# The Effectiveness of Gamification Elements (GEs) in Promoting Plant-Based Diets (PBDs) Among Young Adults: A Systematic Literature Review

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**ABSTRACT**

**PBDs provide substantial health and environmental benefits, yet young adults often struggle to adopt and maintain them consistently. Gamification, which is the use of game design elements in non-game contexts, has emerged as a promising strategy to boost engagement and support dietary behavior change. This systematic review examines the effectiveness of gamified interventions in promoting PBD adoption among young people. A comprehensive search of PubMed, Scopus, and IEEE Xplore, supplemented with manual screening, identified 19 relevant studies involving participants aged 10–30, or with a mean age above 10, reporting dietary, psychosocial, or engagement outcomes. Overall, evidence shows that gamification can improve knowledge, attitudes, and specific behaviors, such as fruit, vegetable, and legume consumption. Commonly used elements include points, challenges, badges, quizzes, and feedback. However, the overall influence on broader and sustained PBD adoption remains moderate and inconsistent. Higher engagement and stronger behavior change were associated with clear goal setting, personalized feedback, and enjoyable user experiences. The findings highlight the importance of grounding gamification designs in established behavior change theories, such as Self-Determination Theory (SDT) and Social Cognitive Theory (SCT), to strengthen intervention effectiveness and support long-term dietary change.**

***Keywords-gamification; plant-based diet; young adults***

## I. INTRODUCTION

PBDs are characterized by the high consumption of fruits, vegetables, legumes, whole grains, and seeds, with reduced or eliminated intake of animal-based foods. They are also acknowledged for their significant health and environmental benefits [1-3]. Extensive research links PBDs to a lower risk of non-communicable diseases, including cardiovascular disease and type 2 diabetes [4-6]. From an environmental perspective, shifting towards PBDs is crucial for reducing greenhouse gas emissions, deforestation, and other ecological impacts associated with the livestock industry [7, 8]. Ethical concerns surrounding animal welfare further strengthen PBD adoption [9]. Young adults, particularly university students, represent a key target group for dietary behavior change interventions [10]. This life stage is marked by growing independence and the establishment of long-term lifestyle habits [11]. Many values commonly held by young adults, such as sustainability, social justice, and health, closely align with the principles of PBDs, offering a unique motivational opportunity for well-designed interventions [12]. However, several barriers hinder adoption, including limited nutritional knowledge, inadequate cooking skills, social influences, and perceived higher costs [13]. Additionally, the "intention–behavior gap," where positive intentions do not translate into consistent dietary practices, remains a challenge, often amplified by the pressures of university life [14].

To address these shortcomings, the concept of gamification has emerged as a compelling new approach. Gamification is defined as the use of game design elements, such as points, badges, and leaderboards in non-game contexts to enhance user motivation and engagement [1, 15, 16]. As young adults are generally considered digital natives, they are likely to respond positively to game-like activities. However, the success of these efforts is highly dependent on thoughtful design, as poorly designed programs can lead to negative consequences. Although gamification has been studied across various health

domains, its application in promoting PBDs among young adults remains relatively under-researched [1, 15]. Therefore, a focused systematic review is necessary to determine its effectiveness in this specific context [17]. The former aims to fill this gap by synthesizing empirical research on gamified interventions that encourage young adults to adopt PBDs. This review is designed to explore the following research questions:

- RQ1: How effective is the gamification approach in promoting the adoption of PBDs among young people?
- RQ2: What GEs have been utilized in interventions aimed at promoting PBDs among young people?
- RQ3: How do specific GEs influence PBD behavior change?

By answering these questions, this review seeks to offer evidence-based insights for developing innovative strategies to promote PBDs in the young adult population.

## II. METHODS

This systematic review aimed to synthesize empirical evidence on gamification for promoting PBDs among young adults, using the PICOC framework for eligibility and adhering to PRISMA guidelines for transparency and rigor [18].

### A. Eligibility Criteria

The inclusion and exclusion criteria were structured using the PICOC framework, as presented in Table I.

TABLE I. PICOC FRAMEWORK

| Component | Description |
|---|---|
| Population | Young adults, ages 10–30 years, or mean age >10 years- |
| Intervention | Gamification, serious games, or game-based learning, targeting a shift toward PBDs |
| Comparison | Studies with control groups or pre-post designs to assess change |
| Outcomes | Measurable changes in plant-based dietary behaviors (e.g., increased fruit/vegetable intake, reduced meat consumption) |
| Context | Peer-reviewed journal articles or conference papers in English with relevant empirical data |

### B. Search Strategy

A comprehensive search was conducted across three databases: PubMed, Scopus, and IEEE Xplore. The research was performed in June 2025 using the following Boolean string:

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("Gamification" OR "serious game*" OR
"game element*") and ("plant-based diet*"
OR "vegetarian*" OR "vegan*" OR "fruit
intake" OR "vegetable intake") and ("young
adult*" OR "adolescents*")
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The following filters were utilized: articles published in English, studies involving human participants, and publication years ranging from 2005 to 2025.

### C. Study Selection and Data Extraction

The selection process followed the PRISMA 2020 flow diagram. Initially, 485 records were identified. The selection process is illustrated in Figure 1.

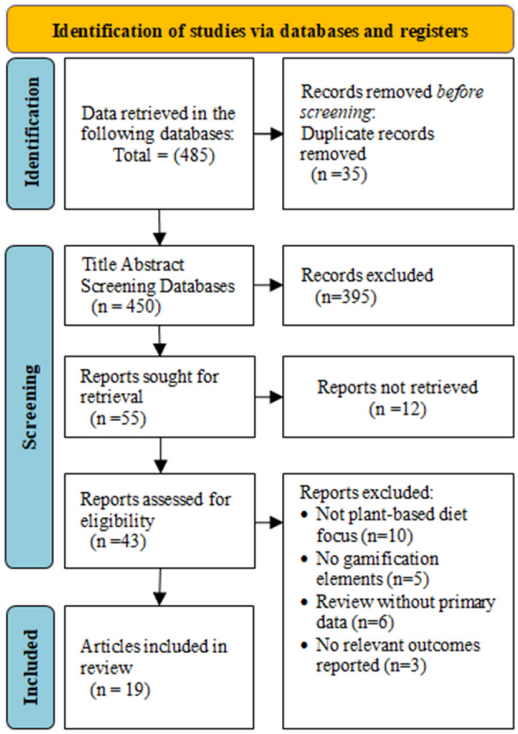


Fig. 1. PRISMA flowchart.

### D. Data Synthesis Strategy

A narrative synthesis approach was employed to accommodate the significant heterogeneity in study designs, GEs, and outcome measures across the included literature. The findings were structured thematically to align with the review's core objectives. The synthesis at first involved summarizing dietary and psychosocial outcomes to determine the overall effectiveness of the interventions. Subsequently, all identified GEs were cataloged and systematically grouped based on their function or design type (e.g., feedback, rewards, social engagement) [1]. Finally, the analysis focused on studies that reported on the role, perception, or effectiveness of these specific elements in driving behavior change. A meta-analysis was deemed not feasible due to the substantial variation in intervention protocols and measurement approaches used across the studies [19].

## III. RESULTS

A comprehensive summary of each included study is presented in Table II. Subsequently, those results are structured to address the three research questions that guided this review.

TABLE II. SUMMARY OF DIGITAL AND THEORY-BASED INTERVENTIONS PROMOTING PLANT-BASED DIETARY BEHAVIORS

| Ref | Study (description + sample size) | Intervention summary and duration | Framework | PBDs targeted |
|---|---|---|---|---|
| [15] | RCT protocol using gamified quizzes, 88 students (18–34 yrs) | Online education + Kahoot! quizzes, 10 weeks | General behavior change theories for gamification | Increased fruits and vegetables, reduced meat |

| | | | | |
|---|---|---|---|---|
| [1] | RCT on gamified quizzes, 88 students (IG=50, CG=38) | Online education + Kahoot! quizzes, 10 weeks | Gamification theory | Increased fruits and vegetables, diet quality |
| [7] | "Veganity, your journey" idle game, 10 adults (design eval) | Mobile game with diet tracking, rewards, and world-building | Behavior change wheel, Hamann framework | Transition to PBDt |
| [20] | "Rango Cards" app, 319 high schoolers (mean age 15.8) | Mobile game, 7–17 days, narrative food classification | SCT | Increased fruits and vegetables, reduced sodium |
| [21] | "The Green Hub" via Facebook, 19 enrolled (17 completed) | 4 weeks, cooking challenges, quizzes, sharing | BCW, TDF | Sustainable diets (higher plant-based, reduced animal products) |
| [22] | "Alien Health Game" Kinect exergame versus web game, 108 children (10–13 yrs) | Exergame on food choices, immediate and 2-week follow-up | Situated/ embodied cognition | Healthier food choices, Nutritional knowledge |
| [23] | WFPB vegan diet intervention, 66 undergrads (18–25 yrs) | 3-week, 3×75 min lunch-and-learn sessions, goal setting | TPB + SCT | Adoption of the WFPB vegan diet |
| [11] | "Green Eating Project" web modules, 608 students (18–24 yrs) | 5 weeks, 1 module/week, quizzes and goals | TTM | Green eating, meatless meals, sustainable proteins |
| [24] | Gamified app + social media, 32 young adults (mean age 23.1) | Smartphone app (points, badges, quizzes), push notifications, social feed | COM-B, BCT, ELM | Increased vegetable intake |
| [25] | Gamified app vs standard, 97 young adults (18–30 yrs) | 4 weeks, daily app use, with Facebook support | COM-B, Michie's BCT Taxonomy | Increased vegetable intake |
| [26] | "JunkFood Aliens" personalized persuasive game, 272 gamers (mean age 18 yrs) | 20 min game with reward versus competition tailoring | TPB + persuasive strategies | Healthy eating attitudes, self-efficacy |
| [27] | "RightWay Café" RPG, 40 undergrads (mean age 20 yrs) | 42-min session, role-play choices | HBM, SCT, TRA | Healthy diet and weight management |
| [28] | "Challenge to go (C2go)" app concept, adolescents and 210 young adults (14–25 yrs) | Design phase (concept only) | BCW, HAPA | Increased fruits and vegetables, healthier beverages |
| [29] | "Quest to Lava Mountain" 3D game, 107 diverse children (mean age 10 yrs) | Educational adventure, diet and PA choices | SCT + TRA | Healthy diet, reduced sugar |
| [30] | "Balance It" self-regulation game, 231 vocational students (mean age 17.3) | Game-based self-regulation intervention | Self-Regulation Theory + Game Theory | Increased fruits and vegetables, reduced snacks |
| [31] | "Squire's Quest! II" video game + parents, 387 children (mean age 10 yrs) | Online game, 4 groups (goal-setting variations) | SCT + goal-setting | Increased fruits and vegetables |
| [32] | "The Way of Health" app, 53 students (~20 yrs, IG=30, CG=23) | 100-day app program (14 weeks) | Gamification + SCT | Increased Healthy eating behaviors |
| [33] | "Kaledo" educational board game, 1.045 students (9–19 yrs) | Weekly sessions × 20 weeks | Game-based learning, Self-efficacy | Increased Healthy eating, reduced BMI z-score |
| [34] | Active video games + motor games, 47 students (mean age 22.5) | 12 weeks, 2 sessions/week, 2 hrs each | Not explicit (motivation focus) | Mediterranean diet adherence (Increased fruits and vegetables) |

### *A. RQ1: How Effective Is the Gamification Approach in Promoting the Adoption of PBDs Among Young People?*

Evidence for dietary behavior change varied across the studies. Several interventions demonstrated statistically significant improvements in plant-focused behaviors, including higher vegetable intake scores, more frequent meatless meals, and increased legume consumption [2, 3]. One study also reported improved adherence to the Mediterranean diet [34]. However, these positive outcomes were not consistent. Some well-designed studies found no significant differences in the overall diet quality or fruit and vegetable intake between gamified and control groups, nor between standard and gamified self-monitoring apps [24], indicating that gamification does not always translate into direct dietary change. In contrast, improvements in psychosocial outcomes were more consistently observed. Many interventions led to higher nutritional knowledge, more positive attitudes towards sustainable eating, and increased self-efficacy for adopting target behaviors [28]. These psychological gains are important precursors to long-term behavior change. Engagement and retention also emerged as key determinants of effectiveness. Studies with greater user engagement tended to show more favorable outcomes; however, sustaining participation over time remained challenging, with several interventions reporting high attrition rates [34].

### *B. RQ2: What GEs Have Been Utilized in Interventions Aimed at Promoting PBDs Among Young People?*

This review identified a wide range of GEs used in interventions designed to promote PBDs among young people. These elements were frequently combined to enhance engagement and create an interactive user experience. Table III summarizes the specific elements incorporated across the included studies.

TABLE III. DISTRIBUTION OF GEs BY STUDY AND PLATFORM

| Ref | Platform | GEs Used |
|---|---|---|
| [15] | Online website + Kahoot! quizzes | Quizzes, leaderboard, points |
| [1] | Online website + Kahoot! quizzes | Quizzes, leaderboard, points |
| [7] | Mobile serious game "Veganity, your journey" | Progress, diet tracking, rewards, goal setting, world-building |
| [20] | Mobile game "Rango Cards" | Narrative, quizzes, challenges, role-play |
| [21] | Mobile game "Healthy Foodie" | Food classification game, traffic light system, and immediate feedback |
| [22] | Facebook group (web-based) | Cooking challenges, quizzes, and social interaction |
| [23] | Exergame "Alien Health Game" (Kinect) | Forced-choice nutrition tasks, physical movement, and active gameplay |
| [11] | Lunch and learn sessions (education) | Goal setting, interactive experiential activities |
| [24] | Web-based modules | Quizzes, goal setting |
| [25] | Smartphone app + social media | Points, badges, challenges, progress indicators, social feed |
| [26] | Smartphone app + Facebook support | Points, badges, challenges, progress indicators, social feed |
| [27] | Video game "JunkFood Aliens" | Rewards (points), competition, comparison, personalized strategies |
| [28] | Computer-based role-playing game "RightWay Café" | Simulation, narrative role-play, feedback |
| [29] | Mobile app (concept) "Challenge to go (C2go)" | Goal setting, habit tracking |
| [30] | Video game "Quest to Lava Mountain" | Narrative, levels, healthy food = avatar health, simulated physical activity |
| [31] | Serious game "Balance It" (PC/web) | Goal setting, self-regulation missions, and a peer support system |
| [32] | Online video game "Squire's Quest! II" | Goal setting (action plans, coping plans), narrative missions |
| [33] | Board game "Kaledo" | Turn-based play, point accumulation, and educational challenges |
| [34] | Xbox 360 Kinect + motor games | Active video gameplay, physical movement |

The most used GEs were points and rewards, goal setting and challenges, feedback mechanisms, badges, quizzes, leaderboards, social competition, and progression or level-based systems. Less frequently used, but present in some computer-based games and more sophisticated app designs, were the avatars and narrative or storyline features [17, 24].

### C. RQ3: How Do Specific GEs Influence PBD Behavior Change?

Direct empirical evidence isolating the independent effects of specific GEs on behavior change related to PBDs is limited, as most interventions bundle multiple components together. However, the reviewed literature provides valuable insights into the differential impact and perceived utility of certain elements [26]. Several studies suggest that GEs fostering enjoyment, personal relevance, and a sense of progress are particularly effective. For instance, authors in [27] found that the "fun" factor, derived from narrative and challenges, along with personalized feedback, was positively correlated with improved self-efficacy and intention to eat healthily. Similarly, the ability to set personal goals and see tangible progress was found to be highly engaging and fostered a more positive attitude towards PBDs [23]. Conversely, literature offers critical cautionary findings. The addition of GEs can be counterproductive if not seamlessly integrated. Authors in [25] discovered that their gamified app, which included badges and challenges, resulted in higher dropout rates and lower ease-of-use ratings compared to its non-gamified version, with no additional benefit to engagement or vegetable intake. This suggests that GEs that add unnecessary complexity can be detrimental [35].

## IV. DISCUSSION

### A. Principal Findings: Synthesizing the Evidence

Regarding RQ1 (Effectiveness), the findings across the 19 studies were modest and varied. Gamified interventions consistently showed improvements in PBD-related knowledge, attitudes, and self-efficacy. Also, several studies reported positive changes in specific dietary behaviors, such as increased fruit, vegetable, or legume intake [1, 7, 11]. However, evidence of broader and sustained PBD adoption (e.g., long-term vegetarian or vegan practices) remains limited, while some studies found no significant behavioral differences compared to the control groups [23]. Regarding RQ2 (Gamification Elements Used), a wide range of GEs was identified, with points and rewards, goal setting and challenges, feedback systems, badges, and quizzes being the most applied elements [1]. Regarding RQ3 (Influence of Specific GEs), direct evidence isolating the impact of individual elements is limited. Nonetheless, the findings suggest that GEs which enhance enjoyment, deliver clear and personalized feedback, support goal progression and mastery, and provide meaningful rewards are generally well-received and more likely to drive behavior change [32]. In contrast, elements that increase the cognitive load or add unnecessary complexity can reduce engagement and limit effectiveness.

### B. Theoretical Implications

The effectiveness of gamification lies not just in the "what" (the elements used) but in the "why" (the psychological mechanisms targeted). Two theoretical frameworks are particularly relevant: SDT and SCT [34, 35]. SDT posits that intrinsic motivation is driven by the fulfillment of three basic psychological needs: competence (feeling capable and effective), autonomy (feeling a sense of choice and control), and relatedness (feeling connected to others) [37]. GEs can be designed to support these needs. For example, points and badges can enhance a sense of competence by providing positive feedback on achievements. Offering choices in challenges or personalized goals can support autonomy. Leaderboards or team challenges, if well-designed, can foster a sense of relatedness. However, if these elements are perceived as controlling (e.g., a leaderboard creating excessive social pressure), they can undermine autonomy and reduce intrinsic motivation [23, 35]. SCT emphasizes the role of self-efficacy and observational learning (modeling) in behavior change [11]. Gamification directly targets self-efficacy. Completing progressively difficult challenges or achieving set goals provides mastery experiences, which are the most potent source of self-efficacy. Feedback and progress indicators visually demonstrate one's capability, further building confidence. Table IV maps common GEs identified in this review as key

constructs in SDT and SCT, providing a framework for future theory-based intervention design [36, 37].

TABLE IV. MAPPING GEs TO KEY CONSTRUCTS IN BEHAVIOR CHANGE THEORIES

| GEs | SDT construct | SCT construct |
|---|---|---|
| Points/ rewards [1, 23] | Competence (provides performance feedback); can undermine autonomy if perceived as controlling. | Reinforcement (provides positive consequences for behavior). |
| Badges/ achievements [23, 27] | Competence (symbolizes mastery and accomplishment). | Self-efficacy (acts as a source of experience mastery). |
| Challenges/ goals [11, 20] | Competence (optimal challenges foster growth); autonomy (personal goal-setting supports self-direction). | Goal setting (directs attention and effort); self-efficacy (achieving goals builds confidence). |
| Leaderboards [1, 15] | Relatedness (fosters community/ competition); can undermine autonomy if it creates social pressure. | Observational learning (social comparison can model behaviors and standards). |
| Narrative/ storyline [7, 26] | Relatedness (creates connection to characters/world); autonomy (provides meaningful context for choices). | Observational learning (characters can model desired behaviors and outcomes). |
| Feedback [7, 26] | Competence (essential for learning and skill development). | Self-efficacy (corrective feedback improves performance and belief in ability). |

### *C. Sustaining Long-Term Engagement and Reducing Attrition*

A significant limitation in the existing literature is the dominance of short-term study designs and the limited availability of long-term follow-up data [25]. Evidence suggests a "decay effect," where behavioral improvements decline after the intervention ends, although they typically remain above baseline levels [25]. Some findings indicate that very short interventions, lasting only days or weeks, may be more effective than longer ones, potentially due to a novelty effect that diminishes over time [38, 39]. Gamification also presents the risk that users may "game the system," prioritizing the accumulation of points or badges rather than internalizing knowledge or adopting genuine behavior change. To address this issue, game mechanics should be intentionally aligned with the learning objectives so that rewards are tied to the demonstrated mastery rather than simple task completion. GEs should also balance intrinsic and extrinsic motivation by supporting autonomy and competence, helping users develop internal motivation to learn. Additionally, providing rich, actionable feedback is crucial, not just scores, but explanations that clarify why the responses are correct or incorrect to facilitate deeper learning and more meaningful outcomes [1, 7].

### *D. Limitations*

Despite expanding the evidence base to 19 studies, several limitations persist. Although the broader age range enhances generalizability, the literature remains focused on young people in educational settings. Potential publication bias toward positive findings may also be present. Furthermore, substantial heterogeneity in intervention designs, target populations, and outcome measures continues to limit comparability across studies and prevents the conduct of quantitative meta-analysis.

### *E. Future Research*

To advance the field, future research must address key gaps to strengthen the effectiveness of gamified interventions for PBDs. The emphasis should shift from determining whether gamification works to understanding how, for whom, and under what conditions it is the most effective. A focused research agenda is therefore required. First, dismantling studies are needed to isolate the effects of individual GEs (e.g., points, badges, leaderboards) to determine "what works for whom" [35, 40]. Such studies will help identify the active components of interventions and support more targeted and efficient designs. Second, long-term Randomized Controlled Trials (RCTs) with extended follow-up periods (e.g., ≥6 months) are essential to examine the sustainability of behavior change beyond the initial novelty of gamification [24, 41]. Third, future interventions should be explicitly grounded in established theories, such as SDT and SCT, with mediating psychological variables (e.g., perceived competence, self-efficacy) measured to clarify the mechanisms underlying behavior change [19]. Finally, research should extend beyond university student samples to include more diverse populations across cultural contexts, socioeconomic groups, and age ranges to enhance generalizability [42]. Addressing these priorities will improve the scientific rigor of gamification research and support the development of more effective, scalable, and sustainable strategies for promoting PBD behaviors [41].

## V. CONCLUSIONS

Gamification offers a promising and engaging approach to promoting PBDs among young people. This systematic review shows that gamified interventions can enhance knowledge, attitudes, and certain PBD-related behaviors. However, evidence for achieving comprehensive and sustained PBD adoption remains limited and mixed [24, 40]. The effectiveness of gamification is not achieved simply by adding Ges. It relies on thoughtful, theory-informed, and user-centered design, with elements integrated in ways that enhance rather than complicate the user experience [26]. Features that promote enjoyment, provide clear and actionable feedback, support goal attainment, and deliver meaningful rewards appear to be the most effective [28]. Nevertheless, notable gaps persist, particularly regarding the long-term impact of these interventions and the distinct contribution of individual GEs. Future research should prioritize rigorous, theory-driven RCTs with extended follow-up periods, dismantling studies to isolate the effects of specific GEs, and the exploration of personalized gamification tailored to the diverse needs and preferences of young people [22, 32].

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