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Dyadic Effects of Pokémon GO on Physical Activity and Sedentary Behavior in Mothers and Children

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ABSTRACT

International Journal of Exercise Science 15(5): 142-151, 2022. Family-based mobile health applications may be an opportunity to increase children's physical activity (PA) levels. Researchers have highlighted Pokémon GO as a potential model for future PA interventions as it integrates PA with social gamification. This study provides descriptive data on Pokémon GO usage among mothers and their children and examines differences in moderate to vigorous PA (MVPA) over time among individuals playing Pokémon GO compared to non-players using a dyadic subsample from a three-year longitudinal study. After the release of Pokémon Go in July 2016, 156 mother-child dyads completed questionnaires about Pokémon Go usage and wore accelerometers continuously for seven days at baseline (Sep 2016), six months, and twelve months. Independent sample t-tests and chi-square tests were used to investigate differences in demographics and daily MVPA by player status cross-sectionally at each time point. At baseline, six mothers and 21 children reported playing Pokémon Go. Baseline demographic characteristics were not associated with player status. Across time, mothers engaged in an average of 21.12 minutes of daily MVPA (*SD* = 19.7) and children in 29.35 minutes (*SD* = 18.88). Children's daily MVPA did not differ by player status, but mothers who reported playing engaged in higher daily MVPA (*M* = 46.84, *SD* = 38.07) compared to non-players (*M* = 21.40, *SD* = 23.31). This naturalistic study lacked power to further analyze changes in MVPA after the release of the game due to lack of engagement with Pokémon GO. Understanding how to design a family-oriented game to bring together gamification, physical activity, and family-based interventions will be important for future public health efforts.

KEY WORDS: Pokémon Go, physical activity, family intervention, mother-child dyad, gamification

INTRODUCTION

Lack of physical activity (PA) and excess of sedentary behavior contribute independently to obesity and chronic disease risk in adults and children (30). Behavioral interventions seeking to increase physical activity and reduce sedentary behavior have been moderately successful, with some promising long-term maintenance (11, 25). However, the steps needed to scale such

interventions to both a population level and across underserved groups are neither well understood nor feasible in some cases.

Advancements in mobile computing have resulted in a near-ubiquitous adoption of smartphones across socioeconomic groups and a proliferation of applications (apps) designed to induce behavioral change (28). However, recent in-depth systematic analyses examining mobile health applications targeting PA change have identified limitations in the efficacy of these apps on inducing behavior change or changing health outcomes due to lack of integration of important behavior change theories and techniques, especially among children (7, 15). Additionally, physical activity app use may only be an additional marker of exercise identity with those with higher exercise identity more likely to use apps and more physically active compared to those with a lower identity (4).

Pokémon GO is a free-to-play location based augmented reality-driven mobile video game with social game mechanics. The game was met with worldwide enthusiasm and adopted quickly and widely around the world with 500 million downloads in the two months after its release in July 2016 (10). Due to the game's objectives that required the players to travel to public locations or walk certain distances, some researchers have highlighted the potential for Pokémon GO as a model for large-scale PA interventions. Recent literature on Pokémon GO as a PA intervention has shown encouraging results in children and adults (1, 2, 13, 28). Of note, Pokémon GO has been found to increase PA levels across typically low active groups (18). Some population-level estimates suggest an increase in approximately 144 billion total steps over three months in the United States as a result of Pokémon GO (9). However, less is known about the long-term sustainability of active mobile video games in general (10). Few studies to date have examined change in PA longitudinally, with varying results. For instance, despite an increase in both walking and running activity by nearly 20% at the onset of playing the game, these gains in activity were lost less than a month after playing Pokémon GO (16). Another study similarly found an initial increase in PA and decreased in sitting when first playing Pokémon Go that subsided over time (3). In addition to initial improvements in PA, the game has also been shown to increase social interaction and improve affect among users (22). A previous paper has suggested that the interactive nature of Pokémon Go could facilitate positive social interactions between parents and children who may enjoy playing to spend time together (19, 26). Children may enjoy the role of teaching their parents how to play the game, and the game could provide parents with an opportunity to bond over an interest of their child (5). Similarly, game design features of Pokémon GO that may encourage parent-child interaction include training children to think logically and fostering children's independence (14).

Previous research has found positive associations between parents' and their children's PA levels and suggests that increases in joint parent-child PA may be an effective method for increasing activity levels of both parents and children (8). Family-based interventions are a promising opportunity to increase children's PA levels. There is a large body of literature that considers families as the primary unit that influences each other to elicit behavior change, specifically highlighting the importance of parent involvement and modeling to increase PA in children (12, 17, 21, 24). The family is the child's most proximal environment and is expected to

have the greatest influence on behavior in early life. Children learn their habits and attitudes toward PA very early in development by observing and imitating their parents and receiving parental influence that increases the level of PA through role modeling (29).

Parental support has been consistently found to increase PA in children, but it is still uncommon for families to engage in PA together during the week, often due to busy lifestyles, money to support activities, and lack of common interests (23, 26). Likewise, very few active mobile games have a social component that is easily accessible to various family members and popular across different ages. Thus, the universal appeal and social interaction components of Pokémon GO, and similar apps present an opportunity for group and family-based mobile health interventions. A previous dyadic Pokémon Go study found significant increases in light and moderate minutes of PA per week for parents while playing Pokémon Go (19). However, the study assessed PA subjectively and retrospectively using a revised Godin Leisure-Time Exercise Questionnaire. No study to date has objectively examined whether joint parent-child engagement with active mobile games, such as Pokémon Go, may increase PA levels over time.

To address the gaps in research on active mobile games and their effect on PA and sedentary time, this exploratory study described the use of Pokémon GO among children and the potential intra-dyadic effects of parental participation and parental supervision. Specifically, the study 1) described usage of Pokémon GO among the dyadic sample by ethnicity, age, BMI, child's sex and 2) examined change in objective PA and sedentary time among individuals playing Pokémon GO compared to those who do not play after the release of the game.

METHODS

Participants

The study used a subsample of individuals from a longitudinal study on the effects of stress on mothers' parenting behavior and their child's health behavior, known as the Mothers and their Children's Health (MATCH) Study. Pokémon GO was released midway through the study, allowing for a historical interrupted time series design with the addition of a supplemental Pokémon GO questionnaire. All participants consented (or assented, for children) to participate in the study, and all protocols were approved by Institutional Review Board at the University of Southern California. All procedures were conducted in accordance with the ethical standards of the Helsinki Declaration. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (20). A detailed discussion of the study design, recruitment strategy, and preliminary findings are available elsewhere (6).

A total of 202 mother-child dyads were recruited at baseline to participate in the study over a period of approximately three years with six assessment waves at six-month intervals. Inclusion criteria for children were 1) being in the 4th or 5th grade and 2) ability to read English or Spanish. Inclusion criteria for mothers were 1) ability to read English or Spanish and 2) ≥ 50% of child's custody. Children and mothers were excluded for 1) currently taking medications for thyroid function or psychological conditions, 2) health issues that limit PA, or 3) currently using oral or inhalant corticosteroids for asthma. Additionally, children were excluded if they were 1)

enrolled in special education programs or 2) classified as underweight (BMI percentile <5% adjusted for sex and age). Mothers were further excluded for 1) pregnancy or 2) working more than two weekday evenings (between 5-9 pm) per week or more than eight hours on any weekend day. For this current analyses, mother-child dyads were also excluded if they did not receive the Pokémon GO supplemental protocol at the fourth assessment wave, for a total of 156 dyads in the analytic sample.

Protocol

Pokémon-Go Engagement: Pokémon Go was released in the United States on July 6, 2016. A questionnaire with nine Pokémon Go specific questions was added to the MATCH questionnaire in September 2016, at the beginning of Wave 4, which served as the baseline for this substudy with follow-up at six months (Wave 5) and twelve months (Wave 6). For this analysis, Pokémon Go player status was determined by the question "Have you ever played Pokémon Go?", for which participants could answer "No", "Yes, but I don't play anymore", or "Yes, and I still play now". We only considered the participant a Pokémon Go player if they answered that they were currently still playing Pokémon Go. The other nine questions asked both mothers and children about daily Pokémon go play time in the previous week (not at all, less than 30 minutes, 30 min - one hour, one - two hours, three - four hours, more than four hours), game-play mechanic usage (How often do you use incense to bring Pokémon to you? If you see a PokéStop with an active lure, how likely are you to go out of your way to walk to it? Which of the following best describes how you play Pokémon Go most of the time?), current Pokémon trainer level, first day of playing the game, total kilometers (km) walked while playing Pokémon Go, and with whom they played Pokémon Go (i.e., the social context of game play) (Children, Father, Friends, Mother, Myself/Alone, Other people, Other family members, People you didn't know, I didn't play Pokémon Go in the past week). Staff assisted participants with locating this information in the app, when necessary and the surveys were set up with guidance (total km or first day of playing the game were obtained by going to the respective badge within the game).

Accelerometer-Measured MVPA: The Actigraph, Inc. GT3X model accelerometer was used for the measurement of daily minutes of moderate-vigorous PA (MVPA) among mothers and children. Participants were instructed to wear the Actigraph on their right hip, attached to an adjustable belt, at all times except during sleeping, bathing, or swimming for up to seven days. Custom R code was used to identify periods of non-wear (> 60 continuous minutes of zero activity counts) and eliminate sleep time and other data anomalies in the accelerometer data. Valid days were defined as at least ten hours (h) of wear and valid participants had four or more valid days of accelerometer data. Cut-points for classifying MVPA were consistent with studies of national surveillance data using age-specific thresholds for children generated from the Freedson prediction equation equivalent to 4 METs (27).

Demographics and Anthropometric Measurement: Participants' age, sex, race/ethnicity, annual household income, and mother's working status were self-reported via paper-and pencil questionnaires at baseline (Wave 4). Staff measured height and weight in duplicate using an electronically calibrated digital scale (Tanita WB-110A) and professional stadiometer (PE-AIM-

101) to the nearest 0.1 kilogram (kg) and 0.1 centimeter (cm), respectively. Body mass index (BMI; kg/m2) was calculated at each time point. For children, BMI category was created using BMI percentile for children based on EpiInfo 2005, Version 3.2.

Statistical Analysis

Independent sample t-tests (for age and physical activity/sedentary behavior by play status) and chi-square tests (for categorical demographic variables by play status) were used to investigate differences in demographics and daily MVPA by player status (still plays vs. doesn't currently play). A post-hoc analysis was conducted on mean minutes of MVPA and SB independently using G*Power to determine achieved power, given the difference in sample size of participants playing Pokémon Go compared to participants not playing Pokémon Go. Analyses for children had an achieved power of 0.72 for PA and 0.90 for SB to detect a large effect size; analyses for mothers had an achieved power ranging of 0.35 for PA and 0.48 for SB to detect a large effect size. The anticipated player base compared to the non-player base did not provide adequate power for multiple linear or logistic regressions controlling for demographics. All analysis was conducted in SAS. An alpha-level of 0.05 was used for the determination of significance.

RESULTS

The final analytic sample consisted of three waves of data, which were conducted six months apart. Baseline (Wave 4) included 156 mother-child dyads, of which six (3.9%) mothers and 21 (13.5%) children reported currently playing Pokémon Go. At six months, we retained 152 mother-child dyads, of which five (3.3%) mothers and 19 (12.5%) children reported currently playing. At twelve months, we retained 150 mother-child dyads, of which four (4.0%) mothers and 11 (7.3%) children reported currently playing.

Descriptive statistics for the sample are shown in Table 1. At baseline, children ranged in age from 9 to 13 years, with an average age of 11.13 years (*SD* = 0.93), and mothers were between 27 to 56 years of age, with an average age of 42.34 (*SD* = 6.11). Slightly more than half of the children (60.53%) and mothers (51.32%) identified of Hispanic race, and 56.5% of children were male. Almost half (40.39%) of children and 69.52% of mothers had overweight or obesity. 27% had an annual household income of less than $35,000, 25.97% earned between $35,001 and $75,000, 20.78% earned between $75,001 - $105,000, and 25.97% earned more than $105,001. A majority of mothers (84.42%) were full-time or part-time employees.

None of the baseline demographic characteristics significantly differed by player status based on chi-square tests and t-tests. However, there were trends such that Caucasian mothers and mothers with a higher annual household income were more likely to be players. In our analysis, neither children's race nor mothers' annual household income was associated with player status for children. Of the six mothers who reported playing Pokémon Go at baseline, five (83.3%) reported playing with their child. Children were more likely to report playing with friends (42.9%), other family members that are not parents (38.1%), or alone (33.3%). Although Pokémon

Go may have achieved widespread adoption, the group may not adequately represent at-risk demographics.

Across all time points, mothers reported engaging in an average of 21.12 minutes of daily MVPA (*SD* = 19.7), and children reported 29.35 minutes (*SD* = 18.88). When comparing the daily MVPA cross-sectionally between children who reported playing or not playing Pokémon Go at each time point, we did not see a statistically significant difference between the two groups (Table 2). However, in mothers, we saw that Pokémon Go players consistently engaged in more daily MVPA than non-players and the difference was statistically significant at six months and twelve months. For example, at twelve months, mothers who reported playing Pokémon Go reported over twice as much daily MVPA (*M* = 46.84, *SD* = 38.07) compared to non-players (*M* = 21.40, *SD* = 23.31); $t(145) = -2.55$, $p = 0.01$. Daily sedentary minutes did not differ in children or mothers by player status.

Table 1. Descriptive statistics of mothers and children by Pokémon Go play status at baseline.

	Child Currently Plays (*n* = 21)	Child Doesn't Currently Play (*n* = 135)	p-value for Children	Mother Currently Plays (*n* = 6)	Mother Doesn't Currently Play (*n* = 150)	p-value for Mothers
Race, n (%)			0.65			0.51
White/ Caucasian	3 (14.3%)	19 (14.5%)		3 (50.0%)	32 (21.9%)	
Black/ African American	1 (4.8%)	16 (12.2%)		1 (16.7%)	18 (12.3%)	
Asian/ Native Hawaiian/ Other Pacific Islander	3 (14.3%)	12 (9.2%)		0 (0.0%)	14 (9.6%)	
Hispanic	14 (66.7%)	78 (59.5%)		2 (33.3%)	76 (52.1%)	
Other	0 (0.0%)	6 (4.6%)		0 (0.0%)	6 (4.1%)	
Sex, n (%)			0.07			
Male	13 (61.9%)	54 (40.9%)		-	-	-
Female	8 (38.1%)	78 (59.1%)		-	-	
Annual Household Income, n (%)			0.76			0.29
< $35,000	5 (23.8%)	37 (27.8%)		1 (16.7%)	41 (27.7%)	
$35,001 - $75,000	4 (19.1%)	36 (27.1%)		0 (0.0%)	40 (27.0%)	
$75,001 - $105,000	5 (23.85)	27 (20.3%)		2 (33.3%)	30 (20.3%)	
>$105,001	7 (33.3%)	33 (24.8%)		3 (50.0%)	37 (25.0%)	
Mother's working status, n (%)			0.14			0.94
Currently employed	20 (95.2%)	110 (82.7%)		5 (83.3%)	125 (84.5%)	
Not employed	1 (4.8%)	23 (17.3%)		1 (16.7%)	23 (15.5%)	
Age, mean (SD)	11.14 (1.1)	11.13 (0.9)	0.95	44.33 (5.6)	42.3 (6.1)	0.42

P-value for age is independent sample t-test. All other p-values are for chi-square tests.

Table 2. Mean minutes of physical activity (MVPA) and sedentary behavior (SED) of mothers and children by Pokémon Go play status across time.

	Child Currently Plays		Child Doesn't Currently Play			
Variables	N	M (SD)	N	M (SD)	t value	p
MVPA Baseline	19	36.70 (30.99)	130	30.50 (17.20	-1.3	0.20
MVPA 6 months	19	29.86 (13.45)	127	28.05 (18.39)	-0.41	0.68
MVPA 12 months	11	27.57 (21.94)	135	28.52 (19.17)	0.15	0.88
SED Baseline	19	356.50 (130.80)	130	369.60 (110.30)	0.47	0.64
SED 6 months	19	396.10 (89.74)	127	370.50 (120.10)	-0.89	0.38
SED 12 months	11	373.60 (153.00)	135	395.00 (123.10)	0.54	0.59
	Mother Currently Plays		Mother Doesn't Currently Play			
Variables	N	M (SD)	N	M (SD)	t value	p
MVPA Baseline	6	29.76 (31.33)	143	22.02 (18.50)	-0.97	0.33
MVPA 6 months	4	43.8 (35.5)	145	17.90 (12.79)	-3.75	**<0.01**
MVPA 12 months	6	46.84 (38.07)	141	21.40 (23.31)	-2.55	**<0.05**
SED Baseline	6	530.00 (72.70)	143	460.20 (133.90)	1.27	0.21
SED 6 months	4	527.50 (43.41)	145	453.10 (133.10)	-1.11	0.27
SED 12 months	6	560.00 (43.20)	141	455.70 (157.70)	-1.61	0.11

M = Mean; *SD* = Standard Deviation.

DISCUSSION

Overall, the purpose of this exploratory study was to describe Pokémon Go use among mothers and their child and examine differences in MVPA by player status group across time cross-sectionally. Our results indicated that mothers who reported playing Pokémon had more MVPA on average across time, but this was not seen in children. We also did not find any significant differences in sedentary behavior by Pokémon Go player status in mothers or children.

Our findings support previous findings which found that Pokémon Go increased physical activity across women of all ages, BMI, and prior activity levels, as we found greater MVPA in mothers who played Pokémon Go compared to those who didn't (1, 2, 18). However, the number of women in the current study who identified as current active players was small. Furthermore, women in the current study were mothers, white/caucasian, higher income, and thus may represent a unique population. Our mothers were also extremely engaged in the game. For instance, in follow-up questions, all mothers reported interacting with gameplay elements (e.g., lures) and using in-game items (e.g., incense) to enhance gameplay experience and had walked, on average, 140 km while actively playing the game. These findings indicate that it is challenging to engage mothers with gamified PA apps over the long-term, and even the few who do engage may have already been active prior to starting the game.

The main limitation of the study was the lack of engagement with Pokémon Go among our population which led to the inability to adequately measure Pokémon Go as a natural PA intervention as a result of an underpowered and non-randomized study design. The first surveys with Pokémon Go questions were administered 2 months after the release of Pokémon

GO, but 11% of mothers and 21% of children who had played initially, were already not playing anymore (reported "used to play"). A previous study that explored the Pokémon Go user experience from a family perspective of active players found that the top reason for app disengagement was boredom (19). In this paper, we cannot describe changes in behavior due to Pokémon Go as we did not compare PA/SB before vs. after gameplay. As our sample size was limited, we did not have the statistical power to compare MVPA changes across mother-child dyads that played together, separately, or did not play at all. The results of this study must be interpreted with caution, given that these findings were only in a subsample of four mothers who continued to play the game across time. Usage data has indicated that Pokémon Go users are predominately male thus there may have been low interest in playing the game among mothers. Additionally, the higher rate of employment status in our sample of mothers may have had limited time available to engage with the game.

The primary strengths of this study were the naturalistic experiment design, the unique parent-child dyadic nature of the data from a racially- and SES-diverse population, as well the use of accelerometer-defined PA for objective measurement instead of subjective self-reported activity. The results suggest that it may be difficult to increase physical activity through video game interventions such as Pokémon Go due to the challenges of maintaining engagement and interest in the mobile app long enough to elicit sustained behavior change. Our finding that MVPA was greater for the small subsample of extremely engaged mothers indicates that for those who continually interact with the game, there may be benefits of improved PA. Therefore, this study does not imply that mobile games with real-world interaction do not effectively increase PA but merits further investigation into why such games lack the ability to maintain engagement for an acceptable duration of time to elicit long-term behavioral change. While traditional video games are played independently, the benefit of many new games is the social component of the game play experience. In Pokémon Go, players are encouraged to work together. In our sample, children were more likely to report playing with friends and other family members that are not parents suggesting there also exists a barrier between adolescents playing mobile video games with their parents. Thus, if games can engage family units together as well as over longer periods of time, parents would have opportunities to model healthy behavior, leading to overall behavior change in the family unit (24). Future directions for this analysis include understanding why this subsample of mothers continued to engage with the game to strengthen motivating elements of the game to adopt in future apps and understanding how to better integrate the theory of the family as a unit of behavior change into mobile applications. Understanding how to design a family-oriented game to bring together gamification, family-based interventions, and physical activity interventions will be important to future public health efforts.

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