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The relationship of nutrition literacy to nutrition status and differences by gender in Thai high school students

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ABSTRACT

Nutrition literacy (NL) is an indicator of food consumption nutrition status, and the prevalence of overweight among high school students is increasing. Thus, there is a need for an analysis of nutrition literacy and other factors relevant to overweight, comparing differences based on biological sex and gender to prevent and reduce the risk of overweight among high school students. In this cross-sectional study. Boys represented 63.5% and girls 36.5% of the total. The prevalence of overweight in high school students was found to be 35.1% of all cases. The incidence of overweight was higher in high school student boys at 67.1%. The age range of boy and girl students was found a median of 17.50 years (16.30–18.80). NL was associated with overweight; the main NL protective factors in boys were knowledge of nutrition principles (AOR=0.03; 95% CI: 0.002–0.618; p=0.022), interactive nutritional literacy (INL) (AOR=0.17; 95% CI: 0.03–0.82; p=0.027), and critical nutrition literacy (CNL) (AOR=0.03; 95% CI: 0.003–0.327; p=0.004). The main NL protective factors in girls were INL (AOR=0.20; 95% CI: 0.05–0.71; p=0.013) and CNL (AOR=0.27; 95% CI: 0.08–0.95; p=0.043), after controlling for potential confounding variables. Therefore, gender-specific public health strategies are required to prevent overweight.

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1. INTRODUCTION

Overweight among adolescents is a significant global public health issue, as reported by the World Health Organization (WHO) on a survey which identified approximately 340 million overweight adolescents worldwide [1]. A 2023 report comparing data from several of Thailand's health districts disclosed that Health District 7 in the Northeastern Region of Thailand (consisting of Khon Kaen Province, Maha Sarakham Province, Roi Et Province, and Kalasin Province) ranked 1 out of 10 for overweight conditions in 22.4% of high school students. According to annual nutritional status reports for Maha Sarakham Province, high school students with overweight conditions comprised 14.1%, 13.6%, 14.0%, 14.8%, and 13.2% of the student population, each year, respectively, from 2017 to 2022. This exceeds the 10% annual target set by the Ministry of Public Health [2]. Consumption behaviors, including the consumption of high-calorie foods and snacks; increasing screen time; considerations related to body image, and depressive factors play a significant role in adolescent obesity in Thailand [3]. The results of the national Thai study on the consumption behaviors of overweight adolescents reflect a lack of nutritional literacy (NL), which is a factor contributing to inappropriate eating habits [4].

NL is a necessary skill that empowers adolescents to make informed dietary decisions appropriate for their health. Knowledge of the dietary and physical activity risk factors for obesity can influence students

to make healthier choices regarding food consumption and exercise [5]. One study reporting on results in China and Turkey [6], [7]. Showed a significant reduction in the risk of obesity with increased levels of nutrition knowledge. Increasing nutrition knowledge in children and adolescents may promote healthy food consumption behaviors, such as increasing the intake of fruits and vegetables and reading nutrition labels more frequently. Adequate awareness of food choices, food groups, portion sizes, and nutritional content (as listed on labels) can help adolescents make informed decisions and engage in healthy eating behaviors [4], [8]. Conversely, according to research, low NL may result in unhealthy dietary behaviors, such as consuming high-sugar and high-fat foods which can lead to adverse health effects. An imbalance between energy intake and expenditure can result in weight gain and contribute to the development of overweight conditions [8], [9]. Despite its critical role, nutrition literacy is not evenly distributed across populations, with noticeable gender disparities that merit attention [10].

Gender differences in overweight can be correlated to NL level and food consumption behavior. Previous studies initially found that adequate NL had protective effects on overweight risk in both genders. Gender differences in food consumption behavior, especially adolescent had selected first emerge. Research has shown that boys and girls may approach food and nutrition differently, with boys often exhibiting higher preferences for energy-dense, low-nutrient foods, while girls may focus more on weight management and healthy eating [11], [12]. These differences can affect how nutrition literacy impacts dietary choices and body weight [13]. Girls often demonstrate higher levels of nutrition knowledge and engagement with healthy eating practices [14]. Conversely, boys may exhibit lower nutrition literacy levels, which can contribute to poorer dietary habits and increased risk of overweight, may contribute to overweight in boys more than in girls [15]. Differences in overweight prevalence may be driven by gender-related influences [16]. Understanding these dynamics is essential in designing targeted public health strategies that promote nutrition literacy across diverse populations, ultimately leading to improved health outcomes and reduced prevalence of diet-related chronic diseases. Therefore, we investigated the prevalence of overweight in boys compared to girls and evaluated the association between NL level and overweight by gender. On the basis of several components of the conceptual framework of nutritional literacy [17]–[19]. By drawing on recent literature and empirical data, this research endeavors to elucidate the nuanced interrelations between nutrition literacy and overweight, with a particular focus on gender. The present results may be used to Thai high school students and aiming to inform public health strategies that enhance the well-being of Thai adolescents and reduced healthcare costs.

2. METHOD

2.1. Participants

A cross-sectional study was conducted from April to December 2023 in Maha Sarakham province, Thailand's Northeastern Region. A report comparing data from several of Thailand's health districts disclosed that Health District 7 in the Northeastern Region of Thailand (consisting of Khon Kaen Province, Maha Sarakham Province, Roi Et Province, and Kalasin Province) ranked 1 out of 10 for overweight conditions in 22.4% of high school students. According to annual nutritional status reports for Maha Sarakham Province, high school students with overweight conditions comprised 14.1%, 13.6%, 14.0%, 14.8%, and 13.2% of the student population, respectively, each year from 2017 to 2022. This exceeds the 10% annual target set by the Ministry of Public Health [2]. The target population of our study was 15,226 high school students aged 16-18 years, belonging to the secondary educational service area and living in Maha Sarakham Province.

2.2. Data collection and sampling

The target sample size was computed using G*Power 3.1.9.7. software with the analytical Z-test logistic regression method considering an R^2 deviation from zero and an odds ratio of 0.71 [20]. indicating 80% power with α=0.05. The minimum sample size was calculated as 1,085 and, after considering the dropout rate of 10%, was estimated to be 1,206 [21]. A total of 1,206 people who agreed to participate in this study formed the study group. Inclusion criteria were: the willingness to provide informed consent; being 16-18 years old; being able to read, write, and speak Thai; and having no congenital disease. Changing schools during the research period, insufficient time to participate, and incomplete survey submissions were among the exclusion criteria. By using a stratified random sampling technique, the 1,206 people who met the eligibility inclusion criteria were selected. In the first stage, we utilized random sampling stratified by the size of the schools, including large special schools, large schools, medium-sized schools, and small schools, totaling 35 schools. In the second stage, we randomly selected schools of each size according to the proportion of each type of school (4:5:4:22), using a lottery method. The results were as follows: 4 large special schools, 1 randomly selected; 5 large schools, 2 randomly selected; 4 medium-sized schools, 1 randomly selected; and 22 small schools, 6 randomly selected. Thus, a total of 10 schools were selected. Then, students were randomly selected using a random number table drawn from the student roster of each selected school. A unique three-digit code was assigned to

each student, and those students whose code matched the drawn numbers were selected as the sample group (totaling 1,206 students across all sample groups).

2.3. Questionnaire

Developed based on a literature review, the self-reported questionnaire consisted of three parts, as:

2.3.1. General demographic characteristics questionnaire

This section consists of 11 questions and collects data on general demographic characteristics, including personal factors details such as gender; age; education level; grade point average (GPA); income; parental education level; parental income; self-assessment of body shape; factors related to accessibility of nutrition information, such as sources of nutrition information; factors pertaining to learning including school location and health education courses. This is the closing questionnaire.

2.3.2. Nutrition literacy questionnaire

The NL questionnaire was completed by the students while they were at school. We calculated a Cronbach's alpha score of 0.81. The study utilized the conceptual framework of nutritional knowledge by Deesameer *et al.* [17] and Ashoori *et al.* [18]. This section of the questionnaire consists of 2 components. component 1 is knowledge (10 items) [19]; component 2 is skills. The skills (totaling 61 items) are categorized into 3 levels: i) functional skills (18 items), ii) interactive skills (19 items), and iii) critical thinking skills (24 items). A participant's interactive skills total score is the sum of the scores for component 1 (knowledge) comprised of 10 items. The sum of the raw scores was linearly transformed to a score from 0 to 10, with higher scores indicating a higher knowledge level. In this questionnaire, knowledge scores below 6 are interpreted as poor; those from 6 to 9 are categorized as moderate, and those higher than 8 are considered adequate knowledge. For component 2 (skills) comprised of 61 items, the sum of the raw scores was linearly transformed to a score from 0 to 61, with higher scores indicating a higher NL level. In this questionnaire, NL scores lower than 36 are interpreted as poor, scores from 36 to 48 are categorized as moderate, and those higher than 49 are considered as representing an adequate level of NL.

2.3.3. Food consumption behavior questionnaire

The questionnaire on food consumption behaviors comprises guidelines for food consumption, types of food consumed, food purchasing habits, and regular cooking methods. It consists of 28 positive questions and 32 negative questions. The questionnaire is designed for assessment, with respondents selecting a single answer that best reflects their true behavior. The assessment uses a 4-point rating scale as follows: Strongly Disagree, Disagree, Agree, Strongly Agree, showing a Cronbach's alpha of 0.79.

2.3.4. Anthropometric and biochemical markers

Anthropometric data were collected by recording the age, weight, and height of the participants according to WHO guidelines. The instruments were checked for accuracy before data collection started. The participants were measured with an adjusted weight and height scale by trained data collectors. Weight and height were adjusted to the nearest 0.1 g and 0.1 cm, respectively. The criteria are as follows: normal (Z-scores <1SD), overweight (1SD ≤Z-scores <2SD), and obesity (Z-scores ≥2SD) [22].

2.4. Statistical method

Statistical analyses were performed with SPSS v.25 (IBM SPSS; Chicago, IL, USA), using the Kolmogorov-Smirnov test to assess the normal distribution of the data. Descriptive statistics are reported as frequencies and percentages. All continuous variables are reported as median and quartiles. Univariate logistic regression was used to estimate the association of each independent variable and status. All independent variables with $p<0.25$ in the univariate analyses were included in a multivariate logistic regression analysis to estimate their associations while controlling for the effect of other covariates. Associations between sex risk factors are presented as adjusted odds ratios (OR) with 95% confidence intervals (CI).

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Study populations

This cross-sectional study included 1,206 high school student subjects aged 16–18, comprised of boys 63.5% and girls 36.5% as shown in Table 1. The age of students is found to be over 17 years old, both boys and girls' students, with a median of 17.50 years (16.30–18.80). Most of them were in grade 11, with the percentage of boys (38.7%) exceeding that of girls. The GPA of boys is higher than that of girls, with a median of 3.52 (3.14–3.74). The income received by the school per day was higher for girls than for boys, with a median of 80

baht (60.00-150.00). The education level of parents is secondary school or above, for both boys and girls at 82.2%. The income of parents was found to be higher for parents of girl students than for boy students, with a median of 17,000 baht (9,600–20,000). Self-assessment of body shape disproportionate were higher in boys than girls at 53.8%. The main source of nutritional information that students receive is the teacher at 44.9%, with boys receiving this information more than girls. The location of the majority of schools is in urban areas at 58.4%. The number of hours per week of health education classes at school is mostly under two hours per week for boys and girls at 70.9%. More boys had adequate status food consumption behavior than girls.

Table 1. Gender differences in demographic and factors among participants (n=1,206)

Variable	n% or median (Quartile)			
	Total	Boys	Girls	p-value
Participant, n (%)	1,206 (100.0)	766 (63.5)	440 (36.5)	<0.001
Cases, n (%)	423 (35.1)	284 (67.1)	139 (32.9)	<0.001
Education high school, n (%)				<0.001
Grade 10	292 (24.2)	154 (20.1)	138 (31.4)	
Grade 11	467 (38.7)	317 (41.4)	150 (34.1)	
Grade 12	447 (37.1)	295 (38.5)	152 (34.5)	
Parental education, n (%)				<0.001
Primary school or lower	215 (17.8)	143 (18.7)	72 (16.4)	
Secondary school or above	991 (82.2)	623 (81.3)	368 (83.6)	
Self-assessment of body shape, n (%)				<0.001
Disproportionate	649 (53.8)	463 (60.4)	186 (42.3)	
Proportionate	557 (46.2)	303 (39.6)	254 (57.7)	
Source of nutritional information, n (%)				<0.001
Teacher	541 (44.9)	352 (46.0)	189 (43.0)	
Family	174 (14.4)	102 (13.3)	72 (16.4)	
Friend	66 (5.5)	51 (6.7)	15 (3.4)	
Website	149 (12.4)	84 (11.0)	65 (14.8)	
Social media	148 (12.3)	80 (10.4)	68 (15.5)	
Print media	84 (6.9)	66 (8.6)	18 (4.1)	
Other	44 (3.6)	31 (4.0)	13 (3.0)	
Location of school, n (%)				0.176
Urban	704 (58.4)	436 (56.9)	268 (60.9)	
Rural	502 (41.6)	330 (43.1)	172 (39.1)	
Health education course (hours/week), n (%)				<0.001
<2	855 (70.9)	596 (77.8)	259 (58.9)	
≥2	351 (29.1)	170 (22.2)	181 (41.1)	
Food consumption behavior, n (%)				<0.001
Improvement	270 (22.4)	265 (34.6)	5 (1.1)	
Good	936 (77.6)	501 (65.4)	435 (98.9)	
Student' age (Yr.)	17.5 (16.30-18.80)	17.45 (17.30-18.80)	17.60 (16.30-18.80)	<0.001
Grade point average (GPA)	3.44 (3.00-3.70)	3.52 (3.14-3.74)	3.29 (2.88-3.62)	<0.001
Student' income	80.00 (60.00-100.00)	70.00 (60.0-90.0)	80.00 (60.00-150.00)	<0.001
Parental income	15,000.00 (8,600.00-20,000)	14,500 (8,500.00-20,000.00)	17,000.00 (9,600.00-20,000.00)	<0.001

3.1.2. NL and nutrition status

NL was adequate in 50.3% of high school students; knowledge of nutrition principles was inadequate in 53.8% of boys; this percentage was lower among girls, functional nutrition literacy (FNL) was inadequate in 54.4% of girls; the percentage was lower among boys, interactive nutritional literacy (INL) was inadequate in 53.9%, higher among girls when compared to boys; critical nutrition literacy (CNL) was adequate in 57.6%, higher among girls when compared to boys as shwon in Table 2. The prevalence of overweight among high school students was 35.1% (432 cases) of all cases, and higher among boy high school students at 67.1% (284 cases), with a median of 25.71 (25.06-27.34) as presented in Table 3.

3.1.3. Association between NL and nutrition status

Our study showed an association between NL level and nutrition status differentiated by gender. There is also an association between NL level and other independent variables related to nutrition status. Based on the results of the univariate logistic regression analysis, NL, INL, CNL were significantly associated with overweight in both boys and girls. Knowledge of nutrition principles and FNL were associated with overweight in boys but not in girls. Based on the result of the multivariate logistic regression analysis, this association remained significant after adjustment for potential confounding variables, including age, education level, parental income, self-assessment of body image, health education course, and food consumption behavior. INL and CNL were significantly associated with overweight in both boys and girls. Knowledge of nutrition principles was associated with overweight in boys but not in girls as shown in Tables 4 and 5.

Table 2. Gender differences in nutrition literacy among participants (n=1,206)

Variable	n% or median (Quartile)			
	Total	Boys	Girls	p-value
Nutrition literacy, n (%)				<0.001
Inadequate	599 (49.7)	397 (51.8)	202 (45.9)	
Adequate	607 (50.3)	369 (48.2)	238 (54.1)	
Knowledge of Nutrition Principles, n (%)				<0.001
Inadequate	649 (53.8)	436 (56.9)	213 (48.4)	
Adequate	557 (46.2)	330 (43.1)	227 (51.6)	
FNL, n (%)				<0.001
Inadequate	656 (54.4)	414 (54.0)	242 (55.0)	
Adequate	550 (45.6)	352 (46.0)	198 (45.0)	
INL, n (%)				<0.001
Inadequate	650 (53.9)	401 (52.3)	249 (56.6)	
Adequate	556 (46.1)	365 (47.7)	191 (43.4)	
CNL, n (%)				<0.001
Inadequate	511 (42.4)	364 (47.5)	147 (33.4)	
Adequate	695 (57.6)	402 (52.5)	293 (66.6)	

Table 3. Gender differences in nutrition status among participants (n=1,206)

Variable	n% or median (Quartile)			
	Total	Boys	Girls	p-value
Nutrition status (based on BMI-for-age Z-scores)				
Normal (Z-scores <1SD)	19.05 (17.44-20.80)	18.69 (17.26-20.20)	19.38 (17.91-21.07)	0.005
Overweight (1SD ≤Z-scores <2SD)	25.71 (25.06-27.34)	25.34 (24.91-26.36)	26.26 (25.61-28.71)	0.977
Obesity (Z-scores ≥2SD)	29.35 (28.67-29.86)	29.10 (28.29-29.84)	20.54 (19.02-21.36)	0.021

Table 4. Multivariable logistic regression that investigates the association between NL level with overweight in the boy high school students (n=766)

Variable		Boys	
	Reference	Adjusted OR (95%Cl)	p-value
Student' age	-	3.18 (1.06 to 9.49)	0.038
Education high school	Grade 10		
Grade 11		9.00 (2.76 to 29.35)	<0.001
Grade 12		1.87 (0.67 to 5.26)	0.230
Parental income	-	11.33 (1.78 to 72.18)	0.010
Self-assessment of body shape	Disproportionate		
Proportionate		0.14 (0.04 to 0.49)	0.002
Health education course (hours/week)	<2		
≥2		0.03 (0.007 to 0.161)	<0.001
Knowledge of nutrition principles, n (%)	Inadequate		
Adequate		0.03 (0.002 to 0.618)	0.022
INL	Inadequate		
Adequate		0.17 (0.03 to 0.82)	0.027
CNL	Inadequate		
Adequate		0.03 (0.003 to 0.327)	0.004
Food consumption behavior, n (%)	Improvement		
Good		0.01 (0.002 to 0.057)	<0.001

Table 5. Multivariable logistic regression that investigates the association between NL level with overweight in the girls' high school students (n=440)

Variable		Girls	
	Reference	Adjusted OR (95%Cl)	p-value
Student' age	-	3.12(1.24 to 7.80)	0.015
Self-assessment of body shape	Disproportionate		
Proportionate		0.18 (0.09 to 0.36)	<0.001
INL	Inadequate		
Adequate		0.20 (0.05 to 0.71)	0.013
CNL	Inadequate		
Adequate		0.27 (0.08 to 0.95)	0.043
Food consumption behavior, n (%)	Improvement		
Good		0.01 (0.001 to 0.066)	<0.001

3.2. Discussion

This study examined the NL level associated with overweight among high school students aged 16-18 years in Thailand. To the best of our knowledge, this was the first nationwide survey to study the

prevalence of overweight in high school students, we found that the prevalence of overweight is higher in boys compared to girls, which we previously only knew in general terms, indicating gender differences in overweight that can be explained by gender differences in food consumption behavior, especially adolescent had selected first emerge. Previous studies have shown that boys and girls may approach food and nutrition differently, with boys often exhibiting higher preferences for energy-dense, low-nutrient foods, while girls may focus more on weight management and healthy eating. Also, adolescents exhibit different eating styles according to gender [11], [12]. Pressures to be thin are present in early adolescence, as noted by food consumption behavior starting in very young girls who experience more dissatisfaction with their body weight and shape than boys do [14]. Furthermore, our study found that girls have an adequate NL level more often than boys; this NL score is linked to better food consumption behavior in girls. Research conducted in Turkey reported a similar result. Having adequate NL is an essential skill. Moreover, an adequate NL positively influences high school student food consumption behaviors, enabling them to make appropriate dietary decisions conducive to their health. Adolescents exhibit healthier eating behaviors when they possess a high level of NL. They can read nutrition labels and select food based on dietary guidelines, which significantly contributes to promoting health and preventing non-communicable diseases resulting from dietary behaviors [14]. Importantly, previous studies in Thailand have found that the consumption of high-calorie foods and snacks, greater screen time, body image, and depressive factors play a significant role in adolescent obesity in Thailand. The effects of such factors may be greater overall among boys compared to the effect on girls [3].

Our second aim was to evaluate the association between NL level and overweight by gender. Age, self-assessment of body shape, INL, CNL, and food consumption behavior were significantly associated with overweight in both genders. Furthermore, education level (Grade 11), parental income, courses in health education, and knowledge of nutrition principles were associated with overweight only in boys. The association between these factors and overweight was not found in girls.

Age-related factors are correlated with body mass index (BMI) because, as age increases, there is an increased likelihood of being overweight [23]. This is due to changes in the body's organs and systems as well as cellular and tissue degradation with advancing age. As individuals age, their physical activity levels tend to decrease, leading to a slower metabolism. Consequently, the body's ability to burn calories decreases [24]. Our results showed that age increase is a risk factor for both boys and girls. This result is not consistent with previous studies that found the age of adolescent students was significantly associated with overweight, with early adolescents being 2.45 times more likely to develop obesity than late adolescents. This could be due to differences in population and food consumption behavior. Similarly, most of the time, early adolescents eat creamy snacks. Late adolescent students, in contrast, spend more time away from home, which increases the likelihood that they will not be snacking as often [25].

Student education level, in this study, it was found that education level is a risk factor associated with overweight only in boys. These findings corresponded with those of Chung and Kim [26] since higher education levels are also associated with older age, leading to a slower metabolism. Moreover, skipping breakfast, consuming fast food, increasing portion sizes, and eating when not hungry are common practices that can adversely affect an individual’s weight management. Research indicates that skipping breakfast may lead to greater caloric intake later in the day, ultimately resulting in weight gain [27]. Girls, as they mature into young women, often pay more attention to their physical appearance and take better care of themselves than boys [12].

Parental income, our research showed that parental income is a risk factor associated with overweight only in boys. However, other studies have shown that higher parental income is correlated with obesity in students, in general. Research findings in less industrialized countries, such as Brazil and China, indicate that the prevalence of overweight children is markedly greater in families with high incomes [28]. Lim and Wang [29] suggest that this might be because such families consume more food and have more leisure time to spend on sedentary activities. These results are consistent with the outcomes of a study conducted by Abdullah *et al.* [30] in Saudi Arabia, where an increased risk of obesity is associated with higher family income. That is probably due to children’s access to energy-rich diets and a sedentary lifestyle, where 44% lived in villas or big houses. Therefore, it can be observed that families with higher incomes have access to a variety of foods, and frequent food consumption can lead to overweight or obesity.

Self-assessment of body shape, in this study, it was found that students of both genders who perceived themselves as having a proportionate body shape often exhibited healthier behaviors, had better nutritional knowledge, and had a lower overweight risk. This is consistent with the outcome of research conducted in Lithuania. Furthermore, it was found that individuals with overweight or obesity were less likely to engage in self-improvement if they experienced low self-esteem about their own body shape, possibly due to a lack of information about their own weight and the criteria for assessing their body shape [31]. The findings corresponded with those of Caterson *et al.* [32]. Individuals who are overweight are more likely to change their lifestyle if they are dissatisfied with their current weight.

Health education courses had protective effects against overweight risk only in boys. Such education is crucial for boys because they generally consume more food than girls, and the differences in consumption

are attributed to gender-specific energetic requirements [33]. Adequate health education has been shown to prevent overweight and obesity, which are prevalent among adolescents [34]. Multiple studies have recognized schools as a fundamental resource that can promote health and help prevent disease. Bleich *et al*. believed in the same concept [35]. Since students spend more hours in school than at home, then teachers and facilities can assist in solving the overweight and obesity epidemic. Studies done by Centeio *et al.* [36] elaborated on the importance of education as the first step towards preventative strategies. However, the authors also stressed that robust school-based policies, effective curriculums, and experienced mentors are needed to disseminate healthy eating and physical activity programs in schools.

Food consumption behavior at an adequate level has protective effects on overweight risk in both genders. A previous study found that dietary behaviors play a crucial role in determining the obesity risk of children and adolescents [37]. Similar results were found in a study of dietary behaviors among adolescents in Brazil [38], where adolescents having breakfast every day were found to have a lower risk of overweight than those who have breakfast intermittently or never. Leandro *et al.* [39], found that some dietary behaviors, that is, consumption of fast-food and snack food, less vegetable and fruit intake, skipping meals, breakfast consumption was low, and sedentary behavior are also independently and significantly associated with a higher prevalence of overweight.

An NL level associated with overweight includes knowledge of nutrition principles INL and CNL. This study found that having adequate knowledge of nutrition principles has protective effects on overweight risk only in boys, whereas INL and CNL have protective effects on overweight risk in both genders. Furthermore, studies have found that boys tend to consume more meat, fast food, and snacks than girls [33]. Therefore, students should receive knowledge sufficient to inform their choices and decisions regarding healthier food consumption. The findings corresponded with those of Gunagi *et al.* [5], who found that students with a high level of knowledge regarding the benefits of specific dietary habits and physical activity have reduced risk factors for obesity. These results were similar to previous cross-sectional studies among children and adolescents in Turkey [6] and China [7] which reported a significant reduction in the odds ratio of obesity with increasing levels of nutrition knowledge. Improving nutrition knowledge in children and adolescents may help promote healthy food consumption behavior [40]. Additionally, this study also found that adequate INL and CNL had protective effects on overweight risk in both genders. The findings corresponded with those of Li *et al*. [4] who showed that high INL is associated with increased energy score, and high CNL leads to increased consumption of fruits and vegetables [8]. INL includes the frequency of reading food labels. Adequacy of food choice literacy and food label literacy in children improves their ability to understand information about food items and food groups, read food labels, control their portions, and make informed decisions and healthy eating behaviors [41]. In contrast, studies have shown that low health literacy may lead to future abdominal obesity, and high nutritional literacy may play a role in supporting self-care behaviors and dietary skills [9]. Therefore, nutritional literacy is an important skill that can help adolescents make appropriate nutritional decisions, protect their health, and prevent overweight [4], [42].

This study has several policy implications. Overweight status among young people in Thailand has imposed significant economic, social, and health burdens. Despite efforts by the Thai government to curb the incidence of overweight, including the implementation of national policies and programs to promote healthy lifestyles and habits in schools [43], the prevalence of overweight/obesity is increasing. Promoting NL may improve adolescents' weight status by enhancing students' ability to read and understand nutrition information, and make informed decisions about food choices. Furthermore, this study serves as valuable data that can inform the continued promotion of NL and aiming to inform public health strategies that enhance the well-being of Thai adolescents and reduced healthcare costs.

There are some limitations to this study, including that the analysis did not consider potential gender differences due to the earlier growth spurt in adolescent girls compared to boys; these data show boys being heavier. Examining these issues further could lead to a deeper understanding of gender differences, which may affect the Food consumption behavior and nutritional literacy of boys and girls. Finally, this statement is specific to Thailand and may reflect cultural patterns that differ from other countries, even among Southeast Asian nations.

4. CONCLUSION

This research endeavors to elucidate the nuanced interrelations between nutrition literacy and overweight, with a particular focus on gender. In summary, the study identified risk and protective factors for overweight in both genders, with boys having more protective factors than girls. Our results regarding the correlation between nutrition literacy, student behavior, and health outcomes could inform educational interventions to prevent overweight and can be used to develop public health strategies for adolescents. In the future, it may be possible to further study growth spurts related to nutrition literacy (NL), nutritional status, and gender differences in adolescents.

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