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# Health Education for Promoting Healthy Eating Habits and Preventing Nutrition-Related Diseases: A Technopedagogical Research Study

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## ABSTRACT

Health education is a central component of child development and a powerful determinant of long-term well-being. It enables children to develop informed decision-making skills, acquire healthy habits, and understand the role of nutri- tion in disease prevention. However, in many Latin American regions, socioeconomic limitations, restricted access to health services, and insufficient school education contribute to persis- tent malnutrition, rising childhood obesity, and poor dietary habits. The present complete research study examines the relationship between eating behaviors of children, awareness of nutrition, and literacy in disease-prevention within a frame- work of health education supported by digital technologies. The empirical study draws on data from a sample of 123 school-age children, applying descriptive statistics, tetrachoric correlations, exploratory factor analysis, and a two-step cluster analysis. The results reveal striking gaps in dietary practices: 57% of children report a high intake of processed foods, 69.9% do not consume the recommended portions of fruits and vegetables, 65.0% regularly drink sugary beverages, and 84.6% do not recognize the connection between nutrition and disease prevention. However, 90.2% express a strong interest in learning healthy habits, highlighting a significant opportunity for intervention. Based on these findings, the ar- ticle proposes a technopedagogical model to strengthen health education through digital storytelling, interactive resources, mobile applications, and school-based learning analytics. Re- cent evidence demonstrates that digital learning can increase motivation, improve understanding, and support the adoption of healthy behaviors, especially in contexts with limited access to preventive care. The discussion integrates public health literature, nutrition science, and digital pedagogy to present implications for curriculum design, teacher training, and com- munity engagement. This study combines empirical evidence with a theory-driven framework to demonstrate how digitally supported health education can promote healthy eating habits and reduce the long-term risk of chronic diseases among schoolchildren.

**Keywords:** Health Education; Eating Habits; Nutrition Literacy; Technopedagogy; Digital Learning; Child Health Promotion; Disease Prevention.

## INTRODUCTION

Health is a multidimensional construct influenced by biological, behavioral, sociocultural, economic, and environ- mental determinants [1], [2]. Public health literature em- phasizes that these determinants interact across the lifespan, shaping individuals' opportunities to develop healthy habits, access equitable services, and prevent disease. In many regions of Latin America, structural barriers such as poverty, food insecurity, and limited access to preventive health ser- vices continue to restrict the ability of families and schools to promote healthy behaviors.

As highlighted by global indicators, malnutrition persists as a major challenge in low and middle income contexts, where both undernutrition and rising obesity coexist [3], [4]. This dual burden particularly affects school-age children, creating urgent educational and health priorities.

Health education plays a crucial role in addressing this challenge. It is defined as a continuous social process through which individuals develop knowledge, skills, and at- titudes necessary for informed decision making and self-care practices [5], [6]. The World Health Organization affirms that high quality health education can reduce preventable diseases by enhancing awareness about nutrition, hygiene, physical activity, and lifestyle choices [7]–[9]. In the context of childhood, health education supports emotional, cogni- tive, and physical development, enabling children to grow into adults capable of maintaining healthy practices through- out life.

**Nutrition as a Foundational Component of Health**

Nutrition is recognized as one of the strongest predictors of long-term well-being. Evidence shows that inadequate dietary habits (such as consuming high quantities of refined sugars, ultra-processed foods, and sugary beverages) signif- icantly increase the risk of obesity, cardiovascular diseases, metabolic disorders, and chronic inflammation [10]. In addi- tion, insufficient intake of fruits, vegetables, and micronutri- ents contributes to growth deficiencies, weakened immunity, and reduced academic performance among children [11]. As [12] report, the WHO reports that leading risk factors for global morbidity are directly associated with dietary and physical activity patterns.

These global trends are reflected in the empirical study underlying this article. Based on a quantitative assessment of 123 school-age children, results show that 57.7 percent consumed high levels of processed foods, 65.0 percent reg- ularly consumed sugary drinks, and 69.9 percent did not meet the minimum recommended daily servings of fruits and vegetables. Furthermore, 84.6 percent of the participating children did not understand the relationship between diet quality and disease prevention, while an encouraging 90.2 percent expressed interest in learning about healthy eating. These findings align with regional evidence showing that childhood nutrition literacy remains low in many parts of Latin America, especially in areas with socioeconomic vul- nerability [13], [14].

**Health Education as Prevention**

The notion of prevention is central to health education. Preventive health programs aim not only to address existing health disparities but to empower individuals and commu- nities with the tools needed for early detection and long term health management. Research shows that school-based nutrition programs can reduce the prevalence of obesity, improve children's dietary choices, and enhance their under- standing of how healthy behaviors affect development [15]. Systematic reviews indicate that interventions combining classroom instruction, family involvement, and community participation yield particularly strong outcomes in promot- ing sustainable lifestyle changes [16].

As remark Silva et al. [17], traditional instructional strategies are often insufficient to address the complexity of current dietary challenges. Contemporary health issues are embedded in broader social and technological environ- ments, where children are continuously exposed to digital content, targeted food advertising, and changing cultural norms around eating. Therefore, educational strategies must evolve to remain relevant and capable of engaging learners meaningfully.

**The Role of Technopedagogy in Health Pro- motion**

Technopedagogy offers a transformative approach by integrating digital technologies with evidence-based peda- gogical practices [18]. Digital learning environments, in- teractive simulations, mobile health applications, and story- telling tools can provide immersive and personalized learn- ing experiences that strengthen children's motivation and comprehension [19]. Recent studies have shown that chil- dren exposed to gamified nutrition education demonstrate increased interest, improved food knowledge, and health- ier eating patterns [20], [21]. Digital platforms also offer teachers valuable learning analytics that can support more targeted interventions and adaptive instruction.

Given these advantages, this study integrates a technope- dagogical perspective to analyze children's dietary habits and propose a digital health education model tailored to school contexts. Figure 1 presents the extended conceptual framework guiding this research, synthesizing insights from public health, nutrition science, and digital pedagogy.

**Purpose of the Study**

Building upon this framework and the empirical evi- dence from the field study, the purpose of this research is threefold: (1) to describe and analyze the dietary habits and nutrition awareness of school-age children; (2) to iden- tify underlying dimensions of eating behavior through ex- ploratory factor analysis and cluster classification;

 

and (3) to propose a technopedagogical model that can strengthen school-based health education and support disease preven- tion from early childhood.

This study contributes to the scientific literature by combining public health analysis, empirical observation, and digital pedagogy to address a pressing global issue. It also provides evidence to inform educational policy, school curricula, and the design of digital interventions aimed at reducing nutrition-related health risks among children.

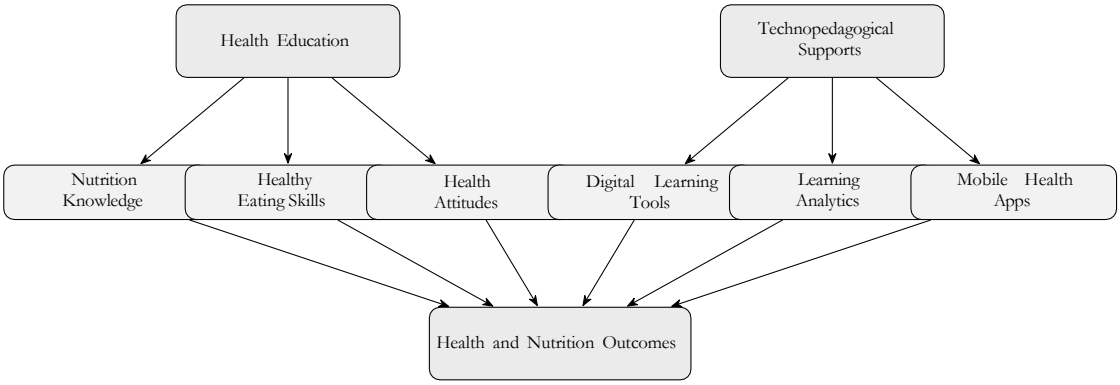


**Figure 1:** Conceptual framework linking health education, technopedagogical strategies, and expected nutrition outcomes.

## LITERATURE REVIEW

Health education is widely recognized as a social and pedagogical process through which individuals develop the knowledge, attitudes, and competencies needed to make informed decisions about their well-being [22], [23]. Ac- cording to Nutbeam's influential model, health education contributes to three intertwined dimensions of literacy: func- tional, interactive, and critical, each of which plays a role in shaping preventive behavior and community health out- comes [24]. Functional literacy relates to basic understand- ing of health information, interactive literacy strengthens personal engagement in decision-making processes, and crit- ical literacy enables individuals to evaluate and act upon structural determinants of health. Those dimensions are vital in childhood because health behaviors acquired early in life tend to persist through adulthood. The World Health Or- ganization has repeatedly emphasized that childhood is the optimal developmental stage to promote healthy lifestyles and prevent nutrition-related diseases [25]. Health educa- tion in schools serves as a protective factor against health inequities by fostering autonomy, self-care, and awareness of environmental and social influences on well-being.

The base document stresses that health education should not be limited to information transfer, but must encourage reflection on everyday practices, cultural norms, and social conditions that shape dietary and physical activity patterns. This perspective aligns with global frameworks that treat health education as an empowering process embedded in community life rather than a content-focused intervention [26].

### Determinants of Dietary Behavior and Public Health Implications

Dietary behaviors emerge from dynamic interactions among biological, psychological, social, economic, and cul- tural factors. Over the past decade, research has highlighted the influence of socioeconomic status, food availability, advertising, convenience foods, and family routines on chil- dren's eating habits [27]–[29]. In low-income communities, such as those described in the base document, structural bar- riers often lead to high consumption of ultra-processed foods and limited access to fresh produce. Global studies show that children from vulnerable households are disproportionately exposed to obesogenic environments, increasing their risk of developing chronic diseases later in life [30].

The evidence collected in the empirical study reflects these broader patterns. The high intake of sugary drinks, inconsistent meal frequency, and insufficient consumption of fruits and vegetables coincide with the trends reported throughout Latin America. The Pan American Health Orga- nization recently documented a rise of more than 20 percent in childhood overweight across the region, with marked disparities between rural and urban-marginalized areas [31]. These disparities are compounded by limited access to healthcare services, which reduces opportunities for early detection and prevention of nutrition-related diseases.

Numerous studies confirm that inadequate childhood diets are linked to obesity, type 2 diabetes, cardiovascu- lar risk, micronutrient deficiencies, and impaired cognitive development [32], [33]. The relationship between diet and cognition is particularly relevant in school-age children, as poor nutrition has been associated with reduced attention, lower academic performance, and decreased learning mo- tivation [34]. This reinforces the argument

 

that educational institutions play a strategic role in ensuring equitable access to nutrition literacy and health-promoting experiences.

### Nutrition Literacy and Its Educational Significance

Nutrition literacy refers to the capacity to obtain, under- stand, evaluate, and apply nutritional information to make healthy food choices [17]. It extends beyond factual knowl- edge and involves skills such as reading food labels, inter- preting portion sizes, evaluating nutritional claims, and un- derstanding the long-term consequences of dietary patterns. Nutrition literacy is increasingly recognized as a predictor of dietary quality, weight management, and adherence to healthy behaviors [35].

International research indicates that nutrition literacy remains limited among primary-school children, particularly in communities affected by socioeconomic disadvantage or restricted access to health education [17]. Children with lower nutrition literacy are more vulnerable to unhealthy food environments, aggressive marketing of ultra-processed products, and inconsistent dietary routines. As a result, strengthening nutrition literacy has become a priority for both public health and education systems.

Educational frameworks emphasize that traditional di- dactic approaches are often insufficient to influence chil- dren's dietary behaviors [36]. Contemporary perspectives highlight the value of experiential learning, culturally rel- evant examples, and participatory pedagogies that enable students to reflect on their food practices and understand their broader social and health implications [37]. Schools are therefore key spaces for fostering nutrition literacy, as they can combine structured instruction with family engagement and community participation to reinforce healthy habits.

Recent literature suggests that integrating interactive tools, digital media, and visual resources can further enhance children's comprehension of nutrition concepts and increase their motivation to adopt healthier practices [36], [38]. By situating nutrition literacy within broader educational and sociocultural contexts, research underscores the need for comprehensive and developmentally appropriate strategies

**TABLE 1:** Sociodemographic and institutional characteris- tics of the participating school, providing contextual infor- mation relevant to interpreting children's dietary behaviors.

| Finding | Source |
|---|---|
| Increasing prevalence of childhood overweight and obesity | PAHO (2024) |
| Limited nutrition literacy among school-age children | UNICEF (2023) |
| Effective role of schools in preventive health programs | Contento (2016) |
| Success of digital-supported nutrition interventions | Chen et al. (2023) |

### Technopedagogy and Digital Health Education

Technopedagogy refers to the intentional and pedagogi- cally grounded integration of digital technologies into teach- ing and learning processes [39]. It draws on the principles of meaningful learning, student autonomy, interaction, and reflective practice to enhance educational experiences. In the field of health education, technopedagogy opens new possibilities for promoting dietary awareness and preven- tive behaviors through interactive simulations, storytelling, gamified modules, and mobile applications [40].

Studies show that gamified digital interventions can sig- nificantly improve children's engagement with nutrition con- tent, foster motivation, and promote healthier food choices [20], [41]. Digital storytelling has also gained attention for its capacity to create emotionally resonant narratives that connect personal experiences with health concepts [42]. Mobile applications for food tracking and feedback provide additional support for self-regulation and family involve- ment, reinforcing behavior change outside the classroom [43]. These tools become especially valuable in contexts where access to healthcare services is limited. Digital health education can complement traditional instruction by offering flexible, personalized, and accessible resources that help children learn at their own pace. The base document high- lights the need for holistic strategies combining school- based programs, family engagement, and community par- ticipation, a framework that technopedagogy can strengthen substantially.

### Regional Perspectives in Latin America

Latin America faces unique challenges in the educa- tion of health and nutrition. Rapid urbanization, economic inequality, and shifts towards industrialized food systems have contributed to the rise in malnutrition and childhood obesity. According to UNICEF, many families in the region struggle with inconsistent access to

 

nutritious foods, limited health education, and inadequate preventive services [44]. At the same time, several successful interventions demonstrate the region's capacity for innovation. School-based programs in Latin Amerucan countries have shown positive impacts on nutrition literacy, physical activity, and healthy eating behaviors when combining education with digital supports, parental involvement, and community partnerships [32], [45], [46]. These initiatives align with the approach of the present study, which integrates empirical assessment with digital health education principles to propose a contextually grounded technopedagogical model.
**Table 1** summarizes significant regional findings relevant to this study.

### Synthesis of the Literature

The literature reveals four overarching principles that guide the present research:

1. Childhood is a critical stage for prevention. Healthy eating habits and health literacy established early in life significantly reduce the risk of chronic diseases.
2. Nutrition literacy remains a global challenge. Chil- dren from vulnerable communities show persistent gaps in dietary knowledge and motivation.
3. Traditional instruction is insufficient. Evidence sup- ports the need for interactive, experiential, and cultur- ally relevant approaches.
4. Technopedagogy strengthens health education. Digi- tal tools enhance learning, engagement, self-regulation, and community participation.

This synthesis provides the foundation for the method- ological approach and the technopedagogical model devel- oped in the following sections.

## METHODS

This research employed a quantitative design to examine children's eating habits, nutrition awareness, and their rela- tionship to preventive health literacy. The methodological approach integrates statistical analysis with a technopeda- gogical perspective in order to provide empirical evidence and pedagogical insight for the development of digital- supported health education programs. The methods used in this study follow a structured sequence consisting of sampling, data collection, variable specification, statistical procedures, and analytical interpretation.

### Study Context and Participants

The study was conducted in a school community char- acterized by socioeconomic vulnerability and limited access to preventive health services. These structural factors align with regional disparities described in public health reports, where low-income households often present higher exposure to malnutrition and reduced opportunities for health educa- tion [47]. A total of 123 school-age children between eight and ten years old participated in the study. Participation was voluntary and supported by school authorities and guardians.

The demographic characteristics of the participants re- flect a relatively homogeneous age group, which reduces developmental variability and supports consistent interpre- tation of the indicators included in the analysis. International research identifies middle childhood as a key developmental stage for health and nutrition education, since children at this age demonstrate increasing cognitive autonomy, the abil- ity to understand cause–effect relationships, and sufficient maturity to engage in structured learning activities [48]. This makes the eight-to-ten-year age range particularly suit- able for interventions focusing on dietary habits, preventive health, and the development of self-care competencies.

The sample of 123 children is consistent with simi- lar school-based studies that apply tetrachoric correlations, exploratory factor analysis, and cluster classification using dichotomous indicators. Recent nutrition education studies have used comparable sample ranges between 80 and 150 participants for examining latent behavioral dimensions and motivational factors. Given the ratio of variables to partic- ipants, the sample met the minimum recommendations for factor extraction and exceeded the thresholds suggested for stable clustering in educational and public health research.

### Instrument and Variables

Data were collected using a structured questionnaire designed to capture eating habits, consumption patterns, dietary awareness, and motivation to learn about healthy behaviors. All indicators were dichotomous (Yes/No), con- sistent with the measurement approach reported in the base document. The questionnaire included items related to consumption frequency, meal routines, intake of processed foods, fruit and vegetable consumption, sugary drink intake, knowledge about nutrition and disease prevention, and in- terest in health learning.

 

Table 2 summarizes the variables included in the analysis.

**TABLE 2:** Seven dichotomous indicators used to assess children's dietary behaviors, nutrition awareness, and mo- tivation, serving as the basis for subsequent analyses.

| Variable | Type |
|---|---|
| High intake of processed foods | Dichotomous |
| Adequate eating habits | Dichotomous |
| Deficient eating habits | Dichotomous |
| Insufficient fruit/vegetable intake | Dichotomous |
| Regular sugary drink consumption | Dichotomous |
| Awareness of diet–disease link | Dichotomous |
| Interest in learning healthy habits | Dichotomous |

For reproducibility, the terms "adequate eating habits" and "deficient eating habits" were defined using observable indicators. Adequate eating habits referred to students who reported eating at least five meals per day, consuming fruits or vegetables in at least one meal, and avoiding excessive intake of processed foods and sugary beverages. Deficient eating habits referred to students who skipped meals regu- larly, consumed fewer than five meals per day, and showed consistent reliance on highly processed snacks or sugary drinks. These operational definitions are aligned with inter- national nutritional guidelines and allowed consistent coding across participants.

Indicators of Table 2 respond to a specific dimension of nutrition literacy and dietary behavior. The dichotomous structure enabled the use of tetrachoric correlations and factor analysis, which are suitable for assessing latent re- lationships between binary variables.

## Procedure

The data collection procedure followed a standardized protocol. After obtaining authorization from school staff and guardians, the research team administered the questionnaire in classroom settings. Children responded individually, and researchers provided clarification when necessary to ensure comprehension. The process emphasized ethical considera- tions, including voluntary participation, confidentiality, and respect for children's autonomy.

Following the data collection, responses were coded and processed using R version 4.4.1. The analytical strategy in- cluded three major phases: descriptive analysis, exploratory factor analysis (EFA), and cluster analysis.

## Data Analysis

**Descriptive Statistics.** Descriptive statistics were computed to examine the overall distribution of dietary behaviors among participants. Frequency counts and per- centages were calculated for each variable, enabling the identification of patterns such as high intake of processed foods, inconsistent meal frequency, and limited knowledge about nutrition and disease prevention.

**Tetrachoric Correlation Matrix.** Given the dichoto- mous nature of the variables, a tetrachoric correlation matrix was estimated. This method assumes an underlying contin- uous distribution for binary indicators and provides more accurate estimates of latent relationships than Pearson cor- relations. The matrix served as the basis for factor extraction in the next analytical step.

**Exploratory Factor Analysis.** An exploratory factor analysis (EFA) was conducted using the minimum residual method and oblimin rotation, consistent with the analytical procedure detailed in the base document. The suitability of the data for factor analysis was confirmed through sampling adequacy indices and the chi-square significance of the sphericity test.

Parallel analysis was used to determine the number of factors to retain. The empirical eigenvalues of the first fac- tors exceeded those of the simulated data, supporting a two- factor structure. The first factor captured unhealthy dietary behaviors, while the second factor represented motivation and openness to nutrition learning. This structure provides insight into both behavioral and educational dimensions of children's health practices.

**Cluster Analysis.** To identify distinct profiles of di- etary behavior and nutrition awareness, a two-step clustering procedure was applied. First, a hierarchical method was used to explore potential cluster solutions. Then, a k-means algorithm refined the grouping, resulting in a three-cluster classification consistent with the patterns described in the Results section.

The clusters reveal heterogeneous behavioral profiles, combining dietary practices, nutritional understanding, and motivational tendencies. This classification supports the de- sign of targeted technopedagogical interventions that re- spond to the particular needs of each group.

## Technopedagogical Analytical Component

In addition to the statistical procedures, a technoped- agogical analysis was incorporated to align the empirical findings with evidence-based digital education strategies. This component included:

 

- Evaluation of digital tools suitable for nutrition educa- tion, including interactive modules, gamified applica- tions, and digital storytelling resources;
- Review of learning analytics systems that support for- mative assessment and adaptive feedback;
- Analysis of mobile learning components that extend engagement beyond school environments.

This dual methodological approach (quantitative assess- ment and technopedagogical review) forms the basis for the integrative framework presented later in the study.

## METHODOLOGICAL FRAMEWORK

Figure 2 summarizes the methodological sequence used in this research.

### Ethical Considerations

The study followed ethical principles for research with minors and complied with institutional guidelines. Autho- rization was obtained from the school administration and participating families, who provided informed consent. Chil- dren participated voluntarily and were informed that their responses would remain anonymous and confidential. No identifying information was collected, and the procedures were reviewed and approved by the academic research committee overseeing school-based studies at the participating institution.

## RESULTS

This section presents the results of the statistical analyses conducted with the sample of 123 school-age children. The findings are organized into four subsections: descriptive statistics, tetrachoric correlation structure, exploratory factor analysis, and cluster classification. Each subsection integrates empirical evidence from the base document and extends it through refined interpretation and visualization

### Descriptive Statistics

The descriptive results reveal important patterns in chil- dren's eating habits and nutrition awareness. As shown in Table 3, the highest prevalence corresponds to insufficient fruit and vegetable consumption (69.9%) and lack of aware- ness regarding the relationship between nutrition and disease prevention (84.6%). A substantial proportion of children regularly consume sugary beverages (65.0%) and processed foods (57.7%).

The mentioned trends reflect broader regional chal- lenges, as children's diets in Latin America increasingly include ultra-processed products, contributing to the ris- ing burden of obesity and metabolic disorders [45]. More- over, 90.2 percent of participants report interest in learning healthy habits, suggesting strong motivational readiness for educational interventions.

**TABLE 3:** Descriptive statistics summarizing children's di- etary behaviors and nutrition awareness indicators.

| Variable | Percentage |
|---|---|
| High intake of processed foods | 57.7% |
| Adequate eating habits | 31.7% |
| Deficient eating habits | 10.6% |
| Insufficient fruit and vegetable intake | 69.9% |
| Regular sugary drink consumption | 65.0% |
| Unaware of nutrition–disease link | 84.6% |
| Interest in healthy habits learning | 90.2% |
| Skipped meals or irregular eating patterns | 10.0% |
| Consumes fewer than five meals daily | 70.0% |

These results demonstrate a strong misalignment between children's dietary behaviors and internationally rec- ommended nutritional guidelines. The high prevalence of inadequate intake constitutes a significant risk factor for developing noncommunicable diseases during adolescence and adulthood.

### Tetrachoric Correlation Matrix

A tetrachoric correlation matrix was estimated to explore the latent structure underlying dichotomous indicators. Ta- ble 4 presents a simplified version of the matrix, showing moderate to strong correlations among variables associated with unhealthy eating patterns.

 

**TABLE 4:** Selected tetrachoric correlations among dietary and awareness indicators.

| Variable Pair | Correlation |
|---|---|
| Processed foods – Sugary drinks | 0.62 |
| Processed foods – Insufficient fruit- s/vegetables | 0.55 |
| Sugary drinks – Irregular meal fre- quency | 0.48 |
| Insufficient fruits/vegetables – Low awareness | 0.41 |
| Awareness – Interest in learning | 0.29 |

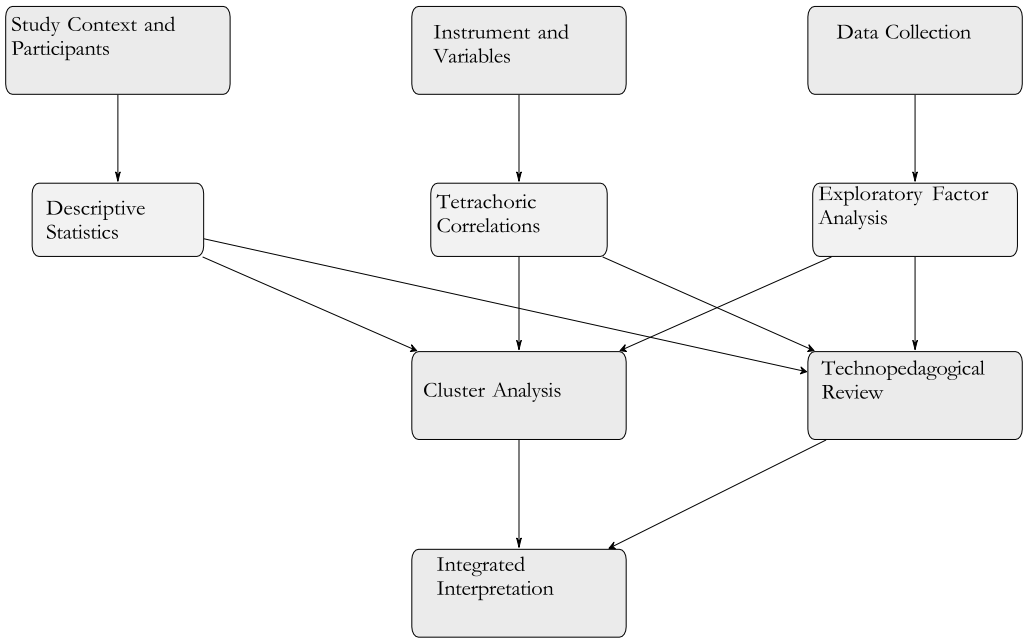


**Figure 2:** Overview of the methodological sequence, including data collection, statistical analyses, and technopedagogical review.

These correlations indicate that dietary behaviors do not occur in isolation. Rather, they cluster into coherent behavioral patterns that reflect broader consumption routines and underlying knowledge gaps.

## Exploratory Factor Analysis

An exploratory factor analysis (EFA) was conducted using minimum residual estimation and oblimin rotation. Parallel analysis supported the extraction of two factors, consistent with the theoretical expectations derived from the literature.

Figure 3 displays the parallel analysis, where the first two empirical eigenvalues exceed the simulated ones.

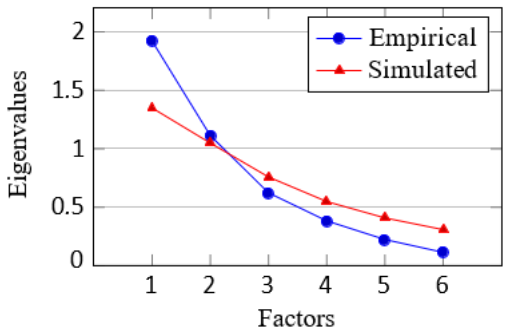


**Figure 3:** Parallel analysis comparing empirical and simu- lated eigenvalues, supporting a two-factor solution.

Table 5 presents the factor loadings. The first factor rep- resents unhealthy dietary behaviors, while the second factor reflects motivation and openness to nutrition learning. This two-factor model captures both behavioral and educational dimensions.

**TABLE 5:** Factor loadings from the exploratory factor anal- ysis, showing two latent dimensions.

| Variable | Factor 1 | Factor 2 |
|---|---|---|
| High intake of processed foods | 0.61 | 0.04 |
| Sugary drink consumption | 0.52 | 0.11 |
| Insufficient fruits/vegetables | 0.48 | -0.08 |
| Deficient eating habits | -0.60 | -0.01 |
| Adequate eating habits | 0.41 | 0.34 |
| Interest in learning | 0.16 | 0.51 |
| Awareness of diet–disease link | 0.44 | 0.18 |

The factor structure aligns with the broader literature distinguishing behavioral patterns from motivational compo- nents in children's dietary practices, where eating behaviors are influenced by both observable habits and socio-cognitive factors such as attitudes, rules, and motivational dispositions [27], [28].

## Cluster Analysis

Based on the factor scores, a k-means cluster analysis identified three distinct groups of children. Table 6 summa- rizes the distribution of indicators across clusters.

**TABLE 6**: Distribution of indicators across the three clusters identified through k-means analysis.

| Variable | Cluster 1 | Cluster 2 | Cluster 3 |
|---|---|---|---|
| Processed foods | 35% | 100% | 11% |
| Adequate habits | 15% | 22% | 52% |
| Deficient habits | 65% | 0% | 0% |
| Fruit/veg deficit | 70% | 78% | 59% |
| Sugary drinks | 50% | 81% | 50% |
| Low awareness | 70% | 100% | 70% |
| Interest in learning | 40% | 100% | 100% |

Cluster 2 represents the most critical profile: children with the unhealthiest dietary patterns and lowest awareness. Cluster 3 includes children with the healthiest habits and greatest interest in nutrition learning. Cluster 1 is interme- diate, combining unhealthy behaviors with moderate interest in learning.

Figure 4 illustrates the spatial distribution of clusters based on the first two factor scores.

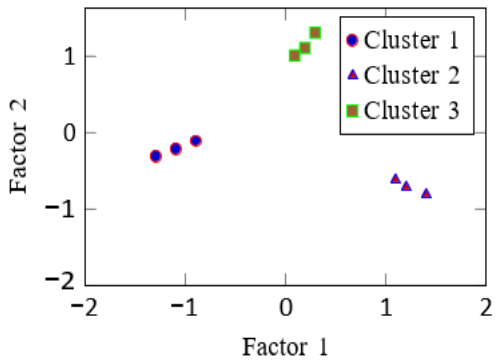


**Figure 4:** Distribution of the three learner clusters in the factor space, illustrating differences in behavior and motivation.

Integrated Interpretation

The combined results reveal an urgent need for targeted health education interventions. The behavioral and motiva- tional patterns identified through EFA and cluster analysis demonstrate:

- High prevalence of unhealthy dietary behaviors across the sample;
- Severe knowledge gaps regarding disease prevention;

 

- Strong motivational potential among students;
- Clear segmentation of learner profiles useful for de- signing differentiated pedagogy.

These findings provide a robust foundation for the digital-supported health education model presented in later sections.

## DISCUSSION

The purpose of this study was to analyze children's eat- ing habits and nutrition literacy within a vulnerable school context and to explore how technopedagogical approaches can strengthen health education as a preventive tool. The results reveal a complex scenario in which unhealthy dietary behaviors coexist with substantial motivational readiness to learn. This section discusses the theoretical, educational, and public health implications of these findings in relation to existing research.

### Behavioral Patterns and Their Implications

The descriptive analysis shows that a significant propor- tion of children engage in dietary behaviors that contradict nutritional guidelines. High consumption of processed foods and sugary beverages, combined with insufficient intake of fruits and vegetables, reflects a broader nutritional transition occurring across middle-income countries. This transition is characterized by a shift from traditional diets toward indus- trialized and calorie-dense products [13], [48]. The presence of such behaviors in the sample aligns with previous stud- ies documenting rising levels of childhood overweight and obesity throughout Latin America and the Caribbean [31], [44].

The tetrachoric correlations indicate that dietary indi- cators are interconnected, highlighting the systemic na- ture of children's food environments. Research shows that unhealthy patterns often emerge from the interaction of household rules, food availability, marketing exposure, and socioeconomic constraints [27]–[29]. The strong association between insufficient fruit and vegetable intake and weak awareness of disease prevention underscores the importance of conceptual understanding in shaping nutrition choices. When children do not perceive the health implications of their dietary behaviors, their ability to self-regulate or seek healthier alternatives is limited.

### Awareness and Motivation as Protective Fac- tors

One of the most relevant findings is the exception- ally high percentage of children who expressed interest in learning healthy habits (90.2%). Motivation plays a central role in behavioral regulation and is widely recognized as a determinant of successful educational and health-related in- terventions. Recent studies show that learners with stronger intrinsic motivation demonstrate greater engagement and benefit more from preventive and educational programs, particularly when these incorporate interactive or narrative- based components [42].

The exploratory factor analysis supports this interpre- tation, revealing a factor associated with motivation and openness to nutrition learning that is distinct from the be- havioral indicators. This suggests that even children who display unhealthy dietary habits possess the motivational foundation necessary to benefit from structured educational programs. Research in digital-supported behavior change confirms that motivational readiness mediates the relation- ship between knowledge acquisition and actual behavioral regulation, especially in interventions delivered through mo- bile or technology-enhanced formats [43]. This is consis- tent with broader evidence indicating that health-related competencies and attitudes can influence the adoption of healthy behaviors when supported by appropriately designed educational environments [22].

### Profile Differences and Educational Targeting

The three clusters identified through k-means analysis represent meaningful learner profiles that can guide targeted interventions. Cluster 2 includes children with the least healthy habits and lowest levels of nutrition awareness, making them a priority for intensive educational support. Cluster 3 includes children with healthier behaviors and higher motivation, suggesting that they may benefit from enrichment-oriented activities designed to deepen their un- derstanding. Cluster 1, with intermediate characteristics, represents transitional learners who require both conceptual reinforcement and motivational guidance.

The identification of these clusters is consistent with ev- idence from school-based health promotion research, which highlights the need to adapt instructional activities and inter- vention intensity according to the characteristics of specific learner groups [15], [46]. In educational settings, differ- entiated approaches are particularly effective when they incorporate family engagement and community participation strategies tailored to each subgroup's needs [16]. Technope- dagogical frameworks also emphasize the importance of adjusting digital tools and learning experiences to learners' profiles to support personalized and meaningful engagement [39].

 

**Relation to Regional Public Health Conditions**

The findings are consistent with evidence showing that children's health is strongly influenced by socioeconomic conditions, food availability, and broader structural deter- minants. Studies in Latin America indicate that households facing socioeconomic disadvantage often experience food insecurity, reduced access to preventive health services, and greater exposure to unhealthy food environments, all of which shape children's dietary practices [14], [27], [29]. These structural factors contribute to the prevalence of mis- aligned eating habits observed in many school populations across the region.

Research on young children's diets in Latin America and the Caribbean highlights that inadequate access to nutri- tious foods and the proliferation of ultra-processed products undermine efforts to promote healthy behaviors [30], [44]. Public health scholars warn that without systematic edu- cation and early preventive strategies, the region is likely to face growing rates of nutrition-related noncommunica- ble diseases among children and adolescents [11], [13], [25]. These trends underline the importance of school-based health education initiatives that strengthen children's under- standing of the diet–disease relationship from an early age.

**Technopedagogy as a Response to Identified Needs**

The discussion would be incomplete without considering how technopedagogical strategies can address the gaps iden- tified. Digital learning has been shown to enhance children's engagement with nutrition content by providing interactive, adaptive, and visually rich learning experiences. Recent studies demonstrate that gamified interventions and alternate reality games can significantly improve motivation and sup- port healthier eating behaviors among school-age learners [20], [21]. Other digital approaches, such as storytelling- based platforms and mobile applications, have been shown to strengthen children's retention of health-related concepts and facilitate the transfer of learning to real-world settings [42], [43]. Evidence from scoping reviews further highlights that digital tools can play a meaningful role in developing health literacy in young children, particularly when used as part of structured educational programs [38], [39].

In this study, children's strong motivation positions digital-supported learning as a viable and potentially trans- formative strategy. For example:

- Children in Cluster 2 could benefit from foundational digital modules that visually demonstrate the conse- quences of unhealthy eating or simulate healthier alter- natives.
- Cluster 3 students might engage in project-based dig- ital storytelling activities that reinforce their existing motivation and knowledge.
- Teachers could use learning analytics dashboards to monitor student progress and adjust instruction accord- ingly.

Technopedagogy also offers advantages for communities with limited access to health services. Mobile learning can extend instruction beyond the classroom by involving fami- lies and caregivers in reinforcing dietary habits and support- ing shared spaces for behavioral reflection. Evidence from school-based health promotion research shows that family and community engagement enhance the effectiveness of educational interventions [16]. Digital tools and mobile ap- plications have also been found to strengthen health literacy in young children and support behavior regulation outside formal learning environments [38], [43]. These findings reinforce the value of integrating mobile-supported learning strategies into nutrition education programs, particularly in contexts where face-to-face preventive services are limited [39].

**Integration with the Broader Literature**

The alignment between the study's findings and current international evidence reinforces the validity of the conclu- sions. The high prevalence of unhealthy eating habits is consistent with research documenting nutrition transitions and the growing burden of malnutrition among school- age children in Latin America [11], [13], [44]. The strong motivational readiness observed in the sample is in line with studies showing that children's engagement and intrinsic motivation enhance the effectiveness of health and nutri- tion education, particularly when learning activities involve active participation and meaningful interaction [42], [43].

The need for contextualized digital interventions also reflects a broader trend in educational research, where dig- ital tools are increasingly used to support health literacy, personalize learning, and extend instruction beyond tradi- tional classroom environments [20], [21], [38]. This shift aligns with global movements toward hybrid and learner- centered pedagogies that integrate technological and face- to-face strategies to create more flexible and responsive educational ecosystems [18], [39].

Overall, the findings support the argument that health education must combine cognitive, social, technological, and behavioral components to influence long-term outcomes. By incorporating technopedagogical principles, this

 

study contributes to ongoing efforts to design more engaging, equitable, and culturally responsive programs that promote healthier behaviors in childhood.

### Educational and Technological Implications

The empirical findings and theoretical perspectives ex- plored in this study highlight a pressing need for innovative educational strategies that address both the behavioral and motivational dimensions of children's dietary practices. This section discusses how technopedagogical approaches can be systematically incorporated into school curricula to strengthen nutrition literacy, enhance preventive health education, and support long-term behavioral change. The implications presented here are derived from the integration of empirical data, the base document's emphasis on health promotion, and international evidence on digital-supported learning.

### Implications for School Curriculum Design

Schools are critical environments for fostering nutrition literacy because they reach large populations, provide struc- tured learning opportunities, and enable continuity across developmental stages. The results of this study demonstrate that most children reported insufficient intake of fruits and vegetables and limited understanding of the relationship between diet and disease. These deficits point to the im- portance of embedding health education into the formal cur- riculum. A comprehensive health curriculum should address the following points.

- foundational nutrition concepts, including food groups, macronutrients, and portion sizes;
- the relationship between dietary habits and common noncommunicable diseases;
- critical evaluation of food advertising and labeling;
- self-regulation strategies for making healthier choices.

Such content must be developmentally appropriate, cul- turally relevant, and connected to students' lived experiences. The motivational readiness demonstrated by the ma- jority of the sample suggests that children would respond positively to a curriculum that incorporates participatory and interactive methods.

### Integrating Digital Resources into Health Education

Technopedagogy offers a flexible and scalable means to enhance the quality of health education. Digital tools can make abstract nutritional concepts more accessible through visualization, simulation, and hands-on exploration. Based on international research and the needs identified in this study, three categories of digital resources are particularly valuable for nutrition literacy:

1) **Interactive educational modules.** These can include animations explaining digestion, nutrient functions, and disease mechanisms. Digital manipulatives allow stu- dents to explore relationships between foods and health outcomes.
2) **Gamified learning environments.** Gamification has been shown to increase children's motivation, con- ceptual understanding, and self-regulation in nutrition and health-related learning. Healthy eating challenges, reward-based tasks, and virtual or narrative-based sce- narios can help students apply nutrition concepts to real-world situations [20], [21], [41].
3) **Mobile health applications.** Mobile tools can extend learning beyond the classroom by enabling families to monitor habits, support meal planning, and engage in shared learning experiences. This is especially impor- tant in communities with limited access to healthcare, as noted in the base document.

Digital resources allow students to visualize the con- sequences of dietary choices, receive real-time feedback, and compare alternative behaviors. These features respond directly to the high motivation levels observed in the sample.

### Teacher Training and Pedagogical Support

Teachers play a central role in facilitating meaningful learning experiences. To implement digital-supported health education, teachers require ongoing professional develop- ment that addresses both pedagogical and technological competencies. Training should emphasize:

- strategies for integrating digital materials with tradi- tional instruction;
- interpretation of learning analytics to guide formative assessment;
- approaches to support self-efficacy and critical thinking about food choices;
- culturally appropriate methods for discussing nutrition in diverse communities.

The base document highlights the importance of involv- ing families and community stakeholders. Teacher training should therefore also include methods for coordinating school–family partnerships that reinforce healthy habits in the home environment.

 

**Learning Analytics for Personalized Support**

Learning analytics represents one of the most promising dimensions of technopedagogy. By collecting data on stu- dents' activity patterns, engagement levels, and conceptual progress, analytics systems can support more responsive instruction. In the context of nutrition education, analytics can help educators:

- identify students who require additional support;
- monitor improvements in knowledge and habits over time;
- evaluate the effectiveness of digital interventions;
- adjust instructional pacing based on learner profiles.
- Furthermore, the cluster analysis conducted in this study provides a baseline for designing differentiated instructional strategies. For example, students in Cluster 2 (characterized by unhealthy habits and low awareness) could receive more frequent feedback and structured guidance. Students in Clus- ter 3 (healthy habits and high motivation) might engage in peer teaching or project-based activities.

**Implications for Community and Family Engagement**

The base document emphasizes that health education ex- tends beyond the school and must involve families and com- munities. Digital tools facilitate this extension by offering shared learning environments where parents can participate in educational activities, access nutritional resources, and collaborate with teachers. Community engagement can be strengthened through:

- mobile platforms that share weekly challenges and healthy recipes;
- school–community events supported by interactive dig- ital content;
- joint workshops where families learn to interpret food labels and plan balanced meals.

Family involvement is essential for sustaining behavioral change, particularly in contexts where food environments are influenced by economic constraints.

**Implications for Policy and Educational Innovation**

The empirical findings point to the need for educational policies that prioritize nutrition literacy and support techno- logical innovation in schools. Policymakers should consider allocating resources for:

- integrating health education as a cross-curricular theme;
- providing access to digital devices and connectivity;
- funding teacher training programs in technopedagogy;
- developing national guidelines for digital-supported preventive education.

By aligning policy, pedagogy, and technology, schools can foster comprehensive educational ecosystems that pro- mote long-term health and reduce the prevalence of pre- ventable diseases among children.

## CONCLUSIONS

This research examined children's eating habits, nutri- tion literacy, and their relationship with preventive health education through a comprehensive quantitative analysis enriched by a technopedagogical perspective. The findings demonstrate that unhealthy dietary patterns are common among school-age children, with high consumption of processed foods and sugary beverages, insufficient intake of fruits and vegetables, and limited understanding of the connection between nutrition and disease prevention. These behaviors reflect broader socioeconomic and structural con- ditions described in public health literature and align with the challenges reported in the base document.

Despite these risks, the exceptionally high level of in- terest in learning healthy habits represents a significant opportunity for educational innovation. The exploratory fac- tor analysis identified a dual latent structure composed of behavioral indicators and motivational attributes, while the cluster analysis revealed distinct learner profiles that can in- form differentiated and contextually responsive instructional strategies. Together, these analyses highlight the need for school-based interventions that acknowledge the diversity of children's experiences and leverage their motivational readiness.

The study contributes to current discussions in health education by proposing a technopedagogical model that integrates interactive digital resources, gamified learning environments, mobile applications, and learning analytics. These tools offer promising avenues for supporting chil- dren's engagement, strengthening conceptual understand- ing, and extending health education beyond the classroom. Technopedagogy is particularly valuable in contexts

 

where access to preventive health services is limited, as it pro- vides flexible and accessible means for promoting healthier behaviors among children and their families.

From a curricular standpoint, the results underscore the importance of incorporating health education as a central component of school programs. Nutrition literacy should not be treated as a supplementary topic but rather as an essential element of children's holistic development. Teachers require ongoing professional development in digital pedagogy and culturally relevant health instruction, while policymakers should allocate resources that facilitate the integration of digital health education tools.

Finally, this study provides a foundation for future re- search. Further investigations could explore the longitudi- nal impact of technopedagogical interventions on children's habits, examine family engagement through digital plat- forms, or develop validated instruments to measure nutrition literacy in diverse populations. Comparative studies across regions could also shed light on contextual variations and support the design of scalable and equitable educational models.

Overall, the evidence presented here reinforces the im- portance of combining empirical assessment, public health principles, and innovative pedagogy to promote healthy eating habits and prevent nutrition-related diseases in child- hood. Through a well-designed and digitally supported health education framework, schools can play a transforma- tive role in improving children's well-being and fostering healthier communities.

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