

Assessment of a Mobile Game ("MobileKids Monster Manor") to Promote Physical Activity Among Children

Ainara Garde,¹ Aryannah Umedaly,¹ S. Mazdak Abulnaga,¹
Leah Robertson,¹ Anne Junker,² Jean Pierre Chanoine,³
J. Mark Ansermino,^{1,4} and Guy A. Dumont¹

Abstract

Objective: The majority of children in North America are not meeting current physical activity guidelines. The purpose of this study was to evaluate the impact of a mobile phone game ("MobileKids Monster Manor") as a tool to promote voluntary physical activity among children.

Materials and Methods: The game integrates data from an accelerometer-based activity monitor (Tractivity[®]; Kineteks Corp., Vancouver, BC, Canada) wirelessly connected to a phone and was developed with the involvement of a team of young advisors (KidsCan Initiative: Involving Youth as Ambassadors for Research). Fifty-four children 8–13 years old completed a week of baseline data collection by wearing an accelerometer but receiving no feedback about their activity levels. The 54 children were then sequentially assigned to two groups: One group played "MobileKids Monster Manor," and the other received daily activity feedback (steps and active minutes) via an online program. The physical activity (baseline and intervention weeks) was measured using the activity monitor and compared using two-way repeated-measures analysis of variance (intervention × time).

Results: Forty-seven children with a body mass index (BMI) z -score of 0.35 ± 1.18 successfully completed the study. Significant ($P=0.01$) increases in physical activity were observed during the intervention week in both the game and feedback groups (1191 and 796 steps/day, respectively). In the game group, greater physical activity was demonstrated in children with higher BMI z -score, showing 964 steps/day more per BMI z -score unit ($P=0.03$; 95 percent confidence interval of 98 to 1829).

Conclusions: Further investigation is required to confirm that our game design promotes physical activity.

Introduction

OBESITY IS AMONG THE MOST URGENT health problems faced by children today. Over the past three decades, the proportion of children who are classified as overweight or obese has increased substantially. Globally, an estimated 170 million children and youth under 18 years of age are now estimated to be overweight.¹ Being overweight or obese has highly negative social² and health³ consequences in children and youth. Greater body mass index (BMI) is associated with increased incidence of diseases such as diabetes, high blood pressure, and stroke and is directly related to a reduced quality of life and greater risk of being teased, bullied, and social isolation.² Because of the increasing prevalence and

associated health consequences, obesity has been considered one of the most serious health challenges of this century.¹

The increased prevalence of obesity has been reported to be due to both an increase in the consumption of unhealthy foods and a decrease in physical activity.^{4,5} Globally, the majority of children and youth do not meet current physical activity guidelines and are considered to be physically hypoactive.⁶ There is a pressing need for interventions that increase physical activity in children; understanding the factors that influence their activity is essential to designing such interventions.⁷ The growing inclination of youth toward sedentary forms of entertainment such as television,^{8,9} social media, and electronic games is listed as a leading cause of the reluctance in children and youth to engage in and maintain

¹Electrical and Computer Engineering in Medicine Group, ³Endocrinology and Diabetes Unit, Department of Pediatrics, and ⁴Anesthesiology, Pharmacology and Therapeutics, The University of British Columbia and BC Children's Hospital, Vancouver, British Columbia, Canada.

²Clinical and Population Studies at the Child & Family Research Institute, Vancouver, British Columbia, Canada.

appropriate levels of physical activity.¹⁰ Thus, a possible solution to promote physical activity among youth could be to engage them using tools and technology that they voluntarily choose, such as mobile devices and games.

Several studies have been conducted to investigate the ability of active videogames (exergames) to promote physical activity in children.^{11–15} In some cases it has been found that energy expenditure increases while playing active videogames, indicating a possible benefit.^{14–18} However, randomized controlled trials studying exergames have produced mixed results.^{6,13} Although some show an increase in physical activity, others have shown no significant difference. More research on the long-term effects of playing exergames is needed.

Exergaming is expanding as an option for reducing sedentary behavior in children. However, the time spent playing indoors, on screens (television, computer, phone, videogames), is one of the known factors inhibiting children from being physically active.^{8,9} Exergaming applied to mobile phones may provide a fun way of promoting indoor and outdoor physical activity that is not constrained by a home console environment. Therefore, we designed a mobile exergame called “MobileKids Monster Manor” (MKMM) with the direct involvement of a group of youth advisors to encourage voluntary physical activity among children. In order to increase the user’s awareness of his or her own level of physical activity, the game integrates data from an activity monitor wirelessly connected to the phone into a reward scheme.

The aim of this study was to assess the effectiveness of the MKMM game in increasing physical activity. We also investigated the effect of providing feedback to children regarding their daily physical activity using software provided by the activity monitor. First, we assessed the hypothesis that although both interventions would raise physical activity above baseline, playing the MKMM game would motivate a greater increase among children. Second, we hypothesized that the children would find the game highly enjoyable as it was developed with the direct involvement of youth.

MKMM Game

Development and design

The MKMM game was developed by Ayogo Games Inc. (Vancouver, BC, Canada), a company focused on gaming psychology and patient self-care. The chosen activity monitor, Tractivity[®], is a commercially available device manufactured by Kineteks Corp. (Vancouver). Tractivity is an accelerometer-based activity monitor that measures the number of steps per minute. Through a wireless connection, the data from the sensor is transmitted to the phone and converted into points within the MKMM game (Fig. 1). Real-world physical activity thereby generates gaming currency that grants the user playtime in the MKMM game. The physical activity measurements are also used to generate interpersonal competition and encourage peer support among young users, with the aim of instilling healthy habits. The MKMM game incorporates several theoretical models of motivation to appeal to children between 8 and 13 years of age, based on the Self-Determination Theory suggested by Deci and Ryan¹⁹ through competence, relatedness, and autonomy.²⁰ MKMM players are able to receive positive feedback from the environment and visualize their achievements and progress within the game. They have autonomy within the game, but also achieve milestones with their peers. MKMM uses a monster character theme for its graphics and rewards players with “gold” tokens to encourage them to venture through the game’s ascending levels.

Game description

The overall goal of the MKMM game is to set the monsters free from a number of mansions (Fig. 1.3). Players achieve this by completing active games or challenges (Fig. 1.2), winning “piñatas” based on their performance and, in turn, earning “beanz,” the currency they need to buy “monsterrific” ingredients. Once the players have collected all of a monster’s required ingredients, the monster will be set free, and the player can



FIG. 1. Some screen shots of the “MobileKids Monster Manor” (MKMM) game: (1) Loading “MobileKids Monster Manor”; (2) starting a challenge; (3) monster rooms; and (4) encouraging your teammates.

collect his or her "gold" and propel his or her team up the leaderboards (Fig. 1.3). These aspects of choice, challenge, curiosity, fantasy, and structural features are suggested by the Theory of Motivation in Videogames^{21,22} as important factors for motivation within gaming.

As teams compete, players can see the overall team rankings as well the amount of gold each member of their team has collected that day (Fig. 1.3). Players are provided an encouragement mechanism to provide positive support and motivation between teammates by stimulating healthy competition, as well as to keep players engaged over the long term (Fig. 1.4). Table 1 at the Appendix of this article provides a detailed description of the MKMM game.

KidsCan: Involving Youth as Ambassadors for Research

Clinical research is changing, with researchers acknowledging the need for direct input from the people they are studying. This can help identify research issues and questions that may be otherwise missed by professionals.²³ To involve young people in research, a youth research advisory group, KidsCan, has been established at the Child and Family Research Institute (CFRI) in Vancouver, according to a protocol approved by the University of British Columbia and the Children's and Women's Health Centre of British Columbia Research Ethics Board (protocol number H13-00448). In 2013, its inaugural year, this advisory group enrolled 17 members 14–18 years of age. The aim of this initiative is to engage youth in pediatric research not only as clinical subjects, but as partners in research related to their demographic. The KidsCan advisors played a role in several stages of the MKMM development. They called on their social networks and community connections to increase awareness of the study and were part of the beta testing of the game, offering feedback in the technical and operational details to be improved prior to the study participants' use.

Materials and Methods

Participants

A convenience sample size of 54 subjects was recruited for the study. Subjects were recruited through poster advertisements in local schools and community centers and through our KidsCan young advisors.²⁴ Subjects 8–13 years of age and fluent in English were recruited according to a protocol as described above. In addition to obtaining written informed consent from a parent/guardian for every subject, written assent was also sought from participants on an assent form, which described the study in an appropriate way for the child's age and learning abilities. Subjects with a medical history that included respiratory, cardiovascular, and/or neurological problems were excluded from participation. Screening for exclusion criteria was completed by the research assistant before enrollment of the subject in the study.

The weight, height, and age values, reported by the children's parents, were used for calculating the BMI. Each BMI value was standardized by conversion to a *z*-score (BMI *z*-score) in groups defined by age and gender, using the World Health Organization child growth standards.²⁵ From the 54 subjects, 47 (16 boys and 31 girls) of 10.2±1.2 (mean±standard deviation) years of age successfully completed the study (all attrition was due to broken/lost sensors). The study

was conducted in two cohorts, during July and August 2013, at the CFRI in Vancouver. The staged design was used to limit the number of mobile devices required for the study.

Study design

Subjects were sequentially allocated into either the "Game" or "Feedback" group (Fig. 2 and Table 2). The participants and the research assistant were blinded to the allocation until the beginning of the intervention. Siblings were allowed to participate and were assigned to the same group. No systematic bias was involved in the allocation process.

Both groups performed the same tasks in the first 7 days of the study (baseline activity): Subjects were given the Tractivity sensor and were required to wear the sensor around their ankle at all times, apart from when in water. We applied a within-subject study design in parallel to assess the effect of the two different interventions (Fig. 2):

- Intervention 1: "Game" group (MKMM game provided). In the second week of the study, the game group was given an Apple (Cupertino, CA) iPhone® 3GS, 4, or 4S with an installation of the MKMM game. The iPhones were restricted to allow access only to the game. Subjects were divided into three in-game teams that competed remotely by having individual players' scores accumulate into a total team score (Fig. 1.3).
- Intervention 2: "Feedback" group (activity feedback, through Tractivity online software provided). In the second week of the study, the feedback group was given access to the Tractivity online software and received quantitative physical activity feedback via a Web-based interface. The software provided subjects with a count of total steps taken in hourly, daily, and weekly formats. The subjects were required to check their physical activity at least once every day.

Data collection

We recruited 54 subjects in this study. After finalizing enrollment, weight, height, and other demographic information including gender and age was collected from each subject. Physical activity was recorded in terms of steps walked and active minutes, using the Tractivity activity monitor.²⁶ Tractivity software considers a minute to be active only if it contains at least 20 steps and it is within a window of 7 active minutes. Both groups were required to wear the sensor continuously for 2 weeks. The first week served as the baseline data collection, and the second week evaluated the effect of the intervention on their activity pattern. The data, which were collected after the second week of the study, were saved on password-protected servers at the CFRI.

To assess the response of the study participants' experience with MKMM and activity monitoring, an eight-question survey was distributed electronically to participants in the game group. The survey was developed based on a validated survey instrument, called the Fun Toolkit, devised to assist researchers and developers in gathering opinions from children about technology.²⁷ This survey posed key questions unveiling information about players' attitudes toward the activity sensor, the game, the social encouragement within gameplay, the requirement of being active to earn points, and if the game encouraged more physical activity overall.

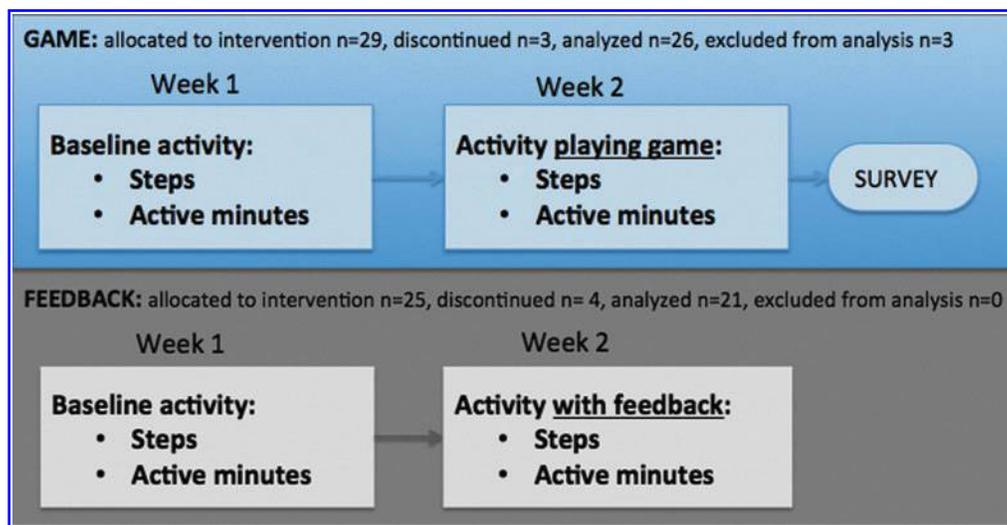


FIG. 2. The protocol of the study for each intervention. The baseline activity of both the game group and the feedback group was recorded during the first week and compared with the second week to evaluate the effect of both interventions. The difference between both interventions was that during the second week, the game group was given the “MobileKids Monster Manor” game with which to play, whereas the feedback group was given an online-based program to track their daily activity (steps and active minutes). Color images available online at www.liebertonline.com/g4h

Data analysis

Data are summarized as mean and standard deviation. After applying the Shapiro–Wilk normality test, a two-way repeated-measures analysis of variance was used to investigate the hypothesis that playing the MKMM game or having daily activity feedback increases physical activity in children. The differences between interventions and across weeks, in both total steps taken and total active minutes, were studied. In addition, a linear regression model was applied to investigate the relationships between physical activity (steps and active minutes) and gender, age, and BMI z-score. A probability of $P < 0.05$ was considered significant. All analyses were performed using IBM (Armonk, NY) SPSS Statistics version 19 software.

The compliance, or “wear time,” is defined as the number of hours the sensor was worn and was calculated by subtracting “non-wear time” from total daily time. As suggested by adolescent accelerometer methods, guidelines, and definitions,²⁸ a consecutive 60 minutes with zero steps is considered a “non-wear time.” Only days with more than 10 hours of “wear time” were considered, and a minimum of 5 wearing days was required for inclusion in the final dataset. The data were normalized with respect to the compliance to avoid the bias introduced by the “wear time.”

TABLE 2. BACKGROUND INFORMATION FOR THE CHILDREN IN THE GAME AND FEEDBACK GROUPS

	Game	Feedback
Number (female, male)	26 (17, 9)	21 (14, 7)
Age (years)	10.2 ± 2.5	10.3 ± 1.3
BMI (z-score)	0.40 ± 1.30	0.34 ± 1.03

BMI, body mass index.

Results

From the 54 recruited subjects, 47 successfully completed the study. From the 29 subjects allocated to the game group, three discontinued the study because they lost or broke their sensor. The remaining 26 children finished the game-based study, but three subjects were excluded from further analysis because they did not meet the “wear time” criteria. From the 25 subjects allocated to the feedback group, four discontinued the study because they lost or broke their sensor, and the remaining 21 subjects successfully finished the study and met the established “wear time” criteria. The BMI z-score (mean ± standard deviation) was 0.35 ± 1.18 (Fig. 3). Based on the World Health Organization guidelines, 9 percent were classified as obese, 19 percent as overweight, 70 percent as normal, and 2 percent as underweight,²⁵ which represents the current BMI distribution of children in Canada.²⁹

The primary outcome of the study was the impact of each intervention on children’s physical activity, and the secondary outcome was the MKMM game enjoyment.

Primary outcome: Intervention effect in activity

The average numbers of steps and active minutes per day during the baseline week and during the intervention week were calculated for each subject within the game and feedback group (Fig. 4). Both groups experienced a significant increase in activity during the intervention period compared with their baseline: The game group had an average individual daily increase of 1191 steps and 25 active minutes, and the feedback group averaged 796 more steps and 6 more active minutes per day, per subject. The horizontal lines in Figure 4a and 4b illustrate this increased tendency in steps and active minutes during both interventions. A steeper increase is reflected in the game group compared with the feedback group, especially in active minutes.

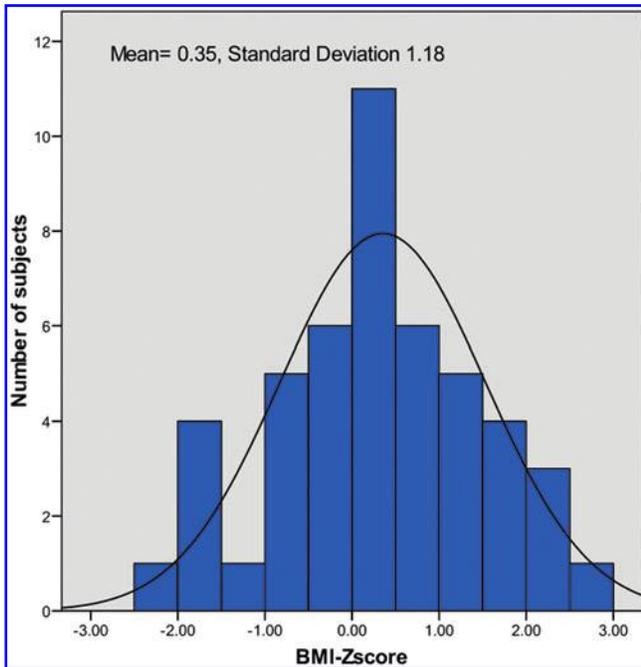


FIG. 3. Body mass index (BMI) z-score histogram for the 47 subjects who successfully completed the study. Color images available online at www.liebertonline.com/g4h

The two-way repeated-measures analysis of variance applied to steps and active minutes showed a significant increase during the intervention week ($F=7.8$, $P=0.01$ and $F=6.0$, $P=0.03$, respectively). Although the physical activity increase was higher in the game group than in the feedback group, the interaction between intervention (game versus feedback) and time (Week 1 or baseline versus Week 2) was not significant. The feedback group was more compliant and wore the sensor significantly longer than the game group ($F=11.4$, $P=0.003$) (Fig. 4c), which showed the requirement of data normalization.

A linear regression model showed that within the game group, subjects with a higher BMI z-score had a significantly greater increase in activity while playing the game. This effect was reflected by an increase of 963 more steps ($P=0.03$; 95 percent confidence interval of 98 to 1829) and 15 more active minutes ($P=0.05$; 95 percent confidence interval of 0.2 to 31) per day for children with each unit higher BMI z-score. The feedback group showed no significant correlation between the BMI and the increase in physical activity.

Secondary outcome: Survey answers

Upon completion of the second week of the study, subjects in the game group filled out a survey based on their experience playing the game and wearing the sensor. Eighty-one percent of subjects reported liking the game, whereas 19 percent reported not enjoying it (Fig. 5). The reasons given by the children for not liking the game were mainly related to exercise suggestions provided by the game, namely, that the younger children misunderstood and thought that they had to perform the suggested activities, rather than any physically active behavior of their choice. These children stopped playing the MKMM early during the intervention week. By selecting only the children who liked the game ($n=22$), the results showed a greater increase reflected by 1845 more steps per day ($F=10.4$, $P=0.005$) and 36 more active minutes per day ($F=7.5$, $P=0.01$) during the intervention week.

The survey also showed that 89 percent of the children liked having to be active to score points in the MKMM game and that 85 percent enjoyed comparing their score with the scores of other players. In addition, 85 percent liked being able to send and receive messages with teammates, and 93 percent of the children found the sensor easy to wear.

Discussion

The aim of this study was to assess the effectiveness of the MKMM game in increasing physical activity among children. The goal of our MKMM game, designed for

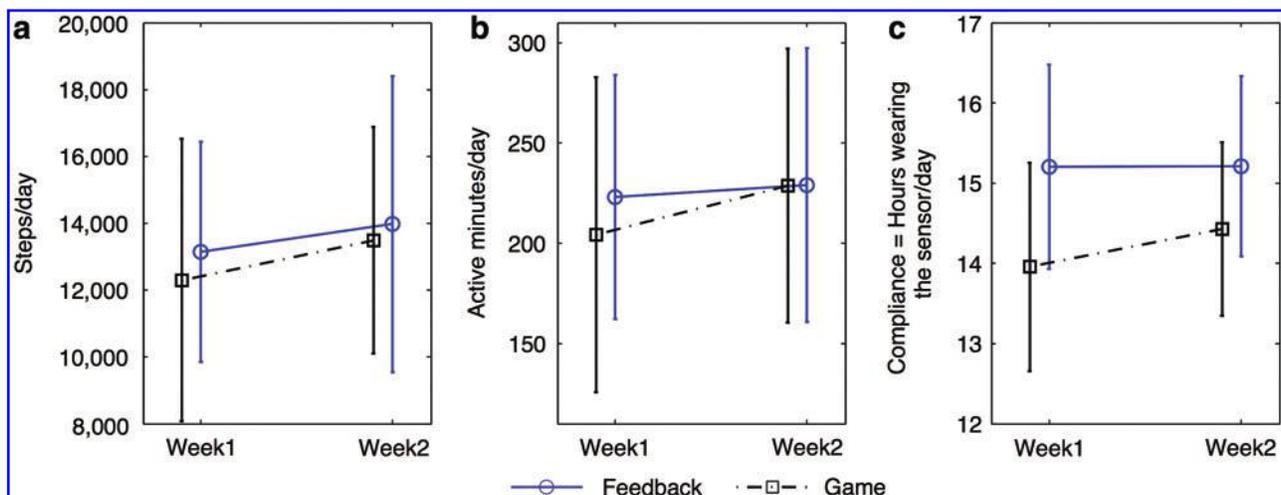


FIG. 4. Mean and standard deviation of (a) the steps walked per day, (b) active minutes per day, and (c) compliance or “wear time” per day for both interventions, during baseline (Week 1) and intervention week (Week 2). The feedback group is represented by a solid line, and the game group is indicated by a dot-dash line. The error bars reflect the standard deviation of the steps, active minutes, and compliance within each intervention during Week 1 and Week 2. Color images available online at www.liebertonline.com/g4h

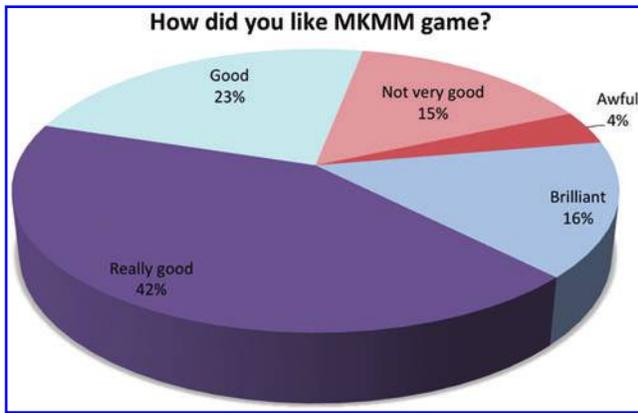


FIG. 5. The answers obtained to the question, “How did you like the MKMM [‘MobileKids Monster Manor’] game?” Eighty-one percent of the subjects reported liking (good, really good and brilliant) the game versus 19 percent who did not find it appealing (not very good, awful). Color images available online at www.liebertonline.com/g4h

children, using advice from other young people, was to promote voluntary physical activity by rewarding higher levels of activity with motivational features and prizes. Despite having advice from our KidsCan young advisors to develop the game, the mobile-gaming intervention did not have universal appeal among children as confirmed from our poststudy participant survey. A statistically significant increase was observed in physical activity during the intervention week. Overall, the game had a positive outcome because it significantly raised physical activity above baseline, and the increase was greater than in the feedback group. The children who reported liking the game (81 percent) showed a much greater increase than children who reported not liking it ($n=4$). These results are particularly promising, but similar to all behavioral interventions, the MKMM game is unlikely to apply to all people with equal success. In addition, children with a higher BMI z -score showed a significantly greater increase in physical activity while playing the game.

We also studied the impact of providing children with feedback about their daily activity. For the feedback group, a significant increase in activity between the baseline and intervention weeks was also observed. Although the increase in the game group was greater than that seen in the feedback group (increases of 1191 versus 796 steps per day), this difference was not significant. This reflects the fact that although the knowledge of their daily activity level enhanced the children’s activity level, more gaming features such as social messaging and healthy competition may further motivate children to increase and sustain this behavior. The MKMM game introduces a fun way to convert active behavior into points that children may find more appealing than steps or active minutes. However, both interventions may be favorably used to encourage a healthier lifestyle among children.

Self-reported physical activity has been described as an unreliable measure of physical activity owing to recall bias and/or its susceptibility to reporting bias by social desirability.^{30,31} An advantage of the MKMM game is that it is synchronized with an activity monitor, providing objective,

real-time physical activity information to the game. The Tractivity sensor was found to be the optimal activity monitor for this study as it introduces minimal inconvenience to the participant³² and permits wireless communication with the phone. The Tractivity device can record and store data for long continuous periods, creating an accurate representation of habitual activity patterns.

Implementing exergames on mobile phones, in comparison with Internet- or computer-based games, has the benefit of providing the ability to play while away from a computer. MKMM is a smart mobile game in which the players have to earn their playtime through physical activity, thus reducing screen time relative to other games. MKMM takes advantage of the affinity of children toward mobile technology and gaming and is not restricted to indoor sedentary play.

Several studies have been conducted to evaluate the ability of active computer and video-console games to promote physical activity among children.^{16,33–36} These active videogames often include multiplayer aspects, both competitive and cooperative, and variable rewards.^{37,38} A systematic review of randomized controlled trials studying the effect of active computer and video-console games has shown that exergames have mixed results.¹³ In general, energy expenditure increased while playing active videogames (measured by BMI changes, step count, or minutes of daily physical activity), indicating a possible benefit to playing active games. “MetaKenkoh,” for example, is an Internet-based game for children to promote physical activity using a pedometer to relate a player’s daily step count to their game progress.³⁹ A pilot study on children 9–11 years of age found that using “MetaKenkoh” increased physical activity by 10 percent.³⁴ However, some studies showed no significant difference.^{40,41} Baranowski et al.¹² reported a study of 133 participants randomized into intervention and control groups where the intervention group played two videogames designed to promote physical activity and nutrition, whereas the control group had an Internet learning experience in two parts. Although 80–90 percent of the children reported enjoying the game, physical activity measured via accelerometry showed no significant difference between the groups immediately after playing the game and 2 months later. The researchers reported that more work is needed in active game design to produce effective games conditional on behavior change, such as MKMM. They hypothesized that there might be a greater effect in children with a higher BMI.⁴⁰ Therefore, we should remain cautious about the ability of exergames to enhance children’s health.

One of the challenges of using games as tools to promote activity is that the game enthusiasm decreases with time, especially in children. A similar study found that the majority of participants increased their awareness of physical activity levels through playing the game. However, interest in the game faded after 2 weeks.¹¹ To further evaluate children’s sustained interest²⁷ in the MKMM game, longer studies will be required. The active involvement of youth in the design and iterative improvement process will help to find innovative ways of sustaining youth interest in the MKMM game. However, we are hopeful that playing the game, even for a short time period, may increase physical activity.

Limitations and future studies

Despite the promising results of the study, further investigation of the MKMM game is needed with an appropriately powered randomized, controlled trial.⁴² The high variability in physical activity shown by children in both groups indicates that a higher sample size is required to improve the significance of the results. Therefore, to evaluate the effectiveness and sustainability of the MKMM game as well as its ability to positively affect children’s health, we plan to perform a larger scale follow-up study that includes children at schools in our region. This will allow us to evaluate the game in a school-based environment to determine the effectiveness of game use in an educational setting.

The primary limitation of using activity monitors is the reliance on the participant wearing them as directed and the inability to verify who is wearing them. Not being able to control compliance or “wear time” was a limitation of the study because, as is illustrated in Figure 4c, the feedback group showed higher compliance than the game group. A possible explanation of this effect could be that although the children in both groups were instructed to wear the sensor at all times, the children in the game group were more focused on the additional equipment (iPhone with MKMM) provided. In this relatively young population, the presence of the equipment may have removed the emphasis of wearing the activity monitor continuously, thus resulting in reduced “wear time.” The children of the feedback group however were more focused on wearing the sensor at all times because it was the sole component of their trial.

Another limitation of the study is the use of parent-reported weight and height values rather than an objective measurement. This makes our observation that children with higher BMI z-score respond better to the game less reliable. To further evaluate the results obtained in this study, showing greater physical activity in children with a higher BMI z-score, we aim to incorporate MKMM into the Shapedown BC obesity management program (www.childhoodobesityfoundation.ca/shapedownbc), at BC Children’s Hospital, as this cohort consists primarily of children who are at or above the 95th percentile for BMI. Children with higher BMIs may be more inclined to sedentary activity using TV/smartphones, so this game presents an opportunity to improve their physical activity by taking advantage of their high affinity/reliance toward technology. Another potential advantage of the game is that it allows for activity within the privacy of the home, as children in this type of program have reported embarrassment exercising in traditional settings.²

Conclusions

Our MKMM game, designed for children with input from youth, enhanced physical activity, especially in children who reported liking the game. Increasing awareness of the importance of maintaining sufficient activity levels among young people has the potential to reduce the impact of obesity-related diseases in children and adults, thus reducing the impact on families and the healthcare system.

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Author Disclosure Statement

The authors declare no competing financial interests exist.

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Address correspondence to:
Ainara Garde Martinez, PhD
Electrical and Computer Engineering in Medicine Group
BC Children's Hospital
Clinical Support Building, Room V3-351
950 West 28th Avenue
Vancouver, BC V5Z 4H4, Canada

E-mail: ainara.garde@cw.bc.ca

APPENDIX

TABLE 1. CHARACTERISTICS OF A VIDEOGAME FOR HEALTH: “MOBILEKIDS MONSTER MANOR”

<i>Characteristic</i>	<i>Description</i>
Health topic(s)	Promoting physical activity
Targeted age group(s)	Children 8–13 years of age
Other targeted group characteristics	NA
Short description of game idea	Physical activity captured through a biometric device advances the player’s in-game economy, which increases the player’s virtual collections and raises his or her team’s standing.
Target player(s)	Individuals and a small group
Guiding knowledge or behavior change theory (or theories), models, or conceptual framework(s)	The game builds relatedness, competence, and autonomy, consistent with Self-Determination Theory. ²⁰ Elements of challenge, curiosity, and fantasy found in the game reflect the influence of the theory of motivation in videogames, ^{21,22} which is built on attribution theory.
Intended health behavior changes	Increase in voluntary physical activity
Knowledge element(s) to be learned	Awareness of the progressive benefit of daily physical activity
Behavior change procedure(s) (taken from Michie inventory) or therapeutic procedure(s) used	Feedback and discrepancy assessment: Individuals compare data on their behavior with goals and standards.
Clinical or parental support needed?	No
Data shared with parent or clinician	No, but possible if required
Type of game	Active
Story (if any) synopsis (including story arc)	The goal of the MKMM game is to unlock all of the hidden monsters in four multilevel mansions. A secondary goal is to help your team compete by participating in the team-to-team activity challenges. Players advance by completing timed activity challenges, therefore earning piñatas. The piñata releases “beanz,” the currency they need to buy “monsterrific” ingredients, which when thrown into a cauldron generate the pieces needed to build a monster. Building a collection of monsters, mansion furnishings, and pets generates additional “gold” that the player can spend in the piñata minigame. Piñatas provide variable rewards of both “beanz” and rare items, but the economy must be continuously recharged by doing more exercise.
How the story relates to targeted behavior change	The story is about progression. As the player’s fantasy collection grows, the player can relate his or her progress to healthy activity progress. Players associate in-game progress with their increase in ability to complete increasingly difficult physical activity challenges.
<i>Game components:</i>	
• Player’s game goal/objective(s)	By doing daily activity, players advance their team and unlock currency to create a complete collection of monsters (and their pets and furnishings) and manors.
• Rules	An activity-monitoring device must be worn by the player to participate and earn currency. Players set personal challenges, and as they move, data from the monitoring device prove their completion of the challenge. Players must unlock all the monsters in one house before being able to unlock the next house.
• Game mechanic(s)	<i>Progression:</i> To advance levels (houses), gain currency, and enrich the economy, the player must exercise. When an activity challenge is in progress, the player receives a countdown on progress toward his or her activity goal. <i>Collection:</i> A player builds a collection of virtual goods, including monsters, furnishing, and pets. <i>Chance/variable rewards:</i> A player purchases piñatas, which the player taps to pieces, resulting in unpredictable rewards of currency and rare items.

(continued)

TABLE 1. (CONTINUED)

<i>Characteristic</i>	<i>Description</i>
Procedures to generalize or transfer what's learned in the game to outside the game	<p><i>Social:</i> Players are allied on teams. The competition between teams is based on which team collectively accumulates the most gold (through collection and through activity). Players support each other through positive encouragements. Team members see the team's relative standing on the team leaderboard.</p> <p><i>Scheduling:</i> The player's collection will produce gold over time, but the economy slows and falters without the input of physical activity.</p> <p>The game's goal of increasing physical activity is tied to the biometric activity monitor, which automatically synchronizes data from the device with the app, turning those data into real-time inputs to the MKMM game.</p> <p>The device measures the player's actual steps and movement as the player completes a challenge. Once complete, the player receives a piñata valued at a fixed value in gold.</p> <p>Once a challenge has been completed, the gold is also attributed to the team's progress, advancing the team's standing on the team leaderboard. The app interprets data from the device and provides players with instant feedback on their progress on a challenge.</p> <p>As players successfully attempt novel physical challenges and experience their physical abilities improving, they are expected to repeat those activities outside of the game.</p>
<p><i>Virtual environment:</i></p> <ul style="list-style-type: none"> • Setting 	<p>A street of spooky old mansions where the player moves from mansion to mansion as they complete their collection of monsters. Each floor of the mansion takes on the personality of the inhabiting monster. The male and female monsters have their own ideas of what is appealing, so they like you to furnish their rooms with customized humorous, quirky, and not-very-scary items.</p>
<p><i>Avatar:</i></p> <ul style="list-style-type: none"> • Characteristics • Abilities 	<p>The individual player is identified by his or her username only and his or her team's identity. The characters in the game are the animated monsters—All have a unique personality as shown by their names, physique, mannerisms, clothing, and furniture.</p> <p>Each monster is built from items that the player has purchased. Once unlocked, they stroll around the mansion.</p>
Game platform(s) needed to play the game	Smartphone, iPod, or tablet
Sensors used	Tractivity (real-time activity monitor)
Estimated play time	30 minutes of physical activity is required to be able to play 5–10 minutes

app, application; MKMM, "MobileKids Monster Manor"; NA, not applicable.