



Using Games to Promote Healthy Behavior in Children: A Narrative Review

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Abstract

BACKGROUND: Games are a fairly effective method to overcome public health problems, especially in children.

AIM: This study aims to review the use of games to promote healthy behavior in children.

METHODS: The method used is to search for literature published in PubMed in 2017–2021. Search using the keywords: Games, intervention, children, health, and behavior. Based on the search, 452 articles were found. Then, the articles are selected based on inclusion criteria, which are open-access articles, original research, and addressing behavioral problems related to public health.

RESULTS: Based on the inclusion criteria, 18 articles were selected to be analyzed. The 18 articles discussed the use of games to overcome health behavior problems in children. In detail, there are three articles on mental health, eight articles on nutritional behavior, four articles on physical and sedentary activity, one article on dental health, and two articles on hand washing practices.

CONCLUSION: The game method is mostly used to shape nutritional behavior. There are still few articles that discuss clean living behaviors, such as waste management. So that research is needed that looks at the effectiveness of the game method to shape waste management behavior in children.

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Introduction

Children consist of preschoolers and schoolchildren. Pre-school children are those who are in early childhood education, namely, 4–5 years of age. While school-age children have an age range between 6–12 years. Although there is literature, which classifies children as young as 10 years old, this includes early adolescent.

Children are a very important period in the life cycle. So that growth and development at this time should receive attention. One of the factors that influence growth and development in children is health. Children must have good health status to grow and develop optimally. Unfortunately, children are prone to various health problems. The problem is triggered by various factors, one of which is the behavioral factor. Therefore, it is very important to form healthy behavior in children.

One of the media that can be used to promote health in children is through games. The game is a rule-based system with variable outcome that can be influenced by the player's appearance [1]. With these rules, players have physical or mental challenges to

achieve game goals [2]. Games differ in processing and forming cognitive patterns from other media because players can be physically, cognitively, and emotionally involved in the game. This gives them the sensation of moving into the game [3]. These states are known as states that can trigger physical responses, pleasure, excitement, engagement, persuasion, and memory. Part of the fun in the game is because it can provide a real-world experience.

Games have the capacity to increase exposure to messages about health [4]. Game facilities can be a strategy to facilitate and strengthen learning [5]. Games can also be used for health promotion in children because they are in accordance with the conditions of children who still like to play [6]. Educational games can eliminate boredom when children learn [7]. Games can also stimulate socializing creativity and intellectual growth in children and can increase concentration [8].

Games have been used to promote health in children. One aspect that is being promoted is healthy behavior, such as breakfast, consuming fruit vegetables, increasing physical activity, and healthy clean living behavior. However, the use of games for health promotion in any field of public health is not yet

known. Hence, the purpose of this paper is to explain the fields that have used games as a medium for health promotion in children.

Methods

Search strategy

This literature review was conducted using the 2015 Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines [9]. The review begins with creating a list of relevant Medical Subject Headings keywords and keyword sub-headings that are generated and used to search for comprehensive peer-reviewed articles from the computerized bibliographic databases of PubMed (Figure 1).

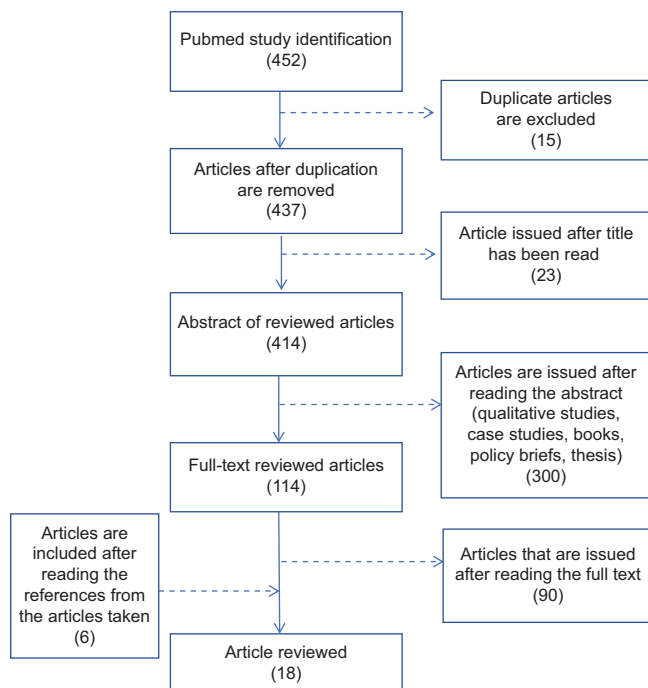


Figure 1: Reference search flow according to the PRISMA method

The search includes research conducted in the world and published between January 2017 and December 2021. Articles extracted from each database are imported into the Mendeley library. The combination of keywords used in the search is as follows: Games, intervention, children, health, and behavior.

Inclusion and exclusion criteria

The research criteria included in this review are open-access articles, original research, and addressing behavioral problems related to public health (qualitative studies, case studies, books, policy briefs, or theses excluded from review); published in a peer-reviewed journal (non-peer-reviewed studies, reviews, or comments are excluded).

Data extraction

All articles identified by the search are exported to the Mendeley Library and duplicates are removed. Furthermore, all publications were screened by reading titles and abstracts. In the final screening phase, the complete text was read of the remaining articles and retained the studies that met the inclusion/exclusion criteria. All data extraction and study assessments taken were assessed independently. A summary of the selected studies is recorded, this includes authors, year of publication, method, result, and conclusion (Table 1).

Results and Discussion

Based on Table 1, it can be seen that there are eight articles that discuss the use of games in the promotion of nutritional behavior. The games used also vary, some use Foodbot Factory [10], Feed the alien [11], My Plate Picks [12], and Play and grow [13]. Research in the field of nutritional behavior also found that the characters used in the game affect the selection, snack consumption patterns [14], and healthy eating patterns [15]. In addition, games are also effectively used to promote healthy eating patterns in obese children [16], [17].

The problem of obesity in children is a global problem, especially in developed and developing countries. The causes of obesity in children are complex, but in general, the cause is an energy imbalance. Related behaviors such as physical activity, sedentary behavior, and unhealthy eating patterns are important factors for intervention [18].

The use of games to conduct nutrition education is an important thing to study. The use of games in nutrition education increases participation and motivation in learning activities. Foodbot Factory was developed jointly by nutritionists, dietetics, game developers, and education experts. Foodbot Factory provides evidence that games can be used as an educational tool about healthy eating patterns and guidelines for children aged 8–10 years [19].

Games in general show effective results to influence healthy eating patterns in children. Video games have multiple levels of challenges, virtual imaginative worlds, and opportunities to lead players to specific goals. Games about healthy eating developed through mobile apps significantly increase knowledge of food selection as soon as the games are finished. The main positive effect will be strengthened when players read more about the nutritional content of the food in the game [20].

Children are often influenced by advertisements for unhealthy food and drinks. These advertisements usually use certain characters to influence children.

Table 1: Use of games to promote health behavior in children

Theme	Title	Author	Method	Result	Conclusion
Nutrition Behavior	The Effectiveness of the Foodbot Factory Mobile Serious Game on Increasing Nutrition Knowledge in children	Froome <i>et al.</i> , <i>Nutrients</i> 2020, 12, 3413; 2018 Jun;7(3):164-174	This study was a single-blinded, parallel, randomized controlled pilot study conducted among children ages 8–10 years attending Ontario Tech University day camps an experimental design with a single between-subjects factor (experimental condition vs. active control condition)	Compared to the control group (n = 34), children who used Foodbot Factory (n = 39) had significant increases in overall nutrition knowledge (10.3 2.9 to 13.5 3.8 versus 10.2 3.1 to 10.4 3.2, p < 0.001), and in Vegetables and Fruits (p < 0.001), Protein Foods (p < 0.001), and Whole Grain Foods (p = 0.040) sub-scores. No significant difference in knowledge was observed in the drinks sub-score	Foodbot Factory has the potential to be an effective educational tool to support children in learning about nutrition
Nutrition Behavior	Feed the Alien! The effects of a Nutrition Instruction Game on Children's Nutritional Knowledge and Food Intake	Hermans <i>et al.</i> , <i>Games Health Journal</i>	An experimental design with a single between-subjects factor (experimental condition vs. active control condition)	Participants who played Alien Health had better knowledge of the five most important macronutrients of foods at immediate posttest, but not at follow-up. Participants were better able to distinguish the healthier food item out of two options over time, but this effect did not differ for those in the experimental versus the active control condition.	A brief game-based intervention like the Alien Health Game has the potential to improve children's nutritional knowledge in the short term, but may not be strong enough to increase nutritional knowledge and actual eating behavior in the long term
Nutrition Behavior	Character Apps for Children's Snacks : Effects of Character Awareness on Snack Selection and Consumption Patterns	Putnam <i>et al.</i> , <i>GAMES FOR HEALTH JOURNAL: Research, Development, and Clinical Applications</i>	Four- and 5-year-old children (n = 132) played a bowling game on an iPad with no character or with a character holding either healthier or unhealthy snacks. After app-play, children selected and consumed healthier or unhealthy snacks.	An ordered logistic regression found no significant effect of treatment conditions compared with the control group. Within treatment conditions, awareness of the character led to selection and consumption of more healthy snacks in the healthier condition (odds ratio b = 10.340, p = 0.008), and of unhealthy snacks in the unhealthy condition (odds ratio b = 0.228, p = 0.033), but children were unaware that the character influenced their decisions.	Results suggest that young children will choose and consume healthier, not just unhealthy, products when they are aware that a popular character in an app is associated with the snack, potentially leading to healthier eating patterns.
Nutrition Behavior	Impact of Pediatric Mobile Game Play on Healthy Eating Behavior Randomized Controlled Trial	Lin <i>et al.</i> , <i>JMIR MHEALTH and UHEALTH</i> 2020; 8(11), e15717	RCT involving 104 children, aged 10–11 years, randomly assigned to the treatment group (played fooya! a dietary mobile game developed by one of the authors) or the control group (played Uno, a board game without dietary education).	Significant main effect of the mobile game on number of healthy foods actually chosen (treatment 2.48, control 1.10; p < 0.001; Cohen d = 1.25) and identified (treatment 7.3, control 6.94; p = 0.048; Cohen d = 0.25). A large variation was observed in children's game play patterns. Children played an average of 15 game levels in 2 sessions, with a range of 2–23 levels	A mobile video game embedded with implicit learning components showed a strong positive impact on children's food choices immediately following the game..
Nutrition Behavior	MyPlate Picks: Development and Initial Evaluation of Feasibility, Acceptability, and Impact of an Educational Exergame to Help Promote Healthy Eating and Physical Activity in Children	Ruggiero <i>et al.</i> , <i>GAMES FOR HEALTH JOURNAL: Research, Development, and Clinical Applications</i> Volume 9, Number 3, 2020	Two phases and multiple pilot groups of youth aged 7–13 years attending nutrition education Programs (n = 48) were conducted using single-group pre-post designs.	Across pilots, youth showed a mean increase of 11.8% on the knowledge survey. In-game knowledge scores in the individual gameplay group also showed a 12.5% increase in knowledge scores. Examination of post-gameplay behavioral intentions found strong reported intentions to eat more fruits and vegetables and get more physical activity. Majority of the youth reported that the game was a lot of fun.	The formative work and initial evaluation of MPP shows promising results for knowledge and behavioral intentions. The youth reported that the team play approach was more fun. The formative work and initial evaluation of MPP shows promising results for knowledge and behavioral intentions. The youth reported that the team play approach was more fun.
Nutrition Behavior	Promoting healthy eating and active playtime by connecting to nature families with preschool children: evaluation of pilot study "Play&Grow"	Sobko <i>et al.</i> , <i>Pediatric Research</i> , 2017, 81(4)	Thirty-eight preschoolers (aged 33.97 ± 9.38 mo), mothers, and their domestic workers were recruited. The families attended one workshop/week for a 4-mo period, consisting of: (i) health topic; (ii) food games; and (iii) nature-related outdoor activities	Feeding practices, particularly Promoting and Encouragement to eat (PE) and Instrumental Feeding (IF) improved after the intervention (p = 0.008 and p = 0.016, respectively).	Modified "Play&Grow" intervention will be conducted in a more rigorous randomized controlled trial to determine the long-term impact on obesity prevention in Hong Kong.
Nutrition Behavior	Effects of a Gamified Educational Program in the Nutrition of Children with Obesity	Del Rio <i>et al.</i> , <i>Journal of Medical Systems</i> (2019) 43:198	The study design was quasi-experimental, with two groups (experimental and control). A long-term longitudinal study (3 years) was carried out. A set of evaluation instruments was used for the different phases.	The results show significant improvements between the experimental and control groups in terms of their knowledge of healthy nutrition and their adherence to the Mediterranean diet	A gamified educational intervention program supported by ICT helps to motivate and promote improvements in the nutrition of children.
Nutrition Behavior	Examination of a board game approach to children's involvement in family-based weight management vs. traditional family-based behavioral counseling in primary care	Sen <i>et al.</i> , <i>European Journal of Pediatrics</i> , 2018, 177:1231-1238	Participants randomly divided into behavioral and game intervention groups.	There were no significant differences between behavioral and game intervention groups in point of BMI and BMI z-scores (p = 0.130 and p = 0.706).	Family-based behavioral group treatment and game (Kaledo) intervention were found to be effective in childhood obesity management in this research. There was no significant difference between the two interventions.
Mental Health	Is RETHink therapeutic game effective in preventing emotional disorders in children and adolescent? Outcomes of a randomized clinical trial	David <i>et al.</i> , <i>European Child and Adolescent Psychiatry</i> (2019) 28:111-122	Randomized-controlled trial 165 children aged between 10 and 16 years were randomly assigned in one of the three group, RETHink condition, rational emotive behavior education condition, waitlist condition	REThink intervention had a significant impact on emotional symptoms (a moderate-effect size, d = 0.46) and on depressive mood (a large-effect size, d = 0.84)	The implications of the RETHink game are discussed in relationship with resiliency building programs designed for youths.

(Contd...)

Table 1: (Continued)

Theme	Title	Author	Method	Result	Conclusion
Mental Health	A Digital Game and School-Based Intervention for Students in Hong Kong: Quasi-Experimental Design	Shum <i>et al.</i> , GAMES FOR HEALTH JOURNAL: Research, Development, and Clinical Applications Volume 7, Number 3, 2018	Quasi-experimental design method was used to evaluate this digital game and school-based intervention.	Compared with the control group, the intervention group was found to have significant association with improved mental health knowledge at the time immediately after the intervention ($\beta = 0.46$; $p = 0.01$) and in the 6-month post-intervention period	The Adventures of DoReMiFa, an integration of a digital game-based and school-based mental health enhancement intervention, was shown to be effective in elevating the knowledge of mental health and promoting perspective taking in the primary school students of Hong Kong.
Healthy Lifestyle	Use of In-Game Rewards to Motivate Daily Self-Report Compliance: Randomized Controlled Trial	Taylor <i>et al.</i> , Journal of Medical Internet Research 2019; 21(1)	RCT. Novel mobile game that is a combination of the idle and pet collection genres to reward individuals who complete a daily diary with an in-game reward.	Significant difference ($F_{2,124} = 6.341$; $p = 0.002$) in compliance to filling out daily diaries, with the Game-Motivated ePRO group having the highest compliance (mean completion 86.4%, SD 19.6%), followed by the ePRO group (mean completion 77.7%, SD 24.1%), and finally, the paper PRO group (mean completion 70.6%, SD 23.4%).	The Game-Motivated ePRO system encouraged individuals to complete the daily diaries above the compliance rates of the Paper PRO and ePRO without altering the participants' responses.
Healthy Lifestyle	Healthy lifestyle promotion in primary schools through the board game Kaledo: a pilot cluster randomized trial	Viggiano <i>et al.</i> , European Journal of pediatrics, 2018, 177:1371-1375	A pilot cluster randomized trial. Participants were randomized into two groups: (1) the treatment group which consisted of playing Kaledo over 20 sessions and (2) the no intervention group	Frequency and duration of self-reported physical activity were also significantly augmented in the treated group compared to the control group at both post-assessments. Moreover, a significant increase in the consumption of healthy food and a significant decrease in junk food intake were observed in the treated group.	The present results confirm the efficacy of Kaledo in younger students in primary schools, and it can be used as a useful nutritional tool for obesity prevention programs in children..
Physical Activity	Efficacy of Online Multi-Player Versus Single-Player Exergames on Adherence Behaviors Among Children: A Non-randomized Control Trial	Kaos <i>et al.</i> , Ann. Behav. Med. (2018) 52:878-889	Non-randomized control trial, 72 children, aged 9–12 years, who were not meeting physical activity guidelines at baseline, were allocated to the multi-player or single-player condition. Six-week cycle-based exergaming trials took place 5 days/week in the early evening with online game supervision.	Adherence was high throughout the trial. Play session duration was $M = 37.65$ (SD = 15.39) min/day, and overall play duration was $M = 133.45$ (SD = 81.27) min in Week 1 and $M = 77.23$ (SD = 84.09) min in Week 6. Total physical activity was significantly higher at 6 weeks compared to baseline ($p = 0.01$, $\eta^2 = 0.13$). There was no significant difference in play duration between conditions ($p = 0.57$, $\eta^2 = 0.01$).	This trial objectively demonstrated that exergames can promote high adherence levels. Multiplayer capabilities did not augment adherence levels. Weekly play duration decreased due to a significant drop in play frequency. For children who enjoy exergames, innovative solutions to promote more frequent exergame play are needed
Sedentary Behavior	Effect and process evaluation of a kindergarten-based, family-involved intervention with a randomized cluster design on sedentary behavior in 4–6-year-old European preschool children: The ToyBox study	Latomme <i>et al.</i> , PLOS ONE, 2017, 12(4)	Randomized cluster design. In total, 2434 preschooler parents/primary caregivers (mean age: 4.7 ± 0.4 years, 52.2% boys) filled out a questionnaire, assessing preschoolers' sedentary behaviors (TV/DVD/video viewing, computer/video games use and quiet play) on weekdays and weekend days.	Positive intervention effects were found for computer/video games use	The ToyBox-intervention had a small, positive effect on European preschoolers' computer/video games use on both weekdays and weekend days, but not on TV/DVD/video viewing or quiet play
Hygiene and Sanitation	The impact of Worms and Ladders, an innovative health educational board game on Soil-Transmitted Helminthiasis control in Abeokuta, Southwest Nigeria	Bassey <i>et al.</i> , PLOS Neglected Tropical Disease, 2020, (5)	RCT design. Schools were randomly assigned into intervention and control group, with the former and latter receiving Worms and Ladders and the common Snake and Ladder board game respectively	There was a significant difference ($p < 0.05$) in prevalence after intervention among the groups. KAP on transmission, control and prevention of STH significantly improved ($p < 0.05$) from 5.2% to 97.9% in the intervention group compared to 6.2–7.1% in the control group.	The Worms and Ladders board game shows the potential to teach and promote good hygiene behavior among SAC.
Hand washing Behavior	Improving young children's hand washing behavior and understanding of germs: The impact of A Germ's Journey educational resources in schools and public spaces	Younie <i>et al.</i> , PLOS ONE, 2020, 15(11)	Randomized cluster design. In Study 1, children ($n = 225$) were recruited from four schools and randomly assigned by classrooms to participate in a multicomponent intervention (vs. control). In Study 2, children ($n = 104$) were recruited from a museum and randomly assigned to participate in a song intervention (vs. control).	In Study 1, significant improvements were observed between baseline and follow up in the intervention group for both behavioral scores (Est = 0.48, SE = 0.14, $t = 3.30$, $p = 0.001$) and knowledge scores (Est = 2.14, SE = 0.52, $z = 4.11$, $p < 0.001$), whereas these improvements were not observed in the control group ($ts < 1$). In Study 2, the intervention group had significantly higher behavioral scores compared to the control group (Est. = -0.71 , SE = 0.34, $t = -2.07$, $p = 0.04$).	This research demonstrates that specifically designed hand hygiene educational resources can improve hand washing practice and understanding in young children, and could lead to the reduction of the transmission of disease within this group.

RCT: Randomized controlled trial

One way to choose a character when promoting certain behaviors in children is that the character must be age appropriate or young [21]. Children when choosing food and drink will be influenced by awareness of a character, but children may not understand the relationship that the character is used to sell products. Popular characters are a potential way to market healthy products, promote healthy eating patterns, and fight obesity in children. Behavior change in children requires parental support.

Several family-based interventions show promising results in preschool children [22].

There are two articles discussing the use of games to promote mental health. The games used are Rethink [23] and digital games [24]. In addition, games are also used to promote a healthy lifestyle. There are two articles that discuss the use of games in this field. Games are used to motivate adherence to lifestyle self-reporting [25].

About 13–20% of children and adolescents suffer from mental disorders. Mental disorders at the age of children and adolescents will increase vulnerability to mental disorders in adulthood. Mental disorders are associated with decreased productivity, increased drug abuse, and increased social burden on society [26]. Rethink is proven to be effective in reducing mental health problems in children and adolescents. In addition, Rethink also reduces depressive symptoms in research subjects. However, Rethink is used in healthy communities, not clinical patients.

The adventure of DoReMiFa games program is effective in promoting mental health in students. This study shows that the use of games and school-based programs are equally effective in increasing knowledge about mental health.

A game called Kaledo is used to promote a healthy lifestyle [27]. Games can also be used to promote physical activity and reduce sedentary. An example is the use of online games (exergames) to increase physical activity in children and adolescent [28]. A game called ToyBox has a positive, albeit small, effect in reducing sedentary activity in kindergarten children [29].

Evaluation of the use of exergames as an educational medium shows promising results. In general, the games developed are acceptable to children. Especially if the game is done in groups. Preliminary findings show that there is an increase in knowledge and most of the targets show an intention to change physical activity patterns and increase vegetable and fruit intake.

Physical activity is very important for children's health. Watching habits are associated with decreased physical activity in children. Giving children digital games that turn passive activities into active ones can be an alternative solution. Games known as exergames were developed for this purpose. Exergames require physical activity to play them [30].

There are two articles that discuss hygiene and sanitation. The game called Worms and Ladders shows potential as a medium to teach and promote good hygiene behavior in students [31]. A game called A Germs Journey has been proven to be able to improve practice and understanding of the importance of hand washing so that it can prevent the spread of infectious diseases in children and adolescents [32].

Efforts to prevent helminth infections require an integrated approach. Not only using medication but also through education about hygiene. Video games are an alternative to carry out this education.

Hand washing behavior is related to disease prevention in children. Studies show that intervention in hand washing habits can improve the quality of health. Childhood is an important moment to inculcate the habit of washing hands [33].

A game called A Germs Journey that targets improving the quality of hand washing in children and understanding bacteria [34], [35]. The games improve the practice of hand washing. The studies conducted have an impact on children's knowledge about the transfer of bacteria and the quality of hand washing.

Conclusion

The game method is mostly used to shape nutritional behavior. There are still few articles that discuss clean living behaviors, such as waste management. So that research is needed that looks at the effectiveness of the game method to shape waste management behavior in children.

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