Digital games for nutrition and healthy eating: A systematic review

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Summary

Nutrition and healthy eating are important to wellbeing. Digital games are an emerging intervention strategy to improve personal health. This review provides an overview of the digital games developed to improve nutrition and eating behavior and their effects on players. Twenty-three articles examining 18 projects using 24 health video games for nutrition and healthy eating published between 1997 and 2012 in English were selected from 2279 articles identified through five major search engines. The results show that academic interest in using health games for nutrition and healthy eating has increased during this time. All but one game were designed and developed by academic researchers. Although most studies had relatively small sample sizes and were of short duration with small to moderate effect sizes, wide ranges of age, gender, theoretical frameworks, game play venues, game platforms, and durations of play were observed. In general, positive outcomes were observed across all reviewed studies. Diet was measured approximately half of the time, often by self-report. Despite the positive trend, stronger measures are needed to more effectively assess effects of health games on nutrition and healthy eating. Perhaps more intensive collaborations between interdisciplinary academic researchers and commercial game companies would mutually propel both fields of health game research and health game production forward.

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Introduction

Diet is a key lifestyle behavior that affects chronic disease risks such as cancer and coronary heart disease (Amine et al., 2012). In the United States, for example, inadequate diet is among the top causes of death (Mokdad, Marks, Stroup, & Gerberding, 2004). Improved dietary intake is beneficial for personal health. For example, fruit and vegetables provide natural antioxidants (Kaur & Kapoor, 2001) and are associated with reduction in cardiovascular disease risk (H.-C. Hung et al., 2004). In order to effectively prevent chronic diseases, strategies should recognize the essential role of nutrition and healthy eating (World Health Organization, 1990).

As part of the serious game movement (Susi, Johannesson, & Backlund, 2007), health games, or interactive digital applications are designed to promote health and wellbeing (Lu, Kharrazi, Gharghabi, & Thompson, 2013). Health games offer an innovative intervention channel that can induce positive health behavior changes (Baranowski, Buday, Thompson, & Baranowski, 2008). For instance, health games have shown to be effective in increasing Fruit and Vegetable (FV) intake (Baranowski et al., 2003) or increasing self-efficacy and perceived benefits of healthy eating (Peng, 2009).

These health games often use the principles of 'behavioral change models' from psychology to motivate their users to adopt healthy behaviors such as adopting a better diet. Behavioral change models are rigorously tested frameworks to motivate users to take a certain action by changing their behavior (Davis, Campbell, Hildon, Hobbs, & Michie, 2014). For example, in the Theory of Planned Behavior's model, changing one of the psychological constructs (called mediating variables) of attitudinal, normative or control beliefs can lead to increased intention to take an action toward a healthy behavior (Cerin, Barnett, & Baranowski, 2009). Games that target healthy eating often use one or part of these behavioral change models. This chapter overviews the existing research on digital games for nutrition and healthy eating.

Methods

A modified version of the Cochrane guidelines for systematic review was utilized (Higgins & Green, 2011). The process involved multiple stages ranging from initially generating a definition of "health games" to progressing to an analysis of individual articles and data extraction. A health game refers to an interactive digital program or application designed for promoting health and wellbeing as part of its goals. To ensure a comprehensive scope of inclusion, two search cycles were performed between 2010 and 2012. The first cycle was conducted as part of a larger systematic review that examined the scope of health game research in general by including papers published before 2011 (Kharrazi, Lu, Gharghabi, & Coleman, 2012), while the second cycle included additional manuscripts published after 2011.

For the first cycle, four independent reviewers representing different academic backgrounds participated in article selection and data extraction to ensure a fair and comprehensive coverage of health game research and inter-rater reliability. Five search engines,

PubMed, EBSCO, IEEE/ACM, Google Scholar, and Health Game Research Database (Health Game Research, 2012), were searched between October 2010 and April 2011 with keywords ((Health OR Rehab*) OR (Exer* OR Acti*) OR Edu* OR Behav* OR Serious OR (Virtual AND Reality)) AND ((Interactive OR Computer OR Video OR Multimedia OR Internet OR Online) AND Gam*). Reviewers intended to capture most or all of the research articles written in English on health games published in peer-reviewed journals and conferences up to 2011. Each reviewer generated an independent list of articles.

The inclusion criteria were independently applied to each article by each of the four independent reviewers (Kharrazi et al., 2012): (1) the primary purpose of the study was maintaining or improving health; (2) the study's research design used one or more health games as the key intervention; (3) the study incorporated quantitative measures; (4) the study was designed for the healthcare-receiver population (e.g., overweight elementary school students) instead of healthcare providers (e.g., orthopedic surgeons); and (5) the publication was an original study, not a review of other studies.

For the first cycle, a total of 2024 articles were identified by all reviewers from the five search engines using the keyword combinations. The articles were reduced to 396 articles to avoid duplication. The abstracts of the 396 articles were retrieved and screened to meet the inclusion criteria. If an abstract did not provide adequate information, the reviewers read the article in full. Consensus on coding results was reached through in-depth discussion. Manual searches were also performed on all of the selected articles' reference lists to ensure inclusion of all eligible articles. A total of 149 articles on health game research were retained. A scoping overview was published elsewhere (Kharrazi et al., 2012). The first two authors then re-examined the 149 articles and identified 15 health game research articles that focused on nutrition and healthy eating.

A second review cycle was conducted in November 2012 by two of the four independent reviewers following a protocol similar to that in the first cycle of review. An additional 8 articles published between January 1, 2011 and November 30, 2012 were identified for a total of 23 articles included in the current systematic review. Figure 1 provides a flowchart of the selection process depicting both review cycles.

Data Extraction and Synthesis:

To ensure inter-reviewer reliability and authenticate the data extraction and interpretation quality, four reviewers participated in a pilot training session by coding 10% of the health game research articles on behaviors other than nutrition and healthy eating. Comparison of the coding results indicated high consistency (85% +). Differences were resolved by internal in-depth discussion. Following this, each coder reviewed and extracted data from the 23 articles separately. Data extracted from the selected articles included (1) publication statistics (Publication year); (2) sample characteristics (Age, Gender, Size); (3) research design (Location, Existence of control group); (4) game characteristics

(Commercial/Noncommercial, Platform, Online, Story, Game duration); (5) intervention goal; (6) psychological and behavioral change theories; and (7) outcome (Measurement, Validation). Extracted results were tabulated in a compiled Microsoft Excel® spreadsheet for further analysis. Additional email inquiries seeking additional information were sent to authors when their articles did not provide enough details about the studies or the games.

Research Question:

Two research questions guided the systematic review: (1) what kinds of health games have been used in nutrition and healthy eating interventions leading to what outcomes?; and, (2) what are the characteristics of the published health game studies for nutrition and healthy eating?

Results

Table 1 addresses the first research question by summarizing characteristics of the games and the interventions. A total of 24 games from 18 projects were studied in 23 publications.

Games: The names of the games seldom revealed the real health purpose of the games. Most game names did not bear direct relevance to nutrition and healthy eating, or health topics (n = 15 games), but tended to focus on the entertainment aspect instead (e.g., *Squire's Quest! The Quest to Lava Mountain*).

Commercial: Except for the earliest study when the researchers used a commercially available game (Brown et al., 1997), the rest of the studies developed their own games.

Platform: Most of the games used personal computers (n = 16 games), but mobile phones recently became an additional platform (n = 7 games). One game was made for both. Except for an early game (i.e., *Packy and Marlon*) which was made for the Super Nintendo system, no games were found on commercial console platforms (e.g., Wii, Xbox, or Playstation)

Online: More than half of the health games were online or used the network to transfer game data (n = 13 games).

Story: One third of the games (n = 8) contained stories or some narrative elements.

Key Intervention Goal: Around a third of the games (n = 8) aimed to change specific dietary behaviors (e.g., fruits, 100% juice, vegetables, healthy snacks, breakfast). The rest focused on cognitive variables, such as knowledge, attitude, general diet quality assessment, or usability tests.

Theory: Most games (n = 15 games) had some type of underlying theoretical framework. A total of 16 different theories were identified with Social Cognitive Theory (SCT) being the most popular (n = 11 games).

Age: Children and adolescents were the predominant target population (4726 across all projects) as compared to 18+ adults (263 across all projects) (Grand total: 4989). Most of the studies involving children had a narrow age range (i.e., 2.9 years apart, *SD* = 1.9); those with adults had a wider age range, 18.6 years apart, *SD* = 10.7.

Number: More male than female participants were included (1618 males vs. 1449 females). Three projects did not report gender distribution among the participants and were not included in calculation.

Game Time: Each game session ranged from several minutes to an hour. The play frequency was generally higher for games meant for repeated play and/or with more levels.

Measurement: Half of the published studies (n = 12) used unvalidated measures for key outcome variables. Seven used validated measures, and four used both unvalidated and validated measures.

Key Findings: Most projects did not aim for behavioral change. Psychosocial variables, such as attitude and knowledge change, were the most popular outcome measures. Only a few studies actually measured dietary behavior directly (n = 7) and even fewer tracked change in diet using a pre- and post-test design (n = 4).

Effect Size: Of the 18 projects, five reported small-to-moderate effect sizes (*d*s = .08 - .5). The rest did not provide effect size statistics.

Table 2 addresses the second research question by providing a summary of published study characteristics. In this section, the unit of review was per article instead of per clinical trial. For example, if data from one clinical trial was reported in 3 publications, all of the 3 articles would be counted.

Year of Publication: There was a trend of increasing numbers of studies across the years. Most articles were published after 2007, with only 13% published before 2003.

Sample Size: Number of participants ranged between 6 and 1876, *M* = 247, *SD* = 487. Over 60% had a sample of 100 or fewer. Around a third of the studies included between 100 and 500 participants. Less than 10% of the manuscripts had more than 1000 participants.

Age Group: About two thirds of the reviewed publications focused on children and adolescents (Age range: 7 to 16).

Gender: Approximately 80% of the studies recruited both genders.

Design: Around three quarters of the studies included control conditions, compared to the rest with treatment group alone.

Game Play Setting: Home was the most popular venue, with half of the studies encouraging participants to play the games at home. The second most popular venue was school, with about 30% of the studies being school based. Recent years saw studies (e.g., Schneider et al., 2012) involving multiple game play locations (both home and school).

Research Duration: Durations of the health game research were short. All were under six months, with over 60% occurring in less than a month and 13% taking place between 3 and 6 months.

Types of Outcome Measures: Two thirds of the 18 studies used only self-report of diet (e.g., survey questionnaires); the rest used a combination of subjective and objective measures (e.g. food photography).

Dietary Intake Measure: While the general goal of most games was improvement in dietary intake, only 10 of the 23 studies measured diet. The rest of the games focused either on contingent measures such as nutrition knowledge and behavioral intention, or on alpha tests or usability of games promoting healthy diet. Among the behavioral measures, the 24-hour dietary recall (Karvetti & Knuts, 1985), one of the more rigorous assessments of dietary intake (Cullen, Watson, et al., 2004), was the most popular (n = 3). Alternative measures, such as food choice (n =1), caloric intake (n =1), food frequency questionnaires (n =1), and food photos (n =1), were also used. Dietary behavior measures without statistical validation were also used.

Location: The United States (US) was the main venue for health game research. Around 80% of all studies took place in the US, as compared to one in Canada, two in Asia, one in South America, and one in Europe.

Discussion

This review surveyed health video game research targeting improved dietary or nutritional outcomes. In the period reviewed, increasing numbers of research articles were published, especially in the US. While some consider video games as primarily created for home entertainment, serious games for health have been employed in and beyond the home. Schools were the second most popular venue to adopt this medium. Both computer and mobile phone platforms may find their way into the school settings as compared to game consoles, which may be deemed as home entertainment equipment (Kaiser Family Foundation, 2010). Alternatively, computers and mobile phones may be more developer-friendly than professional game consoles (Bureau of Labor Statistics, 2011). They are also more open and easy to break into for game developers and cost less (Bureau of Labor Statistics, 2011). Laboratories do not seem to be a popular venue for diet and nutrition studies, suggesting that the dietary intake behavior would be best studied in natural settings with accessible devices (Meiselman, 1992). Half of the studies included games with networking capacity. This is a helpful feature for game researchers to track the dietary related

variables on a continuous basis. A third of the games included stories, which may provide an important motivational aspect with appealing characters and engaging plots (Lu, Baranowski, Thompson, & Buday, 2012).

The theoretical frameworks underlying video game design have been diverse, including the Social Cognitive Theory (SCT) (Bandura, 1986), Transtheoretical Model (TTM) (Prochaska & Velicer, 1997), and Health Belief Model (HBM) (Janz & Becker, 1984). Many psychological, behavioral, and media theories were mentioned in the reviewed articles, including Narrative Transportation Theory (Green & Brock, 2002) and Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1986). This suggests that diverse disciplinary perspectives shed light on health game design and research. Diverse theories may need to be interrelated to provide the strongest foundation for behavior change from video games (Baranowski, Baranowski, Thompson, & Buday, 2011), but the optimal integration remains to be identified.

Almost all of the games being studied in the academic publications were created by researchers instead of professional gaming companies for commercial release. This likely reflects increased academic interest in creating video games for health and the lack of such interest from the professional game production companies. Involvement of these companies in the future may lead to more effective interventions with broader interest and success.

Several studies focused on usability issues (Baranowski et al., 2012; Beasley et al., 2012; Beltran et al., 2012; DeShazo, Harris, Turner, & Pratt, 2010; Thompson et al., 2007), suggesting that these video games will likely be well designed and understood by the players. For example, unnecessary confounding factors such as poor Human-Computer Interaction (HCI) design should be minimized (Buday, Baranowski, & Thompson, 2012). Compared with child players, adult players' age range was much wider (18-50 yo). Future usability studies should accommodate the various developmental stages, or even segue into the senior population (Ijsselsteijn, Nap, de Kort, & Poels, 2007).

Of all of the games included in this review, few were directly applied to more than one round of intervention research. In other words, the games were no longer used when a research project was completed. Given game development costs (Rogers, 2012), future game researchers should try to extend the games to address additional target populations on health outcomes. Alternatively, limited academic attention has been paid to professionally developed nutrition and healthy eating games (e.g. PBSkids.org, Kellogg's *Fun K Town*), thus lacking scholarly publications to inform others. A closer collaboration between the research and industry could be a sustainable strategy for game development (Buday et al., 2012).

Only 5 studies measured changes in diet behavior change and fewer used validated measures. Although the 24-hour recall (Baranowski et al., 2003; Baranowski, Baranowski,

Thompson, Buday, et al., 2011; Lu et al., 2011) was the most popular and rigorous method for recording dietary intake, the time and effort required from the participants' could hinder the accuracy of the measures (Lu, Baranowski, Islam, & Baranowski, 2012). Alternatively, the other dietary intake measures also have limitations. The behavioral food choice measure (Pempek & Calvert, 2009) cannot record regular food intake items on a daily basis. The caloric intake count (Lee, Chae, Kim, Ho, & Choi, 2010), the food photo method (Byrne et al., 2012), and surrogate report (Brown et al., 1997) have serious measurement errors. In fact, none are validated. If the ultimate focus were shifted to more health outcome variables as a consequence of dietary intake, e.g., BMI percentile (Moore et al., 2009), it would be difficult to observe a significant change in the short duration of a typical health game. The small effect sizes in only a third of the studies (n = 8) (Baranowski et al., 2003; Baranowski, Baranowski, Thompson, Buday, et al., 2011; Lu et al., 2011; Lu, Thompson, Baranowski, Buday, & Baranowski, 2012; Moore et al., 2009; Peng, 2007, 2009; Thompson et al., 2009) suggest that video game intervention should be supplementary to other interventions on diet behavior and health outcomes.

The first nutrition education videogame was *Squire's Quest!* (Baranowski et al., 2003). *Squire's Quest!* promoted fruit and vegetable consumption by using a story to attract and engage players (Lu et al., 2012) and inserting social cognitive theory based behavior change procedures in each session. For example, it increased player preference for fruit and vegetables by promoting increased exposure to fruit and vegetables (Birch, 1998), associating fun with their consumption (Mellecker, Lyons, & Baranowski, 2013), promoting increased player asking for fruit and vegetables at home (Jago, Baranowski, & Baranowski, 2007), increasing player skills in recipe preparation using a simulated kitchen and having players make the recipes at home (Cullen, Watson, Zakeri, Baranowski, & Baranowski, 2007) and having players set goals to eat more fruit and vegetables at the end of each episode (Cullen, Zakeri, et al., 2004). *Squire's Quest!* players increased their consumption of fruit and vegetables by a serving a day (Baranowski et al., 2003). Subsequent games, e.g. *Escape from Diab* and *Nanoswarm: Invasion form Inner Space* used similar principles and also changed fruit and vegetable intake (Baranowski, Baranowski, Thompson, Buday, et al., 2011).

Limitations: Due to the heterogeneity of the publications, a meta-analysis was not feasible. We adapted the Cochrane protocol for systematic reviews to health game intervention. The Cochrane quality measures were not applied to the final list because of the limited number of full-featured randomized trials. Only English language articles were included, and the selected articles may also be subject to publication bias for positive findings (Easterbrook, Gopalan, Berlin, & Matthews, 1991).

In summary, health game research for nutrition and healthy eating is still in its infancy. The increasing publication trend suggests the field's emerging status. While sample size, research design, and outcome measurement all need improvement, it is helpful to see

that health game research has found its way into a wider venue, population, and theoretical spectrum. Closer collaboration between academic researchers and professional game development companies could result in more reusable games that can be applied to a wider audience for a longer duration to achieve more meaningful impact. Therefore, research projects could benefit from more support from the industry while game production could be enhanced from a more rigorous design.

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Figure 1: Publication identification process

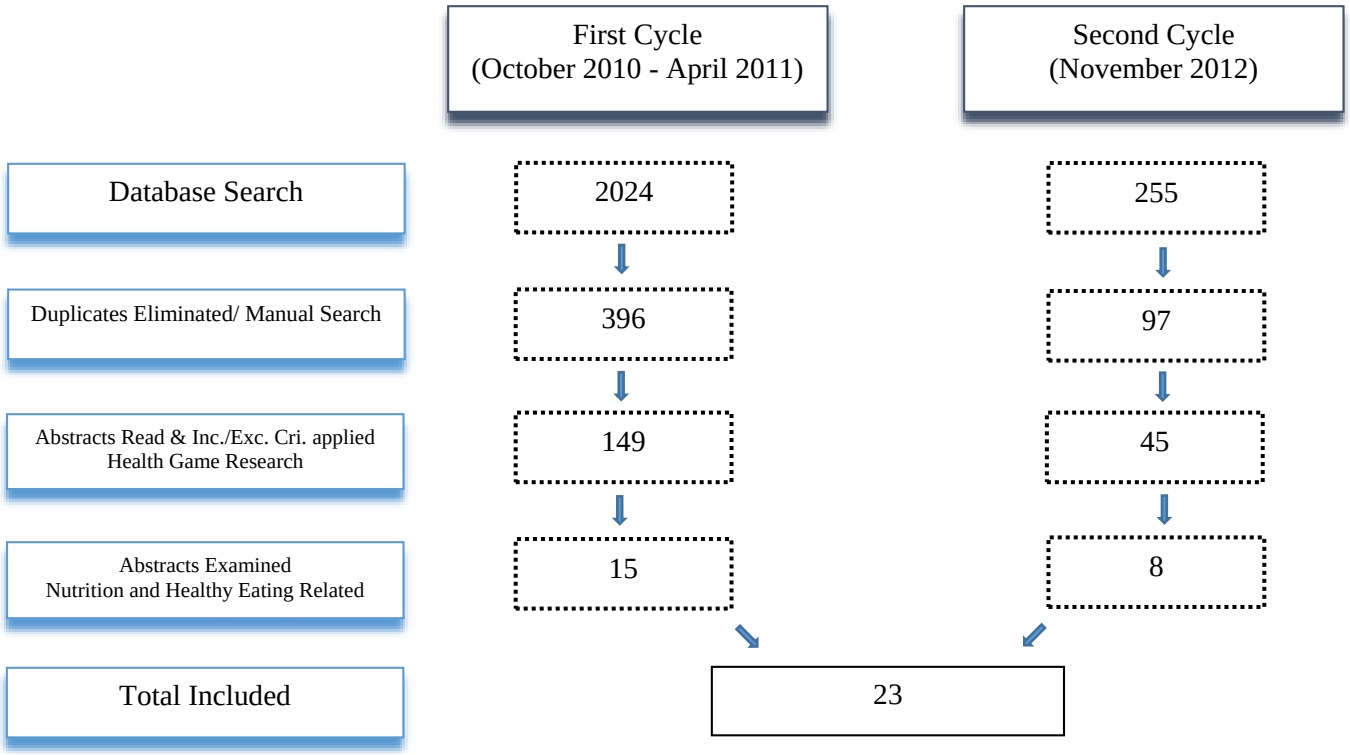

Table 1: Characteristics of health games for health intervention

(Arranged chronologically according to the first year of publication. Each full block refers to a separate project.)

Games	Study (Pub Year)	C[1]	Platform	Online	Story	Theory	Age	Number	Game Time	Key Findings	Effect Size
1. *Packy and Marlon*	Brown et al. (1997)	Y	Super Nintendo	N	Y	SCT[a]	8-16	31 T 28 C (30 M)	18 hrs in 3 months, then 16 hrs in another 3 months	Treatment group saw improvement relative to control group in self efficacy, diabetes communication, and self-care behaviors, and a decrease in unscheduled urgent doctor visits	-
2. *Alimentary My Dear Joe*	Turnin et al. (2001)	N	Computer	N	N	-	7-12	1003 T 873 C	1 Hour x 2 times/wk x 5 weeks	Treatment group had significantly better nutritional knowledge and dietary intake compared to the control	-
3. *Squire's Quest!*	Baranowski et al. (2003)	N	Computer	N	Y	SCT	8-12	785 T 793 C (736 M)	10 x 25 min sessions	Treatment group increased their FJV consumption by 1.0 serving more than the control group	.5
4. *RightWay Café*	Peng (2007) Peng (2009)	N	Computer	N	N	HBM[b]/ SCT	18+ Ave 20 yo	20 T 20 C (8 M)	42 min	The game is effective in teaching nutrition and weight management knowledge and increasing self-	.08-.16

										efficacy (after 1 month), perceived benefit, and behavioral intention	
5. *Escape from Diab (Diab)* 6. *Nanoswarm: Invasion from Inner Space (Nano)*	Thompson et al. (2007)	N	Computer	Y	Y	SCT/ SDT[c]/ BIT[d]/ ELM[e]	9-11	10 T	1 Hour	Alpha testers understood goal setting and review components and were able to complete them quickly	-
	Baranowski et al. (2011)						10-12	103 T 50 C (86 M)	9 x 40 min sessions x 2 games	Treatment group increased FV consumption by about .67 servings per day but not water and moderate- to vigorous PA, or body composition	.18-.26
	Lu et al. (2012) (Studied *Diab* only)						10-12		9 x 40 min sessions x 1 game		.19

7. An unnamed video game based on the food pyramid	Munguba et al. (2008)	N	Computer	N	N	-	8-10	200 T (95 M)	Weekly 30 min for 4 months	Participants learnt nutritional concepts through the game although with a preference for a board game	-
8. *The Fantastic Food Challenge*	Silk et al. (2008)	N	Computer	N	N	-	18-50 Ave 33 yo	47 T 57 C1 51 C2 (0 M)	20-30 min	Compared to the game treatment group, the website control group was liked the most, and had the best knowledge outcomes	-
9. *Color My Pyramid: Blast Off*	Moore et al. (2009)	N	Computer	Y	N	SDNT[f]	9-11	126 T (46 M)	6 times over 3 months	Scores for self-care practices, activity, and systolic blood pressure improved significantly but not BMI percentiles	.163
10. *Pac-Man* Advergame	Pempek et al. (2009)	N	Computer	N	N	-	9-10	20 T 10 C (15 M)	9 min 32 sec	Children who played the healthier version selected and ate significantly more healthy snacks than those who played the less healthy version	-
11. *Little Nutritionist*	Hung et al. (2009)	N	Computer	N	N	-	7-9	33 T 33 C (36 M)	4 X 40 min sessions	Treatment group received better scores on nutrition knowledge, and	-

12. *Presents Falling Down from the Sky* 13. *Save the Kingdom of Nutrition*										diet behavior assessments than control group	
14. *Solve It* 15. *What Moves you?*	Thompson et al. (2009) Lu et al. (2011)	N	Computer	Y	Y	SCT	10 - 14	473 T/C (473 M)	Weekly for 9 weeks X 2 games	Treatment group saw behavioral change in FJ consumption, FJ home availability, and low-fat Vs but the improvement was not maintained 6 months later	.5
16. *Smart Diet*	Lee et al. (2010)	N	Mobile Phone	Y	N	-	Ave 28.2-29.5	19 T 17 C	Once per week for 6 weeks	Treatment group saw decreased body composition measures (fat mass, weight, and BMI) but control group did not	-
17. *Hangman* 18. *Quizshow* 19. *Countdown*	DeShazoal et al. (2010)	N	iPhone, Windows Mobile, and Blackberry	Y	N	HCT[g]/ ET[h]	18+ Ave 38 yo	10 T (3 M)	50 min, 50 min, and 28 min	Participants provided feedback about game design and usability input and tested nutritional knowledge by playing the games	-

20. *Kiddio (Episode 1: Food Fight)*	Baranowski et al. (2012)	N	iPhone	N	Y	SCT/PT[i]/ NT[j]/ CTT[k]	24-43	16 T (0 M)	-	Participants reported that they enjoyed the game, felt the Kiddio character to be like their child, learned new ways to encourage their children to taste Vs, and enhanced their domain of parenting	-
	Beltran et al. (2012)								3-12 min x 3 sessions	Participants reported that they enjoyed the game, provided feedback to improve the game to better teaching them to encourage their children to eat Vs	-
21. *The Quest to Lava Mountain*	Beasley et al. (2012)	N	Computer	Y	Y	SCT/ TRA[l]	8-12	19 T (16M)	90, then 45 min	Participants reported that they enjoyed the game, would like to continue playing, the game taught them to eat healthier foods	-
22. *Time to Eat*	Byrne et al. (2012)	N	iPhone	Y	N	SCT	12-14	25 T 14 C (22 M)	Played in 9 days	Treatment group with a virtual pet providing both positive and negative feedback were twice as likely to eat breakfast than treatment group with only positive feedback or control	-

23. *Lunch Time*	Orji et al. (2012)	N	Computer & Cellphone	Y	N	TTM[m]/ GST[n]/ SLT[o]/ KABT[p]	19-40	6 T (3 M)	Several min daily x 10 days	Game play increased nutrition knowledge, led to reflection, and improved healthy eating attitude	-
24. *Fitter Critters*	Schneider et al. (2012)	N	Computer	Y	N	-	5[th] graders	97 T (49 M)	5 x 52 min daily	Significant increases in positive attitudes toward healthy eating, self-efficacy, and marginally significant increases in nutrition knowledge	-

Superscript:

Abbreviation for Categories

[1]C: Commercial

Abbreviation for Theories (Order of appearance)

[a]: SCT = Social Cognitive Theory (11)

[b]: HBM = Health Belief Model (1)

[c]: SDT = Self Determination Theory (2)

[d]: BIT = Behavioral Inoculation Theory (2)

[e]: ELM = Elaboration Likelihood Model (2)

[f]: SDNT = Self-care Deficit Nursing Theory (1)

[g]: HCT = Health Communication Theory (1)

[h]: ET = Education Theory (1)

[i]: PT = Parenting Theory (1)

[j]: NT = Narrative Transportation Theory (1)

[g]: CTT = Child Temperament Theory (1)

[h]: TRA = Theory of Reasoned Action (1)

[l]: TTM = Transtheoretical Model (1)

[m]: GST = Goal Setting Theory (1)

[n]: SLT = Social Learning Theory (1)

[o]: KABT = Knowledge Attitude Behavior Theory (1)

Table 2: Characteristics of Published Studies

	References	Count	%
Year of Publication		23	100
Before 2000	6	1	4
2001 – 2003	1, 23	2	9
2007 – 2009	9, 13, 14, 16, 17, 18, 20, 21, 22	9	39
2010 – 2012	2, 3, 4, 5, 7, 8, 10, 11, 12, 15, 19	11	48
Sample Size			
0 – 100	3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 22	14	61
101 – 200	2, 12, 20, 13, 14	5	21
401 - 500	11, 21	2	9
1000 +	1, 23	2	9
Age Group			
Children / Youth (7 - 16)	1, 2, 4, 6, 7, 9, 11, 12, 13, 14, 16, 19, 21, 22, 23	15	65
Adults (18 +)	3, 5, 8, 10, 15, 17, 18, 20	8	35
Gender			
Both Female and Male	1, 2, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23	18	78
Female Only	3, 5, 20	3	13
Male Only	11, 21	2	9
Design			

Treatment/Control	1, 2, 4, 5, 6, 7, 9, 10, 11, 12, 13, 16, 17, 18, 20, 21, 23	17	74
Treatment Only	3, 8, 14, 15, 19, 22	6	26
Game Play Setting			
Lab Only Study	17, 18, 22	3	13
Field: School Only	1, 4, 9, 13, 14, 16, 23	7	30
Field: Home Only	2, 3, 5, 6, 7, 8, 10, 11, 12, 15, 21	11	48
Field: Multiple	19, 20	2	9
Research Duration			
1 Day or Less	3, 4, 5, 16, 17, 18	6	26
1 Day - 1 Week	8, 19, 22	3	13
1 Week - 1 Month	7, 9, 12, 15, 20	5	22
1 Month - 3 Months	1, 2, 10, 13, 21, 23	6	26
3 Months - 6 Months	6, 11, 14	3	13
Outcome Measure Types			
Subjective Only	1, 3, 4, 5, 8, 9, 12, 14, 15, 17, 18, 19, 20, 22, 23	15	65
Subjective & Objective	2, 6, 7, 10, 11, 13, 16, 21	8	35
Dietary Intake Measure			
24-Hour Dietary Recall	1, 2, 11	3	13
Food Choice	16	1	4
Caloric Intake	10	1	4

Diet Record	23	1	4
Food Frequency Q	21	1	4
Food Photos	7	1	4
Report by Others	6	1	4
Diet Behavior Qs (U*)	9	1	4
None	3, 4, 5, 8, 12, 13, 14, 15, 17, 18, 19, 20, 22	13	59
Location			
Brazil	14	1	4
Canada	15	1	4
France	23	1	4
South Korea	10	1	4
Taiwan	9	1	4
United States (US)	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 16, 17, 18, 19, 20, 21, 22	18	80

Note:

Reference Numbers: 1. Baranowski et al. (2003); 2. Baranowski, Baranowski, Cullen, Thompson, et al. (2011); 3. Baranowski et al. (2012); 4. Beasley et al. (2012); 5. Beltran et al. (2012); 6. Brown et al. (1997); 7. Byrne et al. (2012); 8. DeShazo, Harris, Turner, & Pratt (2010); 9. Hung, Chiu, Chen, Su, & Chen (2009); 10. Lee, Chae, Kim, Ho, & Choi (2010); 11. Lu et al. (2011); 12. Lu, Thompson, Baranowski, Buday, & Baranowski (2012); 13. Moore et al. (2009); 14. Munguba, Valdes, & da Silva (2008); 15. Orji, Vassileva, & Mandryk (2012); 16. Pempek & Calvert (2009); 17. Peng (2007); 18. Peng (2009); 19. Schneider et al. (2012); 20. Silk et al. (2008); 21. Thompson et al. (2009); 22. Thompson et al. (2007); 23. Turnin et al. (2001).

*: U=Unvalidated