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# Digital strategies for healthy eating in schoolchildren beneficiaries of state programs

## Estrategias digitales para la alimentación saludable en escolares beneficiarios de programas estatales

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## ABSTRACT

This study addresses the application of digital strategies to promote healthy eating among schoolchildren benefiting from state programs, given their relevance to child health and their transformative potential. An exploratory systematic review was conducted, focusing on scientific articles published between 2020 and 2024 in the Scopus database. Twenty-eight selected studies were analyzed using inclusion criteria related to methodological quality, thematic relevance, and open access. The results identify a variety of technologies, such as mobile applications, gamified platforms, chatbots, and artificial intelligence-based systems, highlighting those that offer personalization, accessibility, and motivation as the most effective for improving eating habits. However, their implementation faces structural barriers, such as lack of connectivity, low digital literacy, and limited integration with school programs. It is concluded that digital strategies have great potential to transform food education, but their effectiveness will depend on their cultural contextualization, sustainability, and integration with comprehensive public policies that guarantee equity, community participation, and continued implementation.

**Keywords:** digital access; eating habits; mobile apps; nutritional literacy; school programs

## RESUMEN

El presente estudio aborda la aplicación de estrategias digitales para promover la alimentación saludable en escolares beneficiarios de programas estatales, dada su relevancia en la salud infantil y su potencial transformador. Se empleó una revisión sistemática de carácter exploratorio, centrada en artículos científicos publicados entre 2020 y 2024 en la base de datos Scopus. Se analizaron 28 estudios seleccionados mediante criterios de inclusión relacionados con la calidad metodológica, pertinencia temática y acceso abierto. Los resultados identifican una diversidad de tecnologías, como aplicaciones móviles, plataformas gamificadas, chatbots y sistemas basados en inteligencia artificial, destacando aquellas que ofrecen personalización, accesibilidad y motivación como las más efectivas para mejorar hábitos alimenticios. Sin embargo, la implementación enfrenta barreras estructurales, como la falta de conectividad, la baja alfabetización digital y la limitada integración con los programas escolares. Se concluye que las estrategias digitales poseen alto potencial para transformar la educación alimentaria, pero su efectividad dependerá de su contextualización cultural, su sostenibilidad y su articulación con políticas públicas integrales que garanticen equidad, participación comunitaria y continuidad en su aplicación.

**Palabras clave:** acceso digital; alfabetización nutricional; aplicaciones móviles; hábitos alimentarios; programas escolares

## 1. INTRODUCTION

The promotion of healthy eating in schoolchildren has gained relevance in public policies due to its direct impact on children's physical, cognitive, and emotional development. Faced with the increase in non-communicable diseases associated with poor eating habits, governments have promoted various intervention programs in school settings, supported by international organizations such as the World Health Organization (OMS, 2018) and the Food and Agriculture Organization of the United Nations (FAO), which recommend the use of digital tools as an effective means of promoting healthy nutritional practices from an early age (FAO, 2024; OPS, 2021). Within this framework, digital strategies, such as mobile applications, interactive platforms, chatbots, and serious games, have established themselves as key mechanisms for educating, motivating, and transforming the eating behaviors of children and adolescents (Fernández-Panaifo & Angulo-Ríos, 2023; Herrera Cotrina et al., 2020).

The advancement of digital technologies has generated a new ecosystem of educational interventions that transcends traditional methods. Through the use of personalized technological resources, nutritional messages have been adapted to the language and dynamics of the school population, incorporating gamified content, automated notifications, and real-time data analysis (Moreno-Guerrero et al., 2021; Herrera Cotrina et al., 2020). These systems not only increase student active participation but also involve their families and teachers, generating a collaborative environment that favors the sustainability of changes in eating habits. Compared to conventional models, digital strategies stand out for their scalability, low operating costs, and flexibility to be implemented in diverse school settings, including rural and marginalized urban areas (Berger & Jung, 2024).

Despite their benefits, the adoption of these technologies presents significant challenges, especially in vulnerable contexts. In many cases, schools lack stable internet access, technological devices, or trained personnel to effectively integrate these tools into the educational curriculum (Rodríguez Degiovanni, 2024; Valles et al., 2020). At the local level, programs such as Qali Warma in Peru, which aims to guarantee access to adequate nutrition for students in public institutions, have begun to explore the use of digital tools to reinforce nutrition education. However, the technological gap persists, especially in Andean and Amazonian regions, where connectivity problems, institutional fragmentation, and socioeconomic conditions limit the reach of these types of interventions (MIDIS, 2021).

Internationally, initiatives such as Healthy Schools in the United Kingdom, MyPlate in the United States, and the EPODE program in Europe have incorporated interactive digital resources to strengthen food literacy and nutritional self-care among schoolchildren. These experiences have shown promising results in terms of knowledge, intention to change, and student participation (Jones Bell et al., 2020; Merino-Godoy et al., 2022). However, the effectiveness of these digital solutions depends largely on the socio-educational context, the cultural appropriateness of the content, and the degree of integration with current public policies, both at the central and subnational levels.

A critical aspect for the implementation of digital strategies in school feeding is inter-institutional coordination. In Peru, the coordination between the health, education, and social development sectors still faces difficulties in integrating technological platforms into the operational implementation of food programs (Céspedes Aldana et al., 2021). The lack of unified digital

indicators, online monitoring systems, and impact assessment models with a territorial focus impedes the effective and sustainable adoption of digital tools, especially in regions with high cultural and geographic diversity (Domínguez-Jiménez et al., 2024).

Given this situation, it is necessary to conduct a comprehensive review of the scientific literature addressing the use of digital strategies to promote healthy eating among students benefiting from public programs. This article aims to identify the main technologies used, their most notable results, implementation barriers, and gaps in recent research. Based on an analysis of studies published between 2020 and 2024, the article seeks to provide academic evidence for the design and integration of sustainable digital tools, adapted to real-life school contexts and aligned with the priorities of public programs.

## 2. MATERIALS AND METHODS

To conduct this research, an exploratory systematic review was used, a methodology that allowed for an orderly and critical examination of scientific literature related to the use of digital strategies to promote healthy eating among schoolchildren benefiting from state programs. This approach facilitated the identification of technologies used, results obtained, documented barriers, and research gaps that persist in recent academic literature (Fernández-Sánchez et al., 2020). The application of this methodology also contributes to establishing a solid documentary basis for the design of future digital interventions adapted to vulnerable school contexts (Sunkel et al., 2013).

The methodological procedure adopted was based on the recommendations proposed by Page et al. (2021), structured in two main phases: planning and execution. In the planning stage, the review objectives were defined, five guiding research questions were formulated, and relevant key terms and synonyms were identified to construct the search equations. In addition, the most appropriate academic database, Scopus, was selected for its multidisciplinary coverage. Inclusion and exclusion criteria were established, a checklist was developed to assess article quality, and a form was designed for systematic information extraction.

During the execution phase, specific combinations of keywords related to "digital strategies," "healthy eating," "school-based," "health promotion," and "behavior change" were applied, focusing the search on the period 2020–2024. The results filtering process was carried out in three consecutive stages: first, duplicate studies were eliminated to avoid redundancies; then, the titles, abstracts, and keywords of the filtered documents were reviewed, applying the previously established inclusion and exclusion criteria. Finally, the methodological quality of the studies was assessed using a scoring matrix focused on clarity of objectives, thematic relevance, applicability of results, and analytical rigor.

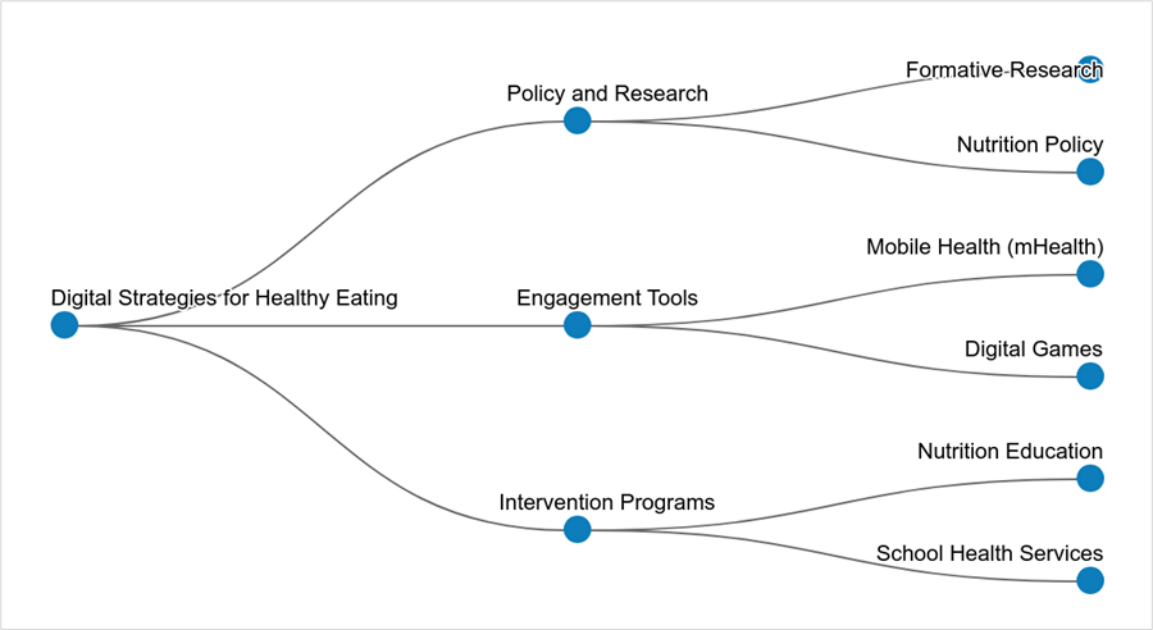


**Figure 1.** Strategic keyword search

Only those articles that met the defined parameters and obtained a favorable methodological rating according to the applied evaluation matrix were considered for the final analysis.

Finally, data from the selected documents were extracted and systematized. This information was organized into an analytical matrix with variables such as article code, title, type of digital strategy, technologies used, beneficiaries' educational level, reported barriers, outcomes, and participation in state programs. This analysis identified predominant methodological approaches, the most effective technologies, recurring implementation challenges, and gaps in the recent literature on digital strategies for promoting healthy eating habits in schools.

### 2.1. Research Questions

The following questions were posed:

1. What digital strategies have been applied to promote healthy eating among schoolchildren in state programs?

2. Which digital technologies have shown the best results in improving eating habits in this group?

3. What barriers have been identified in the implementation of these strategies in vulnerable school settings?

4. What role have state programs played in the adoption of digital tools for healthy eating?

5. What gaps persist in recent research on digital strategies for school nutrition?

### 2.2. Search Strategy

To identify relevant articles, we used a strategy based on key terms directly related to the study's objective, covering concepts linked to digital strategies, school nutrition, food education, and healthy eating habits in children and adolescents. This strategy allowed us to focus the review on scientific research focused on technological solutions applied to promoting healthy eating in education, especially among schoolchildren who benefit from state programs or who are in situations of social vulnerability.

The initial search was conducted in the Scopus database, using the following combination of terms:

*("digital strategy" OR "digital intervention" OR "online approach" OR "e-health") AND ("healthy eating" OR "nutrition" OR "diet" OR "food choices") AND ("schoolchildren" OR "children" OR "youth" OR "students") AND ("education" OR "awareness" OR "promotion" OR "engagement") AND ("behavior change" OR "lifestyle" OR "habits" OR "wellness")*.

This preliminary search yielded a total of 7,819 documents related to the use of digital technologies to promote healthy eating habits in schoolchildren.

To reduce the volume of results and focus the analysis on the most relevant studies, stricter filtering criteria were applied: only scientific articles (document type: "article"), in their final publication stage (publication stage: "final"), written in English, published between 2020 and 2024, and available through open access were considered. Results were also limited to sources such as scientific journals or academic books (source type: "j" or "b"). Applying these filters reduced the total to 2,337 potentially relevant documents.

The selection process consisted of four clearly defined stages. First, the search string was applied, considering titles, abstracts, and keywords. Second, duplicate articles were eliminated, and those that did not meet the established thematic criteria were excluded. Subsequently, the full texts of the selected studies were reviewed, prioritizing those that specifically addressed digital interventions aimed at promoting healthy eating in schoolchildren. Finally, 28 articles were selected that met all the defined quality and relevance parameters.

The selected articles were organized in an Excel 365 spreadsheet, where they were systematically coded according to title, authorship, year of publication, journal, type of technology used, educational level addressed, presence or absence of state programs, methodological approach, and main findings related to improving eating habits through digital strategies. This classification allowed us to identify patterns, regional differences, most commonly used technologies, observed results, reported barriers, and research gaps, which are analyzed in detail in the following sections of the article.

## 3. RESULTS AND DISCUSSIONS

The literature review identified various digital strategies, technologies used, reported benefits, limitations, and opportunities for improvement related to promoting healthy eating among schoolchildren benefiting from state programs. The findings are presented below, organized into five categories, according to the previously defined research questions.

### 3.1. What digital strategies have been applied to promote healthy eating among schoolchildren in state programs?

In recent years, digital strategies for promoting healthy eating among schoolchildren have undergone significant evolution driven in part by the need to modernize traditional approaches to nutrition education and in part by the rise of mobile technologies. These strategies have been primarily designed to strengthen state school feeding programs and are focused on generating positive changes in the eating habits of children and adolescents. Multiple initiatives were identified that use digital platforms as the primary means to encourage more informed and healthy eating decisions from an early age.

One of the most common strategies is the use of interactive mobile applications that provide educational content tailored to the cognitive level of schoolchildren. These apps integrate fun features such as trivia, challenges, and food intake tracking, allowing students to learn about nutrition in a dynamic way. Furthermore, there is a growing trend toward the use of gamification as a pedagogical tool, transforming the nutritional learning experience into a motivating and entertaining process. This type of approach has been implemented in several school settings with institutional support, promoting key dietary skills such as conscious food choices and self-regulation of consumption.

Another important strategy is the use of automated messaging systems, such as educational chatbots via SMS or social media, that offer personalized recommendations on eating habits. These programs have been successfully used in school populations benefiting from state programs in countries such as Denmark, Canada, and Saudi Arabia, where messages targeted at both students and families are integrated. These systems allow for constant monitoring, which is especially useful in settings with limited technological infrastructure or difficulties accessing more complex platforms.

Likewise, intelligent recommendation systems based on artificial intelligence have been developed, capable of suggesting changes to the school diet based on the nutritional profile, cultural preferences, and food access in each region. These tools have been tested primarily as pilots or in controlled trials, and although they are still in the experimental stage in many countries, they represent an innovative opportunity to strengthen school food policies, especially in coordination with state programs or initiatives. Overall, the review found that these digital strategies not only seek to inform but also generate meaningful and sustained experiences. Platforms for monitoring daily consumption, virtual environments for promoting healthy habits, and gamified systems have contributed to consolidating school environments that are more aware of the value of a balanced diet. However, their effective implementation requires the support of public policies, teacher training, and integration with existing school food services.

**Table 1.** Types of digital interventions applied to schoolchildren to promote healthy habits

| Applied Digital Strategy | Article Code |
|---|---|
| Mobile applications (apps) | A1, A4, A6, A7, A8, A9, A13, A14, A19, A20, A22, A26 |
| eHealth or web platforms | A2, A3, A6, A10, A11, A13, A18, A26 |
| Chatbots or automated messaging | A1, A5, A6, A7, A17 |
| Gamification / serious games | A4, A9, A14, A22, A25 |
| Personalized interventions / digital coaching | A2, A6, A13, A19, A20 |
| Participatory tools / citizen science | A23, A28 |
| AI and Big Data-based systems | A16, A24 |
| Educational robotics | A12, A27 |
| Digital assessments in early childhood education | A3, A18 |

### 3.2. Which digital technologies have shown the best results in improving eating habits in this group?

Various studies agree that the most effective digital technologies for improving eating habits in schoolchildren are those that combine personalization, accessibility, and motivational elements. First, mobile apps with personalized feedback stand out, capable of recording food intake, offering recommendations tailored to the user's profile, and delivering motivational messages. These apps

allow for continuous interaction and have been shown to improve adherence to healthy diets when integrated with school curriculum or state food programs.

Second, the positive impact of gamified platforms is highlighted, especially those that use serious games focused on nutrition education. These platforms encourage active student participation through missions, rewards, challenges, and simulations, which contributes to greater knowledge retention and sustainable behavior changes. The studies reviewed show that when these technologies are implemented within the framework of state programs and school wellness initiatives, the effects are longer-lasting and motivation levels increase significantly. Another effective technology is the use of intelligent messaging systems, including chatbots or automatic SMS reminders and social media apps. These tools, although simpler, have proven especially useful in areas with low connectivity or for families with limited digital skills. By offering direct, brief, and contextually relevant recommendations, they have led to improved adherence to healthy daily dietary practices, as well as greater family engagement in the educational process.

Artificial intelligence-based tools, such as dietary change recommenders that analyze individual behavior patterns and preferences, have also shown promising results. These technologies, although still in the pilot phase in many cases, allow for a more scientific and adaptive approach to the design of school menus and consumption suggestions, optimizing the link between education, technology, and public food policy.

Overall, technologies that offer interactivity, mobile accessibility, and personalization stand out for their greater impact on improving eating habits. Their effectiveness is enhanced when combined with state programs that provide institutional support and logistical resources, creating a school environment that not only provides healthy food but also actively educates students about its importance and encourages informed choices from childhood.

**Table 2.** Digital tools with outstanding results in dietary changes

| Effective digital technologies | Article Code |
|---|---|
| Custom mobile apps | A1, A4, A6, A7, A8, A9, A13, A14, A19, A20, A22, A26 |
| Serious games with feedback | A4, A9, A14, A22, A25 |
| Habit monitoring systems (apps + sensors) | A6, A10, A16, A20, A24, A28 |
| Adaptive eHealth platforms | A2, A3, A6, A10, A11, A13, A18, A26 |
| AI-powered chatbots and automated messaging | A1, A5, A6, A7, A17 |
| Virtual assistants / Smart recommenders | A16, A24 |
| Synchronized wearable devices | A10, A20, A28 |
| Data-driven analytics (AI, Big Data) | A6, A13, A16, A24 |

### 3.3. What barriers are identified in the implementation of these strategies in vulnerable school settings?

The implementation of digital strategies to promote healthy eating faces various barriers in vulnerable school settings, especially in rural or marginalized urban areas. One of the most persistent is the lack of internet connectivity and limited access to electronic devices by students, families, and schools. This digital divide impedes the smooth use of mobile applications or educational platforms, limiting the reach of technological strategies even when the content is freely available.

Another major obstacle is the low digital literacy of both teachers and parents, which hinders the proper use of available tools. Many studies report that, despite having basic technological

resources, educational staff and caregivers do not always have the necessary skills to effectively implement digital programs, which generates excessive dependence on external technical support and reduces the sustainability of the initiatives.

In addition, barriers related to the lack of specific training in digital nutrition education are identified. While technologies are available, they are not always accompanied by context-adapted teaching materials or appropriate methodologies for teaching healthy habits in the digital environment. Consequently, strategies lose effectiveness if they are not integrated into the curriculum or do not respond to the cultural and dietary realities of the school environment.

Institutional resistance to change is also common, especially in educational systems with rigid structures or limited experience with technological innovation. This resistance can translate into lack of interest, limited budget allocation, or slow approval of proposals, which limits the implementation of initiatives at the national or local level. Furthermore, in some cases, state programs do not include digital components, forcing schools to seek external funding or advice.

Finally, there is a lack of cultural and linguistic contextualization of digital content designed to promote healthy eating. Many applications and platforms are developed from generic or imported approaches, without considering local food customs, food availability, or the native languages spoken by students. This cultural disconnect limits the appropriation of messages and reduces the real impact of strategies, especially in indigenous or rural communities.

**Table 3.** Main obstacles detected in the implementation of educational technologies in health

| Barriers in vulnerable school contexts | Article Code |
|---|---|
| Limited internet or device access | A1, A4, A6, A10, A13, A16, A20, A21, A26, A27 |
| Low digital literacy among students or families | A3, A5, A13, A15, A18, A19, A20 |
| Lack of family involvement or support from the community | A6, A10, A14, A19, A20, A21, A26 |
| Inequality in school technology infrastructure | A2, A5, A6, A17, A23, A24, A26 |
| Low motivation or sustained adherence | A1, A4, A8, A13, A20, A22 |
| Lack of training for educational staff | A3, A15, A18, A21, A27 |
| Stigmatization or sensitivity regarding food issues | A7, A11, A14, A27 |
| Ethical and privacy issues for minors | A5, A17, A23 |

### 3.4. What role have state programs played in the adoption of digital tools for healthy eating?

State programs have played a fundamental role in the adoption and expansion of digital tools aimed at promoting healthy eating in school settings. In many countries, these programs have functioned as structural support platforms that not only guarantee access to food but have also begun to incorporate educational and technological components to promote healthy habits. The case of Qali Warma in Peru, for example, demonstrates an approach that goes beyond the simple delivery of food rations, also promoting training actions aimed at students, families, and educational communities.

One of the key contributions of these programs has been their ability to integrate technology through institutional partnerships, bringing together ministries of education, health, telecommunications, and cooperation agencies. These synergies have enabled the implementation of educational platforms, mobile applications, and digital content adapted to the school curriculum, especially during the pandemic, when the virtual environment became the only means of educational and training continuity. This coordination between public policy and technology

has been instrumental in reducing gaps and creating more conducive environments for digital intervention.

Likewise, state programs have acted as facilitators of the infrastructure necessary for the implementation of these strategies. Through investments in connectivity, tablet distribution, and teacher training, they have created minimum conditions for the implementation of interactive platforms on nutrition and healthy living. This role has been particularly important in rural and vulnerable areas, where state intervention is key to leveling the playing field in accessing educational technology.

However, it has also been observed that state participation is uneven and, in some cases, limited to declarative actions without sustained monitoring. Some programs lack specific indicators to evaluate the impact of digital strategies on nutrition, which hinders continuous improvement. Furthermore, many of the digital tools used were not created by the state programs themselves, but rather come from academic or private initiatives, which poses challenges in terms of scalability and sustainability. As a whole, state programs have been instrumental in legitimizing, funding, and implementing digital tools that promote healthy eating habits in schools. Their role is crucial not only as food providers but also as promoters of healthy citizenship from a holistic perspective. The inclusion of digital components in these programs represents a strategic opportunity to transform the school environment into a space for active and preventive learning on food safety issues.

**Table 4.** Government participation in promoting digital solutions for healthy eating

| Role of state programs | Article Code |
|---|---|
| Partial support through funding or validation | A1, A5, A6, A10, A14, A19, A26 |
| Active participation in school implementation | A3, A15, A18, A21, A27 |
| Alignment with public health or education policies | A2, A6, A11, A13, A20, A25, A27 |
| Absence of direct state intervention | A4, A7, A9, A16, A22, A23, A24 |
| Collaboration with public or municipal institutions | A3, A12, A18 |
| Potential for integration into existing programs | A2, A13, A20, A26 |
| Disarticulation between levels of government and institutions | A6, A10, A17, A21 |
| Lack of regulations promoting digital adoption | A5, A8, A11, A17 |

### 3.5. What gaps persist in recent research on digital strategies in school feeding?

Despite the growing number of studies on digital strategies for promoting healthy eating in schoolchildren, current research still presents significant gaps that limit their large-scale application, especially in the context of state programs. One of the main gaps identified is the limited longitudinal evaluation of the impact of these tools. Many studies focus on short-term or pilot interventions, which makes it difficult to understand whether changes in eating habits are sustained over time and whether they actually translate into improvements in the nutritional health of schoolchildren.

There is also evidence of insufficient research that addresses the cultural, territorial, and socioeconomic diversity of the beneficiary students. Most of the digital strategies analyzed have been developed and tested in urban contexts or in countries with extensive technological infrastructure, without considering the specific characteristics of rural areas, indigenous communities, or environments of structural poverty. This lack of contextualization limits the applicability of the findings to school feeding systems in regions such as Latin America, where specific conditions affect technology adoption.

Another important gap is the poor integration of technological components with existing state food programs. In many cases, digital strategies are developed in parallel or externally to state programs, creating a gap between digital educational content and the actual food supply in schools. This prevents a comprehensive and coordinated approach between education, nutrition, and technology, reducing the potential impact these tools could have if they were part of public policy design from the outset.

Furthermore, there is limited scientific research on the role of families and teachers in the implementation of these digital strategies, which is critical considering that schoolchildren's immediate social environment directly influences their eating habits. The lack of studies analyzing how to effectively involve these key stakeholders in the use of digital tools represents a challenge for designing more participatory and sustainable interventions.

Finally, there is a clear need to strengthen interdisciplinary research linking nutrition, technology, education, and public policy. Most studies remain within narrow disciplinary approaches, making it difficult to develop comprehensive solutions that address the complexity of the school food problem. Addressing these gaps is essential to moving toward digital strategies that are not only innovative but also inclusive, adapted, and aligned with the health and social development objectives of state programs.

**Table 5.** Underexplored areas in research on digital technologies in school nutrition

| Gaps in current research | Article Code |
|---|---|
| Lack of long-term impact assessment | A1, A5, A6, A10, A13, A19, A22, A25, A27 |
| Poor validation in vulnerable or rural contexts | A2, A4, A7, A11, A13, A14, A17, A20 |
| Poor integration with school curricula | A3, A9, A15, A18, A21, A26 |
| Weak analysis of intervention sustainability | A5, A10, A16, A20, A24, A28 |
| Little evidence of actual dietary behavior change | A6, A12, A19, A23, A25 |
| Lack of qualitative studies with students or teachers | A3, A13, A14, A21, A27 |
| Limited cultural and linguistic adaptation of tools | A7, A10, A17, A24, A26 |
| Lack of comparisons between different digital technologies | A1, A2, A4, A6, A9, A22 |

## Discussion

The results of this systematic review show that digital strategies to promote healthy eating in schoolchildren are consolidating, with significant advances in the development of interactive technologies, but still facing structural, social, and political limitations that limit their effectiveness within the framework of state programs. The digital initiatives reviewed show an increasingly user-centered approach, combining recreational resources, recommendation systems, and mobile applications that seek to generate engagement, motivation, and sustained changes in the eating habits of children and adolescents. However, this technological evolution has not been uniform or fully accessible to the most vulnerable school settings.

A key observation is that the effectiveness of these digital tools depends not only on their design or functionality, but also on their integration with solid public policies that guarantee continuity, equity, and cultural relevance. State school feeding programs, such as Qali Warma in Peru and similar programs internationally, have shown a willingness to integrate educational components, but they do not always include digital strategies in a structured manner. The incorporation of technology into these programs has been more reactive than planned, often limited to emergency

situations such as the COVID-19 pandemic, highlighting the lack of long-term digital planning in school food policies.

Furthermore, the review reveals that many digital strategies have been designed under universal logic, without considering the territorial, cultural, or socioeconomic specificities of the beneficiary students. This lack of contextualization represents a significant challenge, as technological solutions applied in urban areas or high-income countries are not always replicable in rural, indigenous, or communities with limited infrastructure. The challenge of designing tools that respond not only to the promotion of healthy habits but also to the specific food realities of each territory remains an outstanding issue in the literature and in practical interventions.

It was also identified that, while there are promising advances in the use of artificial intelligence, automated messaging, and gamification, these technologies must be complemented with participatory and intersectoral approaches. The inclusion of teachers, families, and local authorities in the design, use, and evaluation of these tools is essential to ensure their relevance and sustainability. In this sense, the gaps identified in the research suggest the need to strengthen the community component of digital strategies, as well as to promote qualitative and participatory research that captures users' real-life experiences.

The discussion highlights that for digital strategies to transcend their informational function and become agents of change in school eating behavior, a clear, sustained public policy supported by contextualized scientific evidence is required. The digital transformation of the school food environment cannot depend solely on isolated technological solutions but must be accompanied by a pedagogical, inclusive, and transformative vision, where the State plays an active.

## CONCLUSIONS

This review revealed that digital strategies used to promote healthy eating among schoolchildren benefiting from state programs are expanding, characterized by the incorporation of mobile technologies, interactive platforms, educational video games, artificial intelligence, and automated messaging tools. These strategies not only seek to improve nutritional knowledge but also to promote sustainable eating habits from an early age. While there are encouraging results regarding their impact on schoolchildren's food awareness and behavior, longitudinal and contextual evaluations are still limited.

One of the most relevant aspects found is the role that state programs play as key linkers between technology, food policy, and the education system. In the case of Peru, the national Qali Warma program has shown progress in strengthening educational content and incorporating digital technologies as part of its food service strategy. Similarly, programs such as the Healthy Eating Strategy in Canada and the School Lunch Program in the United States are also exploring the potential of digital tools to improve healthy school environments. However, these actions are still being implemented in a fragmented manner or as pilot initiatives, without a sustained digital transformation policy.

The barriers to implementing these strategies remain significant, especially in vulnerable school settings where connectivity gaps, limited technological infrastructure, and limited digital skills among both teachers and families persist. Furthermore, a low level of cultural contextualization was detected in the tools used, which limits their acceptance and effectiveness in rural and

indigenous communities or in areas with food diversity. This situation reinforces the need to design digital strategies that are adapted to the territories, that engage with local knowledge, and that integrate all stakeholders in the educational community.

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## CONFLICT OF INTEREST

There is no conflict of interest related to the subject matter of the work.

## AUTHORSHIP CONTRIBUTION

Conceptualization, data curation, formal analysis, research, visualization, writing -original draft, writing -correction and editing: Lozano-Flores, E. D. M.

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## ANNEXES

**Annexe A.1.** Coded list of articles included in the review

| Codes | Authors |
|---|---|
| A1 | (Hedin et al., 2024) |
| A2 | (Zhu et al., 2024) |
| A3 | (Lian et al., 2024) |
| A4 | (Sousa Basto & Ferreira, 2024) |
| A5 | (Bjerregaard et al., 2024) |
| A6 | (Gazibara et al., 2024) |
| A7 | (Yang et al., 2024) |
| A8 | (Ramezankhani et al., 2024) |
| A9 | (Alawamleh & AlKasasbeh, 2024) |
| A10 | (Berger & Jung, 2024) |
| A11 | (Allcott-Watson et al., 2024) |
| A12 | (Mayoral et al., 2024) |
| A13 | (Rahayu et al., 2023) |
| A14 | (Cuesta-Vargas et al., 2023) |
| A15 | (Burkhart et al., 2023) |
| A16 | (Vandeputte et al., 2023) |
| A17 | (Fagerström et al., 2023) |
| A18 | (Hayek et al., 2023) |
| A19 | (Tugault-Lafleur et al., 2023) |
| A20 | (Shatwan et al., 2023) |
| A21 | (Ardesch et al., 2023) |
| A22 | (Merino-Godoy et al., 2022) |
| A23 | (Truman & Elliott, 2022) |
| A24 | (Ma et al., 2021) |
| A25 | (Froome et al., 2020) |
| A26 | (Joseph-Shehu et al., 2020) |
| A27 | (Jones Bell et al., 2020) |
| A28 | (Halse et al., 2020) |