



Unhealthy Snack Consumption and Nutrition Literacy in a School Setting: A Social-Ecological Lens Qualitative Study

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Abstract

Background: Obesity among school-aged children is a public health concern. Developing context-appropriate school-based prevention requires understanding barriers, facilitators, and stakeholder perspectives on children's eating behaviors. This study aimed to explore perceived influences on unhealthy snack consumption and nutrition literacy among school-aged children across multiple social-ecological levels and identify stakeholder-suggested components that could inform the development of a future school-based obesity-prevention intervention. **Methods:** A descriptive qualitative study was conducted in a rural school in Thailand. Data from 35 key informants students, teachers, parents, school lunch cooks, shop vendors, and the school director were collected through focus group discussions, in-depth interviews, and participant observations. Data were analyzed using thematic analysis informed by both NL and the SE lens. **Results:** Five themes emerged: (1) limited nutrition literacy and misperception of snack food choices; (2) weak family–teacher reinforcement of healthy eating habits; (3) inadequate school policy and learning environment; (4) community and vendor collaboration gaps; and (5) a co-created mutual problem-solving program for obesity prevention. Students chose snacks mainly based on taste, habit, and peer influence and had limited understanding of nutrition and food labels. Support and communication between families and

teachers were inconsistent, school nutrition activities were irregular, and nearby vendors commonly sold fried and sugary foods. **Conclusions:** Preventing obesity among school-aged students requires attention to both individual nutrition literacy and the family, school, and community environments that shape daily food choices. These findings may inform the development of a coordinated, multilevel school-based prevention program integrating nutrition literacy; however, its feasibility and effectiveness require further evaluation.

Keywords: Unhealthy snack consumption, Nutrition literacy, Obesity prevention, School-aged student, Social-ecological lens

What was Known

- Obesity in school-age children remains a public health concern.
- Children's eating patterns are shaped by their immediate environments.
- Nutrition literacy is associated with food choices and health status.

What's New and Next

- Snack intake was influenced by family, school, and nearby food sources.
- Support from teachers and families was limited in guiding eating habits.
- Future work should address nutrition literacy alongside local food contexts.

Introduction

Childhood obesity is a form of malnutrition with increasing prevalence and is associated with later health risks, including type 2 diabetes and hypertension ⁽¹⁻⁵⁾. Globally, the prevalence of overweight, including obesity, among those aged 5–19 years increased from 8% in 1990 to 20% in 2022, while obesity alone rose from 2% to 8%.^(5, 6), In Thailand, 15.4% of children aged 6–14 years were classified as overweight or obese according to the 1999 Thai weight-for-height reference, representing a 2.7-fold increase over 24 years ⁽⁷⁾. These trends underscore the need for context-sensitive prevention strategies addressing children's daily eating behaviors, including unhealthy snack consumption.

During late primary school (grades 4–6), eating patterns become increasingly established, yet high consumption of energy-dense snacks and sugar-sweetened beverages and low fruit and vegetable intake remain common among children, underscoring the need for prevention efforts that support healthier daily food choices ^(1,8). Because education shapes health opportunities and outcomes across the life course, schools provide an important setting for such efforts ⁽⁹⁾. Nutrition

literacy (NL), often discussed within the broader concept of health literacy, refers to the ability to access, understand, and use nutrition information in everyday food decisions; for primary school children, this includes interpreting basic nutrition messages and food labels ^(10,11). However, children's food choices are also shaped by routines, peers, and food availability, indicating that nutrition knowledge should be considered alongside the social and environmental conditions in which food choices are made ⁽⁸⁾.

Previous research has defined the components of food and nutrition literacy among adolescents and identified home and school support as an important correlate ^(12,13). Evidence from Thailand and other settings also indicates that unhealthy dietary behaviors are shaped by interacting family, school, community, and broader environmental influences ^(14,15). Guided by the Social-Ecological Model (SEM), this study examines nutrition literacy (NL) in relation to influences at the individual, interpersonal, institutional, and community levels ⁽¹⁶⁾, recognizing that children's eating behaviors reflect both nutrition-related knowledge and contextual factors, including family practices, school conditions, and institutional support ^(17,18,19). Qualitative research can clarify how these factors operate in everyday settings and identify barriers and opportunities for improving school nutrition ⁽²⁰⁻²³⁾. However, nutrition literacy and social-ecological influences have largely been examined separately, and their integration with stakeholder-proposed intervention components remains underexplored in rural Thai schools ⁽¹²⁻¹⁵⁾.

Students' snack choices depend on both their nutrition literacy and the food environment. Nutrition literacy refers to the ability to understand and use basic nutrition information, but this ability varies across contexts ⁽¹¹⁾. In school, what students eat is often shaped by what is available, school rules, family practices, and food vendors ^(8,23,24). Previous studies, including those conducted in Thailand, have mostly examined these factors separately ^(12,25,26). Fewer studies have examined how these factors relate to one another, particularly the links among nutrition literacy, home-school coordination, school conditions, and nearby food vendors. Examining these factors together may provide clearer guidance for school-based practice.

This study aimed to explore perceived influences on unhealthy snack consumption and nutrition literacy among school-aged children across multiple social-ecological levels and identify stakeholder-suggested components that could inform the development of a future school-based obesity-prevention intervention.

Materials and Methods

1. Study Design

This descriptive qualitative study explored school-aged students' experiences, perceptions, and contextual factors related to obesity risk through Nutrition Literacy (NL) and Social-Ecological (SE) lenses, with the aim of developing collaborative guidelines for obesity prevention in Thailand. This design allowed participants' perspectives to be represented directly without imposing a highly interpretive theoretical approach.

2. Study Setting

This study was conducted at a rural school in northeastern Thailand, located in a remote area far from the provincial municipality.

3. Study participants

Participants were recruited from a public primary school in Udon Thani Province using purposive sampling. The study included students, their parents or guardians, teachers, school food providers, and the school director who were willing to take part. Each group was included based on its role in the study.

1) The student group (n=12) consisted of children aged 10–12 years in grades 4–6 who were identified as needing nutrition literacy support for obesity prevention. Students were excluded if they had a health condition affecting health-related behaviors, were receiving weight-loss treatment, had transferred schools, had a prolonged absence, or had become ill during the study.

2) Parents or guardians (n=11) were included if they were the primary caregivers of participating students, lived in the same household, could communicate in Thai, and could provide information on the child's eating practices and daily activities.

3) Teachers (n=8) were included if they were involved in health promotion, food management, or teaching students in the target group.

4) School lunch cooks and shop vendors (n=3) were included if they prepared or sold food and beverages in the school.

5) The school director (n=1) was also included. All participants provided written informed consent. Those who left their role during the study period were excluded.

3. Theoretical framework

This study used a qualitative approach guided by nutrition literacy (NL) and the social ecological perspective. NL refers to the ability to understand and use nutrition information in making food choices, such as reading food labels and following dietary guidelines. The social-ecological perspective was used to examine factors related to obesity among school-age children at the individual, family, and school levels. In this study, both concepts were applied to explore how these groups can work together to improve nutrition literacy and support obesity prevention.

4. Research Process

The study was the ethical approval was obtained from the Ethical Committee on Research in Human Subjects, Faculty of Public Health, Mahidol University. Approval number MUPH 2024-084. After ethical approval was obtained, stakeholders involved in student care for obesity prevention were recruited. Formal letters were sent to school directors, followed by direct contact to explain the study and discuss participant selection. Directors assisted in identifying suitable participants.

Focus-group discussions and individual in-depth interviews were conducted in a private room at the school. Before data collection, the students and their parents or legal guardians were informed about the study purpose, procedures, confidentiality, the voluntary nature of participation, and the right to withdraw at any time. Written informed consent was obtained from the parents or legal guardians, and assent was obtained from the students. Each focus-group session lasted 60–90 minutes, while each in-depth interview lasted approximately 60 minutes. The principal investigator moderated the focus groups and conducted the interviews, while a trained research assistant managed the audio recording, took field notes, and documented nonverbal behaviors, group interactions, and relevant contextual observations. With permission, all focus-group discussions and interviews were audio-recorded.

5. Data collection approaches

Focus group discussions and in-depth interview took place at school where an audio recorder and field notes were employed. Each focus group discussions and in-depth interview lasted an hour or less. The advisory professors asked to examine content accuracy and completeness in addition to making corrections. Next, three experts consisting of a nutrition therapist, a pediatric nutrition expert and nutrition literacy expert examined content validity. The guide facilitated the researcher concerning the factors and served as a framework for the semi-structured and open-ended questions.

Focus group guideline: The guidelines addressed four groups:

1) Students group (18 items): Sample questions included: When you hear the word “snack,” what do you think it means?, Can you tell us?, What snacks do you usually eat during the day?, Which snacks do you think are good for you?, Why do you think so?.

2) Parents group (20 items): Sample questions included: From which sources do you receive information about healthy snacks for your child?, How do you usually choose snacks for your child?, What approaches do you use, such as teaching, giving advice, or encouraging to help your child choose healthier snacks?.

3) Teachers group (26 items): Sample questions included: Before participating in the program, what was your level of knowledge and understanding of nutrition, particularly regarding snack consumption?, Have you previously taught healthy eating in the classroom? If so, please describe your experience., From which sources do you access health-related information on nutritional literacy for use in your teaching.

4) Vendors group (10 items): Sample questions included: In your opinion, what should a healthy snack be like, How do you choose snacks that are appropriate for students’ health, What changes, if any, have you made to the way you prepare healthier snacks?, How have training or guidance, such as educational materials, posters, or school-provided recommendations or programs supported your preparation of healthy snacks?.

In-depth Interview Guidelines: The guidelines comprised 12 items that explored school director’ perceptions of their children’s obesity, perceived causes, the school food environment, sustainable management, and school policies and curricula related to obesity prevention. Sample questions included: When you think about nutrition in schools, what comes to mind?, In your experience, how do lessons about balanced meals, portion size, and snack choices shape students’ eating habits more generally?, How are topics related to snack choices currently addressed in your school’s teaching activities or lessons?.

6. Data management

All focus group discussions and in-depth interviews were audio-recorded with permission. The recordings were transcribed verbatim by the primary researcher. The researcher listened to the recordings several times to check accuracy and to better understand tone and context. Field notes on the setting, group interactions, and reflections were recorded to support the analysis. Identifying

information was removed, and pseudonyms were used. All data were stored securely and accessed only by the research team.

7. Data analysis

Data were analyzed using thematic analysis, guided by the social ecological perspective. The analysis focused on awareness, barriers, needs, perspectives, policy, resources, and management related to obesity prevention among students. Transcripts were read several times to gain an overall understanding, followed by line-by-line coding. Codes were developed from both the data and the guiding concepts, then grouped into categories and subthemes. Subthemes were reviewed, refined, and clearly defined, and their relationships were mapped. The research team discussed the findings throughout the process to ensure consistency and agreement. Relevant literature was used to support the interpretation.

8. Trustworthiness

Throughout the study, attention was given to how the data were collected and interpreted. The researcher spent time working with participants and checked key points during the focus groups. The team discussed the data at each stage of the analysis. Notes, recordings, and decisions made during the process were kept to track the development of the findings. The study setting and participants were described to help readers judge how the findings may relate to other contexts.

Results

A total of 35 participants took part in the study. Of these, 34 participated in focus-group discussions: 12 students aged 10–12 years (6 boys and 6 girls), 11 female parents or guardians aged 27–67 years, eight teachers aged 24–33 years (4 men and 4 women), and three canteen vendors or cooks aged 47–51 years (1 man and 2 women). The parent and guardian group included six mothers and five other guardians; four were farmers, three were vendors, two were homemakers, one was a government officer, and one was a state employee. The teacher group consisted of three homeroom teachers, one teacher responsible for the school lunch and school health programs, and four teachers of Grades 4–6. Among the canteen vendors and cooks, two provided school lunches, while one sold snack to students before and after school. In addition, one female school director, aged 43 years, participated in an in-depth interview. She had 17 years of experience as a government teacher and had served as a school director for 10 years, including five years at the current school.

Data from the focus-group discussions and in-depth interviews were analyzed using the Framework Method ⁽²⁷⁾. Codes with similar meanings were grouped into subthemes, and related subthemes were combined into broader themes. The Nutrition Literacy framework guided the interpretation of the findings, while the Social-Ecological Model was used to organize them into four levels: individual (students), interpersonal (parents, guardians, and peers), institutional (the school and school environment), and community. Together, the themes described how nutrition literacy could be strengthened among school-aged students.

Theme 1: Limited Nutrition Literacy and Misperception of Snack Food choices; Individual (students) Issue

This theme describes students' limited understanding of basic nutrition and their difficulty applying this knowledge in daily eating. Some students misunderstood what counts as healthy food, misread food labels, and often chose food based on taste or peer influence rather than health. These findings reflect low levels of functional and interactive nutrition literacy at the individual level.

Current and Preferred Sources of Nutrition Learning (Access): Students mentioned that they currently learn about nutrition from teachers in the classroom and from watching video clips. However, several students said they would like more activities to help them understand nutrition in everyday life. Suggestions included cooking activities, extra learning sessions outside the classroom, and inviting parents to join in the learning. Student shared, "I usually learn about food from videos. (Students: A1-5, B4-6, B9, C3-6, & C10-12)", "Our teacher talks about healthy food in class. (all students)", "It would be great if parents could join and learn with us. (all students)"

Limited understanding of nutrition concepts (Cognitive): Students could recall the "five food groups," but their knowledge was mostly superficial. They were uncertain about how to apply it when selecting snacks. Some believed that foods containing milk, such as yogurt or soda, were automatically healthy. Student shared, "We know about the five food groups, but it's not clear how to choose healthy snacks. (Students: A1-9, B2-5, B7-9, C1-6, C9, & C11)" Another explained, "I think fruit juice and soda are both healthy because they provide energy and refresh the body. (Students: A5, A7, A9, A11-12, B3, B6, C7, & C9-12)"

Misinterpretation of food labels and serving sizes (Decision): Most students struggled to interpret nutrition labels and were unfamiliar with terms like calories or sodium. Although they could read the labels, they did not understand what the numbers meant, making it difficult to judge whether a snack was healthy. Student shared, "I can read the label, but I don't know what those

numbers mean, (all students)” while another added, “Calories? I’m not sure how many are okay per day. (Students: A1-3, A5, A8-12, B3-7, C1, C3, C5, & C9-11)”

Taste and peer influence override health awareness (Communication): When discussing how they chose snacks, students often prioritized taste and convenience over nutrition. Student shared, “I always buy what my friends buy, (Students: A5, A7, A9, A11-12, B3, B6, C7, & C9-12)” and another stated, “Fried food tastes better, is easier to eat, and faster to prepare. (all students)”

Low self-regulation and habit formation (Self-Management): Students showed weak control over their eating habits. Many mentioned that they tended to snack when feeling bored or stressed, demonstrating emotional eating and a lack of self-regulation in food-related behavior. Student shared, “When I’m stressed, I buy chips without thinking. (Students: A4, A7, A12, B1, B5, & C7)”

Students’ Familiarity with and Engagement in Snack-Related Media Content (Media Literacy): Many students access food-related media on family members’ phones, most often through TikTok or YouTube. The content appears on their feed, and they continue watching based on how appetizing the food looks. Student shared, “I watch snack videos on my mom’s phone. They just show up, and they look tasty, so I watch them. (Students: A1, A4, A8, A11, B1-3, B7, B10, C2-4, C6, & C12)”, “I don’t know who made the video. If it looks tasty, I just watch it. (Students: A2, A7-9, B1, B3-5, C1, C5-8, & C11)”

At the individual level, this reflects weaknesses in the behavior change domain of NL, emphasizing the need for activities that build mindful awareness and self-monitoring habits.

Theme 2: Weak Family–Teacher Reinforcement of Healthy Eating Habits; Interpersonal (parents, guardant, peers) Issue

This theme describes limited and inconsistent support from families and teachers in promoting healthy eating. Some parents lacked confidence or knowledge of nutrition, and communication between home and school was inconsistent. As a result, nutrition messages were not consistently reinforced. These findings suggest gaps in accessing, communicating, and sharing nutrition information at the interpersonal level.

Limited Access to Practical Nutrition Information at Home (Access and Media): In many cases, parents had limited access to usable, understandable nutrition information. Several said they did not know what their children were being taught in school. They expressed a wish for simple

materials, such as printed leaflets or videos, that could help them explain healthy eating at home. Parents shared, "Sometimes they teach something at school, but we don't know what it is at home. (Parents: P1, P4, & P9-11)" "I wish there were leaflets with pictures, easier to explain to kids. (All parents)" "Short video clips for parents would be helpful. (All parents)"

Gaps in Understanding Nutrition and Its Everyday Relevance (Cognitive): Parents and students often remembered messages like "don't eat too much sugar" or "eat vegetables," but few could explain why. Without understanding the reasons behind these messages, the information did not seem relevant to their daily choices. In some cases, children believed that healthy food had to be expensive. Learning was often focused on memorizing facts for school rather than understanding how food affected their health. Parents shared, "Sometimes the teacher says don't eat sweets, but they don't say why. (Parents: P2, P5, & P7-10)" "My child knows that vegetables are good for health, but doesn't know what benefits they offer. (All parents)".

Inconsistent Communication Between School and Home (Communication): There was often a gap between what students heard at school and what happened at home. Parents were not always informed about what was taught in class. As a result, they couldn't reinforce the same messages. Some students said they rarely talked about food with their families. Parents shared, "School teaches one thing, but at home we eat how we always have. (All parents)" "Teachers don't tell parents what they're teaching about food. (Parents: P2, P5, & P7-11)" "I don't really talk to my children about food, but they learn in class. (Parents: P1, P3, P6, P9, & P11)".

Missed Opportunities for Guided Decision-Making Support (Decision and Communication): Teachers were seen as highly influential, but students were not consistently supported in making their own food choices. Parents did not always knowledgeable to guide them, and schools rarely provided structured activities that helped students practice decision-making about food. As a result, students often made choices on their own without clear guidance. Parents shared, "If the teacher says it, the kids believe it more than when I say it. (All parents)" "Kids want snacks, but nobody says which ones are better. (Parents: P1-2, P4, P6, & P10-11)" "The school doesn't organize activities where students make food choices. (All parents)".

At the interpersonal level, these findings indicate limitations in access to nutrition information, cognitive and communication skills between families and teachers, support for nutrition-related decision-making, and media. This suggests the need for preventive activities, such as the Weak

Family–Teacher Reinforcement of Healthy Eating Habits program, to strengthen students’ nutrition literacy.

Theme 3: Inadequate School Policy and Learning Environment; Institutional (school, school environment) Issue

This theme captures institutional factors that hinder nutrition literacy promotion within schools. It includes fragmented nutrition education across subjects, insufficient teacher training, lack of teaching resources, and weak food environment regulations. The findings represent a deficiency in access, understanding, and sharing within the institutional level of the SE lens, revealing that the school system plays a limited role in sustaining nutrition literacy and shaping supportive health environments.

Limited Access to Coherent and Practical Nutrition Content (Access): Although students learned about nutrition in class, what received contents were basic and scattered. Nutrition appeared briefly in different subjects, but students noted that the content often stayed at the level of definitions and did not relate to what daily eaten. Snacks, for example, were rarely discussed, even though they were a part of students’ real eating habits. The learning didn’t help them make sense of nutrition in practical terms. Teacher shared, “We learn about food groups in science, but it doesn’t connect to what we eat every day. (Teacher: T3 & T5)” “There is no lesson that talks about snacks or foods students actually buy. (All Teachers)” “Students hear bits and pieces, not all of the content. (Teacher: T1-3, T5, & T7-8)”.

Shallow Understanding Due to Lecture-Based Learning (Cognitive): Most nutrition lessons were based on the teacher talking and students listening. Students memorized facts but weren’t given space to ask questions or think through how nutrition related to their lives. There were few examples, no real-life discussion, and almost no activities that encouraged students to reflect. Some students said they could repeat what they’d learned but didn’t really understand it. Teacher shared, “They just talk. We don’t get to do anything or solve real problems. (Teacher: T2, & T5)” “Teachers mostly explain from the textbook, and students just listen. (All Teachers)” “There are no activities that help students think about their own eating habits. (All Teachers)”.

Lack of Institutional Support for Decision-Making Skills (Decision): Students were rarely encouraged to make decisions or compare food choices based on what they learned. There were no structured activities that helped them apply their knowledge in everyday situations, such as buying snacks or choosing lunch. Teachers themselves said they hadn’t been trained to teach this

aspect. In practice, students were told what was healthy but not guided on how to make their own informed choices. Teacher shared, “We only got training about the school lunch policy, not how to teach students. (Teacher: T6, & T8)” “We don’t have activities where students practice choosing food. (All Teachers)” “Teachers are not trained to teach decision-making about food. (All Teachers)”.

Outdated or Inaccessible Media for Nutrition Education (Media): Teachers said they didn’t have much to work with when it came to teaching materials. Most were still using old textbooks, and if they wanted anything extra, they had to make it themselves. Some mentioned that the school had no videos, pictures, or digital content they could use in class. This was a challenge, especially because students were already familiar with online media outside school. A few teachers said that if they had simple materials, such as pictures, games, or short clips, it might help students pay more attention. Teacher shared, “We mostly use old textbooks to teach nutrition. (Teacher: T3, T6 & T8)” “There are no videos or visual materials provided by the school. (Teacher: T2, T5 & T7)” “We need more materials—something with pictures or games to get students interested. (All Teachers)”.

At the institutional level, these findings indicate limitations in access to nutrition information, cognitive support, decision-making support, and appropriate educational media. This highlights the need for preventive actions, such as addressing gaps in school policies and learning environments, to strengthen students’ nutrition literacy.

Theme 4: Community and Vendor Collaboration Gaps; Community Issue

This theme shows that factors outside the school also affect efforts to prevent obesity. Food vendors around the school often lack basic nutrition knowledge, and coordination with local authorities is limited. There are also few ongoing activities or policies in the community that support healthy eating. These conditions make it harder to support students’ nutrition learning at the community level.

Limited Access to Nutrition Guidance and Support (Access): Most food vendors working near schools said they had never received any formal guidance or materials related to child nutrition. Vendor were not included in school-based health initiatives and had no access to clear information about what kinds of food were recommended for students. Without practical or visual materials, vendors continued to sell familiar, popular items based on student demand. Vendor shared, “I’ve never seen any documents from the school about what food to sell. (All food vendors)” “Nobody gave us information. We sell what students like. (All food vendors)”.

Limited Understanding of Nutrition and Health Messages (Cognitive): When asked about healthy food. Most vendors had never heard about healthy food but weren’t sure what exactly

it meant. Some believed that as long as the food was clean and the children ate it, it was good enough. A few mentioned they had heard phrases like "low sugar" or "low fat," but didn't know how to apply them. Many openly said they had never been taught this kind of information and weren't sure how the food they sold affected students' health. Vendor shared, "I've heard of healthy food, but I don't really know what counts as healthy. (All food vendors)" "As long as the food is clean and kids like it, it should be fine. (Food vendors: V2)" "Low sugar, what does that mean? How much is considered low? (All food vendors)".

Food Choices Based on Popularity, Not Health (Decision): Most vendors said they chose foods based on what students usually bought. Fried foods, sugary snacks, and salty items sold well. Some had tried offering healthier options, such as fruit, but reported low sales. There was no clear direction from schools or families about providing healthier food. As a result, vendors continued to sell familiar items. For many, maintaining sales was more important than changing students' eating habits. Vendor shared, "When I sell fruit, students don't really buy it. But fried chicken sells out. (Food vendors: V1 & V3)" "I follow what the kids want. If I change the menu, I might lose money. (Food vendors: V3)" "It depends on what kids want. If I change the menu, they might not buy. (Food vendors: All food vendors)".

Lack of Media or Campaign Materials for Vendors (Media): Vendors said they rarely saw any posters, videos, or campaigns about child nutrition aimed at people like them. Health messages were usually directed at parents or students, not at food sellers. Without clear, practical media in places where vendors work, such as markets or school areas, there was little exposure to information that might influence their choices or attitudes. Vendor shared, "Posters about healthy food are for students. We don't get anything. (All food vendors)" "We never see any videos or campaigns where we sell. (All food vendors)"

At the community level, the findings indicate limitations in access to nutrition information, understanding of nutrition concepts, support for nutrition-related decision making, and the availability of appropriate media. This underscores the need for preventive actions that address gaps in community and vendor collaboration to strengthen students' nutrition literacy.

Theme 5: Co-created Mutual Problem-Solving Program for Obesity Prevention

This theme was developed from the focus group discussions and interviews. Participants described obesity prevention as a shared responsibility among students, families, schools, and the community. They suggested that the program should include student-centered activities, family

involvement, school support, and community-level collaboration. The findings also reflected key aspects of nutrition literacy, including accessing, understanding, communicating, decision-making, behavior change, and sharing.

Strengthening students' NL competencies: (1) Individual (students) Issue. Interactive and playful approaches such as food-label games, "Food Detective" activities, and snack journals were proposed to make nutrition learning more practical and engaging for students. Student shared, "When we learn by playing, it's easier to remember. (Students: A5, A7, A9, A11-12, B3, B6, C7, & C9-12)" These methods aimed to bridge the gap between knowledge and behavior, improving understanding, decision-making, and behavior change at the individual level.

Building home-school collaboration: (2) Interpersonal (parents, guardant) Issue. Parents and teachers suggested creating LINE groups, organizing "Healthy Snack Days," and holding family cooking workshops to encourage joint learning and positive reinforcement at home. Parent explained, "We like receiving reminders and pictures in the LINE group. (Parents: P1-2, P4, P6, & P10-11)" Others emphasized cooking together at home: "Cooking with my child makes them proud of what they eat. (Parents: P1-2, P4, P6, & P10-11)" These shared efforts strengthen communication, sharing, and reinforcement at the interpersonal level, aligning home and school nutrition messages.

Integrating NL into school policy and environment: (3) Institutional (school, school environment) Issue. School leaders highlighted the need to formally embed nutrition literacy into the curriculum and school policies. "We put nutrition posters in the canteen and review menus monthly, (School Director, Teacher: T2 & T5)". Establishing a nutrition committee and improving the food environment reflected institutional commitment to the access and understanding dimensions of Nutrition Literacy.

Community and vendor partnerships: (4) Community (food vendors) Issue. Participants recommended training for food vendors on healthy cooking and portion control. Collaboration with municipal authorities would help sustain school-based nutrition initiatives. A school staff member mentioned "We want to teach vendors about portion size and low-sugar options. All food vendors, Teacher: T2 & T5)"

Monitoring and feedback system: (5) Interpersonal and Institutional Issue. Tools such as student food diaries, photo logs, and recognition for healthy choices were proposed to track progress and motivate students toward continuous behavior change. One parent shared, "We send photos of snacks in LINE; teachers give small compliments. (Parents: P8)" This approach fosters

ongoing engagement and supports decision-making and behavior change through positive reinforcement across interpersonal and institutional levels.

Evaluation and sustainability planning: (6) Institutional and Community Issue. School leaders emphasized the importance of regular review meetings and long-term goals; such as developing “Nutrition Literacy Schools” to sustain progress and maintain program integrity. One school director said “Our goal is to become a ‘Nutrition Literacy School,’ (School Director)”.

This theme presents six proposed components for a school-based obesity prevention program, derived from recurring codes and suggestions in the focus-group discussions and in-depth interviews. These components reflect participants’ shared view that obesity prevention requires coordinated action at the individual, interpersonal, school, and community levels. Together, they provide a practical basis for strengthening nutrition literacy and supporting healthier snack choices among school-aged students. The proposed components represent a synthesis of participants’ perspectives rather than a formally co-designed or evaluated program.

Discussion

This qualitative study explored unhealthy snack consumption and nutrition literacy in school settings using a social-ecological perspective. Data were collected from 12 students, 11 parents or guardians, 8 teachers, and 3 food vendors through focus groups and from the school director through an in-depth interview. The approach helped identify factors related to obesity among school-age students, particularly snack consumption, and guided school-based prevention. The findings support that obesity among school-age students remains an ongoing public health concern.

The analysis showed that prevention cannot rely solely on students. It involves students, families, teachers, food providers, and school leadership. Their roles are connected and influence students’ food choices in everyday school life. The findings also suggest that school approaches should consider students’ needs and the actual conditions in each setting ⁽¹⁶⁾. Based on these results, a framework was developed using the social-ecological perspective, covering individual, interpersonal, institutional, and community levels.

Individual Level – Low Nutrition Literacy and Insufficient Understanding of Snack Options. Such misconceptions about healthful foods among students and difficulties understanding nutrition labels show low NL skill. Though they knew about “five food groups” they had a superficial understanding and often lacked practice. Deesamer, Piaseu (28) demonstrated similar patterns in Thai adolescents, where NL competency scores were lowest for “applying” and “interpreting” food

information. Consistent with Katz, Treu (29), gamified learning such as “Food Detective” and snack journaling can help close this gap by associating knowledge with mindful eating and self-regulation.

Interpersonal Level – Guidance between home and school was not consistent. Some parents said they were unsure how to guide their children’s food choices and wanted simple materials to use at home ⁽³⁰⁾. Communication between parents and teachers was limited, which may result in mixed messages for children ⁽³¹⁾. Although teachers were seen as role models, coordination between home and school was still unclear. Children’s eating behaviors were also influenced by peers and adults around them ⁽³²⁾. Together, these findings suggest that strengthening interpersonal communication and shared guidance between parents and teachers is necessary to support healthy snack-related behaviors.

Institutional Level – Teachers in this study had limited preparation and often used outdated teaching materials. This is consistent with previous studies showing that passive teaching does not support critical thinking or behavior change ^(33,34). Although nutrition literacy has been recommended in school curricula and activities ⁽⁸⁾, in practice, it is still mainly taught in the classroom. School leaders are expected to support this through policy, coordination, and resources ^(8,35). Previous studies also show that principals play a role in organizing school routines and supporting collaboration ^(36,37). These findings suggest that the issue is not only at the teacher level but also relates to how school policies are implemented.

Community Level – Vendors in this study had limited training, and the coordination between schools and local authorities was unclear. Community activities related to healthy eating were also limited. Similar findings have been reported in other settings, where unclear coordination affects the implementation of school food policies ^(38,39). In this study, monitoring of food sales and follow-up were not clearly defined. Vendor training focused mainly on general information, with little attention to food standards. As a result, vendors continued to sell foods that were easy to sell ^(40,41). WHO guidance also notes that school food policies require clear implementation and monitoring ^(42,43).

Integration of Different Levels: Mutual Problem-Solving Program Co-created – Monitoring and Feedback. The findings showed that students developed nutrition literacy through classroom activities and daily school routines. This helped them make their own food choices. Some students also described explaining their choices and suggesting healthier snacks to friends and family. In this way, nutrition literacy was not limited to individual understanding but was used in everyday communication. This is consistent with the view that health literacy can serve as both an outcome

and a form of empowerment⁽⁴⁴⁾ and with recent studies that highlight students' role in applying what they learn⁽⁴⁵⁾. Other studies also show that children can influence eating practices at home by bringing ideas from school into daily routines⁽⁴⁶⁾.

Practice and Policy Implications: Play-based and reflective learning can support nutrition literacy at the individual level. Consistent guidance between home and school may be improved through regular communication between parents and teachers. At the school level, integrating nutrition literacy into policy, teaching, and canteen management, with ongoing monitoring, is needed⁽⁸⁾. At the community level, coordination between schools and local authorities can support healthier food environments^(35,47). These approaches support students in making their own food choices and taking a more active role in daily eating^(44,45).

Viewed through the Nutrition Literacy and Social-Ecological frameworks, the findings suggest that students' snack choices reflect the interaction between their nutrition literacy skills and influences from families, peers, school practices, food vendors, and the wider community^(16,48,49). Strengthening nutrition literacy therefore requires coordinated support across the individual, interpersonal, institutional, and community levels rather than education directed at students alone. The proposed components provide a context-specific basis for future program development and testing, rather than evidence of program effectiveness.

Strengths, Limitations, and Future Perspectives

A key strength of this study was the inclusion of multiple stakeholder groups, which provided perspectives from students, parents or guardians, teachers, food vendors, and the school director and allowed nutrition literacy to be examined across individual, interpersonal, institutional, and community levels. However, because the study was conducted in a single school, used purposive sampling, and relied on self-reported qualitative data, the findings may reflect the specific study context and are not intended for statistical generalization. Their transferability should therefore be considered in relation to similarities in school settings and participant characteristics. Future studies should use mixed-methods or quasi-experimental designs to test the proposed program components, assess changes in snack choices and relevant health outcomes, and examine long-term implementation and sustainability across different school settings.

Conclusion

This qualitative study suggests that nutrition literacy among school-aged students is shaped by interactions across the individual, interpersonal, institutional, and community levels. Interpreted

through the Nutrition Literacy framework and the Social-Ecological Model, the findings highlight the importance of student involvement, consistent support from families and schools, clear school policies and organizational structures, and collaboration with community stakeholders in supporting healthier snack choices. Promoting nutrition literacy should therefore be a shared, multi-level responsibility and may provide a practical basis for school-based obesity prevention.

Ethical Approval Statement

The study was the ethical approval was obtained from the Ethical Committee on Research in Human Subjects, Faculty of Public Health, Mahidol University. Approval number MUPH 2024-084 and conducted in accordance with the Declaration of Helsinki. Prior to the interview, each participant reviewed an information sheet and provided verbal informed consent.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by SP, AP, SL, and RC. The first draft of the manuscript was written by SP, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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