ISSN 0778-3906
Published in JTRM in Kinesiology an Online Peer-reviewed Research and Practice Journal
March 18th 2019

An Examination of the Pediatrician-Prescribed Gaming App-Based Exercise Prescription: A Pilot Study

Sami Yli-Piipari[1,*], Mika Manninen,[1] Bennett L Smith,[2] Casey Hollibaugh,[3] Heather Chambliss,[4] Jon Udwadia[5]

[1] Department of Kinesiology, University of Georgia, Athens, Georgia
[2] Pinellas County School District, Pinellas County, Florida
[3] Department of Kinesiology and Health, Georgia State University, Atlanta, Georgia
[4] St Jude Children's Research Hospital, Memphis, Tennessee
[5] Augusta University & University of Georgia Medical Partnership, Athens, Georgia
*Corresponding author: syp@uga.edu

Abstract This study examined the effectiveness of a physical activity (PA) intervention among obese Hispanic children delivered by a free mobile phone game application (app) recommended by a pediatrician. A sample of 40 (age M=10.16[2.01] years) children participated in this pilot study. Pre- and posttest data were collected on participants' PA attitudes, intention, and objectively measured PA. The intervention was a game-based exercise prescription to engage in at least 20 minutes daily for seven days in moderate-to-vigorous PA (MVPA) delivered by their primary care pediatrician. The results showed a statistically significant decrease in sedentary time (SED) ($t(26)=3.03$, $p=.007$, $d=.66$) and an increase in moderate PA (MPA) ($t(26)=3.19$, $p=.005$, $d=-.69$), vigorous PA (VPA) ($t(26)=-5.74$, $p<.001$, $d=-1.25$), and MVPA ($t(26)=-9.09$, $p<.001$, $d=-1.89$). In addition, the study showed increase in PA attitudes ($t(26)=-3.63$, $p<.001$, $d=-1.10$) and PA intention ($t(20)=-3.13$, $p=.001$, $d=-.94$) after the intervention. This study provides evidence that a mobile app gaming-based exercise prescription may help to engage obese Hispanic children in health enhancing PA.

Keywords: *children, Hispanic, mHealth, physical activity, sedentariness, Treasure Dash, technology*

1. Introduction

Obesity is a metabolic disorder characterized by excessive accumulation of body fat. In addition, obesity presents a chronic inflammatory condition and contributes to the development of other diseases (Pereira-Lancha, Campos-Ferraz, & Lancha, 2012). Obesity is a major factor for increased prevalence of early morbidity in Hispanic populations (Ogden, Carroll, Kit, & Flegal, 2014), with 38.9% of 2- to 19-year old Latino youth being overweight or obese (Ogden et al., 2014). Hispanic youth have been shown to exhibit a higher prevalence of obesity than non-Hispanic white youth (Ogden et al., 2016). Research has shown that a sedentary lifestyle, including a lack of habitual physical activity (PA) and increased sedentary behavior (SED), is a major contributor to childhood obesity (Shields & Tremblay, 2008). Considering the evidence that shows health behaviors learned during childhood continue to adulthood (Craigiea, Lake, Kelly, Ashley, & Mathers, 2011; Telama et al., 2005), efforts to replace SED with PA time are well warranted. Hispanic children are important populations of interest because inequities in access to healthcare and opportunities to make healthy choices have been shown to contribute to the higher rates of obesity in Hispanic compared to non-Hispanic children (National Council of the Raza, 2015). Moreover, Hispanic-origin groups are among the fastest growing populations in the U.S. Thus, addressing these health disparities is essential for national public health and productivity (Colby & Ortman, 2014).

National recommendations suggest that the early identification of weight-related concerns, such as elevated body mass index (BMI) and a lack of PA (Daniels & Hassink, 2015; U.S. Preventive Services Task Force, 2010), is important in tackling childhood obesity (Daniels & Hassink, 2015). Primary care pediatricians are well-suited to detect and treat weight-related conditions because they often follow children over a long period of time, giving physicians opportunities for tailored intervention and follow-up (Dugdill, Graham, & McNair, 2005). Pediatricians can, for instance, provide children and their families with an exercise prescription or community-based exercise-referral (i.e. a prescription by a primary care clinician to increase patient's exercise and/or PA by tailored program) (Pavey et al., 2011; Sedentary Behaviour Research, 2012; Williams, Hendry, France, Lewis, & Wilkinson, 2007).

Exercise prescriptions can target multiple behaviors including reducing sedentary time (SED; any waking behavior characterized by an energy expenditure less than 1.5 metabolic equivalents, such as sitting or watching television) (U.S. Department of Health and Human Services, 2008) and increasing daily MVPA (> 50% of the maximum heart rate) (Duda et al., 2014). Exercise prescription is typically prescribed by a health professional to adults with metabolic disorders (Gidlow, Johnston, Crone, & James, 2005; Moore, Moore, & Murphy, 2011; Pavey et al., 2011). The use among children has been very limited, and physician-delivered exercise prescription studies in children have yet to be published.

Systematic reviews have shown physician-delivered exercise prescription to have small effects on adult PA (Kallings, Leijon, Hellénius, & Ståhle, 2008; Moore, Moore, & Murphy, 2011; Murphy et al., 2012; Pavey & Taylor, et al., 2011; Sharma, Bulley, & van Wijck, 2012). Examining results of international exercise prescriptions studies (N=37, length of the program from 8 weeks to 6 months) (Murphy et al., 2012) showed that, although heterogeneity of the included studies prevented the examination of the effect of the programs on PA, the length of the programs correlated with the greater gains in self-reported PA (pooled PA difference was .93 unit score (CI 95% [−3.57, 1.71]). Meta-analysis examining three randomized and one non-randomized controlled trials showed exercise prescription program to have no effect on participants' metabolic risk factors but some positive effect on exercise motivation (Sedentary Behaviour Research, 2012).

These meta-analyses have identified two main limitations related to the effectiveness of PA prescriptions, namely limited evidence regarding the effect on PA behavior and low adherence rate (Gademan, Deutekom, Hosper, & Stronks, 2012; Gidlow, Johnston, Crone, & James, 2005; Sedentary Behaviour Research, 2012; Sharma et al., 2012). It has been shown that the effectiveness of exercise prescription program may be influenced by the demographic group, medical condition, and location (Murphy et al., 2012). Research suggests that the interventions implemented in home surroundings (Kallings et al., 2008) and targeted to a specific population, have shown to be more effective compared to more general studies (Graf, Pratt, Hester, & Short, 2009; Murphy et al., 2012).

This study tested a novel active video gaming approach to prescribe exercise to children using mobile technology. Active video games or exergames are engaging commercial electronic video games in which PA are combined with interactive play (Maddison et al., 2011; Peng, Crouse, & Lin, 2012). Evidence suggests that active video games can increase PA, replace SED, and be a gateway to more conventional types of PA (Biddiss & Irwin, 2010). To date, numerous studies have shown that playing active video games results in increased energy expenditure, heart rate, perceived exertion, and maximal oxygen intake compared to sedentary activities (Fogel, Miltenberger, Graves, & Koehler, 2010; Peng, Crouse, & Lin, 2012). Similarly, meta-analyses suggest that active video gaming produces PA intensity equivalent to light-to-moderate intensity PA (Fogel et al., 2010; Gao, Chen, Pasco, & Pope, 2015; Peng, Crouse, & Lin, 2012). In addition, numerous studies have shown that participants show high positive affect in response to active gaming including enhanced interest and motivation (Biddiss & Irwin, 2010; Maloney et al., 2008; McDougall & Duncan, 2008; Sun, 2015; Sun & Gao, 2016). Participants also report greater enjoyment playing active video games compared to traditional exercises, such as treadmill walking or jogging (Barkely & Penko, 2009; Fogel et al., 2010; Peng, Crouse, & Lin, 2012; Reategui, Bittencourt, & Mossman, 2016; Sell, Lillie, & Taylor, 2008). Similarly, the meta-analysis of Gao et al. (2015), showed a moderate and positive effect size between exergaming and PA attitudes and exergaming and PA intentions (Hedge's g=.25[.29]).

Due to children's natural draw toward virtual worlds and gaming and a lack of adherence to the traditional exercise prescriptions, this study took a novel approach and tested the effectiveness of a PA intervention among obese Hispanic children delivered by a free mobile phone game application recommended by a pediatrician. It was hypothesized that a prescription for daily 20-minute active video gaming session would reduce participants' SED, increase time engaged in MVPA, and improve PA attitudes and intention.

2. Method

2.1. Participant

A convenience sample of 40 Hispanic children (age M=10.16[2.01] years, range 7.33-13.19 years) and their family members located in the Southeast U.S. participated in the study. All participants were referred to the program by two pediatricians working in two separate primary care centers serving primarily Hispanic youth.

Pediatricians referred potential participants to the researchers based on their professional opinion that their patients could benefit from the intervention to increase their PA behaviors and thus positively affect their weight status. A Spanish speaking interviewer contacted the families by phone and screened for initial eligibility criteria (BMI% >85 percentiles [World Health Organization, 2009]; access to iOS devices, such as iPhone or iPad). The game used in the study was compatible only with iOS, thus, only the families with iPhone or iPad were able to participate.

All 40 families contacted agreed to participate in the study and turned in signed IRB approved assent and parental permissions. Twenty-seven children completed all data collections. Missing data were due to access to the iOS device (n=5) and uncompleted data (n=8). The study was conducted during three weeks in spring 2016 and 2017.

2.2. Procedure

The intervention consisted of three data collection phases (Day 0, 7, and 14; Week 1: Days 0-7; Week 2: Days 7-14; Figure 1), and all communication was bilingual (English and Spanish). Day 0, researchers met with the participants and their guardians, answered questions, and collected signed consent forms. At this visit, participants completed the background questionnaire, and the wrist-worn accelerometers were distributed to each participant. Participants were instructed to wear the accelerometer at all times during waking hours. The only times they were to remove the devices were while sleeping or when showering or swimming. Participants were given a self-report log to record PA and accelerometer wear and non-wear time. Children were instructed to complete the log together with their guardians. Participants were instructed not to change PA habits. Baseline PA was recorded for Week 1.

Day 7, children completed self-report questionnaires which assessed PA attitudes and intentions. Accelerometers were collected and new ones provided for Week 2. Next, researchers uploaded the Treasure Dash cardiogame to participants' devices, and 5-minute video presentation how to play Treasure Dash was presented. Participants were allowed to play the game for 10 to 15 minutes under researcher supervision. Finally, a pediatrician gave each participant a written exercise prescription.

Day 15, accelerometers were collected, and participants completed follow-up PA questionnaires. One week after the completion of the study, families were sent a thank you letter and a gift card ($50.00 value) by mail.

Throughout the study, to increase participant compliance, guardians were contacted daily using text messaging. Non-wearing time was manually administered using accelerometer data and log sheets. In case of missing or conflicting information, participants and their guardians were contacted individually to clarify the disparities

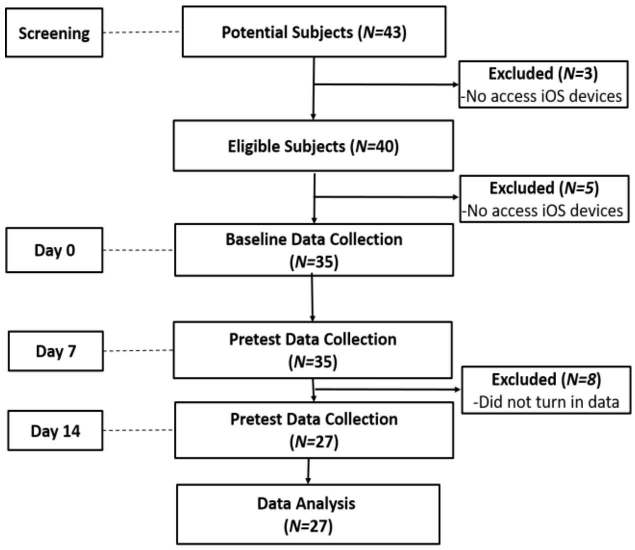

Figure 1. **A flow diagram of the data collection plan**

2.3. Technology-Based Exercise Prescription

Participating pediatricians agreed to provide participants with the mobile app–based exercise prescription. This was a prescription to be physically active for 20 minutes daily for next seven days by playing Treasure Dash cardiogame. Treasure Dash is an active video game in a mobile phone platform. The game is a treasure hunt in which the avatar (player) tries to collect treasures while fighting against different monsters. To move the avatar, the player needs to run or jump in place. The game has shown to be VPA during constant play, but MVPA when given participants of 20 minutes of free gaming time (Author, unpubl. data, 2017). No restrictions whether the game needed to be played in accumulating bouts or 20 minutes of constant play were given. Parents were advised to remind their children to play the Treasure Dash cardiogame each day, and parents were encouraged to let children play as long as they wanted to.

2.4. Measure

2.4.1. Anthropometric data

Height (m) and weight (kg) were measured by trained research assistants to the nearest .1 kg using an electronic weight scale, and height was measured to the nearest .1cm using a stadiometer. BMI and BMI% were calculated (World Health Organization, 2009).

2.4.2. SED and PA Time

Primary outcomes were daily minutes (min/d) of SED and PA measured objectively using wrist-worn ActiGraph Link accelerometers (ActiGraph, LLC, Pensacola, FL). SED was recorded as daily sedentary minutes (smin/d; ranging from 0-1440) and daily sedentary minutes during waking hours (smin/whrs; ranging from 0-60). PA intensity was recorded in daily minutes spend in light intensity PA (LPA), MPA, VPA, and MVPA. Cut-points were used for the estimations as follows: 100cpm for sedentary; 2,296cpm for MPA; and 4,012cpm for VPA (Heil, Brage, & Rothney, 2012). To estimate minutes engaged in sedentariness per each waking hour, self-reported and accelerometer data-observed daily sleeping minutes were deducted from the total 24hrs worth of sedentary minutes and divided with daily waking hours. For example, if the sedentary minutes were 780min/d, and sleeping minutes 480min/night, 300 sedentary minutes were included in the equation. Next, these 300 minutes were divided by waking hours of 18 totaling an average 18.75min/whrs (Equation: [780-480] / 18).

2.4.3. PA Attitudes

Participant attitudes toward PA were measured using the SPARK survey protocol (Sallis et al., 1993; Sallis et al., 1997). This survey uses the stem "how do feel about" with four different items (e.g., "doing PAs with a lot of running or doing PAs that make you tired or make you sweat"). An age-appropriate six-point Likert scale with pictures as anchors (e.g., smiley faces) were used. The scale has shown acceptable validity and reliability (Sallis et al., 1993; Sallis et al., 1997). In this study, internal consistency of the PA attitudes scale was acceptable Cronbach's alphas ranging from .76 (pretest) to .81 (posttest).

2.4.4. PA Intention

Participants' intentions for leisure-time PA were assessed with three items drawn from Hagger et al. (Hagger, Chatzisarantis, Biddle, & Orbell, 2001). The three items were rated on a five-point Likert scale: (1) "I plan to do PAs that make me out of breath for at least three or more times during my free time next week," (2) "I expect to do PAs during my free time next week," and (3) "I intend to do PA that make me out of breath for at least three or more times during my free time next week." (1 = strongly disagree… 5 = strongly agree). The scale has shown to have acceptable internal reliability and construct validity (Hagger et al., 2001). In this study, Cronbach's alphas were .87 (pretests) and .89 (posttest) indicating acceptable internal consistency.

2.5. Statistical Analysis

Descriptive statistics (means, standard deviations) were tabulated. Changes in the primary outcome (SED, LPA, MPA, VPA, MVPA) and PA predictor variables (PA attitudes and intention) were calculated using paired *t* tests. All analyses were performed using the SPSS (version 23.0) (George & Mallery, 2010). Alpha was set at $p<.05$ for all tests. Standardized mean changes (Cohen, 1988) were calculated, with values of .2 (small), .5 (moderate), and .8 (large) used as guidelines for interpreting analyses of covariance effect sizes.

3. Results

Participant BMI ranged from 19.70 to 33.00 kg/m^2 (M=25.37[4.19]) and BMI% ranging from 91 to 99% (M=96.36[2.94]). During the study participants' aggregated nightly sleep minutes ranged between 427.00min (4hrs and 7min) and 580.00 min (9hrs and 40min) (M_{pre}=512.55[44.23]; M_{post}=519.82[48.73]). All participants adhered to their 20-minute daily exercise prescription, self-reported game playing time being on average 82.55(90.34) min/d. Cronbach's alphas' for PA attitudes were .80, .81, and PA intentions .89, .91. In addition, the sample had normal univariate distribution, with kurtosis and skewness values within ±2 (Cohen, 1988).

Results are presented in Table 1. The aggregated mean levels indicated that, at the baseline, participants were sedentary more than 53% of their awake time, and all but one participant failed to meet the 60 minutes of daily MVPA recommendation (M_{MVPA}=23.23[17.06]min/day). Out of daily MVPA, MPA were the main source of activity, because no participant recorded any VPA. The participants had somewhat positive attitudes toward PA (M=2.57[0.94]), and they had somewhat positive PA intentions (M=3.57[.81]).

A paired *t* test elicited that a one week cardiogame-based exercise prescription contributed toward the statistically significant decrease SED (t(26)=3.03, p=.007, d=.66). Participants also showed increases in MPA (t(26)=3.19, p=.005, d=-.69), VPA (t(26)=-5.74, p<.001, d=-1.25), and MVPA (t(26)=-9.09, p<.001, d=-1.89). In addition, *t* tests showed statistically significant and positive changes in PA attitudes (t(26)=-3.63, p<.001, d=-1.10) and PA intentions (t(26)=-3.13, p=.001, d=-.94). There were, however, no changes in participants' LPA (t(26)=.65, p=.522, d=.14).

Table 1. Changes in Study Outcome Variables

Variable list	Pre-M(SD)	Range	Post-M(SD)	Range	*t*	*p*	*d*
Sedentary time while awake (mins/day)	597.39(220.79)	290.05 – 990.17	446.33(145.93)	128.33 – 698.75	3.03	.007*	.66
Sedentariness percent (%/waking hr)	53.82(7.96)	43.12 – 68.56	46.20(5.76)	49.78 – 69.53	2.93	< .008*	.85
LPA (mins/day)	325.80(162.36)	70.67 – 586.50	295.85(154.86)	503.50 – 295.85	.65	.522	.14
MPA (mins/day)	23.23(17.06)	2.25 – 68.00	135.93(160.10)	52.87 – 135.94	-3.19	.005*	-.69
VPA (mins/day)	00(00)	00 – 00	22.68(8.11)	13.13 – 53.00	-5.74	< .001*	-1.25
MVPA (mins/day)	23.23(17.06)	2.25 – 68.00	134.81(57.33)	65.37 – 302.00	-9.09	< .001*	-1.98
PA attitudes	2.57(.94)	1.00 – 3.75	3.16(1.10)	1.75 – 5.00	-2.52	.005*	-1.10
PA intention	3.57(.81)	1.67 – 4.67	4.21(0.52)	3.33 – 5.00	-3.13	.011*	-.94

4. Discussion

The purpose of this study was to examine the effectiveness of a PA intervention among obese Hispanic children delivered by a free mobile phone game application recommended by a pediatrician. This study addresses the urgent need to increase PA and improve PA attitudes among Hispanic youth (Colby & Ortman, 2014). Baseline data showed that the participants did not have any VPA in their every-day life, corroborating previous findings showing Hispanic children to have low levels of VPA (less than 10min daily) (Fairclough et al., 2017; Olvera, Lee, & Smith, 2010). In addition, our study showed that less than 4% (n=1) of our sample, met the daily 60 minutes of MVPA during the week before the intervention. In this study, baseline MVPA was little over 23 minutes. This is lower than the 49.12 minutes of a large-scale study among Hispanic youth (Olvera et al., 2010) and similar to other studies of overweight/obese youth population reporting 18.1 daily minutes of MVPA (Fairclough et al., 2017).

The findings of this study showed that a short, week-long exercise prescription had a positive effect on obese Hispanic children's SED, MPA, and VPA. First, participants adhered to the exercise prescription engaging in over 80 minutes of daily cardiogame play on average. Although more research is needed on children's exercise prescription adherence long-term, the early high adherence to app-based physical activity within our sample is a positive sign. With the cardiogame intervention, time spent on SED declined, and this time was replaced with time in MPA and VPA. These findings are encouraging as physically active children and adolescents have shown to have better cardiometabolic risk factor profiles than their inactive peers (Ekelund et al., 2007), and they are more likely to be active as adults (Telama et al., 2005).

In this study, 26 of 27 children met the daily 60 minutes of MVPA recommendation during the intervention. In addition, VPA increased from 0 minutes daily to an average 22 minutes of VPA daily. However, the variance in VPA during the intervention was large (*SD*=8.11), which reduces the practical significance of this finding. In addition, the study showed that children had significantly more daily MPA during the intervention (134 minutes per day) compared to baseline (23 minutes per day). Considering the greater health benefits of VPA and MPA compared to LPA (Ruiz et al., 2006), these findings are encouraging. Additionally, these demonstrated changes are larger compared to most of the PA intervention studies in children (McDougall & Duncan, 2008). These findings also contradict the meta-analytic conclusion of Williams et al. (2007) showing a non-significant effect of exercise prescription within adult populations.

These results corroborate previous findings showing that gaming-based exercise can have a positive impact on PA attitudes and PA intentions (Peng, Crouse, & Lin, 2012; Rhodes, Warburton, & Bredin, 2009). Participants' PA attitudes changed from mildly positive to very positive, and PA intentions improved from agreement toward strong agreement during the intervention. These findings are important because intentions have been found to be the most proximal determinants of actual behavior, and intentions have been found to mediate between attitudes and behavior in a PA context (Hagger & Chatzisarantis, 2016). Although these results are promising, previous studies have shown these positive psychological and affective effects to decrease over time (Graves et al., 2010; Sun, 2013).

This study has several limitations that need to be addressed in future studies. First, due to the exploratory nature of this study, the study utilized a convenience sample with no control group. Thus, further randomized controlled trials are needed. Second, this intervention was only seven days long. Future studies using a longer term intervention and follow-up are needed. In addition, research is needed to examine the generalizability of this type of intervention across diverse populations considering factors such as gender, age, and ethnicity. This type of low-cost mobile gaming intervention has potential for widespread impact on youth physical activity. Examining the effectiveness among different populations is an important next step.

4. Conclusion

This study tested an innovative approach to increase physical activity in Hispanic youth using a pediatrician-prescribed active video game intervention. Our results showed that a one-week long intervention can reduce SED, increase MPA and VPA, and improve PA attitudes and intention. This study provides early evidence that a game-based exercise prescription using mobile technology may help to engage obese Hispanic children in health-enhancing PA.

Acknowledgments

This project received no funding.

Human Subjects Approval Statement

All participants provided written informed consent before undergoing any screening or study procedures. The study was approved by the Instructional Review Boards of the University of Georgia and University of Tennessee

Conflict of Interest Disclosure Statement

No competing financial interests exist.

References

Barkely, J.E., & Penko, A. (2009). Physiologic responses, perceived exertion, and hedonics of playing a physical interactive video game relative to a sedentary alternative and treadmill walking in adults. *Journal of Exercise Physiology Online, 12*(3), 12-23.

Biddiss, E., & Irwin, J. (2010). Active video games to promote physical activity in children and youth. *Archives of Pediatrics & Adolescent Medicine, 164*, 664-672. doi: 10.1001/archpediatrics.2010.104.

Cohen J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed)*. Hillsdale, IL: Lawrence Erlbaum.

Colby, S.L., & Ortman, J.M. (2014). Projections of the size and composition of the U.S. population: 2014 to 2060. Current Population Reports, P25-1143, U.S. Census Bureau, Washington, DC, 2014. Retrieved from www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf.

Craigiea, A.M., Lake, A.A., Kelly, S.A., Ashley, J. & Mathers, J. (2011). Tracking of obesity-related behaviours from childhood to adulthood: A systematic review. *Maturitas, 70*, 266–284. doi: 10.1016/j.maturitas.2011.08.005.

Daniels, S.R., & Hassink, S.G. (2015). The role of the pediatrician in primary prevention of obesity. *Pediatrics, 136*, 275-292. doi: 10.1542/peds.2015-1558.

Duda, J.L., Williams, G.C., Ntoumanis, N., Daley, A., Eves, F.F., … Jolly, K. (2014). Effects of a standard provision versus an autonomy supportive exercise referral programme on physical activity, quality of life and well-being indicators: A cluster randomised controlled trial. *International Journal of Behavioral Nutrition and Physical* Activity, *11*, e10. doi: 10.1186/1479-5868-11-10.

Dugdill, L., Graham, R.C., & McNair, F. (2005). Exercise referral: The public health panacea for physical activity promotion? A critical perspective of exercise referral schemes; their development and evaluation. *Ergonomics, 48*, 1390–1410. doi: 10.1080/00140130500101544.

Ekelund, U., Anderssen, S.A., Froberg, K., Sardinha, L.B., Andersen, L.B., & Brage, S. (2007). European youth heart study group. Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: The European youth heart study. *Diabetologia, 50,* 1832–1904. doi: 10.1007/s00125-007-0762-5.

Fairclough, S.J., Dumuid, D., Taylor, S., Curry, W., McGrane, B., … Olds, T. (2017). Fitness, fatness and the reallocation of time between children's daily movement behaviours: An analysis of compositional data. *International Journal of Behavioral Nutrition and Physical Activity, 14,* e64. doi: 10.1186/s12966-017-0521-z.

Fogel, V.A., Miltenberger, R.G., Graves, R., & Koehler, S. (2010). The effects of exergaming on physical activity among inactive children in a physical education classroom. *Journal of Applied Behavioral Analysis*, *43,* 591–600. doi: 10.1371/journal.pone.0065351.

Gademan, M.G., Deutekom, M., Hosper, K, & Stronks, K. (2012). The effect of exercise on prescription on physical activity and wellbeing in a multi-ethnic female population: A controlled trial. *BMC Public Health*, *12*, e1. doi: 10.1186/1471-2458-12-758.

Gao, Z., Chen, S., Pasco, D., & Pope, Z. (2015). A meta-analysis of active video games on health outcomes among children and adolescents. *Obesity Reviews, 16,* 783-794. doi: 10.1111/obr.12287

George, D. & Mallery, M. (2010). *SPSS for windows step by step: A simple guide and reference, 17.0 update (10th ed.)* Boston, MA: Pearson.

Gidlow, C., Johnston, L.H., Crone, D., & James, D. (2005). Attendance of exercise referral schemes in the UK: A systematic review. *Health Education Journal, 64*, 168–186. doi: 10.1177/001789690506400208.

Graf, D.L., Pratt, L.V., Hester, C.N., & Short, K.R. (2009). Playing active video games increases energy expenditure in children. *Pediatrics, 124*, 534–540. doi: 10.1542/peds.2008-2851.

Graves, L.E., Ridgers, N.D., Williams, K., Nicola D., Williams, K., … Atkinson, G. (2010). The physiological cost and enjoyment of Wii Fit in adolescents, young adults, and older adults. *Journal of Physical Activity and Health, 7,* 393–401. doi: 10.1123/jpah.7.3.393.

Hagger, M., & Chatzisarantis, N. (2016). The trans-contextual model of autonomous motivation in education: Conceptual and empirical issues and meta-analysis. *Review of Educational Research, 86*, 360-407. doi: 10.3102/0034654315585005.

Hagger, M.S., Chatzisarantis, N., Biddle, S.J., & Orbell, S. (2001). Antecedents of children's physical activity intentions and behaviour: Predictive validity and longitudinal effects. *Psychological Health, 16*, 391–407. doi: 10.1080/08870440108405515.

Heil, D.P., Brage, S., & Rothney, M.P. (2012). Modeling physical activity outcomes from wearable monitors. *Medicine & Science in Sport Exercise, 44*, S50–60. doi: 10.1249/MSS.0b013e3182399dcc.

Kallings, L.V., Leijon, M., Hellénius, M-L., & Ståhle, A. (2008). Physical activity on prescription in primary health care: A follow-up of physical activity level and quality of life. *Scandinavian Journal of Medicine & Science in Sports, 18*, 154–161. doi: 10.1111/j.1600-0838.2007.00678.x.

Maddison, R., Foley, L., Mhurchu, C.N., Jiang, Y., Jull, A., … Rodgers, A. (2011). Effects of active video games on body composition: A randomized controlled trial. *American Journal of Clinical Nutrition, 94*, 156–163. doi: 10.3945/ajcn.110.009142.

Maloney, A.E., Bethea, T.C., Kelsey, K.S., Marks, J.T., Paez, S., ... Sikich, L. (2008). A pilot of video game (DDR) to promote physical activity and decrease sedentary screen time. *Obesity, 16*, 2074–2080. doi: 10.1038/oby.2008.295.

McDougall, J., & Duncan, M.J. (2008). Children, video games and physical activity: An exploratory study. *International Journal of Disability & Human Development, 7*(3), 88-94.

Moore, G.F., Moore, L., & Murphy, S. (2011). Facilitating adherence to physical activity. Exercise professionals' experiences of the National Exercise Referral Scheme in Wales: A qualitative study. *BMC Public Health, 11,* 935. doi: 10.1186/1471-2458-11-935.

Murphy, S.M., Edwards, R.T., Williams, N., Raisanen, L., Moore, G., … Moorel, L. (2012). An evaluation of the effectiveness and cost effectiveness of the National Exercise Referral Scheme in Wales, UK: A randomised controlled trial of a public health policy initiative. *Journal of Epidemiology and Community Health, 66*, e1082. doi: 10.1136/jech-2011-200689.

National Council of La Raza (2015). Profiles of Latino health: A closer look at Latino child nutrition. Retrieved from www.healthyhispanicliving.com/nutrition/healthcare_disparities/profiles_of_latino_health_2015_a_closer_look_at_latino_child_nutrition/.

Ogden, C.L., Carroll, M.D., Kit, B.K., & Flegal, K.M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA, 311*, 806-814. doi: 10.1001/jama.2014.732.

Ogden, C.L., Carroll, M.D., Lawman, H.G., Fryar, C.D., Kruszon-Moran, D., … Flegal, K.M. (2016). Trends in obesity prevalence among children and adolescents in the United States, 1988-1994 through 2013-2014. *JAMA, 315*, 2292-2299. doi: 10.1001/jama.2016.6361.

Olvera, N., Lee, C., & Smith, D. (2010). *Urban Hispanic perception of environment and activity among kids (UHPEAK) study. Progress Report 2010 submitted to the Robert Wood Johnson Foundation*.

Pavey. T.G., Anokye, N., Taylor, A.H., Trueman, P., Moxham, T., … Taylor, R.S. (2011). The clinical effectiveness and cost-effectiveness of exercise referral schemes: A systematic review and economic evaluation. *Health Technology Assessment*, *15*, 1-254. doi: 10.3310/hta15440.

Pavey, T.G., Taylor, A.H., Fox, K.R., Hillsdon, M., Anokye, N., … Taylor, R.S. (2011). Effect of exercise referral schemes in primary care on physical activity and improving health outcomes: Systematic review and meta-analysis. *BMJ*, *343*, e6462. doi: 10.1136/bmj.d6462.

Peng, W., Crouse, J.C., & Lin, J.H. (2012). Using active video games for physical activity promotion: A systematic review of the current state of research. *Health Education & Behavior, 40,* 171–192. doi: 10.1177/1090198112444956.

Pereira-Lancha, L.O., Campos-Ferraz, P.L., Lancha, A.H., Jr. (2012). Obesity: Considerations about etiology, metabolism, and the use of experimental models. *Diabetes Metabolic Syndrome & Obesity, 5,* 75–87. doi: 10.2147/DMSO.S25026.

Reategui, E., Bittencourt, M.Z., & Mossman, J.B. (2016). Students' attitudes in relation to exergame practices in physical education. Games and virtual worlds for serious applications (VS-Games), 2016 8th International Conference. doi: 10.1109/vs-games.2016.7590369.

Rhodes, R.E., Warburton, D.E., & Bredin,. SS. (2009). Predicting the effect of interactive video bikes on exercise adherence: An efficacy trial. *Psychological Health & Medicine*, *14*, 631–640. doi: 10.1080/13548500903281088.

Ruiz, J.R., Rizzo, N.S., Hurtig-Wennlof, A., Ortega, F.B., Wärnberg, J., & Sjöström, M. (2006). Relations of total physical activity and intensity to fitness and fatness in children: The European youth heart study. *American Journal of Clinical Nutrition, 84*, 299-303. doi: 10.1093/ajcn/84.1.299.

Sallis, J.F., Condon, S.A., Goggin, K.J., Roby, J.J., Kolody, B., & Alcaraz, J.E. (1993). The development of self-administered physical activity surveys for 4th grade students. *Research Quarterly for Exercise & Sport*, *64*, 25-31. doi: 10.1080/02701367.1993.10608775.

Sallis, J.F, McKenzie, T.L., Alcaraz. J.E., Kolody, B., Faucette, N., Hovell, M.F. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. *American Journal of Public Health*, *87*, 1328-1334.

Sedentary Behaviour Research (2012). Letter to the editor: Standardized use of the terms "sedentary" and "sedentary behaviours". *Applied Physiology, Nutrition, & Metabolism, 37*, 540-542. doi: 10.1139/h2012-024.

Sell, K., Lillie, T., & Taylor J. (2008). Energy expenditure during physically interactive video game playing in male college students with different playing experience. *Journal of American College Health, 56,* 505–512. doi: 10.3200/JACH.56.5.505-512.

Sharma, H., Bulley, C., & van Wijck, F.M. (2012). Experiences of an exercise referral scheme from the perspective of people with chronic stroke: A qualitative study. *Physiology, 98*, 336–343. doi: 10.1016/j.physio.2011.05.004.

Shields, M., & Tremblay, M.S. (2008). Sedentary behaviour and obesity. *Health Reports, 19*(2), 19-30.

Sun, H. (2013). Impact of exergames on physical activity and motivation in elementary school students: A follow-up study. *Journal of Sport & Health Sciences*, *2*, 138-145. doi: 10.1016/j.jshs.2013.02.003.

Sun, H., & Gao, Y. (2016). Impact of an active educational video game on children's motivation, science knowledge, and physical activity. *Journal of Sport Health Science*, *5*, 239-245.

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O. (2005). Physical activity from childhood to adulthood: A 21-year tracking study. *American Journal of Preventive Medicine, 28,* 267-273. doi: 10.1016/j.amepre.2004.12.003.

U.S. Department of Health and Human Services (2008). 2008 Physical activity guidelines for Americans. Washington (DC). Retrieved from https://health.gov/paguidelines/pdf/paguide.pdf.

U.S. Preventive Services Task Force (2010). Screening for obesity in children and adolescents: United States Preventive Services Task Force Recommendation Statement. *Pediatrics, 125,* 361-336.

Williams, N.H., Hendry, M., France, B., Lewis, R., & Wilkinson, C. (2007). Effectiveness of exercise-referral schemes to promote physical activity in adults: Systematic review. *British Journal of General Practice, 57*, 979-986. doi: 10.3399/096016407782604866.

World Health Organization (2009). WHO child growth standards and the identification of severe acute malnutrition in infants and children: A Joint Statement 2009. Retrieved from www.who.int/nutrition/publications/severemalnutrition/9789241598163/en/.

Suggested Citation:

Yli-Piipari, S., Manninen, M., Smith, B. L., Hollibaugh, C., Chambliss. H., & Udwadia, J. (2019). An examination of the pediatrician-prescribed gaming app-based exercise prescription: A pilot study. *Journal of Teaching, Research, and Media in Kinesiology, 5,* 16-22