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INTERACTIVE DIGITAL NUTRITION EDUCATION FOR PRIMARY SCHOOL CHILDREN: A SYSTEMATIC REVIEW

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ABSTRACT
Interactive digital nutrition education is increasingly used in primary schools, but its effects are clearer for learning than for sustained dietary change. To synthesise evidence on interactive digital nutrition education for primary school children, with attention to nutrition knowledge, food literacy, dietary behaviour, engagement, and implications for school health practice. PubMed and Scopus were searched for studies published from January 2015 to 30 September 2026. Two reviewers independently screened records and resolved disagreements by consensus. Eligible studies involved primary school children using an interactive digital nutrition intervention with at least one measurable child-level outcome. Design-specific JBI tools and the Mixed Methods Appraisal Tool were used for methodological appraisal, and findings were synthesised narratively because interventions and outcomes were heterogeneous. The searches identified 149 records; 134 unique records were screened, 34 reports underwent eligibility assessment, and 20 reports representing 19 unique studies were included. Serious games were the most common modality. Knowledge and food-literacy outcomes were generally favourable, whereas effects on food choice and dietary intake were less consistent. Methodological safeguards were strongest in randomised trials; common limitations were unclear allocation concealment, limited blinding, short follow-up, and absence of control groups in several pilot studies. Interactive digital nutrition education is promising for short-term learning and engagement in primary school children. Behavioural effects appear more likely when digital learning is linked to repeated practice and real food choices in the school environment.

Keywords: dietary behaviour; digital nutrition education; food literacy; primary school; serious game

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INTRODUCTION

Primary school is a formative period for food preferences, eating routines, and the gradual development of independent food choices. Children learn not only from formal lessons but also from family routines, peers, school meals, canteens, and the food environment around them. Nutrition education therefore has to do more than deliver facts. It must help children recognise healthier options, understand why those choices matter, and practise applying that knowledge in situations that resemble everyday eating. Digital tools provide one way to make nutrition education more active. Serious games, gamified applications, interactive websites, multimedia, e-books, and immersive environments can ask children to classify foods, solve problems, make choices, receive feedback, and repeat a task until the concept is understood. Previous reviews suggest that digital interventions can improve nutrition-related learning, but effects on actual eating behaviour remain mixed and highly dependent on intervention design and context (Chow et al., 2020; Prowse & Carsley, 2021; Talens et al., 2025).

This distinction matters for the development of augmented reality (AR) nutrition education. AR may be visually engaging, but novelty alone does not guarantee behaviour change. A broader synthesis of interactive digital nutrition interventions can identify which design features repeatedly support learning and which features appear to help children move from knowledge to food choice.

Such evidence is particularly relevant to school health and community nursing, where digital tools are best understood as supports for health education rather than replacements for professional guidance, family involvement, or a supportive food environment. The present review therefore examined interactive digital nutrition education for primary school children. It aimed to describe the digital modalities used, synthesise their effects on nutrition knowledge, food literacy, attitudes, food choice and dietary behaviour, and identify practical design and implementation lessons that can inform school-health interventions, including future AR-based nutrition education.

METHOD

Design and eligibility

This systematic review followed the PRISMA 2020 reporting framework (Page et al., 2021). The protocol was defined before formal data extraction but was not prospectively registered. Children were eligible when they were approximately 6-12 years old or enrolled in primary or elementary school. Studies with a small age extension to 13 years were retained when the intervention clearly targeted elementary grades; mixed-age studies were excluded when the primary-school subgroup could not be identified. Eligible interventions used digital technology as an active part of nutrition learning rather than as a passive delivery channel. These included serious games, gamification, mobile or tablet applications, interactive websites, multimedia, alternate or virtual reality, AR features, and interactive e-books. At least one measurable child-level outcome was required, including nutrition knowledge, food literacy, attitudes, self-efficacy, food choice, dietary intake, anthropometry, usability, or acceptability. Reviews, protocols, parent-only interventions, passive digital education, qualitative-only studies, and development work without empirical child evaluation were excluded.

Search and study selection

PubMed and Scopus were searched from 1 January 2015 to 30 September 2026. Search concepts covered interactive or digital technology; nutrition education, healthy eating, food literacy, fruit and vegetables, and food choice; and children or primary-school settings. Database-specific Boolean strategies were retained in the review records. Citations were merged and duplicates were identified using DOI, PMID, and normalised titles. Dewi Santi Cahyani completed the first screening pass and data extraction. Endang Triyanto independently reassessed eligibility decisions, reviewed reports advanced to full-text assessment, and examined records that could plausibly have been missed during title-abstract screening. Disagreements were resolved through discussion and consensus. Multiple publications from the same participant sample were linked and treated as one underlying study.

Data extraction and synthesis

Data were extracted on country, design, participant age and sample size, digital modality, nutrition content, intervention structure, comparator, outcomes, and main findings. Methodological quality was appraised using the revised JBI tool for randomized controlled trials, the JBI quasi-experimental checklist, the JBI analytical cross-sectional checklist, and the Mixed Methods Appraisal Tool (MMAT) for mixed-method studies (Barker et al., 2023; Barker et al., 2024; Hong et al., 2018). Items were rated Yes, No, Unclear, or Not Applicable as appropriate. No numerical quality cut-off was imposed and no study was excluded solely because of appraisal findings; instead, methodological limitations were used to qualify the synthesis. When reporting did not support a judgment, the item was rated Unclear rather than inferred. Because intervention formats, comparators, outcome measures, and follow-up periods differed substantially, a pooled effect estimate was not considered appropriate. Findings were synthesised narratively across four domains: nutrition knowledge and food literacy; food choice and dietary behaviour; engagement, acceptability and usability; and intervention design and implementation.

RESULT

Study selection

The database searches identified 149 records: 97 from PubMed and 52 from Scopus. Fifteen duplicates were removed, leaving 134 unique records for title-abstract screening. Following second-

reviewer audit and consensus, 34 reports were assessed for eligibility. Fourteen were excluded because the population was outside the target age range, the digital component was not sufficiently interactive or child-directed, the study was qualitative or developmental without an eligible quantitative child outcome, or no nutrition-specific outcome was reported. Twenty reports were retained, representing 19 unique studies because two FoodRateMaster publications came from the same participant sample. The study-selection process is shown in Figure 1.

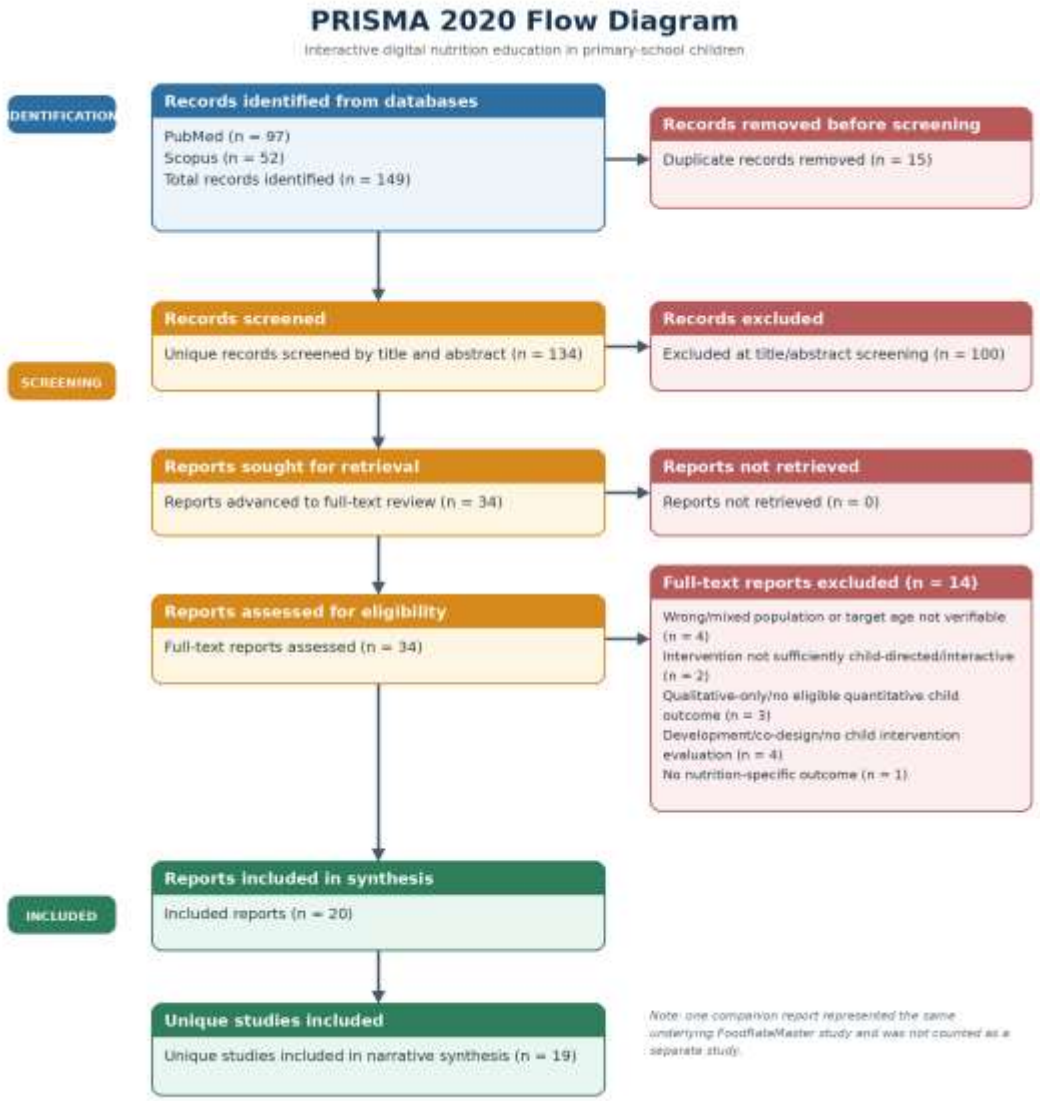


Figure 1. PRISMA 2020 flow diagram of study identification, screening, eligibility, and inclusion.

Study characteristics

Table 1.
Characteristics of included studies

Study	Design / sample	Digital modality	Main outcome
Chinellato et al., 2026	Repeated cross-sectional; children/adolescents n=329 per wave	Interactive website, games, quizzes, storytelling	Dietary pattern, lifestyle, BMI
Arga et al., 2025	Design-based; pre-post n=33	Interactive e-book	Food literacy
Brown et al., 2025	Nonrandomised school feasibility	Foodbot Factory serious game	Nutrition knowledge, feasibility
Wang et al., 2025	Controlled pilot; Grade 3	Alternate reality game	Knowledge, picky eating, food waste
Fowler et al., 2024	Pilot RCT; age 6-12	Virtual reality	Healthy-eating attitudes, usability
Swierad et al., 2024	Mixed-method; Grade 5	Hip-hop nutrition-	Acceptability, completion

Study	Design / sample	Digital modality	Main outcome
		mathematics curriculum	
Franco-Arellano et al., 2024	Post-use usability; Grade 4-5	Foodbot Factory with AR/mini-games	Usability, enjoyment
Yusoff et al., 2021	School intervention	Interactive multimedia, game, video	Nutrition/obesity outcomes
de Vlieger et al., 2022	Controlled school study	VitaVillage serious game	Nutrition knowledge, acceptability
Dominguez Rodriguez et al., 2020	Pre-post evaluation	Interactive web platform	Nutrition knowledge
Kato-Lin et al., 2020	RCT	fooya! mobile game	Immediate food choice
Ruggiero et al., 2020	Feasibility; age 7-13	MyPlate Picks exergame	Knowledge, intention, feasibility
Espinosa-Curiel et al., 2020	Pre-post pilot; age 8-10	FoodRateMaster game	Knowledge, eating behaviour
Brown et al., 2020	Formative mixed-method	Foodbot Factory app	Usability, child comprehension
Froome et al., 2020	Pilot RCT	Foodbot Factory	Nutrition knowledge
Gan et al., 2019	RCT; n=360	Healthy Foodie game	Nutrition knowledge
Hermans et al., 2018	Controlled experiment	Feed the Alien! game	Knowledge, food intake
da Silva et al., 2018	Participatory evaluation	Comer Legal digital game	Food classification, acceptability
Sharma et al., 2015	Group-randomised pilot	Quest to Lava Mountain	Dietary behaviour, attitudes

The 19 studies were published between 2015 and 2026 and represented Europe, Asia, North America, Australia, and South America. Randomised or group-randomised designs were used in several school-based trials, while other studies used nonrandomised, pre-post, feasibility, usability, or mixed-method approaches. Serious games and game-based applications were the dominant format. Other modalities included interactive web platforms, multimedia curricula, an e-book, alternate reality, virtual reality, and AR-enhanced content. Sample sizes ranged from small usability groups to school-based trials involving several hundred children.

Methodological quality

Seven randomized or group-randomized trials, eight quasi-experimental or nonrandomized intervention studies, one quantitative post-use usability study, and three mixed-method or participatory evaluations were appraised. Randomized studies generally reported appropriate random assignment and comparable outcome measurement, but allocation concealment was often unclear and blinding of participants or intervention personnel was rarely feasible. The nonrandomized studies usually established a clear temporal relationship between intervention and outcome, although several single-group pilots lacked a concurrent control and most had only one pre- and one post-intervention assessment. The usability study adequately described its sample and setting but was not designed for causal inference. Mixed-method studies generally showed coherent integration of qualitative and quantitative information, while explicit handling of divergent findings was not always reported. No study was removed solely on methodological-quality grounds. Full item-level judgments are provided in Supplementary Table S1.

Nutrition knowledge and food literacy

Learning outcomes were the most consistently positive findings. The Indonesian interactive e-book produced a modest improvement in food literacy (Arga et al., 2025). Foodbot Factory showed a similar pattern across development stages: formative testing demonstrated that children understood and enjoyed the game (Brown et al., 2020), a later randomised pilot found larger gains in overall nutrition knowledge than a control app (Froome et al., 2020), and classroom feasibility work again showed improvement in food-group knowledge (Brown et al., 2025). The updated game, which added AR and mini-game features, was also rated easy to use and enjoyable by Grade 4-5 students (Franco-Arellano et al., 2024).

Other game-based programmes reached comparable conclusions. Healthy Foodie improved post-test nutrition knowledge beyond standard education (Gan et al., 2019). VitaVillage increased nutrition knowledge in a controlled school study and was well accepted by children (de Vlieger et al., 2022). Feed the Alien! improved short-term knowledge, although the gain did not translate into a differential change in food intake (Hermans et al., 2018). FoodRateMaster also improved children's ability to distinguish healthier from less healthy foods, and its companion analysis suggested that enjoyment and user-experience satisfaction were positively related to learning (Espinosa-Curiel, Pozas-Bogarin, Lozano-Salas, et al., 2020; Espinosa-Curiel, Pozas-Bogarin, Martinez-Miranda, et al., 2020).

Food choice and dietary behaviour

Behavioural outcomes were less consistent than learning outcomes. The clearest effects occurred when the digital task was close to an actual decision. In the fooya! randomised trial, children who played the mobile game made healthier immediate food choices than children in the comparison condition (Kato-Lin et al., 2020). Quest to Lava Mountain was associated with lower sugar intake and more favourable nutrition-related attitudes in elementary school children (Sharma et al., 2015). The alternate-reality game Happy Farm, Happy Meal linked nutrition learning with the school meal context and reported improvements in knowledge together with favourable changes in picky eating and food-waste indicators (Wang et al., 2025). Other studies were more cautious. Feed the Alien! improved knowledge without a corresponding between-group effect on food intake (Hermans et al., 2018). MyPlate Picks improved knowledge and healthy-eating intentions, but short follow-up limited conclusions about sustained behaviour (Ruggiero et al., 2020). The Italian multimedia intervention reported more favourable dietary indicators over time, although the repeated cross-sectional design did not follow the same children at every wave (Chinellato et al., 2026). Overall, digital learning appears capable of influencing behaviour, but the effect is more dependent on repeated exposure, context, and access to real food choices than the effect on knowledge.

Engagement, usability and implementation

Children generally responded well to interactive formats. The updated Foodbot Factory was rated easy to use by most participants and was widely described as fun (Franco-Arellano et al., 2024). The virtual-reality intervention was also highly acceptable and showed a more favourable change in healthy-eating attitudes than an active control condition (Fowler et al., 2024). Multimedia and gamified curricula were feasible in classroom or after-school settings, including the hip-hop themed nutrition-mathematics programme (Swierad et al., 2024) and the Malaysian multimedia package combining games, video, and exergaming (Yusoff et al., 2021). Participatory studies added an important design lesson. Foodbot Factory was refined through repeated child testing before efficacy work (Brown et al., 2020), while the Brazilian Comer Legal project used iterative development with children and nutrition professionals (da Silva et al., 2018). These studies provide less causal evidence than randomised trials, but they show why usability matters: an intervention has little educational value if children cannot understand the task, control the interface, or recognise the foods and situations presented.

Table 2.
Synthesis of findings by digital modality

Modality	Synthesis
Serious games / gamified apps	Most common modality; generally improved nutrition knowledge and engagement. Behavioural effects were mixed but stronger when games required food choices or repeated decisions.
Web / multimedia	Supported knowledge and dietary-pattern change in some studies; effects depended on dose, family or school context, and whether interaction went beyond passive viewing.
VR / alternate reality / AR features	High acceptability and strong engagement; early evidence suggests potential for attitudes and contextual learning, but comparative efficacy remains limited.
Interactive e-book	Feasible for elementary students and associated with modest food-literacy gains in a small pre-post study.
Participatory / mixed-method design	Child testing improved usability, comprehension, and cultural relevance; these studies informed design rather than providing strong causal estimates.

DISCUSSION

The central finding is straightforward: interactive digital nutrition education works more consistently as a learning tool than as a stand-alone behaviour-change strategy. Across countries and technologies, children usually learned more about foods, food groups, and healthier choices after using games, interactive websites, multimedia, or immersive tools. The evidence became less uniform when outcomes moved from knowing the healthier option to repeatedly choosing or consuming it. This pattern is consistent with broader reviews showing that digital nutrition programmes can support knowledge and some health behaviours, but that dietary effects depend strongly on design, intensity, and context (Chow et al., 2020; Prowse & Carsley, 2021; Talens et al., 2025).

Serious games were prominent because they did more than entertain. The stronger interventions required children to use nutrition information: classify foods, solve a problem, make a choice, receive feedback, or progress through a challenge. This active use of information may explain why learning outcomes were more reliable than in passive digital education. It also suggests that engagement is useful when it is part of the learning mechanism rather than an ornamental feature. The weaker behavioural effects are equally understandable. A child may learn that vegetables are the healthier choice and still face a lunchbox, canteen, family routine, peer environment, or school meal that makes another choice easier. Interventions positioned close to real decisions were therefore especially informative. fooya! measured immediate food selection after gameplay, while Happy Farm, Happy Meal linked the digital experience to school mealtimes. These examples suggest that the bridge between knowledge and behaviour is more likely to form when children can practise the same decision in a real food environment. This has direct implications for AR development. The review does not show that AR is inherently superior to a conventional application or serious game. Instead, it identifies design elements worth carrying into an AR nutrition intervention: age-appropriate challenge, immediate feedback, repeated practice, familiar foods, clear goals, and opportunities to apply the lesson to actual meals. For fruit and vegetable education, AR may be most useful when digital objects are linked to foods children encounter in school meals rather than presented as isolated visual effects.

The findings are also relevant to school and community nursing. Nurses do not need to develop the technology themselves to make it useful. Their contribution can be to assess learning needs, ensure that nutrition messages are developmentally appropriate, identify barriers to healthy eating, involve families and teachers, and connect digital learning with the school food environment. This positioning keeps the technology as a tool within health promotion rather than as the intervention goal in itself. Several limitations should be considered. Only PubMed and Scopus were searched, so education-specific and nursing databases may contain additional studies. Interventions differed considerably in technology, dose, comparator, and outcome measurement, preventing meaningful meta-analysis. Many studies were small pilots, long-term follow-up was uncommon, and some samples extended slightly beyond 12 years. The methodological appraisal also showed recurrent concerns around unclear allocation concealment, limited blinding, short follow-up, and lack of concurrent controls in several nonrandomized studies. The review included formative and usability studies alongside effectiveness trials to capture implementation evidence; these studies therefore inform feasibility and design rather than equivalent causal claims about effectiveness.

CONCLUSION

Interactive digital nutrition education is a credible approach for improving short-term nutrition knowledge, food literacy, and engagement in primary school children. Serious games currently provide the broadest evidence base, while web platforms, multimedia, interactive e-books, and immersive technologies expand the available design options. Evidence for sustained dietary change is less consistent. Future interventions should therefore combine interactive learning with repeated exposure, feedback, and opportunities to make real food choices.

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