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A Web-Based Thai School Lunch Program Promotes Children's Heights: A Cross-Sectional Study in Rural Schools

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Abstract. Background: Nutrition has an impact on development and linear growth. However, a few studies examine the connections between children's age-standardized height and their nutritional status and diet quality. Objectives: This study aimed to find a relationship between dietary consumption and height for age among school students under a web-based Thai school lunch program. Methods: Anthropometric data and nutrient consumption were obtained from 24-hour records. Nutrient consumption was calculated using Inmucal. The parent and custodian's data were from the electronic health records. Results: Children's heights were not correlated with parents' heights ($P<0.720$). Moreover, children with low height-for-age Z-score (HAZ) had significantly lower intakes of minerals (iron, magnesium, and selenium) and vitamins (B6, B12, C, and E). On the other hand, magnesium, selenium, vitamin B12, and vitamin E intakes of the children with normal HAZ were higher than their custodians. Conclusion: The Thai school lunch program effectively maintains the normal HAZ of children. Nutritional education in the community is recommended.

Keywords. Web-based nutrition, electronic health records, height-for-age, pediatric nutrition, micronutrients

1. Introduction

In several developing countries, malnutrition is one of the public health concerns related to sustainable development goals (SDGs) [1]. The state of food security and nutrition in the world 2020: transforming food systems for affordable healthy diets). Stunting, long-term nutritional disorders, and chronic diseases are all made more likely by malnutrition. Between 2016 and 2018, there were five million undernourished persons in Thailand; in contrast, ten percent of children were stunted, and five percent of the population was wasting [2]. The severity of vitamin and mineral deficiencies occurs at different levels among race and ethnic groups [3]. Stunting is defined as the children with height-for-age Z-score (HAZ) $<-2SD$, and severe stunting is defined as the children with HAZ $<-3SD$ [4]. According to the 5th National Health Examination Survey in 2014, 3.5 % of Thai children aged 1–14 years were stunted [5].

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In Thailand, one element that affects a child's growth pattern is their family. Family (household economic levels, sanitation, and rearing practices) and child (premature birth, breastfeeding duration, and consumption behaviors) factors are identified as risk factors for stunting (6). Therefore, the health of a family affects the stunting of children [7]. When there is a severe deficit in vitamin A and iron, there is growth retardation [8]. In contrast, in Uganda, stunted children have iron, vitamin B12, and vitamin A deficiencies [9]. In addition, it is well-recognized that dairy product consumption can prevent stunting [10].

It has been suggested that Thai school lunch recipes can improve children's nutritional status; thus, it might be beneficial to improve the HAZ in the students [11]. Thai School Lunch is a scheme that encourages high-quality meals for students and assists schools in estimating their raw material prices. This feature allows for cost estimates and summaries depending on local raw material pricing. However, some schools in rural areas fail to follow the program guidelines. Therefore, this cross-sectional study aimed to investigate relationships between the HAZ and dietary intake of parents and children in Maha Sarakham, Thailand, to improve the lunch menus.

2. Methods

2.1. Workflow of Thai School Lunch Program

The program has been developed by the National Electronics and Computer Technology Center (NECTEC). Users can either construct their menu or let the system automatically rotate dishes from over 1,000 recipes recorded in the system's food menu database. The Thai School Lunch system will calculate the nutrients in the meal recipes given and the number of raw materials used for each purchase.

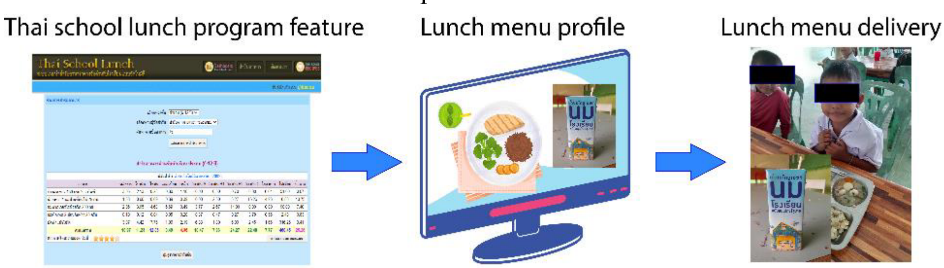

Figure 1. Workflow of Thai School Lunch Program

2.2. Study design, participants, and research tools

This cross-sectional study included 40 school students (3-12 years old) and their custodians (n = 40) from 2 schools in Kantarawichai district, Maha Sarakham, Thailand. Three structured questionnaires were utilized to interview students and their parents/guardians from August-October 2023. Nutrient consumption was determined using 24-hour dietary records and the INMUCAL-Nutrients V.4.0 application. Most pupils resided with their grandparents. Therefore, demographic information about their parents was gathered from electronic medical records (HOSxP for Primary Healthcare, version 3). The youth guidelines describe physical activity levels as appropriate or inadequate; individuals aged 6 to 18 should engage in moderate-to-vigorous physical exercise for at least 60 minutes per day [12]. The protocol has been approved by

Mahasarakham University Ethics Committee for Research Involving Human Subjects (Approval no.295-290/2023).

2.3. Statistical analyses

The relationships between categorical and continuous data were analyzed using χ^2 and Pearson's correlation tests, respectively. Means between two independent groups were compared using the independent t-test. A P-value < 0.05 is flagged with an asterisk (*).

3. Results

3.1. Characteristics of participants

Forty students participated in the study (20 males and 20 females). Five students with low HAZ were female, with averaged heights of 105.0±7.7. They had lower body weights than the normal group, but not statistically significant. These children also had low levels of physical activity but comparable hours of sleep. Details are depicted in Table 1.

Table 1. Characteristics of children (n = 40)

Variable	Height-for-age Z score (HAZ)		P-value
	Normal (n = 35)	Low (n = 5)	
Gender (male/female)	20/15	0/5*	0.01
Age (years)	9.4±0.4	7.2±1.8	0.30
Height (cm)	135.9±2.9	105.0±7.7*	0.01
Weight (kg)	34.9±2.7	23.4±4.9	0.07
Sleep duration (hour/day)	8.2±0.2	9.0±0.3	0.07
Physical activity level (adequate/inadequate)	17/18	0/5*	0.04

Height-for-age Z score (HAZ).

3.2. The heights of children are not correlated with parent's heights

It is well-recognized that the children's height can be determined by genetic heredity. However, the χ^2 analysis showed that children's heights were not correlated with parents' heights (P<0.720) (Table 2).

Table 2. Relationship between heights parents (n = 40) and children (n = 40)

Parent's height	Children's HAZ		χ^2 value	P-value	Contingency coefficient
	Normal (n (%))	Low (n (%))			
Normal	18 (51.4)	3 (60.0)	0.12	0.72	0.05
Low	17 (48.5)	2 (40.0)			
Total	35 (100)	5 (100)			

3.3. Low micronutrient intakes in low HAZ children

The independent t-test analysis showed that children with low HAZ had significantly lower levels of intakes of minerals (iron, magnesium, and selenium) and vitamins (B6, B12, C, and E) (Table 3).

Table 3. Comparison of dietary intake percentage in children with normal and low HAZ

Dietary intake (%DRI)	Height-for-age Z score (HAZ)		P-value
	Normal (n = 35)	Low (n = 5)	
Energy	63.8±6.6	51.6±5.5	0.17
Protein	136.0±17.1	107.1±11.4	0.17
Calcium	20.5±5.4	32.4±13.7	0.45
Phosphorus	58.5±8.8	47.3±10.4	0.43
Iron	49.1±7.0	26.9±3.7*	0.00
Copper	81.4±20.0	44.5±8.8	0.10
Magnesium	21.2±5.5	5.9±2.3*	0.01
Selenium	81.7±10.9	47.0±8.2*	0.01
Zinc	60.3±8.1	66.5±11.2	0.66
Niacin	116.2±11.1	157.6±51.2	0.47
Vitamin A	22.6±7.4	15.1±4.4	0.42
Vitamin B1	145.3±24.0	98.4±31.7	0.26
Vitamin B2	68.3±17.2	79.6±25.9	0.72
Vitamin B6	60.9±8.4	26.6±7.0*	0.00
Vitamin B12	37.1±9.3	10.5±3.6*	0.01
Vitamin C	40.1±7.9	10.7±8.2*	0.02
Vitamin E	8.3±3.0	2.0±0.4*	0.04

3.4. Dietary intakes of children's micronutrients are not correlated with custodians

Children lived with custodians (parents/grandparents). Results showed that magnesium, selenium, vitamin B12, and vitamin E intakes of the children with normal HAZ were higher than their custodians (Table 4).

Table 4. Comparison of dietary intake percentage in children with normal HAZ and custodians

Dietary intake (%DRI)	Group		P-value
	Normal HAZ children (n = 35)	Custodian of normal HAZ children (n = 35)	
Iron	48.9±6.8	63.6±11.2	0.29
Magnesium	23.4±5.5	8.9±1.4*	0.00
Selenium	92.5±11.6	26.3±6.3*	0.00
Vitamin B6	68.1±9.3	14.7±2.6*	0.00
Vitamin B12	42.5±9.3	11.4±3.9*	0.00
Vitamin C	36.7±7.7	29.5±3.7	0.32
Vitamin E	9.3±3.0	2.4±0.9*	0.04

4. Discussion and Conclusions

This cross-sectional study revealed that the Thai school lunch program can improve children's heights. This conclusion is based on our following findings. First, the children's HAZ was not related to their parents. Secondly, standard HAZ students consumed higher amounts of micronutrients. Thirdly, micronutrient intakes of normal HAZ children were higher than their custodians. Even though children's growth primarily depends on genetic factors, environmental factors are also essential [13]. An optimal blood iron level is crucial for proper osteoblast (bone-forming cell) activity [14]. The osteoblast activity also depends on magnesium ion level [15]. Meanwhile, selenium is orchestrated with vitamin D to maintain normal bone metabolism [7]. These minerals are replenished in the Thai school lunch menus. However, we observed that the children with low HAZ consumed less food, including meats (a source of iron and selenium), dairy products, and green vegetables (a source of magnesium) [16,17]. Therefore, it is challenge how to encourage children to comply with the program.

Dairy products are rich sources of vitamins B6 and B12, vital to bone growth [18]. Surprisingly, some children consumed relatively low amounts of vitamin C, which can be easily acquired from local citrus fruits. Our communication with teachers revealed that some preferred sweets to sour foods. Nuts and beans are rich in vitamin E and essential for bone health [19]. In conclusion, our study shows that the web-based Thai school lunch program can maintain optimal children's height. Further, dietary education for children and custodians is recommended.

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