Geographic Information Systems (GIS) for Studying the Prevalence of Overweight among School Children in Phra Nakhon Si Ayutthaya Province, Thailand

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DOI: https://doi.org/10.52939/ijg.v20i3.3119

Abstract
The prevalence of overweight among Thai primary school students has been increasing annually. The upward trend is primarily influenced by various factors, with key fundamental factors being shared behaviors within the community and the geographical features of residential areas which contribute to the increasing prevalence each year. This research aims to study the prevalence of overweight and using Geographic Information Systems (GIS) as a tool for the geospatial clustering analyses. We aim to identify factors contributing to overweight. The research design employed a cross-sectional study among a sample of 1,170 individuals in Phra Nakhon Si Ayutthaya province. The sample was randomly selected, and data were collected through personal questionnaires and anthropometric measurement. The data were analyzed using multiple logistic regression. This study found that the prevalence of overweight was concentrated within specific communities and distributed across all communities. The majority of overweight cases were females, accounting for 50.9%. Multiple logistic regression analysis revealed that having a chronic illness increased the likelihood of being overweight compared to the non-chronic illness group (ORadj = 5.33, 95% CI = 4.06-6.38, P-value < 0.001). Individuals with low physical activity levels were more likely to be overweight than those with higher physical activity levels (OR = 3.97, 95% CI = 3.05-4.98, P-value < 0.001). Moreover, dietary behavior with 1,801-2,000 Kcal. was associated with a higher likelihood of being overweight compared to less than 1,800 Kcal. (OR = 2.42, 95% CI = 1.51-2.89, P-value = 0.044), and receiving more than 2,001 Kcal. was associated with an even higher likelihood (OR = 4.84, 95% CI = 4.13-6.00, P-value < 0.001). Being overweight is influenced by various factors, and using GIS to study overweight prevalence is considered an important method for effective area-based health planning and problem-solving.

Keywords: Ayutthaya, Geographic Information Systems, Overweight, Prevalence, School children

1. Introduction

In the present day, advancements and modernization in healthcare systems have enabled the public to access various forms of medical treatment, placing significant importance on medical care systems and promoting health behaviors to reduce the incidence of non-communicable diseases. According to the World Health Organization in 2016, there were over 340 million children and adolescents aged 9-12 years worldwide who were either overweight or obese [1]. Being overweight is a pressing global issue that requires addressing, as the prevalence of overweight among children continues to increase each year. Approximately 20% of children and adolescents are affected by being overweight, which leads to other complications such as hypertension, diabetes, cardiovascular diseases, and more [2]. As for Thailand, the prevalence of overweight in school-aged children (9-12 years) was 13.4% in 2019, which increased to 17.6% in 2020 and further to 19.1% in 2021 [3].

The causes of childhood overweight are primarily related to excessive consumption of nutritionally unnecessary food, decreased physical activity, and continuous access to high-energy snacks. Additionally, a majority of food choices for children include low-nutrient-dense items such as soft drinks, sugary snacks, reduced breakfast consumption, and fast food [4].

Being overweight has adverse effects on a child's physical, mental, and social aspects of life, leading to internal organ fat accumulation, particularly in the liver over an extended period, increasing the risk of type 2 diabetes and other complications [5].

Addressing the problem of childhood overweight requires accurate situational awareness and understanding of the contextual management of overweight children. Geographic Information Systems (GIS) are a valuable tool to analyze overweight prevalence and support decision-making processes regarding childhood overweight [6]. An analysis of health data in Phra Nakhon Si Ayutthaya province in 2019 found that children aged 6-14 years had a prevalence of overweight at 14.2%, which increased to 16.3% in 2020 and further to 17.6% in 2021. The trend indicates an increasing prevalence of childhood overweight. The use of GIS in assessing childhood overweight prevalence among upper primary school children in Phra Nakhon Si Ayutthaya province will provide crucial data for addressing childhood overweight issues effectively in the future.

2. Method

2.1 Study Area

Phra Nakhon Si Ayutthaya, commonly known as Ayutthaya, is a historical city in Thailand, located in the central region of the country as shown in Figure 1. It is the capital of Phra Nakhon Si Ayutthaya Province. The following are the information about the study area, Ayutthaya:

- Geographic Coordinates: Ayutthaya is situated approximately at 14.3588° N latitude and 100.5681° E longitude.
- Location: Ayutthaya is located in the central plains of Thailand, approximately 80 kilometers north of Bangkok, the capital city of Thailand.
- Adjacent City: Ayutthaya is adjacent to several cities, including Bang Pa-in to the south and east, and Ang Thong to the north.
- Main Road: The major road that connects Ayutthaya with other cities is Highway 32 (also known as Asian Highway 1), which runs through the city and connects it to Bangkok to the south and to the northern provinces of Thailand.
- Main River: Ayutthaya is situated at the confluence of three major rivers: the Chao Phraya River, the Pa Sak River, and the Lopburi River. The Chao Phraya River, in particular, plays a significant role in the city's history and served as a major transportation route during the Ayutthaya Kingdom era.
- Historical Significance: Ayutthaya was the capital of the Ayutthaya Kingdom, one of the most prosperous and powerful kingdoms in Southeast Asia from the 14th to the 18th centuries. The city was known for its impressive architecture, trade networks, and cultural heritage, until it was sacked and destroyed by the Burmese in 1767. Today, Ayutthaya is a UNESCO World Heritage Site, attracting tourists from around the world to explore its ancient ruins and historical sites.

2.2 Research Objectives

The following are the objectives of this study:

- To study the geographical density of the prevalence estimate of overweight among primary school students in Phra Nakhon Si Ayutthaya province.
- To analyze the relationship between overweight prevalence and individual factors among primary school students in Phra Nakhon Si Ayutthaya province.

2.3 Research Design

This study adopts a cross-sectional descriptive design. The target population includes upper primary school students in Phra Nakhon Si Ayutthaya province, totaling 40,854 individuals. The sample size was estimated using the formula proposed by [7], considering a population proportion of 0.2, resulting in a sample size of 961. The sample size was increased to 1,170 individuals to account for potential non-response effects by using the Adjusted for Non-response method [8]. The sampling process involved multiple steps. Step 1 involved stratified random sampling based on the size of the educational administrative areas of the primary schools in Phra Nakhon Si Ayutthaya, resulting in two strata. Step 2 involved simple random sampling within each stratum, divided according to the size of the schools (small, medium, large, special large, with three schools per size category), resulting in 24 schools. Step 3 involved setting the proportion of data collection based on the total number of students in each school and conducting simple random sampling as the final step. These methods aim to comprehensively analyze the relationship between overweight prevalence and individual factors among primary school students in Phra Nakhon Si Ayutthaya province, using Geographic Information Systems (GIS) as a valuable tool for data analysis in this research.

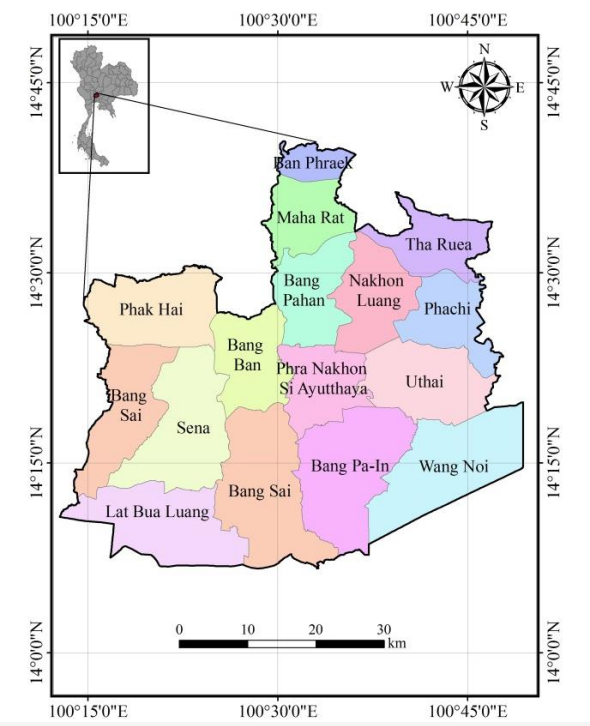

Figure 1: Phra Nakhon Si Ayutthaya, Thailand

2.4 Research Equipment and Research Equipment Quality

- *Questionnaires*: The questionnaires consist of personal data, including age, education level, medical history, dietary behavior, physical activity level, and access to food sources.
- *Anthropometric measurement*: Various body measurement equipment is used, such as weight scales and height measuring devices.
- *Research Equipment Quality Check*: The researcher conducted validity checks, including content validity, by having three experts review the questionnaire. All questions in the questionnaire had an Item-Objective Congruence (IOC) value, and the reliability coefficient was higher than 0.88.

2.5 Statistical Data Analysis

General data analysis was performed using standard statistical software, including descriptive statistics and percentages. Multiple regression analysis was employed, with Body Mass Index (BMI) as the continuous independent variable, and personal data, dietary behavior, and physical activity as dependent variables, in the multiple regression analysis. Additionally, polynomial regression analysis was conducted to explore the relationship between the independent variable and gender.

2.6 Ethical Considerations in Human Research

The research study received ethical approval from the Research Ethics Committee of Mahasarakham University, Certification Number 281-280/2565.

3. Results

Results of the study, based on a total sample of 1,170 individuals, revealed that the prevalence of overweight among upper primary school students in Phra Nakhon Si Ayutthaya Province was 495 persons, accounting for 42.30 percent, as shown in Table 1. Figure 2 illustrates the geographical data on the prevalence of overweight among primary school students in Phra Nakhon Si Ayutthaya province. The figure shows that the prevalence of overweight is clustered within specific communities and is distributed across all communities in the Pratu Chai sub-district and surrounding areas of the communities in Mueang Phra Nakhon Si Ayutthaya district.

The research findings revealed that the majority of the sample group were girls, accounting for 50.9% of the participants. They were in the 5th grade of primary school, comprising 34.6% of the total. Furthermore, 97.6% of the participants had no chronic diseases.

Table 1: Prevalence of overweight of upper primary school students in Phra Nakhon Si Ayutthaya province

Weight status	Student numbers	Percentage [%]
Overweight	495	42.30
Normal weight	526	44.90
Underweight	149	12.80
Total	**1,170**	**100.00**

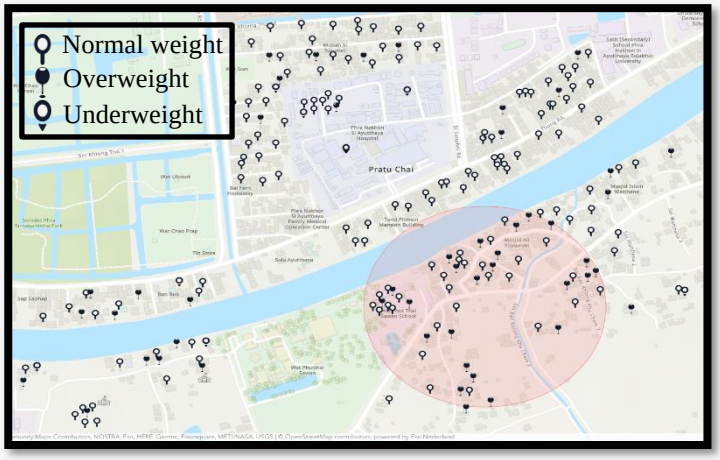

Figure 2: Locations of data acquisitions in Mueang Phra Nakhon Si Ayutthaya district

Table 2: Information of upper primary school students in Phra Nakhon Si Ayutthaya province (n=1170)

Variables	Number (%)
1. Gender	
Boys	575 (49.1)
Girls	595 (50.9)
2. Educational level	
Grade 4	387 (33.1)
Grade 5	405 (34.6)
Grade 6	378 (32.3)
3. Chronic disease	
Have	28 (2.4)
Do not have	1142 (97.6)
4. Physical activity level	
High	384 (32.8)
Moderate	531 (45.4)
Low	255 (21.8)
5. Energy intake	
< 1,800 Kcal.	232 (19.8)
1,801 – 2,000	684 (58.5)
> 2,000 Kcal.	254 (21.7)
6. Food source access	
Inside school premises	781 (66.7)
Outside school premises	389 (33.3)
7. Weight status	
Overweight	495 (42.3)
Normal weight	526(44.9)
Underweight	149 (12.8)

Table 3: Variables related to the occurrence of overweight (n=1,170)

Variables	Weight status		χ^2	P-value
	Normal weight numbers (%)	Overweight numbers (%)		
Gender			0.89	0.297
Boys	340(59.2)	235(40.8)		
Girls	335(56.3)	260(43.7)		
Educational level			1.20	0.131
Grade 4	312(80.6)	75 (19.4)		
Grade 5	321(79.3)	84 (20.7)		
Grade 6	300(79.4)	78 (20.6)		
Chronic disease			30.91	<0.001*
Have	16(57.2)	12 (42.8)		
Do not have	917(80.3)	225 (19.7)		
Physical activity level			26.34	<0.001*
High	302 (78.6)	82 (21.4)		
Moderate	325 (61.2)	206 (38.8)		
Low	72 (28.2)	183 (71.8)		
Energy inake			20.09	<0.001*
< 1,800 Kcal.	222 (90.4)	10 (9.6)		
1801 – 2,000 Kcal.	465 (68.0)	219 (32.0)		
> 2,000 Kcal.	13 (5.1)	241 (94.9)		
Food source access			1.19	0.116
Inside school premises	58 (7.4)	723 (92.6)		
Outside school premises	200 (51.4)	189 (48.6)		

*Significant at P=0.05

Regarding physical activity, 45.4% of the participants had a moderate level of physical activity. In terms of dietary behavior, 58.5% of the participants consumed energy between 1,801 – 2,000 Kcal. Moreover, 66.7% of the participants accessed food sources within the school premises. Additionally, 66.7% of the participants were within the normal weight range, as indicated in Table 2. Statistical analysis results revealed that there was a statistically significant relationship (P < 0.05) between chronic diseases, physical activity level, and dietary behavior among students and the occurrence of overweight. However, sex, education level, and access to food sources do not show a significant relationship with overweight status, as indicated in Table 3.

The results of multiple logistic regression analysis, controlling for variables related to overweight status, revealed the following findings:

- The sample group with chronic diseases was 5.33 times more likely to have overweight than the group without chronic diseases (OR = 5.33, 95% CI = 4.06-6.38, P-value < 0.001).
- The sample group with a low physical activity level was 3.97 times more likely to have overweight than the group with a high physical activity level (OR = 3.97, 95% CI = 3.05-4.98, P-value < 0.001).
- The sample group consuming energy between 1,801 – 2,000 Kcal. was 2.42 times more likely to have overweight than the group consuming energy less than 1,800 Kcal. (OR = 2.42, 95% CI = 1.51-2.89, P-value = 0.044).
- The sample group consuming energy greater than 2,001 Kcal was 4.84 times more likely to have overweight than the group consuming energy less than 1,800 Kcal. (OR = 4.84, 95% CI = 4.13-6.00, P-value < 0.001). These analysis results are shown in Table 4.

4. Discussion

From the research study analyzing geographical information system (GIS) data to study the prevalence of overweight in upper primary school students in Phra Nakhon Si Ayutthaya province, the following points can be summarized:

1. Prevalence of Overweight: The study observed that the prevalence of overweight in upper primary school students varied according to geographical contexts. Specifically, students living in urban and semi-urban areas showed a higher prevalence of overweight. This

observation suggests that lifestyle factors related to geographical locations, such as access to food, sex, and education level, were significant contributors to the occurrence of overweight. This aligns with previous studies conducted by [9], which investigated the impact of online technology on lifestyle changes, leading to changes in food consumption patterns, accessibility, gender equality, and educational data.

2. Factors Related to Overweight: The research findings indicated that several factors were significantly associated with the occurrence of overweight in upper primary school students. Notably, having pre-existing health conditions was strongly linked to being overweight, with students having higher odds (5.33 times) of being overweight if they had underlying health issues. Additionally, students with low physical activity levels were nearly four times (3.97 times) more likely to be overweight compared to those with high physical activity levels. Moreover, the study revealed that the amount of calorie intake influenced overweight prevalence, as students consuming 1,801-2,000 Kcal. had 2.42 times higher odds of being overweight, while those consuming more than 2,001 Kcal. had 4.84 times higher odds compared to those consuming less than 1,800 Kcal. These findings corroborate previous research conducted by [10], which emphasized the impact of various lifestyle factors on overweight occurrence. The study by [11] further supports the notion that changes in food consumption patterns during the COVID-19 pandemic led to increased consumption of low-nutrient foods, resulting in overweight cases.

In conclusion, the research emphasizes the importance of understanding the geographic context and its impact on overweight prevalence in upper primary school students. It highlights that multiple factors, such as health conditions, dietary habits, and physical activity, significantly influence the occurrence of overweight. These insights align with previous studies by [12], which demonstrated that environmental factors linked to geographic locations contribute to the development of overweight. Therefore, addressing overweight as a health issue requires a multifaceted approach, including local policy initiatives, advocacy, and diversified access to health-promoting foods that correspond to the region's food context. By providing options for lifestyle modifications, effective strategies can be implemented to reduce overweight prevalence in students over time.

5. Conclusion

This study demonstrated that being overweight is influenced by multiple factors, including health conditions, dietary habits, physical activity, and environmental factors linked to geographic locations, all of which significantly contribute to the occurrence of overweight. The utilization of Geographic Information Systems (GIS) to study overweight prevalence is considered a crucial method for effective area-based health planning and problem-solving. Therefore, addressing overweight as a health issue necessitates a multifaceted approach, which includes local policy initiatives, advocacy efforts, and diversified access to health-promoting foods that align with the region's food context. By offering options for lifestyle modifications, effective strategies can be implemented to gradually reduce overweight prevalence in students over time.

Acknowledgements

The authors would like to thanks Faculty of Public Health, Mahasarakham University, Research participants, and all other partners for research collaboration.

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