

## Research Article

# Designing and Developing an Educational-Therapeutic Game for Improving Healthy Lifestyle in Children and Adolescents

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Educating healthy lifestyle behaviors through game can help children and adolescents achieve healthy habits. The aim of the present study was to develop a game to promote children's and adolescents' lifestyle behaviors. The "Toward Health" is a board game designed by a multidisciplinary team consisting of nurses, nutritionists, physical activity experts, pediatricians, pediatric psychologists, graphic artists, and experts in designing board games to help children adopt healthy eating and sleep habits and become physically more active. Players move their tokens based on the number of squares indicated by a dice rolled. If a player's token lands on the square containing questions or points related to a healthy lifestyle, he/she must answer the question or read the point loudly. If answers to the questions are correct, the player takes the card. Interventional studies are recommended to confirm the potential of these games in preventing and/or treating childhood obesity. In the future, we are going to assess the validity and acceptance of the game in various age groups.

## 1. Introduction

Obesity and overweight in childhood increase the risk of mortality and morbidity, as well as the occurrence of chronic noncommunicable diseases such as blood lipid disorders, hypertension, nonalcoholic fatty liver disease, type 2 diabetes, polycystic ovary syndrome, and obstructive sleep apnea in adulthood. Obesity is also associated with psychosocial problems such as discrimination, social isolation, and lack of self-confidence. Epidemiological evidence shows that unhealthy lifestyle is a main risk factor for obesity and overweight in children and adolescents. Behaviors such as low consumption of fruits and vegetables, high consumption of fatty and sweet foods and snacks, less than one hour of physical activity per day, watching TV and screen time more than two hours per day, and sleeping less than 10 hours are among the most important lifestyle factors that are believed

to increase the risk of obesity and overweight in children and adolescents [1–3].

Since lifestyle behaviors during childhood and adolescence may persist through adulthood, it is necessary to employ lifestyle modification interventions to reduce the likelihood of obesity and overweight in later stages of life. Play-based learning is a powerful strategy for educating children and can be more bifacial than direct instructions in enhancing their knowledge [1]. In recent years, different health-related games have been developed to integrate knowledge with predefined educational outcomes [4]. To prevent obesity in children, they can be taught how to make healthy lifestyle choices through serious health-related games [5]. A literature review shows that serious games related to health can be promising and innovative approaches to help improve health outcomes through increasing knowledge, transmitting a convincing message, and supporting behavioral changes [6].

Serious games incorporate the engagement and entertaining aspects with educational and psychological approaches to achieve better health outcomes [6]. There are a wide variety of serious health-related games developed for health education, physical therapy, psychological therapy, and self-management of chronic diseases [7]. Considering that most children enjoy playing video games, the use of serious video games to encourage them to adopt healthy lifestyle behaviors has been increasingly welcomed [8]. However, one of the concerns related to these games is the prolongation of the screen time, which is a risk factor for health and an emotional and psychological issue in children [1, 9, 10]. Despite the popularity of digital games, nondigital formats (board games) still have their fans and have also received attention in recent years [11]. Therapeutic board games are frequently used, especially in psychotherapy [12–14]. The findings of a systematic review demonstrated that board games might improve knowledge comprehension and increase participants' interpersonal interactions and motivations [15].

In addition to engagement and fun features, one of the great benefits of playing a board game is the establishment of face-to-face interactions with peers, coaches, family members, or a therapist, which increases learning opportunities. However, a few board games have been subjected to thorough evaluations in the literature [16]. Based on available evidence, it is still too premature to draw conclusions on whether or not board games affect knowledge or other educational outcomes in medicine [17, 18]. Recent research has revealed the possible positive effects of board games on health behaviors (e.g., eating habits) and objective indicators of health (e.g., improved HbA<sub>1c</sub> levels among patients with diabetes) [19].

Among the board games designed to improve the eating habits and food choices of children, we can mention the “Kaledo” and a card game named “Top Grub” [20–22]. It has been shown that Kaledo can positively affect the BMI z-score among children via improving nutritional knowledge and dietary behaviors. As the results of these studies have been promising, there is a need to design new games to understand their weaknesses and strengths and improve their efficacy [23]. The objective of this article is to describe designing and developing an educational-therapeutic game for improving healthy lifestyle in children and adolescents.

In this research, we proposed an exergame aiming to entertain players and encourage a healthy life style by exercise stimulation. In the following sections, we have described the design and development of the board game (Section 2), overall process for the preparation of the game's content (Section 3), how to play the game (Section 4), and end game and winner determination (Section 5). In the final sections, the results are discussed (Section 6), and the conclusions and contributions of this work are provided (Section 7).

**1.1. Steps of Game Development.** In order to design and produce the game, a group of specialists from different fields, including pediatricians, nutritionists, sports experts, pediatric psychiatrists, psychologists, nurses, game directors, graphists, and illustrators, gathered and started designing the game at different levels following the principles of game

development. The designing, producing, and development of the game lasted a whole year, comprising six stages as described in the following.

In the first stage, a team of game directors and psychologists gathered together in brainstorming sessions to determine the game scenario.

Designing the executable story (scenario): going forward through the game based on dice, picking cards or doing what the card says based on content-based items, winner determination based on the number of correct answers to more questions, and following the instructions written on cards.

Content design (conceptual design): reaching the health climax in the context of matched-age personality (for more identification).

Based on the platform developed in the first stage, a scientific and content team consisting of experts in nursing, psychology, nutrition, sports, and pediatric psychiatry designed and classified playing cards within an appropriate framework.

In the third stage, a session was held between the graphist, the illustrator, and the project's manager to decide on the appearance of the cards and other parts of the game (size, color, etc.) based on the information acquired from the previous steps. In the fourth stage, based on the game's storyline developed in the first stage and the outcomes of previous stages, the game's instructions (process, scoring, etc.) were determined.

After further consultation with the graphist and according to the instructions agreed, the content was sent to the production department in the fifth stage. Ultimately, with the cooperation between the graphist and the head of the Shadram production department, arrangements such as deciding on the type of cards, tokens, and pieces were made in the sixth stage to produce the final version of the game. Between the fourth and fifth stages, eight brainstorm sessions were held between the Shadram team (the game producer) and the research group to evaluate different parts of the game and introduce changes required in terms of the number, content, and design of playing cards, as well as other parts of the game.

## 2. The Board Game's Design and Development

The game developed here was named “Toward Health” and designed with an educational-therapeutic approach and with the help of experts in various fields. After the approval of the design, different parts of the game were created after consultation between the production team and the research-scientific group as follows.

**2.1. Pieces and Tokens.** A similar process as mentioned earlier was followed to produce game pieces and tokens. First, two series of the materials designed were printed as labels on A4 papers. The main body, which was considered to be made of wood, was attached to the label on one side and cut with a laser. Then, for the other pieces and tokens, labels were initially cut with a laser and finally attached to the main body (Figure 1).

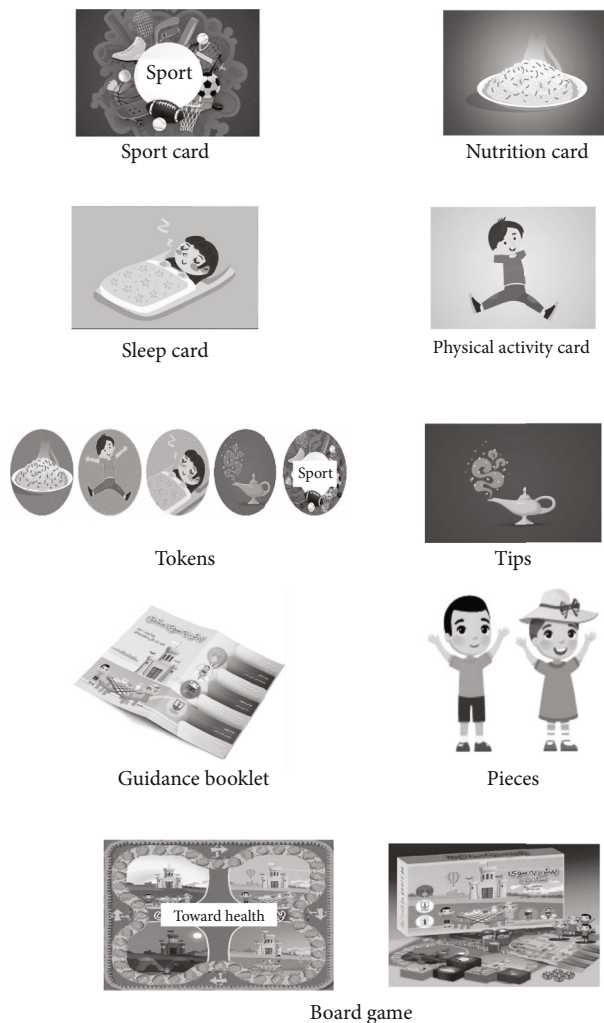


FIGURE 1: Playing cards and board game.

**2.2. Game Components.** There are one game board, one manual, four character-figures, one dice, 40 wooden tokens, and a total of 108 cards (eight blue cards for physical activity, five pink cards for sleep, 33 white cards for nutrition, and 62 yellow cards for notes).

**2.3. Playing Cards.** The cards were printed on 300 g glossy paper.

**2.4. Booklet.** The booklet was prepared by book binding with staples.

**2.5. The Box Separator.** This element was initially designed in Corel software according to the dimensions and sizes of different parts of the game and then produced with polyethylene material by laser cutting.

**2.6. Game Board.** This part was created using sticker labels.

**2.7. Game Box.** The hard box material was used to build the game box.

**2.8. Material.** The materials are coated wood, hardcover, etc.

**2.9. Game Size.** The game size is large (for more attractiveness and the possibility of providing more information).

**2.10. The Type of the Game.** This is a question-answer card game.

**2.11. Education Method.** The education method is token economy, question and answer, learning based on a supervisor instructor, or exemplary responses on cards.

**2.12. Method of Scoring.** The methods of scoring are correct answers to cards and learning-conditioning of correct answers.

### 3. Game Content

**3.1. Pregame.** In the game “Toward Health,” the story of the game written in the manual is initially narrated to the children. In this game, the number of players is between two and four. After hearing the story, players would choose their pieces and place them in the start pace. Each group of playing cards (sleep, nutrition, physical activity, and tips) is selected and placed on the side of the board. The cards are placed in a way that the players cannot read the question on the other side of the card. Five sets of pieces are also placed next to the game board.

### 4. How to Play the Game

First, the youngest player throws the dice and starts moving based on the number that appeared. When the player stops at any house, he/she must pick the corresponding card. For example, if he/she stops on the houses of questions for sleep, nutrition, or physical activity, he/she would pick a related card, read the question, and answer it. If the stop is on a house of tips, a related card is picked, and its tip is read loudly to all players. The innovation used in the design of this game is to perform the physical activity while playing the game when a player chooses a sports card. If other players or the supervisor confirm the correctness of the response provided, the player takes the card for himself/herself; otherwise, the card should be placed back among the other cards in that group. Then, the next player would roll the dice and follow the same instructions. The game is started by the youngest player and continued by the person next to him/her in a counterclockwise direction, and then, others proceed with the game as mentioned. When a player collects two cards from each set of cards by responding correctly to questions, he/she can take a piece in front of the respective deck. For example, if a player correctly answers two sleep cards, he/she can take a sleep piece (every two correct responses = one piece).

### 5. End Game and Winner

The game ends when a player reaches home while having at least one piece of each deck (one sleep piece, one nutrition piece, one physical activity piece, and one tip piece). A player exits the game if he/she reaches home without having five pieces. Other players will continue the game until the winner is determined.

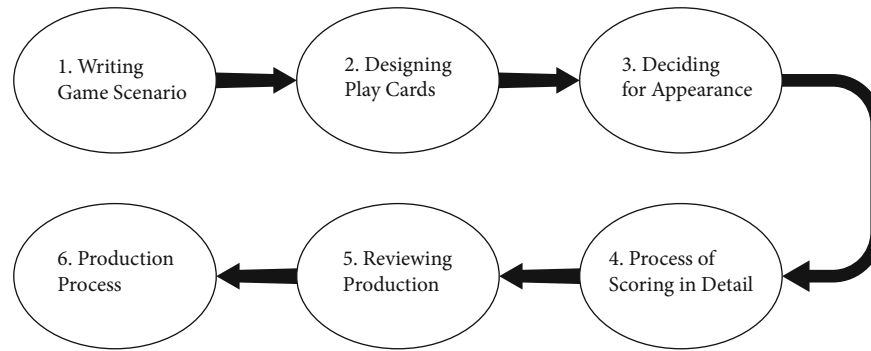


FIGURE 2: The steps to designing the game.

The winner of the game is the player who reaches home first while having all five pieces (i.e., one piece from each of sleep, nutrition, physical activity, and tips). If two players reach home at the same time while having all five pieces, the winner is the player who has more pieces (Figure 2).

## 6. Results and Discussion

This study presents the designing and developing of an educational-therapeutic game to improve healthy lifestyle in children and adolescents. The “Towards Health,” which aims to upgrade lifestyle by making healthy food choices, performing adequate physical activity, and receiving sufficient sleep, is a simple and effective way to achieve this goal. Board games have been suggested to be most effective and have long-term positive outcomes in children seven years and older. In this age range, children can realize, perform, and use all aspects of board games.

Based on a previous study, serious games can be optimally tailored to individuals’ socio-demographic characteristics, requiring information and data regarding theoretical foundations, behavioral prediction, and game theories. These games can be effective either as a stand-alone entity or a multicomponent program and are applicable to various populations regardless of age and gender [24]. Creating a board game based on fun, movement, and education can cause a healthy childhood lifestyle to persist through adulthood. This finding supports hypotheses from previous studies suggesting that the good theoretical blending of the “fun” and “educational” element is critical for a game to be effective [25, 26]. By virtue of a unique combination between entertainment and science, the game “Toward Health” provides children with a good educational opportunity to adopt a healthy lifestyle [27]. Available evidence shows that the proper theoretical combination of the “fun” and “education” elements is important to enhance the effectiveness of a serious game [24, 25, 26, 28]. High interactivity and visual attractiveness are among the inherent features of serious games [29], which coupled with their intrinsic motivating fun aspect, provide them with a better medium than other computer-based interventions, and enable them to reach the target audience in a large scale [24].

One of the most noticeable advantages of board games compared to electronic games is the improvement of communication and active learning skills based on interaction

with other players. It has been shown that compared with single-player games, competitive games against peers decrease perceived exertion and positively affect children and adolescents [30]. Cooperative games can motivate children to engage in interactions to progress with the game, enhancing their self-efficacy and nurturing their prosocial behaviors [31]. In one study, significant weight loss was achieved in overweight and obese adolescents who played a cooperative exergame [32].

Our board game is based on exercising activities that are supposed to have positive impacts on the level of physical activity of children and adolescents. In a pilot study, the “Helper Friend” video game, which was designed to improve healthy lifestyle among children, was shown to enhance their knowledge and intention to perform physical activities. However, in this game, doing physical activity was not an element of the designed game [33]. The positive effects of exercise board games on improving the capacity of physical activity in the elderly have been shown [34, 35].

Being engaged in physical activities is a multidimensional behavior influenced by environmental, social, cultural, psychological, and cognitive factors. A review showed that there was a close relationship between social support by parents, peers, and significant others and willingness to perform physical activities among children and adolescents [36, 37]. Adolescents considering the cooperative nature of the “Toward Health” game can play a positive role in encouraging children and adolescents to participate in physical activities [38]. The effectiveness of the “Kaledo” game in the management of childhood obesity (reduction of BMI and BMI Z-score) was comparable to that of family-based behavioral group treatment. Since the principles of the “Kaledo” board game are consistent with those of the “Toward Health” game designed in the present study, the recent game is likely to be effective in managing childhood obesity [10].

Sleep was another dimension considered when designing the “Towards Health” game. Based on our literature review, a few games have focused on this area. The strength points of this game in terms of lifestyle improvement include designing questions to upgrade the child’s knowledge and performance concerning sleep quality, preventing obesity and overweight in the upcoming years of life, as well as providing tokens assisting in boosting the child’s performance.

It has been reported that serious games, either alone or in combination with an educational component, can



encourage people to pursue a healthier lifestyle [39, 40]. Nevertheless, there is no conclusive evidence yet supporting the effectiveness of game-based intervention in improving lifestyle and life quality [41]. The term “invisible risk” has been proposed to designate inadequate, delayed, and poor sleep, which, despite being a serious health threat for children by affecting mood, cognitive function, nutrition, and daytime activity, is often neglected by parents and health professionals [42].

When designing the “Toward Health” game, we provided instructions asking children not to overuse cell phones and not to watch TV before bedtime. In parallel with technological advances, the use of media has increased, especially among children, who mainly use this platform for entertainment and games. Although age-restricted access to these technologies has been offered for children, these offers generally disregard the objective and content designed for electronic devices [43, 44]. For example, having access to electronic media (e.g., television, video games, and computer) in the bedroom encourages children and adolescents to use them just before their bedtime, which ultimately leads to a reduction in sleep quality and quantity. Moreover, sleeping while smartphones are on the bedside has been shown to reduce sleep duration in children, partly due to frequent sleep interruptions by notifications [45, 46].

In order to improve sleep quality and, subsequently, health outcomes in children and reduce future social and therapeutic burdens, it is important to follow sleep hygiene practices. The serious game designed in the present study, “Toward Health,” can be applied either in educational and medical settings or at home under parental supervision to persuade children to pursue a healthy lifestyle to avoid the adverse consequences of unhealthy behaviors, such as overweight, obesity, and delayed development.

## 7. Conclusion

Nowadays, children and adolescents spend a lot of time using mobile phones, tablets, and television. Playing board games together with family members can help strengthen communication between family members, increase children’s mobility, and reduce screen time. Playing such games will increase children’s knowledge about healthy lifestyles, such as having a healthy diet, doing more physical activity, and having adequate sleep, which can finally improve their lifestyle.

Due to the cooperative nature of these games, policy-makers and health care professionals may therefore consider board games as an alternative to computer games. There is no research on the time efficiency and cost-effectiveness of education through games designed to promote a healthy behavior. It has been suggested that game-based learning may take longer to be stabilized than learning through traditional methods, which requires further research to be confirmed [24]. In the future, we are going to assess the validity and acceptance of the game and improve it based on feedback given by players in various age groups.

## Data Availability

The data are available from the corresponding author, upon reasonable request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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## References

- [1] A. F. Schwarz, F. J. Huertas-Delgado, G. Cardon, and A. DeSmet, “Design features associated with user engagement in digital games for healthy lifestyle promotion in youth: a systematic review of qualitative and quantitative studies,” *Games for Health Journal*, vol. 9, no. 3, pp. 150–163, 2020.
- [2] F. V. Cureau, K. Sparrenberger, K. V. Bloch, U. Ekelund, and B. D. Schaan, “Associations of multiple unhealthy lifestyle behaviors with overweight/obesity and abdominal obesity among Brazilian adolescents: a country-wide survey,” *Nutrition, Metabolism, and Cardiovascular Diseases*, vol. 28, no. 7, pp. 765–774, 2018.
- [3] H. J. Wilkie, M. Standage, F. B. Gillison, S. P. Cumming, and P. T. Katzmarzyk, “Multiple lifestyle behaviours and overweight and obesity among children aged 9–11 years: results from the UK site of the International Study of Childhood Obesity, Lifestyle and the Environment,” *BMJ Open*, vol. 6, no. 2, article e010677, 2016.
- [4] J. W. Higgins, K. B. Riecken, C. Voss et al., “Health promoting secondary schools: community-based research examining voice, choice and the school setting,” *Journal of Child and Adolescent Behaviour*, vol. 1, no. 3, p. 118, 2013.
- [5] C. Y. Chow, R. R. Riantiningtyas, M. B. Kanstrup, M. Papavasileiou, G. D. Liem, and A. Olsen, “Can games change children’s eating behaviour? A review of gamification and serious games,” *Food Quality and Preference*, vol. 80, article 103823, 2020.
- [6] S. V. Gentry, A. Gauthier, B. L’Estrade Ehrstrom et al., “Serious gaming and gamification education in health professions: systematic review,” *Journal of Medical Internet Research*, vol. 21, no. 3, p. e12994, 2019.
- [7] B. A. Primack, M. V. Carroll, M. McNamara et al., “Role of video games in improving health-related outcomes: a systematic review,” *American Journal of Preventive Medicine*, vol. 42, no. 6, pp. 630–638, 2012.
- [8] S. L. Holzmann, F. Dischl, H. Schäfer, G. Groh, H. Hauner, and C. Holzapfel, “Digital gaming for nutritional education: a survey on preferences, motives, and needs of children and adolescents,” *JMIR Formative Research*, vol. 3, no. 1, article e10284, 2019.
- [9] W. Liu, X. Wu, K. Huang et al., “Early childhood screen time as a predictor of emotional and behavioral problems in children at 4 years: a birth cohort study in China,” *Environmental Health and Preventive Medicine*, vol. 26, no. 1, 2021.

- [10] M. Sen, A. Uzuner, M. Akman, A. T. Bahadir, N. O. Borekci, and E. Viggiano, "Examination of a board game approach to children's involvement in family-based weight management vs. traditional family-based behavioral counseling in primary care," *European Journal of Pediatrics*, vol. 177, no. 8, pp. 1231–1238, 2018.
- [11] N. B. Sardone and R. Devlin-Scherer, "Let the (board) games begin: creative ways to enhance teaching and learning," *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, vol. 89, no. 6, pp. 215–222, 2016.
- [12] S. C. Bratton, D. Ray, T. Rhine, and L. Jones, "The efficacy of play therapy with children: a meta-analytic review of treatment outcomes," *Professional Psychology: Research and Practice*, vol. 36, no. 4, pp. 376–390, 2005.
- [13] E. T. Nickerson and K. B. O'Laughlin, "It's fun-but will it work?: the use of games as a therapeutic medium for children and adolescents," *Journal of Clinical Child Psychology*, vol. 9, no. 1, pp. 78–81, 1980.
- [14] J. Wilde, "The effects of the Let's get rational board game on rational thinking, depression, and self-acceptance in adolescents," *Journal of Rational-Emotive and Cognitive-Behavior Therapy*, vol. 12, no. 3, pp. 189–196, 1994.
- [15] S. Noda, K. Shiotsuki, and M. Nakao, "The effectiveness of intervention with board games: a systematic review," *BioPsychoSocial Medicine*, vol. 13, no. 1, p. 22, 2019.
- [16] K. Bochennek, B. Wittekindt, S.-Y. Zimmermann, and T. Klingebiel, "More than mere games: a review of card and board games for medical education," *Medical Teacher*, vol. 29, no. 9-10, pp. 941–948, 2007.
- [17] E. A. Akl, R. W. Pretorius, K. Sackett et al., "The effect of educational games on medical students' learning outcomes: a systematic review: BEME guide no 14," *Medical Teacher*, vol. 32, no. 1, pp. 16–27, 2010.
- [18] G. Blakely, H. Skirton, S. Cooper, P. Allum, and P. Nemes, "Educational gaming in the health sciences: systematic review," *Journal of Advanced Nursing*, vol. 65, no. 2, pp. 259–269, 2009.
- [19] A. Gauthier, P. M. Kato, A. K. C. M. Bul, I. Dunwell, A. Walker-Clarke, and P. Lameris, "Board games for health: a systematic literature review and meta-analysis," *Games for Health Journal*, vol. 8, no. 2, pp. 85–100, 2019.
- [20] S. J. Brown, D. A. Lieberman, B. A. Germen, Y. C. Fan, D. M. Wilson, and D. J. Pasta, "Educational video game for juvenile diabetes: results of a controlled trial," *Medical Informatics*, vol. 22, no. 1, pp. 77–89, 1997.
- [21] T. Baranowski, J. Baranowski, K. W. Cullen et al., "Squire's Quest!: dietary outcome evaluation of a multimedia game," *American Journal of Preventive Medicine*, vol. 24, no. 1, pp. 52–61, 2003.
- [22] N. Charlier and B. D. Fraine, "Game-based learning as a vehicle to teach first aid content: a randomized experiment," *The Journal of School Health*, vol. 83, no. 7, pp. 493–499, 2013.
- [23] E. Viggiano, A. Viggiano, A. Di Costanzo et al., "Healthy lifestyle promotion in primary schools through the board game Kaledo: a pilot cluster randomized trial," *European Journal of Pediatrics*, vol. 177, no. 9, pp. 1371–1375, 2018.
- [24] I. Mayer, G. Bekebrede, C. Harteveld et al., "The research and evaluation of serious games: Toward a comprehensive methodology," *British Journal of Educational Technology*, vol. 45, no. 3, pp. 502–527, 2014.
- [25] T. Baranowski, J. Baranowski, D. Thompson, and R. Buday, "Behavioral science in video games for children's diet and physical activity change: key research needs," *Journal of Diabetes Science and Technology*, vol. 5, no. 2, pp. 229–233, 2011.
- [26] H. Kharrazi, A. S. Lu, F. Gharghabi, and W. Coleman, "A scoping review of health game research: past, present and future," *Games for Health Journal*, vol. 1, no. 2, pp. 153–164, 2012.
- [27] M. Belghali, Y. Statsenko, and A. Al-Za'abi, "Improving serious games to tackle childhood obesity," *Frontiers in Psychology*, vol. 12, article 657289, 2021.
- [28] P. M. Kato, "Evaluating efficacy and validating games for health," *Games for Health Journal*, vol. 1, no. 1, pp. 74–76, 2012.
- [29] R. Crutzen, J. Nooijer, W. Brouwer, A. Oenema, J. Brug, and N. K. Vries, "Strategies to facilitate exposure to internet-delivered health behavior change interventions aimed at adolescents or young adults: a systematic review," *Health Education & Behavior*, vol. 38, no. 1, pp. 49–62, 2011.
- [30] J. F. Lisón, A. Cebolla, J. Guixeres et al., "Competitive active video games: physiological and psychological responses in children and adolescents," *Paediatrics & Child Health*, vol. 20, no. 7, pp. 373–376, 2015.
- [31] A. M. Marker and A. E. Staiano, "Better together: outcomes of cooperation versus competition in social exergaming," *Games for Health Journal*, vol. 4, no. 1, pp. 25–30, 2015.
- [32] A. E. Staiano, A. A. Abraham, and S. L. Calvert, "Adolescent exergame play for weight loss and psychosocial improvement: a controlled physical activity intervention," *Obesity*, vol. 21, no. 3, pp. 598–601, 2013.
- [33] I. E. Espinosa-Curiel, E. E. Pozas-Bogarín, M. Hernández-Arvizu et al., "HelperFriend, a serious game for promoting healthy lifestyle behaviors in children: design and pilot study," *JMIR Serious Games*, vol. 10, no. 2, article e33412, 2022.
- [34] F. Buckinx, O. Bruyère, L. Lengelé et al., "The effects of GAMotion (a giant exercising board game) on physical capacity, motivation and quality of life among nursing home residents: a pilot interventional study," *Experimental Gerontology*, vol. 138, article 110983, 2020.
- [35] A. Mouton, N. Gillet, F. Mouton et al., "Effects of a giant exercising board game intervention on ambulatory physical activity among nursing home residents: a preliminary study," *Clinical Interventions in Aging*, vol. 12, pp. 847–858, 2017.
- [36] J. F. Sallis, J. J. Prochaska, and W. C. Taylor, "A review of correlates of physical activity of children and adolescents," *Medicine and Science in Sports and Exercise*, vol. 32, no. 5, pp. 963–975, 2000.
- [37] M. Rütth and K. Kaspar, "Educational and social exergaming: a perspective on physical, social, and educational benefits and pitfalls of exergaming at home during the COVID-19 pandemic and afterwards," *Frontiers in Psychology*, vol. 12, article 644036, 2021.
- [38] E. Sterdt, S. Liersch, and U. Walter, "Correlates of physical activity of children and adolescents: A systematic review of reviews," *Health Education Journal*, vol. 73, no. 1, pp. 72–89, 2014.
- [39] A. DeSmet, D. Van Ryckeghem, S. Compennolle et al., "A meta-analysis of serious digital games for healthy lifestyle promotion," *Preventive Medicine*, vol. 69, pp. 95–107, 2014.
- [40] H. M. Lau, J. H. Smit, T. M. Fleming, and H. Riper, "Serious games for mental health: are they accessible, feasible, and effective? A systematic review and meta-analysis," *Frontiers in Psychiatry*, vol. 7, p. 209, 2017.

- [41] P. Moreno-Ger, I. Martinez-Ortiz, M. Freire, B. Manero, and B. FernandezManjon, "Serious games: a journey from research to application," in *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, pp. 1–4, Madrid, Spain, 2014.
- [42] Y. Komada, T. Abe, I. Okajima et al., "Short sleep duration and irregular bedtime are associated with increased behavioral problems among Japanese preschool-age children," *The Tohoku Journal of Experimental Medicine*, vol. 224, no. 2, pp. 127–136, 2011.
- [43] T. Baranowski, F. Blumberg, R. Buday et al., "Games for health for children-current status and needed research," *Games for Health Journal*, vol. 5, no. 1, pp. 1–12, 2016.
- [44] A. J. V. Rooij, R. Daneels, S. Liu, S. Anrijs, and J. V. Looy, "Children's motives to start, continue, and stop playing video games: confronting popular theories with real-world observations," *Current Addiction Reports*, vol. 4, no. 3, pp. 323–332, 2017.
- [45] N. Cain and M. Gradisar, "Electronic media use and sleep in school-aged children and adolescents: a review," *Sleep Medicine*, vol. 11, no. 8, pp. 735–742, 2010.
- [46] J. Falbe, K. K. Davison, R. L. Franckle et al., "Sleep duration, restfulness, and screens in the sleep environment," *Pediatrics*, vol. 135, no. 2, pp. e367–e375, 2015.