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Posted Date: 7 April 2025

doi: 10.20944/preprints202504.0461.v1

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Original Research

Nutritional Practices Among Ethnic Minorities High school Students in Northwestern Mountainous Areas of Vietnam

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Abstract: Background: Malnutrition among Vietnamese children, especially children in ethnic minority and mountainous areas, remains high. **Objective:** The current study explored the nutritional status of ethnic minority secondary school students in some mountainous provinces in the Northwest of Vietnam and identified some related factors. **Methods:** We recruited 1,847 high school students who are ethnic minorities in 2 provinces of the northwestern mountainous region of Vietnam by convenience sampling from a primary healthcare setting to carry out the cross-sectional study over 6 months. The malnutrition status of study participants was measured using the 2006 WHO Child Growth Standards. The nutritional practices of study participants were assessed using a 4-point scale based on food consumption frequency and eating habits. **Results:** This study found that the prevalence of stunting and wasting in children was 16.7% and 6.2%, respectively, while the prevalence of overweight/obesity in children was 8.3%. Some factors related to the rate of stunting are male students, the number of children born living in the family, poor/near-poor household economy, low maternal education level, and frequent gastrointestinal and respiratory diseases. Children who ate more than 3 meals/day, snacked at night, ate fried foods, ate less vegetables and fruits, and were less active/day were associated with a higher risk of overweight/obesity. **Conclusions:** Our study shown a comprehensive picture of malnutrition among children in ethnic minority areas. Essential nutritional intervention programs, projects and models are a top priority to reduce the disease burden, for children's bright future and to enhance socio-economic development in the Northwest mountains.

Keywords: malnutrition; adolescents; northwest mountains; ethnic minorities; Vietnam

1. Introduction

Nutrition is considered the foundation of health, a reasonable diet will create favourable conditions for maximum development in stature, physical strength and intelligence. Nutritional needs for each stage of the body's development are different. For high school age, it is an important transition period with many psychological, physiological and physical changes [1,2]. This is also the country's future workforce. Many studies suggest that 25% of human height is achieved during adolescence, this is a period of very rapid growth in terms of weight, height, muscle as well as fat reserves, so it is necessary to have a good diet and a healthy living environment for children to have the best physical and physical development [3,4].

The nutritional census report in Vietnam shows that malnutrition and stunting among school-age children decreased from 23.4% in 2010 to 14.8% in 2020. However, disparities between regions in the rate of stunting are still high, especially in rural and mountainous areas. In addition, the rate of

overweight and obesity increased sharply from 8.5% in 2010 to 19% in 2020. Notably, in rural and mountainous areas, this rate also increased significantly [5].

The data from the 2019 nutrition monitoring system, shows that stunting malnutrition in mountainous areas accounts for a high rate (38%) [5]. According to a report by the World Bank and the Institute of Nutrition, ethnic minorities in Vietnam often face malnutrition: ethnic minority children have a malnutrition rate twice as high as that of Kinh children (31.4% compared to 15.0%), the rate of ethnic minority children with underweight malnutrition is 2.5 times higher than that of children in other regions (21% compared to 8.5%). Furthermore, up to 60% of children with stunting in the 10 provinces with the highest stunting rates in the country are ethnic minorities [6].

Although there have been many studies assessing the prevalence of malnutrition and undernutrition in children under 5 years of age and adults, studies on nutritional status in school-age children, especially children in ethnic minority areas, are still limited. Therefore, our research is really necessary, this will be the basis from which to propose timely measures to minimise nutrition-related health problems of school-age students and help propose appropriate and specific intervention solutions for students in disadvantaged areas in the Northwestern mountainous province. Our project was conducted to describe the nutritional status and some related factors of ethnic minority high school students in some Northwestern mountainous provinces in Vietnam.

2. Materials and Methods

2.1. Research Subjects

Ethnic minority students are studying at high schools in Son La and Dien Bien; agreed to participate in the study. Exclude students with hunchback, scoliosis and chronic diseases at the time of the study.

2.2. Research Design

A cross-sectional study was conducted on the student population of 6 high schools in 2 provinces of Son La and Dien Bien in the mountainous region of Northwest Vietnam from June 2023 to December 2023, including Son La and Dien Bien. Ethnic minorities often concentrate in mountainous and remote areas [7].

2.3. Sample Size and Sample Selection

The study carried out multi-stage sampling. Each province (Son La, Dien Bien) is divided into three regions: city center, town, and commune of Region III. The six selected regions include Son La city, It Ong town, Co Ma commune (Son La), Dien Bien city, Muong Cha town, and Bung Lao commune (Dien Bien). All students at the research location fully meet the selection standards that have been invited to participate in the research. A total of 1847 students participated in the survey, with a response rate of 100%.

2.4. Methods and Techniques Applied in Research

- Interview:

Before participating in the interview, the interviewer will introduce the participants and their guardians to the purpose of the study. Then, the subjects are instructed and agree to sign the consent form to participate in the study.

Using pre-designed questionnaires and checklists to collect different information from the research subjects about:

- + General information of the research subjects.
- + Some factors related to nutritional status.
- + Knowledge, attitudes, nutritional practices and physical activity.
- Age calculation method:

The age of students in the study was calculated according to WHO conventions. Data on date of birth and survey data are entered into the WHO Anthroplus software to calculate the child's age. Age is calculated in 12 months, specifically:

- + Children from 180 months to under 192 months are 15 years old;
- + Children from 192 months to under 204 months are 16 years old;
- + Children from 204 months to under 216 months are 17 years old;
- + Children from 216 months to under 228 months are 18 years old.
- Evaluate anthropometric characteristics

Measure height and weight according to routine methods prescribed in anthropometric surveys. We used a TANITA scale (Body Composition Analyzer SC—331S, Tanita, Japan) with an accuracy of 0.1 kg. The weighing device was placed in a stable and flat position with adequate lighting, checked, and calibrated before weighing. We measure standing height using a Seca ruler (minimum scale is 0.1cm) and the ruler is assembled and placed close to the wall plane and perpendicular to the floor plane. The wall surface must be flat, and the floor surface must be flat and stable.

Assessment of nutritional status: Investigators used Z-scores (standard deviations) of height-for-age and body mass index (BMI)- for age to assess malnutrition in children aged 5 to 19. Details of the criteria for comparing currently used indicators are shown in Tables 2.1 and 2.2 [8].

Table 2.1. Evaluate height-for-age Z-score (HAZ).

<i>CC/T Z-Score (HAZ)</i>	<i>Evaluate</i>
< -3 SD	Severe stunting malnutrition
< -2 SD	Moderate stunting malnutrition
-2 SD ≤ Zscore ≤ 2 SD	Normal
1 SD < Z-score ≤ 2 SD	Overweight
Z-score > 2 SD	Fat

HAZ, height for age z-score; SD, Standard Deviation.

Table 2.2. BMI assessment by age.

<i>Z-Score Index</i>	<i>Z-Score Evaluation</i>
< -3 SD	Severe malnutrition and wasting
-3 SD ≤ Z-score < -2 SD	Born with malnutrition and wasting
-2 SD ≤ Z-score ≤ 1 SD	Normal
1 SD < Z-score ≤ 2 SD	Overweight
Z-score > 2 SD	Fat

BMI, Body Mass Index; SD, Standard Deviation.

- Health risk behaviors related to nutritional status: The present study assessed some risk factors associated with nutritional status of ethnic minority high school students. These factors include household economic conditions, the number of children born living in the family, occupation, mother's education level, respiratory and digestive diseases, and student information: Physical activity time, sedentary time, total number of meals per day, breakfast and snack habits, and food consumption frequency of students. At least 60 minutes a day is the amount of time that children and adolescents should participate in moderate to vigorous physical activities, including sports games, activities, recreation, fitness classes and sports. School sports, activities during breaks between classes; walking, running or cycling to school and extracurricular activities, picnics, practising sports... [9].

- Food consumption frequency: A 4-point scale (never, monthly/seasonal, weekly, and daily) will be used to assess the frequency of consumption of primary food groups that students use. Food groups are divided into three groups based on macronutrient composition, including: i) Carbohydrate group (rice, white bread, instant noodles, vermicelli/noodles/rolls, potatoes, tubers); ii) Protein group (meat, eggs, fish, shrimp, crab, animal organs); iii) Fat group (fat, cooking oil).

In addition, vegetables and fruits, snacks (canned foods, soft drinks, candy, and snacks/chips), and fried foods are also assessed separately to further assess participants' frequency of consumption.

- Determining household economic status: According to the classification of the Commune People's Committee according to the Prime Minister's decision in 2015.

Students' physical activity levels are determined based on WHO recommendations: children aged 5 - 19 years old should participate in 60 minutes of physical activity/day, of which strenuous activities range from moderate to severe. should be done at least 2-3 times/week [10].

2.5. Statistical Analyses

Data entry using Epidata 3.1 software. Use WHO Anthro Plus 2006 software to process anthropometric data and analyze using SPSS 20.0. Before using statistical tests, variables were checked for normal distribution. Qualitative data are presented as frequencies and percentages. Quantitative variables with normal distribution are presented as mean value (\bar{X}), and standard deviation (SD). Children's weight and height are entered using WHO-Anthro plus 2007 to calculate Z-score BMI/age and height/age. ANOVA test, T-test are used to compare average values with normal distribution. Non-parametric tests are used to test mean values that are not normally distributed. The χ^2 test is used to compare percentages. The first quartile was used as a reference to estimate odds ratios (OR) and 95% confidence intervals (CI). A two-sided P value of less than 0.05 was considered statistically significant.

2.7. Ethical Consideration

The study complied with the review process of the Ethics Committee of Tay Bac University code B2023-TTB-04, based on the principles of the Declaration of Helsinki. The data collection process is carried out under the approval of the Department of Education and Training of Son La and Dien Bien. Data is confidential and used for research purposes only. Students participate voluntarily and can withdraw from the study at any time. Subject information is kept confidential and is only used for research.

3. Results

3.1. General Characteristics of Study Participants by Gender

Students are Thai ethnic group (48.6%), Mong ethnic group (46.1%), other ethnic groups (5.3%). The average age is 17.02 ± 0.84 . 38.0% are from poor/near-poor households. Regarding anthropometric characteristics, the average height and weight of male students are 161.3 ± 6.9 cm and 51.9 ± 8.8 kg, and of female students are 155.2 ± 6.2 cm and 47.8 ± 7.6 kg. The average HAZ index is -1.27 ± 0.88 , higher in females than in males, $p < 0.05$.

Table 1. Demographic and nutritional characteristics of participants by gender.

Variable	Male n(%)	Female n(%)	Total n(%)	P
Class				<0.01 ¹⁾
Grade 10	316 (31.9)	318 (37.1)	634 (34.3)	
Grade 11	378 (38.1)	244 (28.5)	622 (33.7)	
Grade 12	297 (30.0)	294 (34.4)	591 (32.0)	
Ethnic groups				0.145 ¹⁾
Mong	478 (48.2)	374 (43.7)	852 (46.1)	
Thai	464 (46.9)	434 (50.7)	898 (48.6)	
Other	49 (4.9)	48 (5.6)	97 (5.3)	
Economic conditions				0.034 ¹⁾
Poor households	215 (21.7)	149 (17.4)	364 (19.7)	

Near poverty	191 (19.3)	146 (17.1)	337 (18.3)	
Medium	513 (51.7)	492 (57.4)	1005 (54.4)	
Wealthier	72 (7.3)	69 (8.1)	141 (7.6)	
The number of children born living in the family				0.055 ¹⁾
≤ 2 children	419 (42.3)	400 (46.7)	819 (44.3)	
> 2 children	572(57.7)	456 (53.3)	1028 (55.7)	
Age (years)	17.03±0.82	17.01±0.86	17.02±0.84	0.52 ³⁾
Weight (kg)	51.9±8.8	47.8±7.6	50.0±8.5	<0.01 ²⁾
Height (cm)	161.3±6.9	155.2±6.2	158.5±7.3	<0.01 ³⁾
HAZ	-1.44±0.81	-1.06±0.91	-1.27±0.88	<0.01 ²⁾
BAZ	-0.42±1.05	-0.43±0.98	-0.43±1.02	0.825 ²⁾

HAZ, height for age z-score; BAZ, Body Mass Index for-age z-score; ¹⁾χ² test; ²⁾Mann-Whitney test; ³⁾ t-test.

3.2. Nutritional Status

In Table 2, the rate of moderately stunted students was 12.5%; severe stunting was 4.2%, in which male students were higher than female students. In addition, the rate of wasting in male students according to BMI for age was higher than that in female students (6.2% and 5.0%, respectively). The rate of overweight/obesity in ethnic minority students was 8.2%.

Table 2. The distribution of nutritional status of participants by gender.

Nutritional Status	Male n(%)	Female n(%)	Total n(%)	P
Stunting malnutrition (height for age)				0.008 ¹⁾
Severity level	52 (5.2)	26(3,0)	78 (4.2)	
Moderate level	137 (13.8)	94 (11.0)	231 (12.5)	
BMI for age				0.145 ¹⁾
Marasmus	61 (6.2)	43 (5.0)	104 (5.6)	
Normal	848 (85.5)	743 (86.8)	1591 (86.1)	
Overweight/Obese	82 (8.3)	70 (8.2)	152 (8.2)	

¹⁾χ² test; BMI, Body Mass Index.

3.3. Health Risk Behaviors Related to Nutritional Status

In Table 3, health risk behaviors related to nutritional status of ethnic minority school-age students. About 19.9% of students regularly skipped breakfast, 21.2% only eat 2 meals/day, 19.5% eat snacks after dinner. 36.5% regularly eat fried foods; 15.9% often eat snacks; 75.9% and 61.7% regularly eat green vegetables and fruits. 29.7% met recommendations for physical activity and the average physical activity time was 42.8±25.8 minutes/day, with differences between men and women.

Table 4. Factors related to stunting in male students (OR=1.4; 95% CI: 1.1-1.9); living in a family with more than 2 children (OR=1.9; 95%CI: 1.5-2.5), poor or near-poor households (OR=3.0; 95%CI: 2.3-3.8), low maternal education level (OR=1.9; 95%CI: 1.5-2.4); frequent digestive diseases (OR=3.5 ; 95%CI: 2.6-4.6), respiratory (OR=3.3; 95%CI: 2.5-4.4).

The results in Table 5 found several factors associated with overweight and obesity among students eating more than 3 meals/day (OR=2.8; 95% CI: 1.9-3.9); eating extra snacks in the evening (OR=2.4; 95% CI: 1.7-3.5); frequently eating fried foods (OR=2.4; 95% CI: 1.7-3.3); frequent snacking (OR=3.0; 95%CI: 2.1-4.3); rarely/sometimes eat vegetables and fruits (OR=1.7; 95% CI: 1.2-2.4); and physical activity does not meet needs (OR=3.2; 95%CI: 1.9-5.2).

Table 3. The distribution of health risk behaviours of participants by gender.

Health Risk Behaviour	Male n(%)	Female n(%)	Total n(%)	P
Often do not eat breakfast	215(21.7)	152(17.8)	367(19.9)	0.034 ¹⁾
Number of meals/day				0.07 ¹⁾
2 meals	237(23.9)	154(18.0)	391(21.2)	
3 meals	538(54.3)	510(59.6)	1048(56.7)	
> 3 meals	216(21.8)	192(22.4)	408(22.1)	
Eat a snack				0.31 ¹⁾
Don't eat snacks	728(73.5)	661(77.2)	1389(75.2)	
Eat after breakfast	35(3.5)	24(2.8)	59(3.2)	
Eat after lunch	22(2.2)	17(2.0)	39(2.1)	
Eat after dinner	206(20.8)	154(18.0)	360(19.5)	
Frequently eat fried foods	352(35.5)	322(37.6)	674(36.5)	0.351 ¹⁾
Snack often	151(15.2)	142(16.6)	293(15.9)	0.428 ¹⁾
Eat green vegetables regularly	719(72.6)	694(81.1)	1413(76.5)	<0.01 ¹⁾
Eat fruit regularly	578(58.3)	561(65.5)	1139(61.7)	<0.01 ¹⁾
Physical activity				0.471 ¹⁾
No	101(10.2)	95(11.1)	196(10.6)	
Not meeting recommendations	584(58.9)	518(60.5)	1102(59.7)	
Meets recommendations	306(30.9)	243(28.4)	549(29.7)	
Physical activity time (minutes/day)	5 2.7 ± 26.3	38.9 ± 25.4	42.8 ± 25.8	<0.01 ²⁾
Sedentary behaviour time (minutes/day)	12 4.8 ± 72.4	112.7 ± 74.5	117.3 ± 73.1	<0.01 ²⁾

¹⁾χ² test; ²⁾Mann-Whitney test.

Table 4. Some factors associated with malnutrition and stunting of participants.

Nutritional Status	Stunting Malnutrition		OR 95%CI
	Yes n(%)	No n(%)	
Gender			
Male	189(19.1)	802(80.9)	1.4* (1.1-1.9)
Female	120(14.0)	736(86.0)	
The number of children born living in the family			
> 2 children	211(20.5)	817(79.5)	1.9* (1.5-2.5)
≤ 2 children	98(12.0)	721(88.0)	
Ethnic groups			
Mong	127(17.4)	604(82.6)	1
Thai	172(16.9)	844(83.1)	1.03 (0.8-1.3)
Other	10 (10.0)	90(90.0)	1.9 (0.96-3.74)
Economic conditions			
Poor, near-poor	193(26.0)	549(74.0)	3.0* (2.3-3.8)
Average, well-off	116(10.5)	989(89.5)	
Mother's education level			
Illiterate, primary school	136(23.1)	452(76.9)	1.9* (1.5-2.4)
From middle school and up	173(13.7)	1086(86.3)	
Frequently suffers from gastrointestinal diseases			
Yes	91(35.5)	165(64.5)	3.5* (2.6-4.6)
No	218(13.7)	1373(86.3)	
Frequently suffers from respiratory diseases			
Yes	110 (33.3)	220 (66.7)	3.3* (2.5-4.4)

No	199 (13.1)	1318 (86.9)
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* p< 0.05.

Table 5. Some factors associated with overweight and obesity of participants.

Nutritional Status	Overweight/Obese		OR 95%CI
	Yes n(%)	No n(%)	
Number of meals/day			
Over 3 meals	63(15.4)	345(85.6)	2.8* (1.9-3.9)
≤ 3 meals	89(6.2)	1350(93.8)	
Eat an evening snack			
Yes	53(14.7)	307(85.3)	2.4* (1.7-3.5)
No	99(6.7)	1388(93.3)	
Frequently eat fried foods			
Yes	85(12.6)	589(87.4)	2.4* (1.7-3.3)
No	67(5.7)	1106(94.3)	
Snack often			
Yes	51(17.4)	242(82.6)	3.0* (2.1-4.3)
No	101(6.5)	1453(93.5)	
Eat green vegetables and fruits			
Rarely/occasionally	50(11.5)	384(88.5)	1.7* (1.2-2.4)
Frequent	102(7.2)	1311(92.8)	
Physical activity meets the recommended needs			
No	133(10.2)	1165(89.8)	3.2* (1.9-5.2)
Yes	19(3.5)	530(96.5)	

* p<0.05.

4. Discussion

The current study is one of the few studies in Vietnam showing the double burden of malnutrition among ethnic minority high school students living in the Northwest mountainous region. Of which, the rate of stunting malnutrition is 16.7%, higher than the results of the Vietnam Nutrition Survey 2019-2020 [5], with the rate of stunting malnutrition in school-age children (5-19 years old) being 14.8%. The main reason for this difference is the difference in characteristics of the Northwest mountainous region of Vietnam compared to the provinces and cities in the plains, specifically: The terrain is mainly mountainous - plateau, the household economy is mainly agricultural, living conditions are difficult and do not guarantee basic needs. Stunting at this stage is the consequence of prolonged malnutrition in many previous stages, the consequences of which are difficult to recover because the majority of adolescents are 15-18 years old.

Compared with the study of author Hoang Van Phuong on the same subjects, our results showed a lower rate [11]. Each ethnic minority has its characteristics in terms of physical appearance, socio-economic conditions, customs and living standards, which have different effects on nutritional status; At the same time, our evaluation time is that after 4-6 years, economic and intellectual conditions have improved, nutrition programs have been somewhat effective, so the malnutrition rate has improved. However, it is still much higher than in the delta areas and big cities as researched by Nguyen Hoa (10.8%) [12], Le Tran Tuan Anh (6.4%) [13]; Nguyen Thi Trung Thu (3.9%) [14]. The above results once again show that differences in economic, social and living conditions have a profound impact on nutritional status.

Along with the problem of malnutrition, there is an alarming increase in overweight and obesity rates among children and adolescents. The overall prevalence of overweight and obesity in our study was 8.2%, lower than the overall prevalence of overweight and obesity in the 2020 institute survey

study of 19% [5]. However, it is 6.9% higher than in mountainous areas [5]. Lower than research results in the delta such as research by Nguyen Hoa (9.6%) [12]; Ngo Hong Nhung (13.8%) [15]; lower than some countries such as Northeast Brazil (34.5%) [16]; Poland 25% [17]. Vietnam is suffering from a double impact on nutrition: malnutrition in disadvantaged areas, poverty and overweight and obesity in urban areas. However, overweight and obesity are also gradually appearing in several children in rural and mountainous areas due to inadequate and unbalanced nutrition. Therefore, we still need proper attention and intervention to minimize the increase of this condition.

The basic causes of malnutrition are poverty, backwardness, and economic inequality. Ethnic minorities reside mainly in the Northwest, Central Highlands, Southwest and Central Coast, account for 13.44% of the country's population but account for 52.7% of the country's poor [18]. The current study shows that students with poor or near-poor economic conditions are at risk of stunting and wasting is higher than students from families with average/good economic conditions. It can be seen that the above statements are very consistent with the UNICEF model of causes and consequences of malnutrition and previous reports [19]. Nguyen Thi Loan and colleagues showed that students in poor/near-poor families are twice as likely to have rickets as students from better-off families [20]. The explanation for this may be that children born in better socioeconomic conditions will have better medical care and education, leading to better nutritional practices receive care and guidance on a more reasonable diet, thereby giving birth to healthy children. Creating a future generation that develops well both physically and mentally.

This study also shows that stunting and wasting are higher in male students than in female students. This result is similar to Nguyen Van Tam [21] and Truong Thi Thu Huong [22]. The differences between studies may be due to the different developmental stages of boys and girls, specifically: there are differences in living habits, eating habits, resistance, common diseases and physiological development speed. On the other hand, boys are often more vulnerable and have a higher risk of disease than girls. At the same time, during this period, girls pay more attention to physical awareness, leading to proper nutrition and physical activity to achieve good nutritional status.

Regarding socio-economic conditions, our research has shown that children born and raised in families with two or more children are at higher risk of malnutrition. Having many children in ethnic minority areas is no longer a new thing; this has become a reality that is difficult to change due to the influence of people's customs and beliefs. People talk about having children, having a housekeeper or having a son to worship, continuing the family line, and early marriage. The situation of having too many children leads to a series of consequences such as economic difficulties, economic difficulties, difficulty raising children, and, at the same time, women's health declines...It has a significant impact on social life. Many households need help ensuring nutritious meals for their children. In addition, they face household food insecurity, which is thought to be associated with malnutrition due to low food quality and quantity, adding to the heavy burden of malnutrition in children [6].

The mother's education level is one factor that affects students' nutritional status. For mothers with higher education levels, the rate of stunting and wasting in children is lower. Similar to the study by author Nguyen Thi Loan also shows that Students whose mothers have an education level of less than secondary school have a 1.6 times higher risk of stunting than students whose mothers have an education level of lower secondary school or higher ($p < 0.05$) [20]. Research on 12-18-year-old children in Nigeria shows that age and household economy are related to stunting [23]. This association is explained by the fact that mothers with higher levels of education tend to have better knowledge and practices about child nutrition. In addition, mothers with higher levels of education have access to more information sources that help supplement their understanding of child-rearing and care more scientifically and methodically.

Malnutrition and respiratory and digestive diseases such as pneumonia, diarrhoea, loose stools, or constipation are often closely related. Illness in children leads to anorexia, reduced absorption of nutrients, and limited food intake, leading to malnutrition. When children suffer from respiratory

and digestive tract infections, their need for energy and nutrients is more significant than usual, while ethnic minority mothers have higher levels of education. Low, so there is often a concept for children to abstain from: do not let children eat greasy foods when they have loose stools or diarrhoea and do not feed fishy foods according to folk beliefs. However, after the child recovers, not feeding them to compensate for the previous period leads to malnutrition, which is common in these children. In our study, students frequently suffered from gastrointestinal diseases, respiratory diseases have a higher risk of stunting and malnutrition when having frequent gastrointestinal diseases, respiratory.

Students' eating habits are an important factor affecting nutritional status. Our research shows that students who eat more than 3 meals/day and eat an extra meal in the evening have a higher risk of being overweight and obese. Many lifestyle studies show that when consuming food late at night, the body is more likely to cause excess energy and fat will accumulate in the body, causing weight gain [24,25]. Our study shows that students who regularly eat fried foods and snack foods are at risk of being overweight and obese. This is perfectly reasonable because fried foods often contain significantly more fat and calories than non-fried foods prepared by other methods. On the other hand, toxic substances will appear during processing at high temperatures, affecting health. Moreover, the suitability, variety of designs, attractiveness, and convenience of snacks have increased students' demand for this type of food. Our study found a relationship between snacking habits and overweight and obesity; specifically, students who regularly snack have a higher risk of being overweight and obese compared with other students. The study by Aljefree et al. also showed that obese students consumed potato chips (56.8% vs. 45.2%; $p = 0.004$), popcorn (41.7% vs. 33.3%; $p = 0.04$), and cookies (20.9% vs. 14.3%; $p = 0.04$) more frequently than non-obese students [26].

In addition, the current study showed that students who rarely or occasionally eat vegetables and fruits have a higher risk of being overweight and obese (OR=1.7; 95% CI: 1.2-2.4). Similar to the study by author Le Thi Huong, students who do not eat vegetables regularly have a 1.57 times higher risk of being overweight and obese [27]. The study by author Le Huy Hoang and colleagues also showed that the risk of being overweight and obese in children is reduced when children regularly eat fruits and regularly eat green vegetables ($p < 0.05$) [26]. According to the 2020 Vietnam Nutrition Survey report, the average amount of vegetables and fruits consumed per capita has increased from 190.4g of vegetables/person/day; to 60.9g of ripe fruit/person/day (2010) to 231.0g of vegetables/person/day; 140.7g of ripe fruit/person/day (2020); However, the amount of vegetables and fruits consumed about 66.4% - 77.4% of the recommended needs [7]. Meanwhile, a diet rich in meat cannot provide enough fiber needed for a healthy digestive system and not enough vitamins for comprehensive development. Therefore, parents and caregivers need to increase their diet with vitamins and green vegetables and limit and reduce fatty foods, especially fast food and food at convenience stores.

Not only nutrition but also physical activity contributes significantly to the comprehensive development of students. Exercise will help children be healthier and more balanced because these activities help children feel mentally comfortable and have a better appetite. However, students who do not exercise or do not participate in physical activities will not burn off all their energy, leading to overweight and obesity [36]. Students who exercise less than 8 hours/day and whose exercise time does not meet the recommended needs are at higher risk of being overweight and obese. Ngo Thi Xuan et al. have shown that students who exercise less in the past week (time spent watching TV, using computers/surfing the web, taking extra classes, reading books/stories) have a higher rate of overweight and obesity than other groups of students [28]. On the other hand, in a study of primary school children in Pakistan, children who participated in vigorous physical activity more than twice a week had a lower risk of being overweight or obese (OR = 0.49), similar to children with a sedentary lifestyle > 1 hour/day, which increased the risk of being overweight and obese by 1.56 times compared to other children [29].

These results provide important evidence to develop long-term interventions to improve child nutrition nationwide, especially for adolescents from ethnic minorities.

4.1. *The Current Study Draws Some Implications*

Firstly, it is necessary to organize nutrition education communication sessions with the participation of parents and caregivers of students and distribute leaflets with instructions on proper nutrition to households. Instruct parents on a balanced and reasonable diet and increase the use of foods suitable for the child's age. In addition, schools organize extracurricular activities to provide children with information on the harmful effects of malnutrition and simple and easy-to-apply ways to prevent malnutrition and encourage children to practice every day. Organize appropriate physical exercise and sports sessions for children. At the same time, equip parents with knowledge about nutrition suitable for the child's age and spend time preparing appropriate meals for children. Second, families need to ensure food security, for impoverished and near-poor households, improve nutrition for children in remote areas, and take advantage of locally available food sources. Third, ethnic minority students should be ensured access to nutritious food and the government's milk program to improve their weight and height. Last but not least, it is necessary to guide students to develop and manage positive lifestyle changes, such as monitoring anthropometric indicators, creating a healthy diet, regularly eating vegetables and foods rich in vitamin A, reducing snacking, and increasing physical activity as recommended.

4.2. *This Study Has Some Limitations*

First, due to the cross-sectional study design, the study design was cross-sectional, so it is difficult to establish a causal relationship between undernutrition/overnutrition and to accurately identify risk factors. On the other hand, our study assessed dietary habits based on food consumption frequency but did not investigate the actual diet of students. Besides, recall bias may occur due to students' responses.

5. Conclusions

In summary, this study shows that malnutrition is still common among ethnic minority school children in the mountainous Northwest of Vietnam, along with the increasing rate of overweight and obesity. These issues are all related to students' socioeconomic conditions, eating habits and living habits. Therefore, it is necessary to develop and deploy nutrition and health education interventions suitable to local culture and ethnic characteristics to attract the community, raise awareness and practice nutrition. Thanks to that, we can improve the nutritional status of ethnic minority children.

Author's Contribution: NTN and PTKC were responsible for all aspects of protocol development; NTTN and DTLH were responsible for data collection, data analysis and report writing; VPL, TTM, MVQ were responsible for data analysis and report writing.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Acknowledgments: This study belongs to the topic "Assessing the nutritional status and some related factors to guide school physical improvement in ethnic minority high school students in some Northwest provinces" Code No.: B2023-TTB-04. The authors would like to thank the Ministry of Education and Training for allowing and supporting us to carry out this topic.

Conflicts of Interest: All authors state that they have no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BAZ, Body Mass Index for-age z-score; BMI, Body Mass Index; NCHS, National Centre of Health Statistics; HAZ, height for age z-score; SD, Standard Deviation; WHO, World Health Organization.

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