistic regression provided insights into the SDH factors influencing nutrient inadequacy. Among thin adolescents, a larger family size was associated with inadequate protein and vitamin B1 intake, possibly reflecting household food resources or unequal food distribution within families.[13,35] Male gender was associated with insufficient vitamin A and sugar intake, emphasizing gender-based dietary differences and nutritional needs.[13,22]

For younger EBW adolescents (13–15 years) with lower academic performance (GPA < 3.00), protein and iron inadequacy are consistent with the heightened nutritional requirements of early puberty and a tendency toward snack-based, nutrient-poor diets.[36,37] Adolescents with less academic achievement may also face limited health literacy or reduced access to healthy foods, further compounding risk.[38]

At the behavioral level, breakfast skipping emerged as a risk factor associated with inadequate protein, fat, carbohydrate, and vitamin B2 consumption. The result supports an international study that suggests breakfast omission negatively impacts overall diet quality and increases the risk of being overweight and obese.[24] These results reinforce the importance of school-based breakfast programs and family-centered nutrition education in addressing DBM.[28] Additionally, physical inactivity was linked to excessive sugar intake, often associated with sedentary behaviors such as prolonged television viewing and mobile phone use.[38,39] Unexpectedly, smoking in EBW adolescents was associated with higher sodium intake. Prior studies suggest that smoking may reduce taste sensitivity, which can alter salt preferences, though reduced overall food intake may also contribute to this finding.[40]

Together, these results highlight the combined influence of structural factors (family size, age, gender, and academic performance) and behavioral factors (breakfast skipping, physical inactivity, and smoking) on nutrient inadequacy among adolescents. They align with the study's hypotheses and emphasize the importance of the SDH framework in understanding and addressing DBM in this population.

Limitations

This study has limitations. First, the cross-sectional design prevents causal inference regarding the relationships between SDH and nutrient inadequacy. Second, dietary intake was assessed using three non-consecutive 24-hour recalls, which may not fully capture long-term dietary patterns and could be subject to recall bias or underreporting. Although strategies such as interviewer training, the use of portion-size aids, and the inclusion of both weekdays and weekends were employed to improve accuracy, some degree of misreporting is still possible. Third, anthropometric and dietary assessments were limited to self-reported dietary recalls and physical measurements; the inclusion of biochemical markers would provide a more comprehensive evaluation of nutritional status. Future studies may benefit from repeating this research with alternative dietary assessment instruments or more extended recall periods, as well as incorporating longitudinal designs to track dietary patterns and nutrient adequacy over time.

Conclusion and Implications for Nursing

This study highlights that nearly half of Thai adolescents face the DBM, with 24.2% being underweight and 23.1% having EBW. More than 95% of adolescents consumed inadequate amounts of calcium, vitamin C, zinc, selenium, and magnesium, regardless of nutritional status. Breakfast skipping, large family size, low academic performance, and physical inactivity were identified as key predictors of insufficient nutrient intake. These findings confirm the intraindividual double burden of malnutrition in adolescents and underscore the urgency of nutrition-focused action.

For nursing practice, education, and administration, this research highlights the crucial role of school and community nurses in addressing the DBM. Nurses are uniquely positioned to lead prevention efforts by collaborating with school health educators to improve screening, nutritional knowledge, advocate for school food policies, and foster healthy environments. These results also reinforce the importance of nursing education by integrating robust nutrition content into both undergraduate curricula and continuing education programs. By incorporating the latest evidence on DBM, nursing education can better equip future nurses with the necessary nutrition skills and add DBM to the nursing curriculum. Finally, for nursing administration, these findings suggest a need to re-evaluate staffing models and strategically allocate resources. This would support the expanded roles of school and community nurses, enabling them to lead and deliver targeted, equity-focused interventions.

Author Contributions

Conceptualization, Method and design, Tool development/translation and validation, Data collection, analysis and interpretation, Drafting and revising the manuscript: P.K., N.N.

Revising and editing manuscript, Final approval of the submitted version: C.P., R.P., A.R.

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Conflict of Interest

The authors declare that they have no conflicts of interest in conducting or reporting this research.

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ความชุกและปัจจัยทำนายปัญหาทุพโภชนาการสองด้านและการได้รับสารอาหารที่ไม่เพียงพอของวัยรุ่นไทย : การศึกษาแบบภาคตัดขวาง

พิกุลทิพย์ ขุนเศรษฐ นัยนา หนูนิล ชูชาติ พันธ์สวัสดิ์ เรวดี เพชรศิราสัณห์ Atiar Rahman*

บทคัดย่อ : ปัญหาทุพโภชนาการสองด้าน หมายถึงการเกิดร่วมกันของภาวะน้ำหนักน้อยและน้ำหนักเกิน กำลังเป็นความท้าทายที่เพิ่มขึ้นในกลุ่มวัยรุ่นของประเทศรายได้ปานกลางและต่ำ รวมถึงประเทศไทย การศึกษานี้มีวัตถุประสงค์เพื่อประเมินความชุกของปัญหาทุพโภชนาการสองด้านและการได้รับสารอาหารที่ไม่เพียงพอ รวมทั้งเพื่อวิเคราะห์ตัวทำนายทางสังคมประชากรของการได้รับสารอาหารที่ไม่เพียงพอในนักเรียนมัธยมศึกษาของไทย การวิจัยเชิงพรรณนาแบบภาคตัดขวางนี้ ดำเนินการในกลุ่มนักเรียนจังหวัดหนึ่งของภาคใต้ ประเทศไทย จำนวน 1,205 คน อายุ 13–18 ปี เก็บข้อมูลทางสังคมประชากรด้วยแบบสอบถาม ภาวะโภชนาการประเมินโดยใช้ดัชนีมวลกายตามอายุขององค์การอนามัยโลก ส่วนการบริโภคอาหารประเมินจากแบบบันทึกการบริโภคย้อนหลัง 24 ชั่วโมง และความเพียงพอของสารอาหารวิเคราะห์ตามเกณฑ์ปริมาณสารอาหารที่แนะนำสำหรับคนไทย ใช้การทดสอบไคสแควร์และการถดถอยโลจิสติกพหุคูณเพื่อวิเคราะห์ความสัมพันธ์ระหว่างตัวแปรสังคมประชากรและการบริโภคสารอาหารไม่เพียงพอ

ผลการศึกษาพบว่าความชุกของภาวะน้ำหนักน้อยและน้ำหนักเกินอยู่ที่ร้อยละ 24.2 และ 23.1 ตามลำดับ การบริโภคแคลเซียม วิตามินซี สังกะสี ซีลีเนียม และแมกนีเซียมที่ไม่เพียงพอพบมากกว่าร้อยละ 95 ในทุกกลุ่ม ตัวทำนายของการบริโภคสารอาหารไม่เพียงพอ ได้แก่ การไม่รับประทานอาหารเช้า ขนาดครอบครัวที่ใหญ่ เพศชาย อายุที่น้อย และการไม่มีกิจกรรมทางกาย ผลการศึกษานี้ชี้ให้เห็นว่าวัยรุ่นไทยมีการขาดสารอาหารอย่างกว้างขวางทั้งในกลุ่มที่มีภาวะโภชนาการต่ำและเกิน จึงควรมีการดำเนินการด้านโภชนาการที่เหมาะสมกับช่วงวัยและเพศโดยพยาบาลโรงเรียนและชุมชนเพื่อแก้ไขภาวะทุพโภชนาการสองด้าน โดยร่วมมือกับครูอนามัยโรงเรียนเพื่อปรับปรุงการคัดกรอง การให้ความรู้ด้านโภชนาการ สนับสนุนนโยบายอาหารในโรงเรียน และส่งเสริมสภาพแวดล้อมที่มีสุขภาพดี

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คำสำคัญ : โภชนาการวัยรุ่น ภาวะทุพโภชนาการสองด้าน การบริโภคสารอาหารไม่เพียงพอ การบริโภคอาหาร ประเทศไทย

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