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Educational Animation for Improving Children's Nutrition Knowledge: A Systematic Literature Review

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ABSTRACT

Childhood nutrition knowledge remains a persistent public health concern, particularly where growth disorders and adolescent obesity coexist. Educational animation is increasingly used to convey nutrition concepts to children, yet the evidence has not been synthesized systematically. This systematic literature review, following PRISMA 2020, examines animation's effectiveness in improving children's nutrition knowledge, the design characteristics behind successful outcomes, research trends from 2020-2026, and remaining gaps. Searches of Scopus, ScienceDirect, PubMed, SpringerLink, Web of Science, IEEE Xplore, Wiley, Taylor & Francis, and ERIC yielded 30 eligible studies after a four-stage screening process. Animated video and game-based interventions consistently produced measurable knowledge gains compared with conventional lecture or printed media, with narrative structure, character relatability, colour use, and multimedia design principles as recurrent contributors to effectiveness. However, most studies relied on short-term, single-group, quasi-experimental designs concentrated in few countries, restricting generalizability. This review contributes an integrated, theory-informed synthesis of animation-based nutrition education research and outlines directions for more rigorous, longitudinal, and geographically diverse future studies.

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1. INTRODUCTION

Adequate nutrition knowledge during childhood underpins lifelong healthy dietary behaviour, yet children in both low-, middle-, and high-income countries continue to show limited understanding of balanced diets, food groups, and the consequences of unhealthy eating. This gap coexists with the double burden of malnutrition: stunting and micronutrient deficiencies remain prevalent in many developing regions, while overweight and obesity keep rising among school-age children and adolescents, especially in urban and economically developed areas. Because dietary habits form early and often persist into adulthood, schools, healthcare providers, and families increasingly favour nutrition education as prevention rather than relying on treatment after problems occur.

Conventional methods such as classroom lectures, leaflets, and posters often fail to sustain children's attention or promote long-term retention. Children process information differently from adults: they have shorter attention spans, think more concretely, and respond better to visual stories than to text. These characteristics have driven the adoption of multimedia approaches combining animation, audio, storytelling, and interactivity. Educational animation, spanning two- and three-dimensional animated video, serious games, and more recently virtual and augmented reality, has become a promising medium because it delivers information simultaneously through visual, auditory, and narrative channels.

This educational value is supported by the Cognitive Theory of Multimedia Learning, which holds that learners process verbal and visual information through separate, capacity-limited channels; well-designed materials can therefore reduce unnecessary cognitive load while encouraging active knowledge construction [2], [3]. Animated pedagogical agents and character-based narratives further improve learning through social cues that enhance motivation beyond text alone [2]. These advantages matter for nutrition education, where effective interventions should shift not only knowledge but also attitudes and behaviours.

A growing body of studies has evaluated animation-based nutrition education across populations and settings. Research from Indonesia consistently reports significant knowledge improvements among elementary and adolescent students after animated videos on balanced nutrition, stunting prevention, and anaemia [6], [8], [10], [20], [28], [30]. International studies examined animated videos and gamified interventions for hand hygiene, food safety, healthy eating, obesity prevention, and COVID-19 education, mostly positive despite methodological differences [7], [9], [11], [13], [31]. Serious games and mobile applications have likewise delivered nutrition education through interactive environments, with knowledge gains comparable to or greater than conventional animated video [14], [16], [19]. More recently, virtual and augmented reality have extended animation-based learning through immersive environments, such as virtual supermarkets and gardens, that let children practise healthy food selection in simulated settings [4], [5], [17].

Although this evidence base continues to expand, it remains highly heterogeneous in design, sample size, duration, outcome measurement, and reporting quality. Many studies rely on single-group pre-post designs without comparison groups, limiting causal strength, while others use quasi-experimental designs with follow-ups from immediate to several months. Existing reviews are also narrow in scope, mostly focusing on a single technology such as gamification [12], virtual reality [4], or combined virtual/augmented reality [5], or on specific populations such as preschoolers or particular health conditions. Consequently, no recent review has comprehensively synthesized educational animation, spanning videos, serious games, mobile applications, and immersive technologies, as a broad category for improving children's nutrition knowledge.

This review addresses that gap by synthesizing studies published between 2020 and 2026 on educational animation as an intervention to improve children's nutrition knowledge, treating animation as an integrated family of media rather than separate technologies. It compares evidence across animated videos, serious games, mobile applications, and immersive environments, identifying design characteristics common to successful outcomes, particularly narrative structure, character design, colour usage, interactivity, and immersion, and interprets these findings through multimedia learning theory. By integrating empirical findings with theoretical interpretation, this review offers practical guidance for future intervention development and directions for subsequent research.

Accordingly, this review addresses four research questions: how effective is educational animation in improving children's nutrition knowledge; which animation characteristics contribute most to successful outcomes; what research trends emerged between 2020 and 2026; and what gaps remain for future research. The remainder of this article describes the review methodology, presents the synthesized findings, discusses their implications, and concludes with recommendations for research and practice.

2. RESEARCH METHOD

This study employed a systematic literature review (SLR) design following the PRISMA 2020 statement, which structures the process into four stages: identification, screening, eligibility, and inclusion [1]. PRISMA was chosen for its transparent, replicable protocol, essential given the fragmented, multidisciplinary nature of the animation-nutrition literature spanning public health, educational technology, and human-computer interaction.

2.1 Database Selection and Search Strategy

The search covered nine major electronic databases: Scopus, ScienceDirect, PubMed, SpringerLink, Web of Science, IEEE Xplore, Wiley Online Library, Taylor & Francis Online, and ERIC. Google Scholar and manual backward citation searching supplemented the search for relevant studies not retrieved initially.

The search strategy combined three groups of keywords using Boolean operators. The first group represented the target population and included terms such as *children*, *child*, *adolescent*, *school-age*, and *preschool*. The second group represented the intervention and included *animation*, *animated video*, *cartoon*, *serious game*, *gamification*, *virtual reality*, *augmented reality*, and *multimedia*. The third group represented the outcome and included *nutrition knowledge*, *nutrition education*, *dietary knowledge*, and *healthy eating*. The complete search strategy is presented in Table 1.

The search was limited to studies published between January 2020 and June 2026, applying database filters where available to include only peer-reviewed journal articles, conference proceedings, and systematic reviews in English or Indonesian.

Table 1. Search Strategy

Search Component	Specification
Databases	Scopus, ScienceDirect, PubMed, SpringerLink, Web of Science, IEEE Xplore, Wiley Online Library, Taylor & Francis Online, and ERIC. Google Scholar was used as a supplementary source.

Population keywords	*children, child, adolescent, school-age, preschool*
Intervention keywords	*animation, animated video, cartoon, serious game, gamification, virtual reality, augmented reality, multimedia*
Outcome keywords	*nutrition knowledge, nutrition education, dietary knowledge, healthy eating*
Boolean search structure	(Population) AND (Intervention) AND (Outcome)
Publication period	January 2020 to June 2026
Language	English or Indonesian
Document types	Peer-reviewed journal articles, conference proceedings, and systematic reviews

2.2 Eligibility Criteria

Studies were included if they met four criteria: participants were children or adolescents aged 3-18 years (or results were reported separately for this group); the intervention involved educational animation, including animated videos, cartoons, serious games, gamified apps, or VR/AR simulations; the outcome measured nutrition or closely related knowledge, such as dietary or food-related understanding; and the study was published between 2020 and 2026 in a peer-reviewed journal or conference proceeding.

Studies were excluded if they focused exclusively on adults without child-specific results, addressed physical activity, oral health, or general health promotion without a nutrition knowledge outcome, were opinion papers, editorials, or non-peer-reviewed grey literature, or lacked sufficient methodological detail for quality assessment. The complete criteria are presented in Table 2.

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Population	Children/adolescents aged 3-18 years	Adults only, no child-specific data
Intervention	Animated video, serious game, gamified app, VR/AR simulation	Non-animated/static media only (text, poster) as sole intervention
Outcome	Nutrition/dietary/food knowledge measured	Physical activity, oral health, or general wellbeing without nutrition knowledge outcome
Publication year	2020-2026	Before 2020
Document type	Journal article, conference proceeding, systematic review	Editorial, opinion piece, non-peer-reviewed grey literature
Reporting	Sufficient methodological detail for quality appraisal	Insufficient detail to assess design or outcomes

2.3 Screening, Quality Assessment, and Data Extraction

The search initially identified 550 records (512 from databases, 38 from other sources). After removing 96 duplicates, 454 records were screened by title and abstract, excluding 372 clearly irrelevant records. The remaining 82 full-text articles were assessed in detail; 52 were excluded for wrong population, absence of a nutrition knowledge outcome, inappropriate publication type, insufficient data, or duplicate samples, yielding 30 studies for qualitative synthesis, as shown in the PRISMA flow diagram in Figure 1.

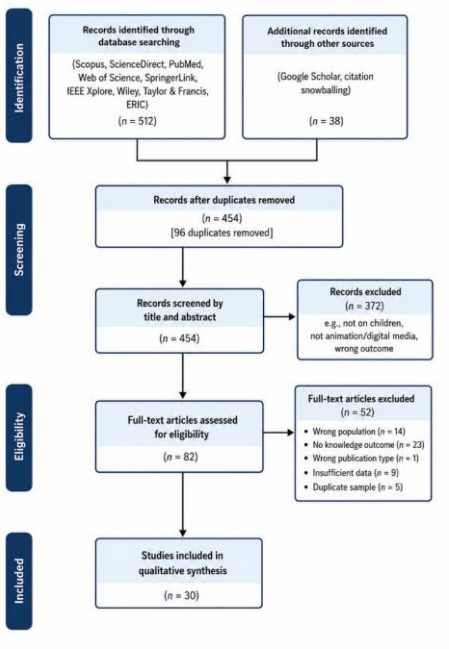

Figure 1. PRISMA Flow Diagram of the Study Selection Process

Two reviewers independently screened records at each stage, resolving disagreements through discussion or, if needed, a third reviewer. Methodological quality was appraised using a checklist adapted from the Mixed Methods Appraisal Tool, covering randomization or comparison group use, outcome validity, reporting completeness, and confounding control; no numeric cut-off excluded otherwise eligible descriptive studies, consistent with practice for a heterogeneous, fast-evolving literature. Data extraction captured author, year, country, sample characteristics, animation type, nutrition topic, study design, outcome measures, and key findings, underpinning Table 3 and the synthesis in Section 3.

Data synthesis followed a narrative thematic approach rather than meta-analysis, because outcome metrics (percentage score change, mean difference, categorical knowledge level) and intervention durations varied too much for statistical pooling. Findings were grouped according to the four research questions: overall effectiveness, animation design characteristics, temporal and technological trends, and research gaps.

3. RESULTS AND ANALYSIS

3.1 Overview of Included Studies

The 30 included studies were published between 2020 and mid-2026, with annual counts rising from three in 2020 to a peak of seven in 2023 before levelling off in 2024-2026 (Figure 2), consistent with a growing but still-maturing research area rather than a saturated field.

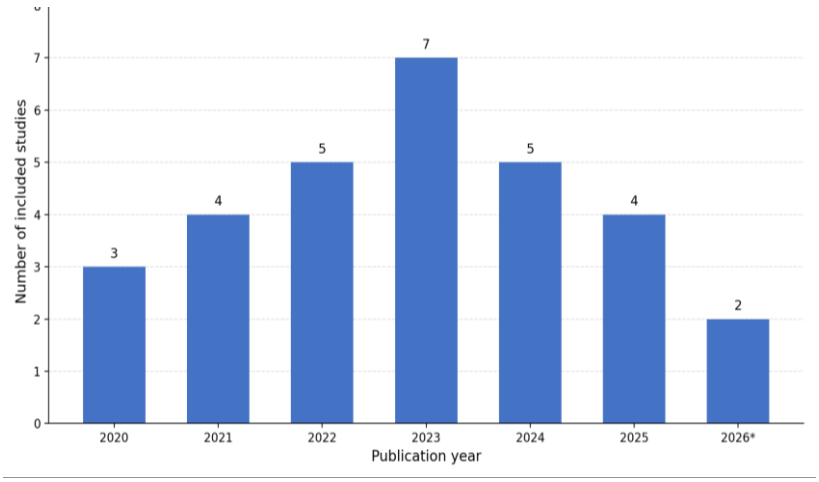

Figure 2. Publication Trend of Included Studies (2020-2026). Note: the 2026 count is partial, reflecting the June 2026 search cut-off.

Geographically, the evidence base is heavily concentrated in Southeast Asia, particularly Indonesia, which accounted for over half of the included studies, reflecting substantial national investment in stunting- and obesity-prevention research (Figure 3). Studies from the Americas, Europe, Africa, the Middle East, and Oceania were comparatively sparse, indicating the evidence is not yet globally representative.

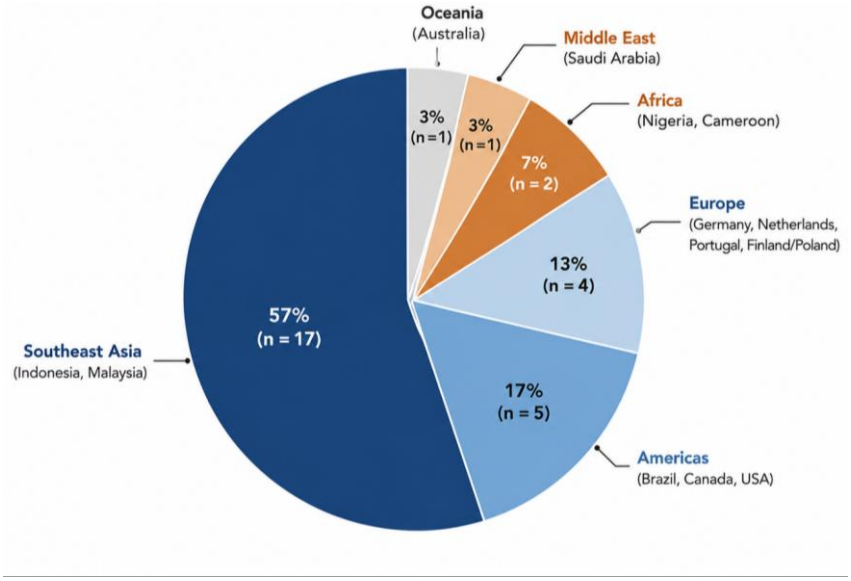

Figure 3. Geographic Distribution of Included Studies

Table 3 summarizes the included studies' educational level, predominant study design, and typical sample size. Most targeted elementary or adolescent students; only a minority addressed preschool-age populations [22], [33], despite dietary preferences forming early in life.

Table 3. Characteristics of Included Studies (n = 30)

Characteristic	**Category**	**n (%)**
Educational level	Preschool/Early Childhood	4 (13%)
	Elementary School	14 (47%)
	Secondary School/Adolescents	10 (33%)
	Mixed Population/Caregiver-Mediated	2 (7%)
Study design	One-Group Pre-test/Post-test (Quasi-Experimental)	13 (43%)
	Non-Equivalent Control Group (Quasi-Experimental)	8 (27%)
	Randomized Controlled Trial (RCT)	6 (20%)
	Systematic Review/Meta-Synthesis	3 (10%)
Typical sample size	< 50 participants	9 (30%)
	50–150 participants	15 (50%)
	> 150 participants	6 (20%)

3.2 Effectiveness of Educational Animation on Nutrition Knowledge (RQ1)

Across nearly all included studies, animation-based interventions produced statistically significant knowledge gains from pre-test to post-test: a one-month animated video series on nutritional needs ($p = 0.000$) [6], animated videos on anaemia prevention using a health belief model [7], hand-washing education among elementary pupils [10], and food-processing guidance for Brazilian adults [9]. Where a comparison arm existed, animation consistently outperformed no-intervention controls, though its advantage over other active media such as comics or booklets was less consistent: one Indonesian study [23] found a numerically larger attitude gain with comics despite similar or slightly lower knowledge gains, suggesting animation is not universally superior to other visual media but performs strongly against passive or lecture-only formats; a comparable booklet-versus-video comparison among caregivers of children with autism spectrum disorder likewise found no consistent advantage for either medium [32].

Randomized and cluster-randomized evidence, though less common, corroborates these quasi-experimental findings. A cluster-randomized trial of a serious game addressing nutrition, physical activity, and stress coping among children aged 9-12 found significant knowledge gains regardless of parental involvement [13]; a cluster-randomized game-based intervention improved eating behaviour relative to a no-game control [14]; and the Rango Cards game produced significant gains in knowledge and self-efficacy among high-school students in a cluster-randomized design [11]. Together, these controlled studies increase confidence that the knowledge gains seen in quasi-experimental studies are attributable to the intervention itself rather than to test-retest or maturation effects.

Effect magnitudes were not directly comparable, as studies reported gains as raw score increases, percentage changes, or categorical shifts from "poor" to "good" knowledge. Table 4 compares design features and effectiveness across a representative subset, illustrating this heterogeneity alongside a consistent direction of effect. Reviews echo this pattern at an aggregate level: a systematic review of VR interventions for children's healthy eating and physical activity found that the minority of primary studies measuring knowledge directly reported significant post-intervention gains, while behavioural outcomes such as food intake changed less consistently [4]. Likewise, a review of gamification for childhood obesity concluded that ICT-supported gamified interventions motivate nutrition-related improvement, while cautioning that underlying behaviour-change theories are often loosely specified [12].

Table 4. Comparison of Selected Studies on Animation-Based Nutrition Education

Study	Country	Population	Animation Type	Key Finding
Masitah et al. [6]	Indonesia	Adolescents	2D animated video	Significant knowledge gain, $p = 0.000$
Aisah et al. [7]	Malaysia	Female adolescents	Animated video (HBM-based)	Improved anaemia-prevention knowledge
Weiland et al. [13]	Germany	Children 9-12	Serious game	Knowledge gain regardless of parental involvement
Folkvord et al. [14]	Netherlands	Children 8-12	Serious game	Improved eating behaviour vs. control
dos Santos Chagas et al. [11]	Brazil	High-school students	Card/board game	Gains in knowledge and self-efficacy
Vepsäläinen et al. [18]	Finland/Poland	Preschoolers	Mobile app	Increased fruit/vegetable acceptance
Zhang et al. [4]	Multi-country (review)	Children 4-15	Virtual reality	Knowledge gains in eating-focused VR studies

3.3 Animation Characteristics Contributing to Effectiveness (RQ2)

Beyond confirming that animation works, this review identifies which design characteristics recur in effective interventions. Four emerged consistently: narrative structure, character relatability, colour and visual design, and interactivity or immersion.

Narrative structure was repeatedly cited as central to sustaining attention and message retention. Studies of serial versus episodic narrative formats in children's active video games found that a serialized, cliff-hanger structure sustained engagement more effectively than self-contained episodes, because unresolved tension motivated continued play [26], and embedding narrative and immersion in active video games was shown to mediate increases in children's activity engagement relative to non-narrative conditions [27]. Although these two studies concerned physical activity rather than nutrition knowledge, they offer transferable evidence: the same narrative-transportation mechanism is invoked in nutrition-focused serious games and animated interventions to explain why children absorb embedded content without perceiving it as instruction [4], [14].

Character relatability and animated pedagogical agents also emerged as salient. Multimedia learning research shows animated agents enhance learning outcomes and sustain attention more than narration alone, partly through social cues mimicking a human instructor [2]. Several Indonesian studies used relatable child or animal characters to model desired eating behaviour, reporting stronger engagement than plain instructional video, though few isolated the character variable experimentally.

Colour and visual design interact with content type in shaping health-communication outcomes. A study of COVID-19-themed animated cartoons found colour choices moderated message effectiveness among social media audiences, indicating colour is an active design lever rather than a cosmetic detail [8]. Though not nutrition-specific, its approach of systematically varying one design element while holding content constant is a rigour nutrition-animation research would benefit from adopting. Adjacent science-education evidence reinforces this: video animation of a physiological coordination system improved students' cognitive ability relative to non-animated instruction, showing that animation's learning benefit is not confined to nutrition topics but reflects a more general instructional mechanism [34], [35].

Finally, interactivity and immersion distinguish newer technologies, serious games, mobile applications, and VR/AR, from passive video. The Foodbot Factory mobile serious game was iteratively updated with interactive features to strengthen nutrition knowledge acquisition, reflecting a design philosophy treating interactivity as central rather than incidental [15]. Reviews of AR/VR for nutrition education found AR games particularly promising for children, while VR was more often applied to adult-oriented virtual supermarket simulations, suggesting immersive interactivity may need age-specific tailoring [5]. Within VR specifically, self-determination theory and social cognitive theory were the most frequently applied frameworks underpinning goal-setting, progress tracking, and virtual avatars, reinforcing that immersive animation's effectiveness is mediated by deliberate behavioural-theory-informed design rather than novelty alone [4].

3.4 Research Trends and Technology Distribution (RQ3)

The technology delivering educational animation diversified markedly over the review period. Two-dimensional animated video remained the most common format, present in almost half of the studies, while serious games and gamified apps formed a substantial second category; VR/AR, still a minority, grew from negligible presence before 2020 to a recurring feature from 2022 onward (Figures 4 and 5). This mirrors the broader trajectory of educational technology, in which passive video is progressively supplemented, though not replaced, by interactive and immersive formats.

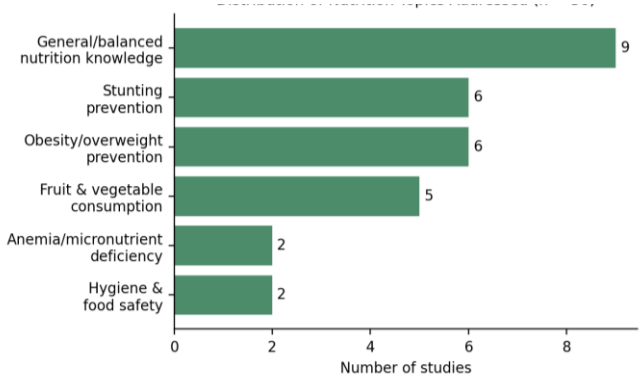

Figure 4. Distribution of Nutrition Topics Addressed Across Included Studies

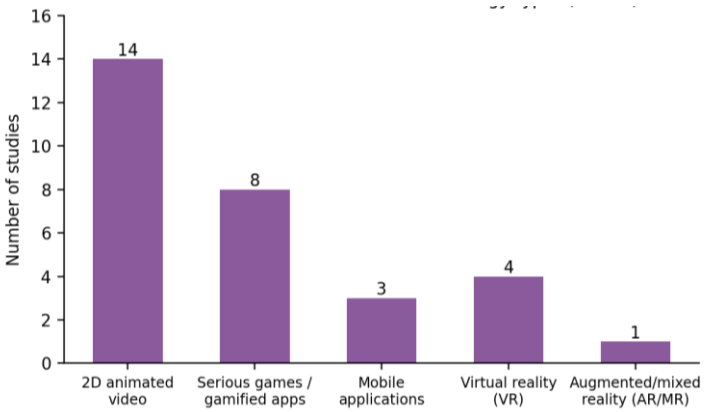

Figure 5. Distribution of Animation-Related Technology Types Across Included Studies

Regarding topic focus, general or balanced nutrition knowledge and stunting-related content dominated, reflecting the concentration of Indonesian studies, where stunting is a national health priority, including family- and caregiver-mediated interventions targeting maternal knowledge as a pathway to child outcomes [21], [25]. Obesity and overweight prevention formed a second major cluster, concentrated in European and North American studies and complemented by Indonesian school-based obesity-prevention trials [24], [29], showing the same medium addressing opposite ends of the malnutrition spectrum depending on regional priorities. Anaemia, micronutrient deficiency, and hygiene topics were addressed less frequently, indicating scope for animation-based interventions to expand beyond energy-and-macronutrient framing toward broader dietary quality and food safety content.

3.5 Theoretical Grounding: Why Animation Works

Animation's recurring effectiveness across heterogeneous settings is well explained by the cognitive theory of multimedia learning (CTML), which posits separate, capacity-limited channels for verbal and pictorial information and holds that meaningful learning requires active selection, organization, and integration [3]. Animation aligns naturally with CTML's dual-channel principle by presenting information simultaneously through moving images and narration or on-screen text, letting concepts such as food groups or portion sizes be encoded both visually and verbally. When animated agents narrate or model behaviour, the resulting social and generative processing has been shown to enhance learning outcomes and, in neurophysiological studies, learning-related brain activity [2].

At the same time, CTML implies boundary conditions the reviewed literature only partially respects. The coherence principle holds that extraneous decorative elements can impair learning by consuming cognitive capacity irrelevant to the instructional goal, yet few studies tested simplified versus decorated versions of the same content. Similarly, the segmenting and pre-training principles, recommending learner-controlled segments and pre-taught key terms, were rarely applied explicitly, most interventions instead delivering animation as a single continuous video. This suggests nutrition-animation researchers draw on multimedia learning theory only implicitly, leaving its more granular design principles unoperationalized and room for theory-driven experimental manipulation in future work.

3.6 Limitations Across the Reviewed Literature

Several methodological limitations recur across the included studies. Most consequential is the predominance of one-group pre-post designs (43% of the sample): without a control group, maturation, testing, or history effects cannot be ruled out as alternative explanations. Follow-up periods compound the problem, since most studies measured outcomes only immediately or a few weeks after the intervention, so whether gains persist or translate into behaviour change is largely unknown; Zhang et al.'s VR-focused review flagged the same short durations and small samples, and the critique applies to the wider evidence base [4]. Outcome instruments were also rarely validated, with many studies relying on unreported researcher-developed questionnaires, complicating cross-study comparison. Finally, the geographic concentration noted earlier, drawn overwhelmingly from a few countries and principally Indonesia, limits how confidently findings generalize to different cultural, dietary, and educational settings.

3.7 Research Gaps and Future Directions (RQ4)

Synthesizing these limitations against the review's four research questions surfaces six gaps, summarized in Table 5: methodological rigour (few RCTs with adequate follow-up), theoretical specification (limited explicit use of multimedia design principles beyond basic narrative and character use), population coverage (preschool children under-represented despite early habit formation), geographic diversity (evidence concentrated in Indonesia and a handful of high-income countries), outcome measurement (inconsistent, largely unvalidated instruments), and behavioural translation (few studies tracking whether knowledge gains translate into dietary intake or food choice).

Table 5. Research Gaps Identified in the Reviewed Literature

Gap	Description	Illustrative Evidence
Design rigour	Predominance of uncontrolled pre-post designs; few RCTs with long follow-up	43% one-group designs; only 20% RCTs [Table 3]
Theoretical specification	Limited explicit application of granular multimedia design principles (coherence, segmenting, pre-training)	Section 3.5
Population coverage	Preschool-age children under-represented relative to elementary and adolescent groups	Only 13% preschool studies [Table 3]
Geographic diversity	Evidence concentrated in Indonesia and a few high-income countries	Figure 3
Outcome measurement	Reliance on unvalidated, researcher-developed knowledge instruments	Section 3.6
Behavioural translation	Rare tracking of dietary behaviour or intake change beyond immediate knowledge scores	[4], [12]

Addressing these gaps requires multi-country trials with harmonized, validated instruments; experimental manipulation of individual multimedia design features (e.g., narrative versus non-narrative versions of the same

content); expansion into preschool and early-childhood populations, where dietary habits first form; and longer-term follow-up linking knowledge gains to sustained behaviour change. Emerging AR/VR technologies also warrant further controlled evaluation in nutrition contexts, given that current evidence for these formats remains sparse relative to two-dimensional video and gamified applications.

3.8 Novelty and Contribution of This Review

Unlike prior reviews examining a single animation-adjacent technology in isolation, such as gamification for obesity [12], VR for healthy behaviour broadly [4], or AR/VR for diet education generally [5], this review integrates animated video, serious games, mobile applications, and immersive technologies within a single analytic frame specific to children's nutrition knowledge. By mapping recurring design characteristics against multimedia learning theory rather than reporting isolated effect directions, it offers a more actionable account of not only whether animation works, but which design choices are most likely to make it work, and where the evidence for those choices remains thin.

4. CONCLUSION

This review synthesized 30 studies published between 2020 and 2026 on the effectiveness of educational animation in improving children's nutrition knowledge. The evidence consistently shows animated video, serious games, and, increasingly, immersive technologies produce significant knowledge gains relative to no-intervention controls, and often compare favourably with lecture-based instruction, though animation's advantage over comics or booklets is less uniform. Effective interventions tended to share four recurring design characteristics: narrative structure that sustains engagement, relatable characters or pedagogical agents, deliberate colour and visual design, and increasing interactivity or immersion in newer serious-game and VR/AR applications. These characteristics align closely with the cognitive theory of multimedia learning, which explains animation's effectiveness while highlighting design principles the current literature has not yet systematically tested.

The review's principal contribution is an integrated, theory-linked synthesis treating animation as a family of related instructional media rather than a single fixed technology, enabling comparison across format and over time in a way single-technology reviews cannot. Practically, educators and public health practitioners designing nutrition education programmes should prioritize narrative-driven, character-based animation with age-appropriate interactivity, while researchers should move toward randomized designs, validated instruments, and longer follow-up to establish whether knowledge gains are durable and translate into behaviour change.

This review is limited by its reliance on published, English- or Indonesian-language literature in major databases, which may under-represent grey literature or non-indexed regional journals, and by its narrative rather than meta-analytic synthesis, necessitated by outcome-metric heterogeneity. Future research should pursue multi-country randomized trials with harmonized instruments, extend investigation to preschool populations, and evaluate emerging immersive technologies within nutrition education contexts, so the promise shown by accumulating animation research can be more rigorously and equitably realized.

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