THE DEMOGRAPHICS, BEHAVIORAL THEORY, AND PHYSICAL ACTIVITY PATTERNS OF POKÉMON GO GAME PLAYERS

by

JARED JASHINSKY

(Under the Direction of Marsha Davis)

ABSTRACT

Playing Pokémon Go has been associated with increased physical activity in many studies, but work needs to be done to limit the possibility of confounding variables by showing that physical activity is specifically occurring during habitual gameplay. The purpose of this study was to determine the patterns of active smart phone gameplay (i.e., Pokémon Go) concerning the physical activity frequency, intensity, and time during play.

A cross-sectional design and sample of Pokémon Go players in Athens, Georgia were used to answer the research questions. A sample of 48 participants was recruited through Pokémon Go related Facebook groups. Participants reported their demographic characteristics, Pokémon Go relative reinforcing value, contexts in which they played Pokémon Go, and other study related variables. Physical activity levels were assessed for a week using Actigraph accelerometers and gameplay times were reported in response to two text messages sent daily. The overlap of these measures assessed physical activity patterns during gameplay. Descriptive statistics, t-tests, and linear regressions were used to answer the research questions.

The sample was evenly split between males and females and generally represented a dedicated group of players. Participants played 116 minutes of Pokémon Go on average per day

and spent 22% of gameplay time in moderate to vigorous physical activity (MVPA) compared to 7% of comparable non-gameplay time ($t=5.520$; $\bar{x}=0.153$; $p<0.001$). Males played at significantly higher physical activity intensities compared to females ($\beta=0.14$; $p=0.01$) with 14% more of gameplay time spent in MVPA, but no other participant characteristics were associated with gameplay amount of intensity. Lastly, participants reported playing Pokémon Go while walking to be significantly more reinforcing than walking while not playing Pokémon Go, and participants spent 20% more of gameplay time in MVPA when playing in open public spaces compared to playing at home ($t=2.840$; $\bar{x}=0.201$; $p=0.011$).

This research provides further evidence that Pokémon Go gameplay engages participants in more MVPA than they otherwise would if not playing Pokémon Go. Researchers should understand the varied gameplay patterns when studying Pokémon Go gameplay, and more should be done to promote the use of Pokémon Go, specifically in areas amenable to physical activity.

INDEX WORDS: Physical activity, Pokémon Go, augmented reality games, smart phone, location-based smart phone games, accelerometer

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DEDICATION

To Meghan, the love of my life.

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CHAPTER 1

INTRODUCTION

Problem

Two thirds of American adults and one third of American youth are overweight or obese.[1,2] Adult overweight and obesity has been shown to increase the risk of coronary heart disease, type-2 diabetes, dyslipidemia, stroke, sleep apnea, liver disease, gall bladder disease, osteoarthritis, and gynecological problems.[3] High rates of overweight and obesity in the United States (US) result in at least two to three times greater direct medical costs for treatment compared to other developed nations. It is estimated that in 2008 the US spent $115 billion on direct medical care for overweight and obesity, totaling to 4.8% of all US medical expenditures.[4]

Daily physical activity plays an important role in the health of children and adults. National recommendations suggest that children accumulate 60 minutes of moderate to vigorous physical activity (MVPA) daily to achieve the related health benefits.[5] Adults are recommended to participate in 150 minutes of moderate intensity physical activity, 75 minutes of vigorous intensity physical activity, or an equivalent mix of moderate and vigorous physical activity per week.[5] Physical activity protects against excessive weight gain and its related negative health outcomes such as cardiovascular problems, diabetes, osteoarthritis, sleep apnea, and asthma.[6–8] Furthermore, acquiring sufficient physical activity has been linked to decreases in a variety of negative health outcomes independent of weight loss including cancer, cardiovascular disease, diabetes, depression, and osteoporosis.[9] Increased exercise independent of weight loss has been associated with decreases in abdominal fat, increases in glucose uptake and improvements in

physical function.[10,11] However, according to accelerometer measured physical activity, only 5% of adults and 8% of adolescents acquire sufficient levels of physical activity for the related health benefits.[12]

Active video games are a type of digital game that requires moving significant portions of the body, above typical hand movements required by traditional games, to advance gameplay. A classic example of active video games is Nintendo's popular Wii Sports[13] which recreates sports such as bowling, tennis, and boxing through the use of a motion sensitive controller. Players move their arms and legs to immerse themselves in gameplay and accomplish gameplay tasks. Other examples include the Xbox Kinect, immersive devices that control games through active means, and location-based smart phone games.[14–16]

Significance

The use of active gaming to promote physical activity grew rapidly after the release of the Nintendo Wii, and largely focused on home-based console gaming.[17] These console-based active video games were found to elicit light to vigorous absolute intensity physical activity in users in laboratory settings.[18–20] However, in applied trials with control conditions, a minority of active video game interventions led to improved total physical activity levels among game players.[17] Observational and experimental studies have tended to show heightened active video game use at baseline and declined use at follow-up.[19] Even though at this time active video games can promote physical activity for shorter intervention periods lasting from 6-12 weeks, this may not be fostering sustained physical activity.[19] It is possible that earlier active video games were not sufficiently enjoyable or varied enough to create sustained physical activity.

A new wave of location-based active smart phone gaming has revived interest in the field. These augmented reality smart phone games require players to travel to real-world

locations to advance gameplay. These games, developed by companies such as Google and Nintendo,[21,22] hold promise to be sufficiently enjoyable to produce sustained increases in physical activity. Niantic's first augmented reality smart phone game Ingress has about a million active users,[22] and Pokémon Go still had 65 million monthly users nine months after its release.[23] Pokémon Go requires players to walk to encounter and "hatch" more Pokémon, specifically linking in game tasks to real-world travel.[24] Additionally, locations such as banks, parks, and public art can serve as "gyms" where their Pokémon can battle with others for more points and items. Designing the game to be played in real-world locations incentivizes playing outdoors. A study of cell-tower data suggested that more people were outside during the week following the release of Pokémon Go compared to the week before.[25]

Playing Pokémon Go has been associated with increased physical activity in many studies.[26–36] One study reported that the improved physical activity did not remain at a six week follow-up,[27] while two other studies did not find significant associations between gameplay and physical activity.[37,38] Other work has shown possible improvements in psychological distress and anxiety among Pokémon Go game players,[31,39,40] finding that gameplay may foster improved mental health in addition to possible physical activity benefits.

Finding significant associations between gameplay and physical activity in observational settings is promising, but work needs to also show that physical activity is specifically occurring during gameplay to limit the possibility of confounding variables. Two studies have investigated the physical activity intensities of individuals specifically during Pokémon Go gameplay.[41,42] These studies help demonstrate that Pokémon Go can promote physical activity in a way that studies using aggregate measures have not. However, these studies did not assess habitual physical activity patterns but rather one specific bout of gameplay in open public spaces.

Before future work is done, a detailed analysis of physical activity patterns during habitual gameplay should be done with objective measures of physical activity. Identifying what frequency, intensity, time, and type of physical activities are performed while playing Pokémon Go, though not conclusive, would provide further evidence that Pokémon Go is leading to increased physical activity.

Purpose

The purpose of this study is to determine the patterns of active smart phone gameplay (i.e., Pokémon Go) concerning the physical activity frequency, intensity, and time during play. Previous work has tested the association between gameplay and overall activity levels, but this study will add to the literature by determining when people play and what physical activity intensities occur during gameplay. The following research questions will be answered:

1. What physical activity intensities occur during Pokémon Go gameplay and at what proportions?
    a. Hypothesis: Gameplay time will on average entail 50% sedentary activity, 40% light intensity activity, and 10% moderate intensity activity.
2. How much time do people spend playing Pokémon Go, and at what times?
    a. Hypothesis: Participants will play an average of 15 minutes of Pokémon Go per day. Gameplay will occur throughout the day, but predominantly during non-work hours. Gameplay will occur during weekdays and weekends, but more on the weekends.
3. Do physical activity intensity during Pokémon Go gameplay or time spent playing vary by demographic characteristics such as sex, age, BMI, dog ownership, or gameplay history?

    a. Hypothesis: Women and men will play at similar physical activity intensities and for similar lengths of time. Those of differing BMI will play at similar physical activity intensities and for similar amounts of time. Age will be positively associated with gameplay time and negatively associated with physical activity intensity during gameplay. Dog owners will play at higher intensities and for longer lengths of time. Lastly, those with a shorter gameplay history will play at higher intensities but shorter lengths of time.

4. Do people find walking while playing Pokémon Go to be more reinforcing than walking while not playing Pokémon Go?
    a. Hypothesis: Players will find walking while playing Pokémon Go to be more reinforcing than walking while not playing Pokémon Go.
5. Do people vary their physical activity intensity by context in Pokémon Go (i.e., who they are with, their modality, and where they are)?
    a. Hypothesis: Players will be at higher physical activity intensities while playing alone, when they are walking while playing, and when they are playing in public open spaces compared to home.

Answering these questions will provide valuable context for future work in promoting physical activity with active smartphone games. This research will add to our knowledge of how to maximize the impact of these new technologies to promote physical activity, and in turn, prevent obesity and other chronic diseases.

CHAPTER 2

LITERATURE REVIEW

Problem

Two thirds of American adults and one third of American youth are overweight or obese.[1,2] Adult overweight and obesity has been shown to increase the risk of coronary heart disease, type-2 diabetes, dyslipidemia, stroke, sleep apnea, liver and gall bladder disease, osteoarthritis, and gynecological problems.[3] High rates of overweight and obesity in the United States (US) result in at least two to three times greater direct medical costs for treatment compared to other developed nations. It is estimated that in 2008 the US spent $115 billion on direct medical care for overweight and obesity, totaling to 4.8% of all US medical expenditures.[4]

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physical function.[10,11] However, according to accelerometer measured physical activity, only 5% of adults and 8% of adolescents acquire sufficient levels of physical activity for the related health benefits.[12]

Definition of Physical Activity

The most often cited definition of physical activity was originally written in 1985 and is still espoused by the World Health Organization today, "physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure."[43,44] Though the definition of physical activity is straightforward, multiple features of physical activity should be assessed to ensure a complete understanding of the behavior: frequency, intensity, time, and type. To help illustrate how the features of physical activity helps one understand physical activity, take the example of a woman who performs physical activity. At this point, the only known thing is that she engages in physical activity.

Frequency refers to how often physical activity occurs. This could be anywhere between once a month and multiple times a day. Continuing with the physically active woman example, it turns out she performs physical activity twice per day. At this point it is understood she repeatedly performs physical activity, but a full picture is not understood. Does she lift groceries into her car and then to her home every day, or does she swim for three hours in the morning and three hours in the evening every day? While both are valuable, the latter will have a larger impact on her health and whether she meets physical activity guidelines.

Intensity refers to how much energy expenditure occurs during physical activity per unit of time. Furthermore, intensity can be split into absolute intensity and relative intensity. Absolute refers to energy expenditure per unit of body weight per unit of time. Absolute intensity is often expressed in METs and standardizes physical activity behavior across individuals. Relative

intensity refers to the perceived energy expenditure or difficulty of physical activity. Less fit individuals would participate in higher relative intensity physical activity performing the same activity as a more fit individual. The understanding of physical activity is limited without the intensity information. For the example woman, it turns out her physical activity is performed at a moderate intensity twice per day. While a lot more is understood about her physical activity, it is still not known how much physical activity is performed because she could be playing moderate intensity volleyball for one hour in the morning and evenings, or she could be jogging five minutes to and from the park with her child each day.

Physical activity intensity can be precisely defined in terms of metabolic equivalents (METs). A MET is the amount of oxygen consumed per kilogram of body weight per minute while the body is at rest, which is roughly 3.5 ml of O_2.[45] A person engaging in a two MET activity burns twice as many calories as they would at rest, three times as many during a three MET activity, and so on. Physical activity guidelines divide physical activity into three categories including light intensity as between 1.1 and 2.9 METs, moderate intensity as between 3.0 and 5.9 METs, and vigorous intensity as 6.0 METs or greater.[5] Moderate and vigorous intensity physical activities have specifically been associated with health benefits.[46] Vigorous intensity physical activities are also shown to provide more health benefits per minute of participation than moderate intensity physical activities.[46] Though moderate and vigorous intensity physical activities have the most benefits, even light intensity physical activity has been shown to have health benefits.[47] For example, light intensity physical activity has been inversely associated with all-cause mortality risk after adjusting for potential confounders.[48]

Time refers to how long the physical activity is performed. Bouts of physical activity could last anywhere from a couple seconds to hours. There is a large difference between a 10-

minute jog and an hour jog. Understanding the time of physical activity is a crucial feature to know what is occurring. For the example woman, it turns out she performs moderate intensity physical activity, twice per day, for 30 minutes at a time. Now a quite complete picture of her physical activity is understood. She performs seven hours of moderate intensity physical activity each week, with two half-hour bouts performed every day. At this point it can be determined that she does indeed meet physical activity guidelines by accumulating more than 150 minutes of moderate intensity physical activity per week in at least 10-minute bouts. However, the last piece of information missing is exactly what she is doing.

The type of physical activity details which specific activity is being performed. For example, physical activity could be playing basketball, lifting weights, or doing yoga. There are nearly limitless types of physical activity to perform, but they can be categorized into more broad types. Some specific categories include leisure, work, aerobic, and strength-training. In the case of the example woman, it turns out she spends 30 minutes twice per day performing moderate physical activity by taking her dog out on brisk walks. This picture is much more complete than the original information that she simply performs physical activity. Knowing the frequency, intensity, time, and type help to understand more about an individual's physical activity and any related health benefits that might arise.

Definition of a Game

Different definitions exist for what a game is. The purpose of this section is not to fully review the history and intricacies of the definition of games, but rather to propose two definitions that are commonly discussed. It is helpful to detail what a game is before moving forward, even though many would feel they already know what a game is. Precise definitions are at the heart of science and allow one to create reliable and valid measures.

Bernard Suits proposed in 1967 that "a game is to engage in activity directed toward bringing about a specific state of affairs, using only means permitted by specific rules, where the means permitted by the rules are more limited in scope than they would be in the absence of the rules, and where the sole reason for accepting such limitation is to make possible such activity."[49] This definition sets apart a game from other rule-based activities by making the distinction that engaging in the activity is for the sole purpose of accomplishing a task within a set of limitations for the sake of engaging in the prescribed experience. Following rules in this sense is different than following societal rules which are constantly being balanced against other competing interests and rules. This perspective casts gameplay as an immersive imaginative experience where an activity is engaged simply for the entertainment or challenge.

A definition proposed by Salen and Zimmerman in 2003 is that "a game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome."[50] This definition mirrors aspects of the previous, but is generally easier to digest. The "artificial conflict, defined by rules" evokes the idea of using "only means permitted by specific rules" to accomplish a task "where the sole reason for accepting such limitation is to make possible such activity." At the heart of gameplay is engaging in an "artificial conflict." Lastly, Salen and Zimmerman argue that a game needs to result in a quantifiable outcome, which is similar to Suits mention of "bringing about a certain state of affairs." The goal of checkers is to remove all the other players' pieces from the board and the goal of Pac Man is to get a high score. Both outcomes are quantifiable and are "certain state[s] of affairs" discussed by Suits.

History of Physical Activity Promoting Games

Active video games are a type of digital game that requires moving significant portions of the body, above typical hand movements required by traditional games, to advance gameplay.

Some original examples of active video games were console-based games that were played while standing on a touch sensitive mat. Examples included the original Nintendo Entertainment System's Power Pad released in 1988 which allowed players to run in place on the ground to control games and Dance Dance Revolution released in 2001 which had players step on four different directional buttons to dance along to music.

Nintendo Wii

The use of active gaming to promote physical activity grew rapidly after the release of the Nintendo Wii in 2006, and largely focused on home-based console gaming.[17] A classic example of an active video game on the Nintendo Wii was the popular Wii Sports[13] which recreated sports such as bowling, tennis, and boxing through the use of a motion sensitive controller. Players hold the controller and move their arms and legs to immerse themselves in gameplay and accomplish gameplay tasks. A boxing game has players shifting left and right with their upper bodies to dodge punches and pushing their arms forward to throw punches. One problem with the Nintendo Wii was that games using the motion controller could often be "tricked" into simulating a bodily movement my lightly moving only one hand.[51] For example, Wii sports could be played while standing and engaging fully in physical activity, or could be completed while reclining on a couch and lightly flicking the wrist. The Wii Balance Board was introduced in some future games and helped limit the player's ability to be sedentary during play.

The Wii Fit was a game released by Nintendo for the Wii in 2008 that used a unique Wii Balance Board, and was one of the best-selling games of all time.[52] The Wii Fit used the motion sensitive controller in conjunction with a weight sensitive Balance Board that could detect shifts in balance, stepping on the device, or stepping off the device. Games using the balance board in combination with the motion sensitive controller helped require more full body engagement with

the games. The Wii Fit was the most focused of all the Nintendo Wii games on specifically promoting physical activity. Players could work with a digital personal trainer to engage in traditional exercises such as pushups and squats. Mini-games were also included that required movement, such as a game where players had to safely land a bird on a variety of targets by flapping their arms and angling their body in different directions.

Xbox Kinect

Another example of a console-based active gaming platform was the Xbox Kinect released in 2010.[14] The Xbox Kinect differed from the Nintendo Wii by creating a hands-free device that measured body movements from an infrared projector and camera near the TV. The Xbox Kinect allowed for games to be controlled by body gestures, facial recognition, and voice recognition.[53] One of the most familiar games played on the Xbox Kinect was Just Dance, which had players mirror the movements of dance instructions on the screen along to popular music. Importantly, the Xbox Kinect could track movement in the upper and lower body, combating some of the problem observed in the Nintendo Wii where players could gesture with one hand and still "dance along" with the game. A meta-analysis found that active video games that engage both the upper and lower body in gameplay elicited higher intensities of physical activity compared to those only engaging the upper body.[54]

Virtuix Omni

Another example of active gaming includes recent developments in unique active gaming hardware setups. The Virtuix Omni is a 360 degree treadmill that controls proprietary video games.[16] Combined with virtual reality headsets and handheld controllers, individuals control the games by walking along the treadmill, twisting their bodies, moving their head, and manipulating the controller. The Virtuix Omni is expanding on previous active video games to create a more

fully immersive and engaging experience. Developers want to eventually have the controller compatible with popular gaming systems such as the Xbox or Playstation.[16] No studies have investigated Virtuix Omni games and physical activity. Currently the reach of the Virtuix Omni is limited to arcade play or wealthy enthusiasts. Expansion of this technology and its possible effects on physical activity will expand as these devices become compatible with traditional gaming consoles.

Impact of Console-based Active Video Games

These console-based active video games were found to elicit light to vigorous absolute intensity physical activity in users in laboratory settings.[18–20] A meta-analysis of nine studies on active video games found that youth ages 6-18 were playing, on average, at a physical activity intensity of 3.1 METs, passing the threshold of 3 METs, counting as moderate intensity physical activity.[18] The same review noted that no studies found youth participating at a vigorous physical activity, 6 METs or higher. An individual study of 53 young adults playing four different Kinect active video games found that physical activity intensity varied from 3.8 to 7.4 METs, with an average of 6.1 METs.[20] This study averaged nearly twice the intensity of that found in the youth systematic review. The difference might stem from the study focusing on young adults, using solely Xbox Kinect games, or possible random error. A meta-analysis of 18 studies found that adults on average expended less energy while playing active video games than children, but did not differ on other measures of relative physical activity intensity including heart rate and $V0_2$.[54]

In applied trials with controlled conditions, a minority of active video game interventions led to improved physical activity levels among game players.[17] Observational and experimental studies have tended to show heightened active video game use at baseline and declined use at follow-up.[19] Even though at this time active video games can promote physical activity for

shorter intervention periods lasting from 6-12 weeks, they did not foster sustained physical activity.[19] It is possible these games were not sufficiently enjoyable, variable, or preventive of sedentary gameplay enough to create sustained physical activity. New developments in active smart phone games may be a way to promote more sustained physical activity.

Active Smart Phone Games

Location-based active smart phone games are a class of video games offered on mobile devices that require players to visit real-world locations to advance gameplay. Another name for these types of games include augmented virtual reality games. A variety of game titles fall under this genre, including Ingress, Pokémon Go, Merchant, CodeRunner, SpecTrek, Turf Wars, Run an Empire, and Life is Crime. The most popular location-based active smart phone games include Ingress and Pokémon Go.

Ingress

Ingress, created by the Google start-up company Niantic in 2012, has about a million active users and represented a new wave of active video games.[22,55] Ingress is a free downloadable app available for both Apple and Android devices that engages players in a fictional plot to save the world. Players are quickly informed that a "mysterious energy" has been uncovered by scientists, and that they must join the team combating the energy or the other team attempting to harness the energy.[55] Players then can travel to real-world locations to gain the items they need to help control "portals" for their team.

To the author's knowledge, no published research has investigated an association between Ingress gameplay and physical activity. However, other work has argued that playing Ingress leads to an increased awareness of the physical environments people live in.[56] Instead of absent-mindedly travelling from point A to point B, Ingress players can discover new locations,

historical landmarks, or public art that are relevant to gameplay.[56] Exploring and learning about the environments people live in may be a first step in being comfortable outside or finding new locations to be active. Furthermore, the very act of exploring one's environment could directly lead to increased physical activity.

Pokémon Go

Pokémon's long history started in 1998 with the US release of the first Pokémon Gameboy games and now has seven generations of core Pokémon games with a host of spinoff games.[57,58] Pokémon games have players explore fictional worlds finding and collecting creatures called Pokémon. Often, Pokémon, are fanciful versions of animals known in the real world. Other times, Pokémon can be entirely unique creations only seen in the games. The goal of all the core Pokémon games has always been to collect all the Pokémon and battle your Pokémon in controlled fights against rival players. Pokémon Go represents the first and only location-based active smart phone game version of the Pokémon game franchise. Released in July of 2016, Pokémon Go has been downloaded over 650 million times.[59] Though the popularity of the game has subsided since the initial release, Pokémon Go still had 65 million monthly users nine months after release.[23]

Pokémon Go was developed by Niantic and mirrors many of the same mechanics found in the original games, but with an augmented virtual reality twist. Players travel their neighborhoods and cities to find and capture Pokémon, with more Pokémon appearing the more distance a player travels.[24] Items necessary to capture the Pokémon can be collected at locations throughout town including restaurants, parks, historical sites, and public art. However, players cannot repeatedly harvest items from one location in succession. Items can be collected from one location again only after waiting a period of about five minutes. To maximize the number of

items a player can collect, players must move from location to location and return to collected locations after the waiting period has expired, further incentivizing movement. Another way players can collect Pokémon is through the incubation process. Pokémon eggs are one of the items that can be collected during gameplay and are hatched with the in-game "incubator." Each egg is either a 2K, 5K, or 10K egg and represents the amount of distance a player must travel before the egg is fully incubated and hatches. Rarer and stronger Pokémon hatch from the eggs requiring more distance. Players can also strengthen their collected Pokémon and battle them against other player's Pokémon at gyms located throughout town. Battling Pokémon gives players more in game items and points that further advance gameplay.

Niantic also periodically introduces new content to keep the game novel and interesting.[24] New characters have periodically been introduced to the game, to ensure there are always new Pokémon for players to catch. Holiday events often have increased spawning of certain types of Pokémon, such as ghost Pokémon around Halloween. Often extra points are available to players and the in-game events spur a renewed interest and increased gameplay.[60]

Pokémon Go borrowed heavily from gameplay mechanics found in Niantic's original game Ingress. All the locations relevant for gameplay in Pokémon Go were simple repackaging of the information and images originally used in Ingress.[61]

Active Smart Phone Games Research

Researchers have studied Ingress and Pokémon Go from a variety of disciplines including communication, surveillance, and geography.[62–64] Of particular importance for public health is the host of research that has investigated the dynamics between Pokémon Go and physical activity, mental health, and distracted driving.

Associations with Physical Activity

As mentioned previously, the author was not able to find any published work testing the association between Ingress gameplay and physical activity. However, playing Pokémon Go has been associated with higher levels of physical activity in many studies.[26–36] One study reported that the improved physical activity did not remain at a six week follow-up,[27] while two other studies did not find significant associations between gameplay and physical activity.[37,38] Most of the published research suggests Pokémon Go gameplay is associated with increased physical activity.

One of the above studies sent a digital survey to Pokémon Go players between the months of July and August 2016, catching players who had recently started playing the game after release.[32] The survey retrospectively assessed physical activity with an adapted Godin Leisure-Time Exercise Questionnaire both before and after playing Pokémon Go, and found significant changes in physical activity. Respondents reported 47 more minutes of mild, 38 more minutes of moderate, and 14 more minutes of strenuous physical activity per week. The researchers also asked participants about their time spent in sedentary behaviors and found a reduction of 30 minutes per day in sedentary behavior.

Another study recruited participants who played Pokémon Go soon after release and used the iPhone Health app.[26] The participants sent screenshots of their daily step counts taken from the iPhone Health app for the three weeks before and the three weeks after the release of Pokémon Go. Participants additionally reported the XP (i.e., in-game points) accumulated to date from the app. Participants reported playing a median of two hours per day of Pokémon Go. More than 85% of participants accumulated more steps after playing Pokémon Go. Participants on average walked 1976 more steps per day after Playing Pokémon Go compared to before.

Participants accumulated 10,000 steps per day on 15.3% of days before playing Pokémon Go and 27.5% of days after. Interestingly, the study found the largest increases were for participants who were over 30, overweight/obese, had low baseline physical activity, and those who played Pokémon Go more based off XP accumulation.

A different study used similar methods to the above study, but instead sampled people with Amazon Mechanical Turk, an online service offered by Amazon where people are paid to complete online tasks. Participants included 18-35 year olds and included both players and non-players. Participants reported their steps as recorded by the iPhone Health app, and their Pokémon Go playing for the four weeks before and six weeks after installation of Pokémon Go.[27] The researchers found a 955 step increase in daily steps during the first week of installation for Pokémon Go players that was not observed in non-players. However, daily step counts reverted back to pre-installation levels at six weeks.[27] The extended follow-up may have caught more of the reversion to baseline compared to the three-week study. Pokémon Go was very popular upon release, but many people stopped playing quickly afterwards. Though millions still played the game months after release,[23] it is possible that some of these early studies noting decreased impact at follow-up may stem from the initial large contingent of people that stopped playing. It would be interesting to conduct studies on this association months or years after the initial release.

A second study using Amazon's Mechanical Turk was published in 2018 and had people self-report their Pokémon Go use and physical activity.[34] The study found a positive association between self-reported gameplay and physical activity levels. Specifically, higher physical activity levels were higher due to the physical activity required for gameplay and not a general increase in physical activity outside of the game.

Another study recruited a group of people that wore Microsoft Bands, a specific brand of step counting wrist bands, to test the association between Pokémon Go gameplay and physical activity.[29] People gave their permission for Microsoft data collected from the devices to be used in research. Participants were coded as game players or not based on whether they searched for terms only Pokémon Go players were likely to search for such as "Pokémon Go IV calculator," "how to play Pokémon Go," or "Pokémon Go Eevee evolution." The initial search query was coded as time zero for when a participant started playing Pokémon Go. The study took a random sample of Microsoft Band users as a control group and constructed time zeros to match the distribution of start times in the sample of game players. Daily steps were tracked with the Microsoft Band data for 30 days before and after time zero in both groups. A small but significant difference was noted with players increasing their steps by 192 steps per day, on average, compared to the control group who decreased their steps by 50 per day, on average. In addition, the study noted a dose-response improvement in steps for those who engaged with the game more, as measured by the quantity of Pokémon Go related search queries. Pokémon Go was related to improved physical activity in males and females, different BMIs, and prior physical activity levels. Pokémon Go showed better improvements than major competing health apps and were used by people with lower prior physical activity. This study again demonstrated that higher engagement with Pokémon Go was related to higher levels of physical activity, showed benefit for females, and showed benefits for those with high BMIs who traditionally are at higher need of increased physical activity.

Another study conducted in September of 2016 recruited college students who had downloaded Pokémon Go.[30] Respondents retrospectively reported their sedentary and walking time with the IPAQ for the one-week period before they downloaded Pokémon Go, the week

after they downloaded the game, and the week the study occurred. This led to follow-up periods anywhere between one week and two months. The study found significantly more walking and lower sedentary activity levels during the week after and the follow-up point compared to baseline, but the follow-up levels were not as good as immediately after the game was downloaded. This study with a more extended follow-up found diminished yet still significant therapeutic effects on walking and sedentary activity.

A study published in November of 2017 sampled dog owners who played Pokémon Go.[31] Participants self-reported spending more time with their dog, walking their dog, with other people, and exercising from playing Pokémon Go. Though this study only sampled dog owners, it is possible that Pokémon Go gameplay interacts with other personal characteristics to create unique effects in participants. Since Pokémon Go is a game that can be played while walking, and dogs benefit from walks, a synergistic effect might impact dog owners who play Pokémon Go.

A study conducted about two and a half months after release of Pokémon Go sampled participants using Amazon Mechanical Turk.[65] Participants retrospectively reported exercise frequency the week before they downloaded the game, and the week after they downloaded the game. Almost two-thirds of game players reported increased exercise after playing Pokémon Go. Interestingly, this study also characterized the amount of drop-off in the first couple months after release. This study reported that 23% of game players had quit or were about to stop playing, and another 55% of game players had already reduced the amount of time they played the game. The study also noted that people were more likely to play in their own neighborhood if it was a more walkable community, as measured by the previously validated and publicly available algorithm Walk Score®.[66,67] The likelihood of benefitting from active smart phone games may interact

with the walkability of individual's environments. If sidewalks are not available or traffic speeds are high, people may not feel comfortable going outside to play.

A cross-sectional study of college students in Hong Kong sampled all students using an online survey one month after release of Pokémon Go in Hong Kong.[37] Students were between the ages of 18 and 25. The survey assessed physical activity with the IPAQ-S, asked about time spent playing Pokémon Go, and assessed playing outdoors. About 40% of the sample currently played, 30% used to play, and 30% of the sample never played Pokémon Go. Approximately 43% of people who originally played Pokémon Go had stopped playing one month after release, a higher loss than that reported in the previous study. People who played Pokémon Go were more likely to be young adults and those who did not previously go outdoors as much. Almost two-thirds of the players spent less than an hour a day playing the game, suggesting fairly casual use among the sample. Current players were more likely to play outdoors and walk to play the game compared to how ex-players used to play the game. These results suggest that those who were being the most active playing the game were those who were most likely to continue playing. T-tests were used to compare walking, moderate, vigorous, and total physical activity between the three groups, but no significant differences were observed.

A study published in May of 2017 surveyed 444 players between the ages of 12 and 50. Players self-reported their time playing Pokémon Go for each of the previous seven days as well as their physical activity using the IPAQ-S.[33] Participants also reported their motivations for playing the game including things such as health benefits, being outdoors, and joining teams in the game. The study found that those who played the game more were more active six weeks later and spent more time outdoors.

One study used Ecological Momentary Assessment to assess whether 74 college students had played Pokémon Go during the day and how many steps they accumulated using phone apps.[38] The study sent a brief questionnaire to participants three times per day. This study failed to find a significant association between gameplay amount and steps accumulated.

A study conducted in Japan recruited older Pokémon Go players and a matched sample of non-players.[36] With participants wearing pedometers, the investigators found that Pokémon Go players had significantly more steps per day than non-players after months of follow-up. These results are unique as it used a sample of older individuals, on average in their 50's, and showed players maintained higher step counts during winter months when activity is more difficult.

Another study in Asia investigated the physical activity patterns of 210 individuals in Hong Kong before and after they downloaded Pokémon Go.[28] Physical activity was measured using smartphones and found that participants walked and ran 18% further after they downloaded Pokémon Go compared to before. This study additionally found that activity was higher when the day had lower wind speeds, more sunshine, and higher temperatures. Physical activity was also higher when playing in green spaces. Participants who were less active at the beginning had the largest improvements in physical activity.

A study published in November of 2018 studied 127 individuals who reported their physical activity and Pokémon Go gameplay using a novel "Physical Activity and Pokémon Go questionnaire" based off the International Physical Activity Questionnaire.[35] Participants responded to this survey one month after the release of Pokémon Go and at a 3-month follow-up period. Some participants played Pokémon Go and others did not. Those who played Pokémon Go reported participating in significantly more days of walking and moderate intensity physical activity, but less days of vigorous intensity physical activity.

Most studies reviewed here found significant associations between Pokémon Go gameplay and higher levels of physical activity. Though observational in nature, these studies suggest Pokémon Go gameplay promotes physical activity and warrant experimental research. However, these studies all characterized physical activity and gameplay patterns on the aggregate scale.

Physical Activity during Gameplay

Two studies have investigated the physical activity intensities of individuals specifically during Pokémon Go gameplay. These studies help demonstrate that Pokémon Go can promote physical activity in a way that studies using aggregate measures have not. Showing high physical activity intensity during gameplay helps reduce the possibility that other studies have had confounding variables produce the identified associations.

One study recruited 46 college students to wear an accelerometer, pedometer, and heart rate monitor while they played Pokémon Go.[41] Participants were bound to a two-mile campus radius to prevent participants from crossing streets and were followed by a research staff member who could help answer questions and ensure safety. All metrics supported participation in MVPA, and the accelerometer estimated that participants spent 82% of their time in MVPA while playing Pokémon Go. This study added to the other literature by objectively measuring physical activity intensity during gameplay but had three important limitations. First, all participants were college students. Second, participants were only tracked for 60 minutes in a public open space, which did not reflect habitual gameplay. Third, participants were all followed by a research staff member during data collection. Reflexivity might have led participants to be more active than they might otherwise have been.

The second study recruited 100 individuals walking on a greenway, 13 of which were playing Pokémon Go.[42] This study had all participants wear an Omron pedometer and an accelerometer while they carried on with their activities. This study found that Pokémon Go players on average spent 55% of their time participating in MVPA compared to 82% for those who were not playing. This study is stronger than the previous study inasmuch as it found people who were visiting the greenway as part of their typical Pokémon Go gameplay and were not placed their as part of the study. This study found less MVPA during gameplay than the previous study, and significantly less than the non-gameplayers in this study.

Before future work is done, a detailed analysis of physical activity patterns during habitual gameplay should be done with objective measures of physical activity. Identifying what frequency, intensity, time, and type of physical activities are performed while playing Pokémon Go, though not conclusive, would provide further evidence that Pokémon Go is leading to increased physical activity.

Mental Health

Aside from physical activity benefits, there may be mental health benefits for those who play these types of games. Some work has shown possible improvements in mental health markers among those who play Pokémon Go.[31,39,40]

A study published in November of 2017 sampled dog owners who played Pokémon Go.[31] Participants self-reported less anxiety about leaving the house, meeting strangers, and visiting new places.[31] Having positive experiences outside the home and meeting new people while playing Pokémon Go may have a positive impact on people dealing with anxiety. Exploring new environments and social situations can be difficult, but Pokémon Go may help facilitate this exploration through structured activities and mapped locations.

A different study used a retrospective design to test the effects of playing Pokémon Go on psychological distress.[39] Participants reported in late 2015 and early 2016 baseline levels of psychological distress, and reported these levels again in December of 2016, about five months after release of Pokémon Go. Game players were defined as those who had played for over a month, while non-players were defined as those who played less than a month. Game players tended to be younger than non-players. The study found significantly better improvements in psychological distress among game players compared to non-players.

An 8-week RCT investigated the effects of playing Pokémon Go on physical activity and cognitive performance was published in 2017.[40] In a sample of 190 adolescents from Spain, the study found significantly improved levels of selective attention, concentration levels, and sociability levels. Participants on average played 40 minutes of Pokémon Go, and boys played more than girls on average.

Though not conclusive, these three studies taken together suggest there may be mental health benefits to playing location-based active smart phone games. Physical activity has been generally linked with improved mental health, with hypothesized effects through psychological and physiological mechanisms.[68] If location-based smart phone gameplay is truly linked to improved mental health, it is possible the phenomenon is mediated by increased physical activity. Conversely, increased interaction with other people playing the game, the entertaining value of the game, or interacting with new environments are hypotheses that could be explored.

Distracted Driving

Motor vehicle accidents are the largest cause of death among those 10-24 years old, and are a major cause of death for all ages.[69] Distracted driving represents a serious risk of motor vehicle accidents, particularly among young drivers.[70] Pokémon Go and other location-based

smart phone games represent a new form of potential distraction for drivers. Driving in a vehicle is an easier way to travel between points in a game, and if the game allows it, players can advance gameplay easier or quicker than they would walking or biking. In addition to the risk of motor vehicle accidents, driving while playing these games negates the potential impact on physical activity.[71]

A study mined text from Twitter and news reports for about a week and a half in mid-July (i.e., during peak use) to identify cases of traffic concerns.[71] After reviewing the obtained Twitter and news messages, the researchers found 14 motor vehicle crashes attributable to Pokémon Go, and that 18% of tweets involving Pokémon Go and driving were from people talking about operating a vehicle while playing Pokémon Go. While these numbers do not precisely estimate the overall incidence of motor vehicle crashes from location-based active smart phone games or the prevalence of driving while playing among users, they do highlight that they are occurring. These games can be viewed as just another option for distracted driving amongst the many devices and applications vying for driver's attentions. Companies marketing these games should do all they can to discourage operating a vehicle during gameplay.

A study discussed earlier that found increased steps among Pokémon Go game players after the release of the game, also asked participants about the frequency of playing the game in a car.[26] Ninety percent of respondents reported playing Pokémon Go in a moving vehicle, but the researchers could not tell if they were personally operating the vehicle or riding as a passenger due to how the question was worded. Another study had 27% of participants report they were likely or very likely to play Pokémon Go while driving.[72] Future work assessing driving safety among Pokémon Go players should assess driving while playing more accurately.

Lastly, a Japanese study did not find a significant increase in traffic fatalities when comparing the month before and the month after the release of Pokémon Go.[73] Though this study was quasi-experimental and on the aggregate level, it suggests that the traffic risks of Pokémon Go might be negligible. Furthermore, this study occurred during the peak popularity of Pokémon Go and when it was the newest to gameplayers, which would likely make it the point in time when you would most notice any possible changes in traffic fatalities.

Starting in November of 2016 with version 1.15.0 and after, a speed cap was put in place to prevent driving while playing the game.[74,75] The speed cap prevents Pokémon from spawning and players from being able to interact with item stops and gyms. Taking away the ability to play the most pivotal parts of the game at high speeds likely decreased driving while playing. However, the speed caps operate between 10-20 miles an hour, meaning that people driving at slow speeds or in stop and go traffic may still be able to play the game. The implementation of speed caps in the game occurred after most of the reviewed literature on this game. It is possible that driving while playing has decreased.

Theoretical Discussion of Physical Activity

Understanding the behavioral theory underlying behavior change is valuable for intervention development and the scientific understanding of human behavior. The following sections detail a foundational behavioral theory and hypothesize the possible theoretical drivers of physical activity from location-based active smart phone gameplay.

Introduction to Behaviorism

B.F. Skinner published the book *The Behavior of Organisms* in 1938, where he demonstrated the effects of consequences on animal behavior,[76] shaping the field of Behaviorism understood today. Behaviorism explains how human behavior is caused by the conditions in

which behaviors occurs and the related consequences. Behaviorism separates human behavior into two distinct types, respondent and operant behavior. Respondent behavior, often thought of as reflexes, are human actions that are not caused by consequences, but by a stimulus that occurs immediately before the behavior. Examples of respondent behaviors are the body tearing after wind blows across the eye, salivating at the smell of food, and reflexively withdrawing the hand after touching a hot surface. The wind, smell, and hot surface are all unconditioned stimuli in that they naturally elicit the respective behaviors; however, as with Pavlov's dogs, conditioned stimuli can be created by repeatedly pairing a novel stimulus such as a bell with an unconditioned stimulus such as food.

Operant behavior covers most behaviors humans perform and are what many people assume are controlled by an individual's "free-will" or other mental processes. Operant behaviors are those behaviors that increase or decrease in frequency after being paired with respectively a reinforcing or punishing consequence. Examples include doing homework after receiving praise and treats in the past for doing so, exercising after receiving a deduction in their insurance copay for being active, and not speeding after being fined for driving over the speed limit. Reinforcers and punishers can be divided into unconditioned or conditioned consequences. Unconditioned refers to the consequence being naturally reinforcing or punishing such as food, water, pain, temperature, and intimacy. Conditioned reinforcers or punishers alter human behavior after they have been repeatedly paired with unconditioned consequences. Examples of conditioned consequences include money, grades, and verbal praise.[77]

The behavioral ecological model (Figure 1) conceptualizes the theory underlying behaviorism in an ecological perspective, and explain its interaction with how other scientific understanding such as biology and physiology affect human behavior. As can be seen in the

middle of Figure 1, behavior is first a product of the antecedent conditions an individual is in and the history of consequences they have experienced after performing a given behavior.[78] These experiences interplay with characteristics of the individual such as physiology and the genome and with characteristics of their environment such as other individuals, policies, and culture.

Great successes have been observed with the application of behaviorism to animal training,[79] interventions to improve behaviors in mentally disabled individuals,[80,81] and has been extended to understand behaviors on ecological levels.[78] Applying the principles of behaviorism on ecological levels have found success in areas such as improving delinquent student behavior and increasing child safety seat enforcement.[82,83]

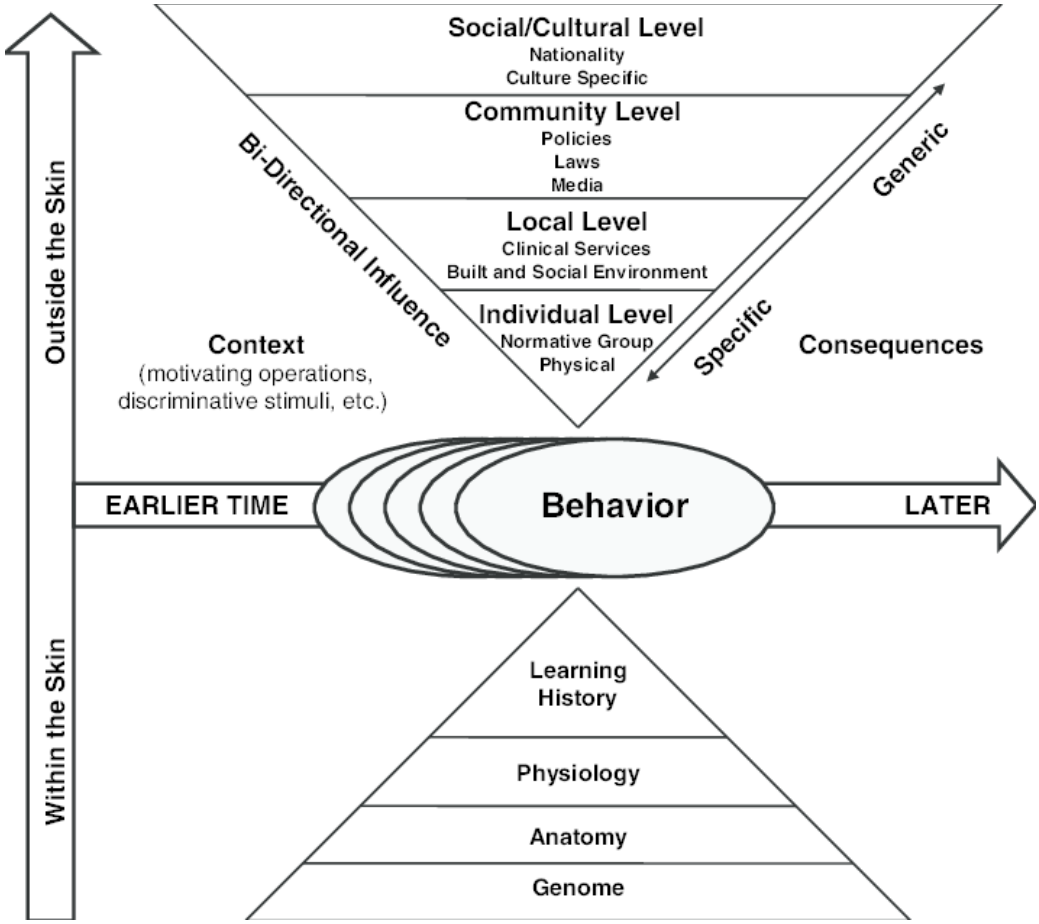

Figure 1: Diagram of The Behavioral Ecological Model. Reprinted from Hovell and Hughes.[84]

Application of Behaviorism to Physical Activity

Whatever frequency an individual currently exhibits a given behavior is the balance between the previous reinforcing and punishing experiences they have experienced in the environment they are currently in. In much older times, the punishing aspects of physical activity such as pain, sweat, and fatigue were overcome by the reinforcing consequences of acquiring food, finding shelter, or avoiding danger. In modern times, the development of cars, machines, and other technologies alter the balance between the punishing and reinforcing consequences of physical activity, primarily that acquiring food, shelter, safety, and most other things are no longer consequences of physical activity since they can be acquired by other means.[85] Weight loss, health, or fitness are often touted as rewarding consequences of physical activity, but they are so far removed from the behavior that they do not have much of an effect. Proximal consequences such as pain and sweating are much more salient and primarily drive the behavior.[85]

People are often not required to physically exert themselves aside from tasks around the home and active transportation. Physical activity is often viewed as something children should enjoy doing, which often can be the case. However, people with some body types may find certain activities more punishing and less reinforcing than people with other body types.[85] Even though some physical activities can be enjoyable, these behaviors must compete with their inherently punishing consequences (e.g., pain, fatigue). Higher physical activity intensities result in more punishing consequences, but even light physical activity expends some of the limited energy the body has at any given moment. Additionally, physical activity has to compete with other highly reinforcing sedentary activities such as watching television, sitting to relax, or playing computer games. Research has shown that people who report ‘liking’ physical activity

and find it relatively more reinforcing than other behaviors exhibit more physical activity.[86] Finding ways to make physical activity easier (i.e., removing punishers) or more enjoyable (i.e., more reinforcing) will naturally increase the amount of physical activity people perform.

Behaviorism and Location-based Active Smart Phone Games

Location-based active smart phone games may increase physical activity through altering the positive and negative consequences people experience for walking. It is possible these consequences are altered through point accrual, praise, engaging in a narrative story, visiting public spaces, or being distracted from the aversive consequences of walking. Other work has identified escapism, nostalgia, challenge, friendship maintenance, relationship initiation, being outdoors, and achievement as potentially reinforcing aspects of playing Pokémon Go.[87–89]

Games frequently provide points to players as a way of quantifying game achievement. Examples of points systems are pervasive, ranging from professional sports to video games. A study asking people to complete a simple task repeatedly found that people completed the task more often when points were awarded for completing the task.[90] Points would likely be serving as a conditioned reinforcer in that they have previously been paired with other reinforcing consequences and, in and of themselves, are not naturally reinforcing stimuli.

Verbal praise from others for performing a behavior is a reinforcing consequence that can increase the likelihood of the behavior happening in the future.[77] Praise from friends, or others involved in gameplay, for playing or accomplishing tasks could be another reinforcing aspect. These games foster cooperative play and mutual experiences that may naturally lead to praise for advancing through the game. Other research has found that engaging in social contact to play Pokémon Go was positively associated with game satisfaction.[91] As advancing through the game often requires physical activity, people may be indirectly reinforced for physical activity.

People enjoy compelling stories in the form of movies, books, games, and narrated experiences from friends. A study found that people randomly selected to learn about a product brand with an additional story about the product's company had a more positive view of the company compared to those that learned about the product without hearing the company's story.[92] Ingress and Pokémon Go both to some degree engage the players in stories by having them choose teams, fight for their side, and learn of new events occurring in the game.

Gameplay occurs at locations approved by the game developers including historical or educational locations, public art or architecture, libraries, and places of worship.[93] Visiting interesting locations might be an appealing or reinforcing activity that individuals may not experience during their normal activities. Previous work has shown positive views towards a location where people play Pokémon Go are positively associated with game satisfaction, and that discovery and relaxation are involved in player's choices of where to play.[91,94]

Lastly, it is possible that gameplay serves as a distraction from some of the immediate negative consequences of physical activity. Research has found that people exercising at the same heart rate reported less perceived exertion when listening to music compared to when they were not listening to music.[95] Being focused on something entertaining may limit the body's ability to register the aversive consequences of extended walking such as fatigue or sweating.

These potential alterations in consequences experienced for being physically active while playing these games may be increasing the likelihood people are physically active. Identifying which, if any, reinforcers are at play could lead to a better understanding of these games' effects.

Future of Active Smart Phone Games

Scientific evidence suggests an association between playing location-based active smart phone games and increased physical activity. Current games are played by millions with new

content and events coming every year. Additionally, Niantic announced in November of 2017 they are working on a new Harry Potter location-based active smart phone game that will have players training to become wizards, learning spells, and battling enemies.[96] Though not everyone is interested in Pokémon, others might be interested in Harry Potter. As more games and more content are released, it becomes increasingly likely that more will get involved in these active games. Understanding both the physical activity patterns of game players and the theoretical foundations for these games' effects on physical activity are essential moving forward.

CHAPTER 3

METHODS

Study Purpose and Questions

The purpose of this study was to determine the patterns of active smart phone gameplay (i.e., Pokémon Go) concerning the physical activity frequency, intensity, and time during play. Previous work has tested the association between gameplay and overall activity levels, but this study adds to the literature by determining when people play and what physical activity intensities occur during gameplay. The following research questions were proposed:

1. What physical activity intensities occur during Pokémon Go gameplay and at what proportions?
    a. Hypothesis: Gameplay time will on average entail 50% sedentary activity, 40% light intensity activity, and 10% moderate intensity activity.
2. How much time do people spend playing Pokémon Go, and at what times?
    a. Hypothesis: Participants will play an average of 15 minutes of Pokémon Go per day. Gameplay will occur throughout the day, but predominantly during non-work hours. Gameplay will occur during weekdays and weekends, but more on the weekends.
3. Do physical activity intensities during Pokémon Go gameplay or time spent playing vary by demographic characteristics such as sex, age, BMI, dog ownership, or gameplay history?

    a. Hypothesis: Women and men will play at similar physical activity intensities and for similar lengths of time. Those of differing BMI will play at similar physical activity intensities and for similar amounts of time. Age will be positively associated with gameplay time and negatively associated with physical activity intensity during gameplay. Dog owners will play at higher intensities and for longer lengths of time. Lastly, those with a shorter gameplay history will play at higher intensities but shorter lengths of time.

4. Do people find walking while playing Pokémon Go to be more reinforcing than walking while not playing Pokémon Go?
    a. Hypothesis: Players will find walking while playing Pokémon Go to be more reinforcing than walking while not playing Pokémon Go.
5. Do people vary their physical activity intensity by context in Pokémon Go (i.e., who they are with, their modality, and where they are)?
    a. Hypothesis: Players will be at higher physical activity intensities while playing alone, when they are walking while playing, and when they are playing in public open spaces compared to home.

Answering these questions provides valuable context for future work in promoting physical activity with active smartphone games. This research adds to the knowledge of how to maximize the impact of these new technologies to promote physical activity, and in turn, prevent obesity and other chronic diseases.

Study Design

This section will detail aspects of the study design used to answer the research questions. Before details of the study are addressed it is necessary to understand its overall design.

A cross-sectional design was used. The cross-sectional design assesses the exposure and outcome variable of interest simultaneously. Though many limitations exist in cross-sectional research, namely the ability to determine the proper temporal order of exposure and outcome variables, the design is often used in etiologic research.[97] The cross-sectional design is appropriate for this study as the five research questions are descriptive in nature.

Though the design did not describe changes in gameplay patterns over time in individual participants, the design was able to describe snapshots of each participant. Answering the research question of whether higher levels of gameplay were associated with higher levels of physical activity was not optimally answered with a cross-sectional design, but was balanced against the appropriateness for the other research questions and the feasibility of the project.

The following sub-sections will explain the finer details of the study. Sub-sections include a description of the study sample, recruitment strategy, and measurement procedures.

Study Sample

A sample of Pokémon Go players in Athens, Georgia was sought. The purpose was to make the results more generalizable to players in a college-town with a strong representation of Pokémon Go players. Additionally, this would not limit the findings to college-aged populations like done in other studies.[30,37] Participants needed to report playing Pokémon Go at least once per week, be at least 18 years old, and be a resident of Clarke County to participate in the study.

Athens is part of Clarke County, Georgia and the following demographic statistics come from the County Health Rankings website.[98] Clarke County tends to have more people in the

middle of their life than the state of Georgia. Seventeen and a half percent of Clarke County residents are less than 18 years old compared to 24.4% for Georgia, and 10.2% of Clarke County residents are 65 and older compared to 13.1% for Georgia. The racial ethnic breakdown for Clarke County is similar to Georgia, with a slightly higher presence of non-Hispanic whites (55.3% to 53.4%) and a slightly lower presence of non-Hispanic African Americans (10.2% to 13.1%). American Indian and Alaska Natives (0.4% to 0.5%), Asians (4.4% to 4.1%), Pacific Islander (0.1% to 0.1%), and Hispanics (10.8% to 9.4%) are all similarly represented between Clarke County and Georgia as a whole. In terms of education, 70% of Clarke County adults between the ages of 25-44 have some college education, compared to 62% of adults between these ages in the state of Georgia.

The following statistics additionally are sourced from the County Health Rankings website and help describe the health of Clarke County residents.[98] Adult obesity is at 26% in Clarke County compared to 30% for Georgia overall. Twenty-two percent of Clarke County adults report no leisure-time physical activity, compared to 24% of adults in Georgia. In terms of access to areas to be physically active, Clarke County fairs better than Georgia with 87% of Clarke County residents living close to a park or exercise facility compared to 77% of Georgia residents. Clarke County residents on average experience 4.3 poor mental health days in the past month, compared to 3.8 days for Georgia overall.

The above data for Clarke County describes the overall population, but this study specifically recruited Pokémon Go players instead of the general population in Athens. Previous work has found that Pokémon Go players tend to be in their late 20's, but can vary greatly in age.[26,27,29,65] Samples have also tended to have more males than females.[26,27,29]

Looking at Clarke County overall and previous work with Pokémon Go players, it was expected that the sample of Pokémon Go players in Athens Georgia would be representative of a smaller college town in the Southern US with a strong representation of Pokémon Go players, that is slightly more represented by younger individuals, males, more active individuals, and those with poorer mental health. How this sample was collected is detailed in the following section.

Recruitment

The recruitment strategy obtained a sample Pokémon Go users in Athens Georgia who used three local Facebook groups dedicated to Pokémon Go in Athens, GA: "Athens' Pokémon Go Facebook Raid Group," "Pokémon Go: Athens GA," and "Athens, GA Pokémon Go Researchers Group." Individuals were invited to participate in the study through the groups. The first two groups had over 1,400 members each and the third had over 500 members. Announcements were posted to the groups inviting people to complete an initial screening if they are interested in participating. Rolling waves of participants were enrolled in the study. If more people responded to a given post than could be accommodated at a given time, they were followed-up with after spots were available. A limited number of accelerometers for physical activity measurement necessitated this rolling approach. Though this approach potentially introduced self-selection bias into the study, it still benefited from the more representative original sample of the Facebook group.

A final analysis sample of 64 people was intended. This sample size was determined through the following power analyses. As the second and fourth research questions use one-sample t-tests to compare the observed means with the hypothesized values, Soper's a-priori sample size calculator for student t-tests was used with 0.8 as the desired power, 0.05 as the

significance level, and a Cohen's d of 0.5 representing a medium effect size.[99,100] As the third research question uses linear regression, a second power analysis was conducted to see if it required a larger sample size. Based off a power analysis conducted in G-Power for linear regression with a power of 0.8, significance level of 0.05, and an f^2 of 0.15 representing a medium effect size, the required sample size was 55.[100–102] The sample size required for research question three was less than two and four, so the t-test power analysis was used. Power for a medium effect size was chosen as previous work had not measured physical activity intensity or gameplay frequency in the same manner as this study, limiting the ability to conduct a power analysis based off previous work. Assuming approximately 15% of the recruited sample will give incomplete data, it is expected that 76 people will need to be recruited to achieve the final analysis sample of 64.

Recruitment efforts were not able to meet the planned analysis sample of 64. Adding the third Facebook group and snowball sampling were used to expand the sample, but not many extra participants were recruited with these methods.

Measurement Procedures

The following measurement procedures commenced after people expressed interest in participating in the study and passed the initial eligibility criteria (i.e., play Pokémon Go at least once per week, 18 years of age or older, and Clarke County resident). This section will describe study procedures starting from the consent process to the exit interview. Details about the specific measurements used will be given in the following section.

Initial screening for eligibility criteria took place over Facebook messenger. Potential participants were informed of the fundamental aspects of the study and screened for initial eligibility criteria including gameplay time, age, and county residence. Interested individuals

who did not meet the screening criteria were thanked for their interest but informed they do not qualify. Those who expressed interest and passed the initial screening criteria were scheduled for a study enrollment visit.

Study enrollment visits took place in public locations convenient to each participant. Locations for study enrollment visits included a local library, coffee shops, and locations on UGA campus. The study enrollment visit started with informing potential participants about the study and inviting them to read a copy of the informed consent document. If potential participants agreed to sign the informed consent document they were officially enrolled in the study, or if potential participants were no longer interested they were thanked for their time and not enrolled in the study.

Individuals' study ID number (i.e., birth year followed by first three letters of mother's first name), phone number, email, home address, and demographic information were collected through a Qualtrics survey after people agree to participate in the study (see Appendix A). The two best times of the day to send gameplay questionnaire texts were collected. Contact information allowed for continued contact throughout the measurement period and facilitated collection of the costly monitors used to assess physical activity patterns. After contact and schedule information were collected, participants were given a physical activity monitor to be worn for a one-week period. Participants were given a printout detailing how to wear the device on their body, when they should put it on, and for which activities they should take the device off (see Appendix D). The handout also included reminders of when gameplay questionnaire texts were scheduled to be sent and when to meet to complete the study. Details about the device and settings employed for the study can be found in the Measures section. Lastly, a time and place to meet for a study completion visit were scheduled a week from the study enrollment visit.

Participants tracked the times they played Pokémon Go by responding to gameplay questionnaire texts twice per day (see Appendix B). Each text contained a link to a survey asking participants when they have played Pokémon Go since the last time they were contacted. Participants were sent a total of 14 gameplay questionnaire texts during the seven-day period. Texts were scheduled in advance using ohdontforget.com.

Participants met to return their physical activity monitor at the study completion visit. Participants also took an end of study survey to collect data on Pokémon Go gameplay, the reinforcing value of walking and Pokémon Go gameplay, and demographics. Participants completed the survey on their phone through a Qualtrics survey (see Appendix C). Details of the questions can be found in the Measures section. Participants were also asked to participate in a brief end of study interview to report the contexts in which they played Pokémon Go.

After the participants completed the survey and returned the device, they were emailed a $10 iTunes or Google Play gift card for their participation through PayPal's digital gift service. If participants also responded to at least 12 of the 14 gameplay questionnaire texts, they were compensated with a $15 gift card instead of a $10 gift card. These gift cards were chosen as they can be redeemed for in-game currency in Pokémon Go, which might enhance the relevance of the incentive in recruiting those who play Pokémon Go. The increased incentive for completing the gameplay questionnaire texts was planned to increase adherence to the procedure. Digital receipts of the gift cards sent to people's emails documented incentive delivery and facilitated reimbursements from the internal grant.

Measures

The following sections will detail the specific measures used to assess the study variables: Pokémon Go gameplay, physical activity, relative reinforcing value, and

demographics. The following measures were chosen for their reliability, validity, and practicality. In combination, they allowed for conclusions to be drawn about the proposed research questions.

Pokémon Go Gameplay

As discussed in the measurement procedures, participants tracked the times they played Pokémon Go by responding to gameplay questionnaire texts twice per day. Each text contained a link to a survey asking participants when they had played Pokémon Go since the last time they were contacted. Minutes logged through the gameplay questionnaire texts were used to calculate for each participant the average minutes of gameplay per day and length of gameplay bouts. Data collected from the gameplay questionnaire texts and the end of study interview were used to calculate average minutes of gameplay per day during work hours, average minutes of gameplay per day during non-work hours, and length of gameplay bouts.

The end of study survey had participants report many aspects of their Pokémon Go gameplay from the in-game records. Variables to be collected included total XP accumulated, kilometers walked, battles won, eggs hatched, Pokémon caught, Pokéstops visited, Pokédex entries, raids won, legendary raids won, field research tasks completed, and gameplay start date. These variables were used to characterize length of gameplay time and style of gameplay. Gameplay history was reported using the gameplay start date. Gameplay history will be converted to half year windows (e.g., 0-6 months, 7-12 months) since the initial download of the game. Participants also reported the frequency they operated a vehicle while playing Pokémon Go with a question adapted from previous work asking about texting while driving.[103] Participants were also asked “how often do you operate a vehicle while playing Pokémon Go?”,

with response options including ‘never’, ‘sometimes’, ‘about half the time I play’, ‘most of the time I play’, and ‘always’.

The last Pokémon Go gameplay variable assessed in the end of study survey was how much money participants had spent in the Pokémon Go shop. The question asked “Approximately how much money have you spent in the Pokémon Go shop on in-game items?” and include the following response options: $0, $1-10, $11-20, $21-30, $31+.

Physical Activity

The physical activity of all participants was tracked using the Actigraph GT3X accelerometer. Accelerometer methods followed closely those used in the primary analysis of NHANES accelerometer data.[12] Participants wore the device for a total of seven days. Devices were attached to the waist with an elastic belt, placing the accelerometer on the hip and above the centerline of the right thigh. Participants were instructed to wear the device when they wake up until they go to bed at night. Participants were asked to take the device off only for bathing, swimming, and other water activities. Accelerometers were set to collect data at 10 second epochs.

Bouts of non-wear time were removed from data analyses and did not count towards sedentary activity, similar again to the analysis of NHANES accelerometer data.[12] Non-wear time was determined from the data with approaches used previously in research instead of using participants logged wear time. This approach minimized participant burden while still generating estimates of non-wear time. Non-wear time was defined as any period exceeding an hour with successive zero counts, permitting small spikes in the counts for up to two minutes accounting for random spikes in the data. Wear time was designated as all times that were not non-wear time. At least four days of 10 or more hours of valid wear time was needed to include in

estimates of habitual physical activity, but no minimum amount wear time was required for estimates of gameplay intensities. Accelerometer cut points were used to assess times spent in either sedentary, light, moderate, or vigorous intensity physical activity for valid wear days. Cut points for sedentary (0-99 counts/min) and light (100-1951 counts/min) intensity physical activity were chosen from previous research of adults.[104] Freedson's 1998 cut points for adults were used to determine time spent in moderate (1952-5724 counts/min) and vigorous (≥ 5725 counts/min) intensity activities.[105]

The average minutes spent in sedentary, light, moderate, and vigorous intensity physical activity per day were calculated for each participant. The average steps per day and the total daily physical activity (i.e., light, moderate, and vigorous intensity physical activity) was also calculated for each participant. Adults are recommended to participate in 150 minutes of moderate intensity physical activity, 75 minutes of vigorous intensity physical activity, or an equivalent mix of moderate and vigorous physical activity per week.[5] Minutes of moderate and vigorous physical activity recorded on the accelerometer were used in the following formula to determine if participants met physical activity guidelines for adults during the week: $(minutes\ of\ mod + 2(minutes\ of\ vig)) \geq 150$. Proportions of Pokémon Go gameplay time spent in sedentary, light, moderate, vigorous, and MVPA during any bout length were also calculated for each participant.

Times when participants did not respond to the survey about whether they played or not were treated as not play time since 73% of participants had complete gameplay time data, most participants who had missing data were only missing one day, and there was a chance that some of the participants did not respond to the texts because they did not play during that time. The

partial gameplay time was used to estimate physical activity intensities in cases when times partially overlapped with accelerometer wear time to maximize data use.

Corresponding non-gameplay times were designated for each bout of gameplay. Non-gameplay times were selected as time the participant did not play Pokémon Go, between the time of day as the gameplay, but on the "following day." The corresponding "following day" was Monday for Friday and Saturday for Sunday. This helped keep weekdays and weekends separate, helping ensure the corresponding non-gameplay times would be as similar to the gameplay times as possible. The corresponding "following day" for the last day of participation was the first day of participation.

Relative Reinforcing Value

Reinforcing value represents the positive consequences an individual experiences for engaging in a given behavior. The relative reinforcing value represents how much more reinforcing a given behavior is in comparison to another behavior. The relative reinforcing value of a Pokémon Go walking break during work was compared to a normal walking break during work for each participant.

The relative reinforcing value of the two behaviors was assessed using a novel method inspired by Kirby's assessment of delay discounting.[106] Participants were asked a series of 10 questions for a given hypothetical situation. For each question, participants imagined they were at work and offered to take either a walking break or a Pokémon Go walking break by their boss. However, the boss gave different length breaks depending on which activity they chose. Participants responded for 10 different time choices. The 10 time choices were given in random order and were between a 20-minute walking break or a 2-minute gameplay walking break, a 20-minute walking break or a 4-minute gameplay walking break, a 20-minute walking break or a 6-

minute gameplay walking break, a 20-minute walking break or an 8-minute gameplay walking break, a 20-minute walking break or a 10-minute gameplay walking break, a 20-minute walking break or a 12-minute gameplay walking break, a 20-minute walking break or a 14-minute gameplay walking break, a 20-minute walking break or a 16-minute gameplay walking break, a 20-minute walking break or an 18-minute gameplay walking break, and lastly a 20-minute walking break or a 20-minute gameplay walking break.

The point between which the respondent flipped from choosing a gameplay walking break to a walking break represented the relative reinforcing value between the two behaviors. For example, consider the respondent that says they would take a 12-minute gameplay walking break but would not take the 10-minute gameplay walking break. This means 11 minutes of gameplay walking break is equal to 20-minutes of walking break. Taking the ratio of these two says that gameplay walking time was 1.8 times more reinforcing than walking time.

In cases where respondents flip-flopped on type of break choices, the middle point between when participants responded uniformly was used to assess the relative reinforcing value. For example, consider a person who said they would take the 10-minute gameplay walking break, not take the 8-minute gameplay walking break, take the 6-minute gameplay walking break, and not take the 4-minute gameplay walking break. This person answered consistently for 10 minutes and above as well as four minutes and below. Their cut point would be the average of the two which would be seven. The ratio of seven and twenty would be used to determine that the participant found gameplay walking to be 2.9 times more reinforcing than walking.

Gameplay Context

Participants participated in a brief end of study interview to report the contexts in which they played Pokémon Go. The date, day of the week, start time, and end time data were collected

from Qualtrics for each participant. Participants were verbally walked through their week and asked three questions about each bout of gameplay. First, participants were asked “Who were you with?” with response options including ‘alone’, ‘family’, ‘friend’, ‘coworker’, and ‘other’. Second, participants were asked “Were you sitting, standing, walking, driving?” with response options including ‘sitting’, ‘standing’, ‘walking’, ‘driving’, and ‘other’. Third, participants were asked “Where, or near where, were you playing?” with response options including ‘home’, ‘work/school’, and ‘other’.

Demographics

Demographic data were collected on each participant in the initial study survey. Participants self-reported their sex, age, height, weight, education, and current dog ownership. Sex was reported as either male, female, or other with the ability to free respond. Age was reported as a continuous variable. Height was reported in feet and inches. Weight was reported in pounds. Height and weight were used to calculate BMI for analyses. Education was reported as high school degree or less, some college, undergraduate degree, or graduate/professional degree and converted to undergraduate degree or higher and some college or lower for analyses. Dog ownership was reported as yes or no. A check all that apply question assessed which possible reinforcing consequences were at play when people started playing Pokémon Go. Response options included to improve health, to be more active, to lose weight, for entertainment, for social benefits, to explore new environments, and to enjoy the challenge. A second question asked the same but about reinforcing consequences for continuing to play Pokémon Go.

Analyses

The sample was described by reporting the mean, median, standard deviation, skewness, and kurtosis values for the average minutes spent in sedentary, light, moderate, and vigorous

intensity physical activities per day. The same statistics were calculated for steps per day, gameplay history, total XP accumulated, kilometers walked, battles won, eggs hatched, Pokémon caught, Pokéstops visited, raids won, legendary raids won, age, and BMI. Categorical proportions were calculated to describe the sample in terms of what percent met physical activity guidelines, length of time since started playing, participant sex, current dog ownership, frequency of operating a vehicle while playing, amount of money spent in the Pokémon Go shop, reinforcers for starting to play, and reinforcers for continuing to play.

Research Question 1 Analyses

The first research question asked what physical activity intensities occur during Pokémon Go gameplay and at what proportions. The hypothesis is that gameplay time would on average entail 50% sedentary activity, 40% light intensity activity, and 10% moderate intensity activity. It is also hypothesized that people will participate in more MVPA during gameplay time compared to corresponding non-gameplay time.

The mean, median, range, standard deviation, skewness, kurtosis, and confidence interval values were calculated for the proportions of gameplay time spent in sedentary, light, moderate, and vigorous intensity physical activities. The confidence interval estimates for proportion of time spent in sedentary, light, and moderate intensity activity during Pokémon Go gameplay including the hypothesized 50%, 40%, and 10% would confirm the original hypothesis. A two direction paired samples t-test tested the hypothesis that the proportion of MVPA was higher during gameplay time compared to corresponding non-gameplay time.

Research Question 2 Analyses

The second research question asked how much time people spend playing Pokémon Go, and at what times. The hypothesis was that participants would play an average of 15 minutes of

Pokémon Go per day, based on previous research.[65] The other hypotheses were that gameplay would occur throughout the day, but predominantly during non-work hours, and that gameplay would occur during weekdays and weekends, but more on the weekends.

The mean, median, range, standard deviation, skewness, and kurtosis values were be calculated for minutes of gameplay per day, minutes of gameplay per day during work hours, minutes of gameplay per day during non-work hours, minutes of gameplay per day on weekdays, and minutes of gameplay per day during weekends. The confidence interval estimate for minutes of gameplay per day including 15 would confirm the original hypothesis. Two direction paired samples t-tests tested the hypotheses that more gameplay occurs during non-work hours compared to work hours and weekends compared to weekdays.

Research Question 3 Analyses

The third question asked if physical activity intensities during Pokémon Go gameplay or time spent playing varied by demographic characteristics such as sex, age, BMI, education, dog ownership, or gameplay history. The hypotheses were that those of different sexes, BMIs, and educations would play Pokémon Go similarly, dog owners and younger individuals would play for more time and at higher physical activity intensities, and those with a shorter gameplay history would play at higher intensities but shorter lengths of time.

Bivariate linear regressions were used to test the associations between demographic variables and the average minutes of gameplay per day, as well as demographic variables and proportion of time spent in MVPA during gameplay. First, bivariate linear regressions tested the associations between NHANES methods accelerometer wear time and average minutes of gameplay per day, as well as wear time and proportion of time in MVPA. Linear regressions were used to test the associations between demographic variables and minutes of gameplay, as

well as demographic variables and the proportion of time spent in MVPA during gameplay. NHANES methods accelerometer wear time was to be added as a control variable in these linear regressions if they were independently associated with the dependent variables. Non-significant associations for the sex, BMI, and education variables would confirm the lack of differences hypothesized. Significant associations for two-direction tests for age, dog ownership, and gameplay history would confirm the hypothesized differences.

Research Question 4 Analyses

The fourth research question asked if people would found walking while playing Pokémon Go to be more reinforcing than walking while not playing Pokémon Go, with the hypothesis that players would find walking while playing Pokémon Go to be at least 1.5 times more reinforcing than walking while not playing Pokémon Go.

The mean, median, range, standard deviation, skewness, kurtosis, and 95% confidence interval values were calculated for the relative reinforcing value between walking while playing Pokémon Go and walking while not playing Pokémon Go. The 95% confidence interval not containing a potential relative reinforcing value below 1.5 would be used to test the hypothesis.

Research Question 5 Analyses

The fifth research question asked if people varied their physical activity intensity by context in Pokémon Go (i.e., who they are with, their modality, and where they are). The hypothesis was that players would be at higher physical activity intensities when they played alone compared to with friends, when they walked while playing compared to sitting while playing, and when they were playing in public open spaces compared to home.

The first analysis described the patterns of gameplay during the different contexts. The mean, median, range, standard deviation, skewness, kurtosis, and confidence interval values

were calculated for minutes of gameplay for each of the gameplay contexts (i.e., alone, with family, friends, coworker, other person, sitting, standing, walking, driving, other modality, at home, at work or school, other location).

The second analysis tested if gameplay contexts were associated with different physical activity intensities. Two direction paired samples t-tests were instead used to test the hypothesized differences in MVPA during gameplay.

CHAPTER 4

RESULTS

Demographic Results

Descriptive analyses were conducted to describe the study sample. Table 1 details the number and percentage of participants in each group of the categorical variables. Notable results were that the sample was evenly split between male and female, contained mostly long-term players, and were generally highly educated. Table 2 details the mean, median, standard deviation, skewness, and kurtosis values for the continuous descriptive variables. Notable results were that the sample had a large range of participant ages and BMIs. A total of 48 participants were included in descriptive analyses, except for physical activity measures which were limited to the 34 participants who wore the accelerometer sufficiently long to estimate habitual physical activity.

Table 1: Categorical Demographic Variable Frequencies

Demographic Variables	n	%
Sex		
Female	23	47.9%
Male	25	52.1%
Years Played		
< 1 year	4	8.3%
1-1.9 years	1	2.1%
2-2.4 years	2	4.2%
2.5+ years	41	85.4%
Education		
Less than a high school degree	0	0%
High school degree	3	6.3%
Some college	18	37.5%
Undergraduate degree	18	37.5%
Graduate/professional degree	9	18.8%

Dog Ownership		
Yes	14	29.2%
No	34	70.8%
Driving while Playing		
Never	15	31.3%
Sometimes	21	43.8%
About half the time I play	6	12.5%
Most of the time I play	6	12.5%
Always	0	0%
Money Spent		
$0	8	16.7%
$1-10	6	12.5%
$11-20	6	12.5%
$21-30	6	12.5%
$31+	22	45.8%
Reasons for Starting to Play*		
Improve health	7	14.6%
Be more active	20	41.7%
Lose weight	4	8.3%
Entertainment	44	91.7%
Social benefits	15	31.3%
Explore new environments	15	31.3%
Enjoy the challenge	31	64.6%
Reasons for Continuing to Play*		
Improve health	16	33.3%
Be more active	27	56.3%
Lose weight	8	16.7%
Entertainment	40	83.3%
Social benefits	32	66.7%
Explore new environments	18	37.5%
Enjoy the challenge	28	58.3%
Pokémon Go Plus Use		
Yes	15	31.3%
No	33	68.8%
Meets Physical Activity Guidelines		
Yes	31	8.8%
No	3	91.2%

**Participants could choose multiple response options*

Table 2: Continuous Demographic Variable Statistics

Variable	Mean	SD	Median	Range	Skew	Kurt
Age	28.65	8.08	26.00	18.00-60.00	1.74	3.96
BMI	28.13	7.53	24.88	15.78-47.23	1.00	0.18
Sedentary PA (min/day)	644.96	15.65	617.13	544.75-1018.97	2.29	7.65
Light PA (min/day)	138.26	8.98	135.77	60.07-322.98	1.40	3.69
Moderate PA (min/day)	55.33	4.11	48.01	9.57-98.29	0.05	-1.01
Vigorous PA (min/day)	4.55	1.23	1.08	0.04-29.71	2.14	4.25
Steps per Day	8201.55	651.63	7042.52	2955.06-17959.29	0.67	-0.33
Relative Reinforcing Value	3.75	3.41	2.11	1.00-10.00	1.24	-0.32
In-Game Metrics						
XP (Millions)	13.37	2.10	8.72	0.81-66.23	2.09	4.49
KM Walked	1400.77	1445.46	884.95	90.00-6738.60	2.06	4.60
Battles Won	2082.23	3281.39	892.50	52.00-17529.00	3.09	10.86
Eggs Hatched	762.00	917.02	480.00	52.00-4645.00	2.62	7.66
Pokémon Caught	18201.31	20190.01	10826.50	1031.00-91695.00	2.12	4.59
Pokéstops Visited	14039.79	15893.72	8458.50	495.00-72748.00	2.28	5.42
Raids Won	107.13	137.85	50.00	7.00-768.00	2.86	10.58
Legendary Raids Won	129.13	148.69	90.50	0.00-782.00	2.29	7.12
Research Tasks Completed	596.90	560.96	368.50	41.00-2587.00	1.61	2.57

Research Question 1 Results

The first research question asked what physical activity intensities occur during Pokémon Go gameplay and at what proportions. The hypothesis was that gameplay time would on average entail 50% sedentary activity, 40% light intensity activity, and 10% moderate intensity activity. Table 3 details the descriptive statistics for the proportion of time spent in sedentary, light, moderate, and vigorous intensity physical activities during gameplay. A total of 47 participants completed study measures to be included in these analyses.

Checking for the hypothesized proportions of gameplay intensities to fall within the reported confidence intervals found that gameplay had significantly more than 50% sedentary activity ($\overline{x}$=62.6%; 95% CI: 57.4%, 67.9%), significantly less than 40% light activity ($\overline{x}$=15.6%;

95% CI: 13.8%, 17.5%), significantly more than 10% moderate activity ($\bar{x}$=20.2%; 95% CI: 14.9%, 25.5%), and significantly more than no vigorous activity ($\bar{x}$=1.5%; 95% CI: 0.5%, 2.6%).

Given the non-normal distribution of the moderate and vigorous variables, median quartiles were also used. Checking the interquartile range confirmed the original hypothesis that Pokémon Go gameplay consisted of 10% moderate intensity physical activity (median=14.7%; 25-75% IQR: 8.3%, 26.3%). Checking the interquartile similarly found more vigorous physical intensity activity than hypothesized (median=0.14%; 25-75% IQR: 0.02%, 1.16%).

Table 3: Proportions of Gameplay Spent in Physical Activity Intensities

Variable	Mean	SD	Median	95% CI	Range	Skew	Kurt
Sedentary Activity	0.63	0.18	0.66	(0.57, 0.68)	0.14-0.95	-0.73	0.32
Light Activity	0.16	0.06	0.15	(0.14, 0.18)	0.04-0.33	0.87	1.18
Moderate Activity	0.20	0.18	0.15	(0.15, 0.26)	0.00-0.80	1.62	2.73
Vigorous Activity	0.02	0.04	>0.00	(0.01, 0.03)	0.00-0.16	3.07	9.23

**n=47*

The two direction paired samples t-test found that the proportion of MVPA was significantly higher during gameplay compared to non-gameplay time (t=5.520; $\bar{x}$=0.153; p<0.001), with 15.3% more of gameplay time spent in MVPA compared to non-gameplay time. A total of 46 participants were included in the paired samples t-test. Table 4 details similar paired samples t-test for MVPA, light, moderate, and vigorous physical activity intensities. Looking more specifically, the difference in proportion of time spent in MVPA stems largely from a difference in moderate intensity physical activity.

Given the non-normal distribution of the moderate and vigorous variables, a Wilcoxon signed-rank test was used to test the association as well. The non-parametric test additionally found a significant difference between the proportion of MVPA during gameplay compared to during non-gameplay time (z=-4.977; p<0.01).

Table 4: Paired Samples T-tests comparing Proportions of Gameplay and Non-Gameplay Time Spent in Physical Activity Intensities

Intensity	Non-Gameplay	Gameplay	Mean Difference	SE	t	p
MVPA	0.07	0.22	0.15	0.03	5.52	**<0.01**
Light	0.17	0.16	-0.01	0.01	-1.22	0.23
Moderate	0.06	0.20	0.14	0.03	5.23	**<0.01**
Vigorous	0.00	0.02	0.01	0.00	2.52	**0.02**

**Non-gameplay time is any time not spent playing between the same times of day on the following day*
***n=46*

Research Question 2 Results

The second research question asked how much time people spend playing Pokémon Go, and at what times. The hypotheses were that participants will play an average of 15 minutes of Pokémon Go per day, gameplay will occur predominantly during non-work hours, and that gameplay will occur more on the weekends. Table 5 details the descriptive statistics for gameplay times during the time contexts. A total of 47 participants completed study measures to be included in these analyses.

Checking for the hypothesized minutes of gameplay per day to fall within the reported confidence intervals found that participants played significantly more per day than expected ($\bar{x}$=116.264; 95% CI: 81.862, 150.862). The two direction paired samples t-tests found that participants played significantly more per day during non-work time compared to work time (t=5.182; $\bar{x}$=81.784 ; p<0.001) and not significantly different on weekends compared to weekdays (t=-0.676; $\bar{x}$=-13.313; p=0.502).

Given the non-normal distribution of the gameplay, work, not during work, weekday, and weekend variables, non-parametric tests were used as well. Checking the interquartile range confirmed the original hypothesis that participants played more than hypothesized (median=66.43; 25-75% IQR: 41.43, 146.43). Wilcoxon signed rank tests confirmed the findings

above for both a significant difference between work and not during work (z=-5.513; p<0.01) and not a significant difference between weekdays and weekends (z=-1.460; p=0.144).

Table 5: Descriptive Statistics of Gameplay Time during Time Contexts

Variable	Mean	SD	Median	95% CI	Range	Skew	Kurt
Gameplay bouts	2.02	0.98	2.14	(1.74, 2.31)	0.43-4.57	0.60	0.52
Gameplay bout length	58.43	55.21	42.78	(42.22, 74.64)	11.78-331.55	2.89	12.18
Gameplay	116.26	117.17	66.43	(81.86, 150.86)	5.71-521.00	1.79	2.78
Gameplay at Work	13.58	48.29	0.00	(0.60, 27.76)	0.00-321.43	5.94	37.80
Gameplay not at Work	95.36	95.57	59.29	(67.30, 123.42)	5.71-393.14	1.85	2.87
Gameplay on Weekdays	120.07	126.68	69.00	(82.87, 157.26)	7.20-512.20	2.05	3.69
Gameplay on Weekends	106.76	144.70	47.50	(64.27, 149.24)	0.00-565.50	2.02	3.74

**During work and not during work do not sum to gameplay because some bouts had missing values for time context*
*** Gameplay is in bouts/day, gameplay bout length is in minutes, and all following variables are in minutes/day*
†n=47

Research Question 3 Results

The third question asked if time spent playing Pokémon Go or physical activity intensity during gameplay varied by demographic characteristics such as sex, age, BMI, education, dog ownership, or gameplay history. The hypotheses were that those of different sexes, BMIs, and educations will play Pokémon Go similarly. Dog owners and younger individuals will play for more time and at higher physical activity intensities. Lastly, those with a shorter gameplay history will play at higher intensities but shorter lengths of time.

First, bivariate linear regressions were used to test the associations between NHANES methods accelerometer wear time and average minutes of gameplay per day, as well as proportion of time in MVPA. Minutes of NHANES methods wear time was significantly related to average minutes of gameplay per day (β=0.020; p=0.017) but not proportion of MVPA (β<0.001; p=0.289). It was expected for wear time to not associate with the proportion of gameplay time in MVPA since the proportion variable controls for wear time. Minutes of NHANES methods accelerometer wear time was added as a control variable for regressions with

minutes of self-reported gameplay per day, but not proportion of time in MVPA. Tables 6 and 7 detail the bivariable linear regressions between demographic variables and the average minutes of gameplay per day, as well as proportion of time spent in MVPA during gameplay

No demographic variable was significantly associated with more minutes of gameplay per day. Age was very close to being significantly associated with minutes of gameplay per day after controlling for NHANES methods wear time. This association likely would have been significant if the originally intended sample size was collected, with people playing 2.17 more minutes of physical activity per day for each additional year of life (β=2.17; p=0.052). Only male sex was significantly associated with more MVPA while playing, with males participating in an absolute 14 percent more MVPA on average compared to females (β=0.14; p=0.01).

Table 6: Bivariable Linear Regressions with Minutes of Gameplay per Day as Dependent Variable and NHANES Methods Wear Time as a Control Variable

Variable	Beta	SE	t	p
Male Sex	31.85	32.64	0.98	0.33
Age	2.17	0.01	2.00	0.05
BMI	3.64	2.13	1.71	0.09
Undergraduate Degree or Higher	-58.13	33.59	-1.73	0.09
Dog Owner	27.04	35.77	0.76	0.45
Days since Started Playing	0.07	0.08	0.87	0.39

**p-values < 0.05 are in bold*
***n=46*

Table 7: Bivariable Linear Regressions with Proportion of Gameplay Time in MVPA as Dependent Variable

Variable	Beta	SE	t	p
Male Sex	0.14	0.05	2.77	**0.01**
Age	0.00	0.00	-1.009	0.32
BMI	-0.01	0.00	-1.81	0.08
Undergraduate Degree	0.04	0.06	0.788	0.44
Dog Owner	-0.04	0.06	-0.58	0.56
Days since Started Playing	0.00	0.00	0.871	0.39

**p-values < 0.05 are in bold*
***n=46*

Research Question 4 Results

The fourth research question asked if people find walking while playing Pokémon Go to be more reinforcing than walking while not playing Pokémon Go, with the hypothesis that players will find walking while playing Pokémon Go to be at least 1.5 times more reinforcing than walking while not playing Pokémon Go.

Descriptive statistics for the Relative Reinforcing Value can be found in Table 2. Checking for the hypothesized Relative Reinforcing Value to fall within the reported confidence interval found that participants found walking while playing Pokémon Go compared to walking while not playing to be significantly more than the 1.5 times hypothesized ($\bar{x}$=3.747; 95% CI: 2.758, 4.737).

Exploratory analyses were initiated to test if there was an association between gameplay time and minutes of daily MVPA, with the relative reinforcing value acting as a significant mediator. The association was significant, but in the reverse direction than expected. A higher relative reinforcing value was associated with a smaller relationship between gameplay and daily MVPA.

Research Question 5 Results

The fifth research question asked if people vary their physical activity intensity by context in Pokémon Go (i.e., who they are with, their modality, and where they are). The hypotheses were that players will be at higher physical activity intensities when they are walking while playing compared to sitting while playing, when they are playing alone compared to with friends, and when they are playing in public open spaces compared to home.

Tables 8, 9, and 10 detail the descriptive statistics for MVPA during gameplay for the various contexts. Paired samples t-tests were used to check if there were significant differences

in proportion of time spent in MVPA between gameplay times with missing contexts and those that were non-missing, and all were non-significant. Two direction paired samples t-tests were instead used to test the hypothesized differences in MVPA during gameplay. The t-tests found people participated in 14.9 percentage points higher MVPA when playing while walking compared to sitting (n=34; t=4.388; $\bar{x}$=0.149; p<0.001), people participated in 20.1 percentage points higher MVPA when playing in open public spaces compared to playing at home (n=19; t=2.840; $\bar{x}$=0.201; p=0.011), and that people did not differ on participating in MVPA during gameplay when playing with friends or when playing alone (n=25; t=0.001; $\bar{x}$=-0.048; p=0.962).

Given the non-normal distribution of the home variable, a non-parametric test was used as well to check for a difference between proportion of gameplay time in public open spaces compared to at home. A Wilcoxon signed rank test confirmed the finding above for a significant difference between playing in public open spaces compared to at home (z=-2.374; p<0.01).

Table 8: Descriptive Statistics of Proportion of Gameplay Time in MVPA across Movements

Movement	Mean	SD	Median	Range	Skew	Kurt
Driving	0.09	0.08	0.07	0.00-0.31	1.32	1.30
Sitting	0.11	0.12	0.10	0.00-0.43	1.40	1.46
Standing	0.20	0.23	0.15	0.00-0.87	1.64	2.67
Walking	0.25	0.21	0.21	0.00-0.89	1.17	1.29

**Driving (n=28), sitting (n=35), standing (n=19), and walking (n=45)*

Table 9: Descriptive Statistics of Proportion of Gameplay Time in MVPA across Locations

Location	Mean	SD	Median	Range	Skew	Kurt
Home	0.09	0.14	0.05	0.00-0.61	2.64	8.00
Outdoor Open Spaces	0.30	0.25	0.28	0.00-0.89	0.76	-0.06
Raids	0.16	0.18	0.09	0.00-0.56	1.19	0.54
Travelling	0.22	0.20	0.15	0.00-0.73	1.21	0.97
Work	0.11	0.14	0.05	0.00-0.45	1.28	0.74
Other	0.16	0.18	0.10	0.00-0.72	1.51	1.99

**Home (n=28), outdoor open spaces (n=29), raids (n=18), travelling (n=27), work (n=18), and other (n=29)*

Table 10: Descriptive Statistics of Proportion of Gameplay Time in MVPA across Who Played With

Who Played With	Mean	SD	Median	Range	Skew	Kurt
Alone	0.23	0.20	0.16	0.00-0.81	1.17	0.99
Family	0.11	0.12	0.08	0.00-0.30	0.75	-0.78
Friends	0.19	0.16	0.16	0.00-0.56	0.94	0.40

**Alone (n=43), family (n=6), and friends (n=28)*

CHAPTER 5

DISCUSSION

Demographics

A goal of this study was to recruit a more diverse sample than found in other research of mostly young individuals or students.[27,38,41] The present study successfully recruited a generally older sample with an average age of 29 and an age range between 18 and 60. The split between females (47.9%) and males (52.1%) was also fairly equal. These results helped demonstrate the general appeal of Pokémon Go. Women and older individuals were both represented in the sample. The sample tended to be highly educated with 93.7% having completed at least some college. However, some high school graduates (6.3%) and those with a graduate or professional degree (18.8%) participated as well.

The sample tended to be a group of heavy players. The average participant had over 13 million XP in Pokémon Go, which translates to level 38 of a possible 40. Almost half of participants reported spending over $30 on the game, and most had played since the beginning of Pokémon Go's release (85.4%). Though many people have stopped playing Pokémon Go since its original popular release, a large contingent of people have continued to play.[23,59,65]

A quarter of participants reported driving while playing Pokémon Go at least half of the time they played and 69% reported driving at least sometimes while playing. The frequency of driving while playing is concerning as motor vehicle accidents are a major cause of death for all ages.[69] Though some work has found the risk of fatal traffic accidents from Pokémon Go may be negligible, efforts should be made to make Pokémon Go as safe as possible.[73] It appears there is

more work to do as these driving while playing rates are similar to work published before the implementation of speed caps in the game.[26,72] Niantic might consider lowering the speed caps from the current 10-20 miles per hour to tamp down on driving while playing.

An additional possibility could be that not putting a time window on the question asking about frequency of driving while playing over estimated current driving while playing. Participants might have averaged times of frequent driving while playing soon after release with more recent times when they drive while play less often due to speed caps implemented in the game.

The most frequently reported reasons for starting and continuing to play Pokémon Go was for entertainment. First and foremost, the game is treated as a game, and only secondly is it viewed as a health promoting activity. Around half of participants reported starting and continuing to play to be more active. Interestingly, playing for social benefits jumped from the fourth most frequently reported reason for starting to play to the second most frequent for continuing to play.

Social benefits of Pokémon Go has also been identified in other research as a benefit of playing Pokémon Go.[33,87,91] Niantic has appeared to focus on making Pokémon Go a social game after its original release. Cooperative group activities, player-to-player trading, player-to-player battling, and community events have likely all driven the increase in interest in playing for social benefits.

Question 1

The primary results of this study are the descriptive data found for physical activity intensities during gameplay and during similar non-gameplay times. The results found more sedentary activity and MVPA during gameplay than expected. However, using a non-parametric

test found that possibly only vigorous intensity activity represented a higher proportion than expected. Around two thirds of gameplay time were spent in sedentary activity and about one seventh to one fourth of the time in MVPA depending on the calculation. It was originally expected that more light intensity physical activity would occur during gameplay as the game does not specifically require rapid movements. Most of the game's benefits can occur during a light walk.

The results also showed that people participated in significantly more MVPA during gameplay compared to similar times of the day when people did not play Pokémon Go. Finding participants spent 15% more of their time in MVPA compared to similar times they did not play further suggests Pokémon Go's ability to promote health. It appears that playing Pokémon Go elicits more MVPA than other activities people might participate in if they were not playing. The difference in MVPA largely stemmed from a difference in moderate intensity physical activity, representing almost all the increase in MVPA. People participated in slightly more vigorous intensity physical activity during gameplay as well. Given that Pokémon Go does not require rapid movement, it follows that large differences were not noted in vigorous physical activity.

Though a lot of gameplay time was spent in sedentary activity, practitioners can promote the use of Pokémon Go as it also entails a significant proportion of MVPA. Physical activity guidelines could be met with Pokémon Go gameplay if people play for significant lengths of time as they tended to in this study. The significantly higher participation in MVPA during gameplay should also be interpreted understanding that this analysis was not of true intervention and control conditions, but more of a quasi-experimental investigation. Nonetheless, researchers and practitioners can have greater confidence that Pokémon Go gameplay entails participation in MVPA, and cross-sectional associations likely are not stemming from alternative explanations.

Question 2

Participants on average spent almost two hours, or a little over an hour, per day playing Pokémon Go which was much more than expected. One study estimated their sample played 15 minutes of Pokémon Go per day, and the other study having almost two-thirds of the sample playing less than an hour per day.[37,65] However, the amount was less than the amount found in a different study where participants reported playing a median of two hours per day.[26]

Some individuals played up to five hours on average per day. People on average played twice per day for about 45-60 minutes each time. These represent significant dedicated times for play. The study methods asked people to report only gameplay bouts five minutes or longer which would artificially inflate the average; however, it suggests that large portions of people's gameplay take place during long bouts. The participant with the lowest average gameplay bout length still played in average bouts of 12 minutes. This is another sign that the sample likely represent a group of heavy Pokémon Go users.

The results did show that people spent significantly more time playing outside of work per day compared to during work. Given the requirements of most jobs, it is expected that many people could not multi-task to play Pokémon Go. However, some jobs make it possible and others likely play at work during breaks.

Lastly, people did not play more on weekends per day as expected. Researchers should be aware for future research that gameplay amounts are not necessarily different between weekends and weekdays. Often it is the case in physical activity research that physical activity habits are different between weekdays and weekends, but Pokémon Go use appears not to follow that pattern. Researchers should also consider what type of Pokémon Go players they recruit to their

sample given that samples can range from individuals playing an average of fifteen minutes to two hours per day. It is possible these samples are different in many behavioral aspects.

Additionally, this long after release it is possible that only those players who are dedicated to the game are still playing, which might make most samples moving forward more heavy users. Another study published significantly after the release of Pokémon Go found that users slightly tended to play frequently instead of occasionally.[34] Researchers might find that samples collected after the initial release tend to be more frequent users.

Question 3

The hypotheses were that those of different sexes, BMIs, and educations will play Pokémon Go similarly. Dog owners and younger individuals will play for more time and at higher physical activity intensities. Lastly, those with a shorter gameplay history will play at higher intensities but shorter lengths of time.

Males played at higher intensity levels, contrary to the original hypothesis. Males participated in an absolute 14 percent more MVPA, on average, compared to females. This meant that a male who played the average amount of Pokémon Go per day of this sample would participate in 16 more minutes of MVPA during gameplay compared to a similar female. This result is contrary to other research that found that Pokémon Go gameplay had equal impacts on physical activity between males and females.[29] These results do coincide with general physical activity trends in the US where men tend to be more active than women.[12]

Furthermore, age, dog ownership, and gameplay history were not associated with gameplay amount or intensity. However, confirming the original hypotheses were the findings that those of different sex, BMI, and education played for similar amounts of time, and those of different BMI and education played at similar physical activity intensities.

The finding that participants played Pokémon Go at similar intensities and for similar amounts of time across different BMIs supported other research that has found similar effects of playing Pokémon Go across different BMIs.[29] These results are promising in that the benefits of Pokémon Go appear to not be targeted to only those who are currently at healthy weights. Other work however, has shown that more benefits were among those with higher BMIs, which would only make the effect even better for those who need it the most.[26]

Finding that age and gameplay history were not associated with gameplay amount or intensity did not corroborate with other research which found that older individuals and those who played longer benefited the most from Pokémon Go gameplay.[26] Finding that dog ownership was not associated with higher physical activity intensity during gameplay or amount of gameplay did not support the possible unique effects in dog owners noted in other research.[31]

Older people, those with higher BMIs, and those with lower education played marginally significantly more minutes of Pokémon Go per day. Those with higher BMIs also participated in marginally significantly less MVPA during gameplay compared to those with lower BMIs. These likely would have been significant had the originally intended sample size been collected. These results are hopeful as these groups could all benefit from playing more Pokémon Go and in turn participating in more physical activity. For those with higher BMIs, it is possible that playing for longer times at lower intensities might average out to similar amounts of physical activity from the game as those with lower BMIs.

Generally, these results demonstrate to researchers and practitioners that Pokémon Go elicits similar gameplay amounts and physical activity intensities among various demographic groups. This is generally promising in that special work might not be necessary to ensure everyone benefits. The one exception is that women might benefit from special targeting to

improve physical activity intensity. Game developers might consider more methods to appeal to and incentivize physical activity in women.

Question 4

According to the measure used, participants found walking while playing Pokémon Go to be four times more reinforcing than walking while not playing Pokémon Go. This result hints at a possible theoretical mechanism for Pokémon Go gameplay promoting physical activity. Inasmuch as the game makes walking more enjoyable, the expectation would be that people would participate in additional physical activity.

Finding playing Pokémon Go while walking to be more reinforcing than walking fits within the current literature. The reinforcing aspects of gameplay might stem from aspects noted in other research such as escapism, nostalgia, challenge, social contact, praise, achievement, engaging in a narrative story, visiting public spaces, and being distracted from the negative consequences of physical activity.[33,77,87–92,94,95]

Game creators should do all they can to attach the reinforcing aspects of gameplay to physical activity behavior. Conversely, reinforcing aspects of gameplay should be cut off when driving in a car. Examples of how the game currently works well in these regards include hatching more Pokémon for more walking, catching more Pokémon when walking, getting more items when walking, and the speed cap. Possible improvements could include improving the accuracy of GPS tracking to ensure no distance travelled is not counted towards in game bonuses, implementing minimum distance awards during community day events, or lowering the speed cap to further discourage driving.

Exploratory analyses found that higher relative reinforcing values decreased the association between gameplay and daily MVPA. These results did not fit with the theoretical

expectation. The developed measure might not be accurately capturing the relative reinforcing value of the two behaviors, or it is possible that the theoretical interpretation is incorrect.

It is possible the way the adapted instrument was worded forced the relative reinforcing value upwards as the opposite relative value was not an option. For example, people could not report that they found walking while not playing Pokémon Go to be more reinforcing than walking while playing Pokémon Go. This opposite relative reinforcing value is not necessarily expected but could be a possibility. A second possibility about the measure was people not interpreting the questions correctly. Anecdotally, while administering the survey it appeared that some people might have interpreted the questions as a comparison between playing Pokémon Go however you like (i.e., not walking) and a walking break. Asking for participants to consider playing during a work break might have confused participants given that people tended to play less often during work. Future work could attempt to fix these aspects of the measure, make the relative values more salient by offering actual options to people at work where they could actually take the break, or investigate other possible theoretical explanations.

Question 5

Confirming the original hypotheses, players indeed spent 15% more of their gameplay time in MVPA when they walked instead of sat while playing and 20% more when they played in open public spaces compared to playing at home. These results were greatly expected but good to see confirmed in the data. The one hypothesis not confirmed was that people would play at higher physical activities when playing alone compared to with friends. Researchers should remember that the physical activity patterns of Pokémon Go players significantly vary across contexts. Practitioners using Pokémon Go to promote physical activity should promote the use of these games in open public spaces as much as possible.

Other work that has estimated participation in MVPA during gameplay solely in public open spaces are likely overestimating habitual levels of physical activity intensity.[41,42] A lot of gameplay occurs in environments less conducive to physical activity.

Finding that individuals were more active when playing in open public spaces compared to playing at home coincides with other research finding higher physical activity intensity while playing Pokémon Go in green spaces.[28] Open spaces reduce barriers to movement such as traffic, cross walks, and narrow walkways. The benefits from active smart phone games likely interact with the availability of walkable spaces near the individual.

Other work has found that the day's climate affects how active Pokémon Go players are while playing.[28] The study found that physical activity was higher when there were lower wind speeds, more sunshine, and warmer temperatures. City planners should do what they can to create and improve public spaces to promote walkability. Improvements could include improved and more connected walkways, trees to create shade and block wind, and reduced neighboring traffic.

Strengths and Limitations

This research has strengths and limitations that need to be recognized. The first strength was the strong accelerometer measures specifically during habitual gameplay time. These measures helped describe the physical activity habits of Pokémon Go players in a way not previously done. A low dropout rate after enrollment with over 90% inclusion in the final analyses helped reduce biases that might have arisen from selective dropouts.

The main limitation of this study was the low sample size. Only about 70% of the originally intended 64 participants calculated during a power analysis was recruited to the study. This limited the power of many of the analyses, particularly those that focused on specific

gameplay contexts. It is likely that the type two error rate is higher than desired in this study. This problem could have easily led to some true hypothesized associations not turning out significant when they would have with a larger sample size.

Additionally, repeated measures ANOVA could not be conducted to compare means across context categories. The fact that participants often did not report playing in all contexts left very small sample with complete overlap. Lastly, there were problems with non-normally distributed variables which required the use of additional non-parametric tests and might have confused interpretations.

Conclusions

This research provides further evidence that Pokémon Go gameplay engages participants in more MVPA than they otherwise would if not playing Pokémon Go. The game should be espoused as a positive replacement for sedentary activities, and at a minimum should not be discouraged like other screen time. Gameplay time and physical activity intensities varied across demographic characteristics and gameplay contexts. Participants found playing Pokémon Go to make walking significantly more reinforcing, which might be a theoretical explanation for the associated physical activity benefits. Researchers should understand the varied gameplay patterns when studying Pokémon Go gameplay. More should be done to promote the use of Pokémon Go in open public spaces that facilitate physical activity.

As more content and games are released, it becomes increasingly likely that more people will start playing these games. Understanding both the physical activity patterns of game players and the theoretical foundations for these games' effects on physical activity are essential moving forward.

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APPENDICES

Appendix A: Initial Study Visit Survey

Thank you for agreeing to participate in this study. The following information will be used to contact you during the course of the study, retrieve the physical activity monitor at the end of the study, help describe who participated in the study, and to check if there are any differences between groups of people. Your personal information will be kept confidential.

1. Please help me create your study ID. Your ID is your birth year followed by the first three letters of your mother's name (EX: 1988wen). Please write your study ID below:

_____

2. What is your full name?

_____

3. What is your phone number?

_____

4. What is your email?

○ Email _____

○ I don't have email

5. What is your home address?

_____

6. What is your sex?

- ○ Male
- ○ Female
- ○ Intersex

7. What is your age?

_____

8. What is your height?

- ○ Feet: _____
- ○ Inches: _____

9. What is your weight in pounds?

_____

10. What is the highest level of education you have obtained?

- ○ Less than a high school degree
- ○ High school degree
- ○ Some college
- ○ Undergraduate degree
- ○ Graduate/professional degree

11. Does a dog live in your household?

- ○ Yes
- ○ No

Appendix B: Gameplay Questionnaire Texts

First Text:

Hey! Here is the quick survey asking about if/when you played Pokémon Go since you were enrolled. https://bit.ly/2xvKrHj

Subsequent Texts:

Hello! Please fill out if/when you played since the last text. Also, do not forget to wear the activity monitor. Thank you! https://bit.ly/2xvKrHj

Final Text:

Here is the link for the final quick survey! Thank you for your participation and see you soon. https://bit.ly/2xvKrHj

Appendix C: Initial Study Visit Survey

Thank you for taking the time to complete this survey. The following questions will ask about your accomplishments in Pokémon Go. Please navigate to your account information by opening your Pokémon Go app and tapping your avatar in the lower left corner. This page will help you answer the questions below.

---

1. Please enter your study ID below. You study ID is your birth year followed by the first three letters of your mother's name (EX: 1988wen)

_____

2. How many kilometers have you walked? (Can be found by tapping the "Jogger" medal with the moving shoe)

_____

3. How many gym battles have you won? (Can be found by tapping the "Battle Girl" medal with the two clashing Pokéballs)

_____

4. How many eggs have you hatched? (Can be found by tapping the "Breeder" medal with the egg)

_____

5. How many Pokémon have you caught? (Can be found by tapping the "Collector" medal with the Pokéball and stars)

_____

6. How many Pokéstops have you visited? (Can be found by tapping the "Backpacker" medal with the Pokéstop symbol)

_____

7. How many raids have you won? (Can be found by tapping the "Champion" medal with the dragon face)

_____

8. How many legendary raids have you won? (Can be found by tapping the "Battle Legend" medal with the lugia head)

_____

9. How many field research tasks have you completed? (Can be found by tapping the "Pokémon Ranger" medal with the binoculars)

_____

10. What was the start date (mm/dd/yyyy) when you started playing Pokémon Go? (Can be found by scrolling down under the 'stats' section)

_____

11. How much total XP have you accumulated? (What was the start date when you started playing Pokémon Go? (Can be found by scrolling down under the 'stats' section)

_____

12. How often do you operate a vehicle while playing Pokémon Go?

- ○ Never
- ○ Sometimes
- ○ About half the time I play
- ○ Most of the time I play
- ○ Always

13. Approximately how much money have you spent in the Pokémon Go shop on in-game items?" and include the following response options: $0, $1-10, $11-20, $21-30, $31+.

- ○ $0
- ○ $1-10
- ○ $11-20
- ○ $21-30
- ○ $31+

14. Did you start playing Pokémon Go for any of the reasons below? (*Check all that apply*)

- ☐ Improve health
- ☐ Be more active
- ☐ Lose weight
- ☐ Entertainment
- ☐ Social benefits
- ☐ Explore new environments
- ☐ Enjoy the challenge

15. Do you continue to play Pokémon Go for any of the reasons below? (*Check all that apply*)

- ○ Improve health
- ○ Be more active
- ○ Lose weight
- ○ Entertainment
- ○ Social benefits
- ○ Explore new environments
- ○ Enjoy the challenge

For the following ten questions, imagine you are at work and offered by your boss to take either a walking break or a break to walk while playing Pokémon Go. However, in each of the following questions the boss gives you different length breaks depending on which activity you choose.

---

1. Would you prefer a 20 minute walking break or a 2 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 2 minute break to walk while playing Pokémon Go

2. Would you prefer a 20 minute walking break or a 8 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 8 minute break to walk while playing Pokémon Go

3. Would you prefer a 20 minute walking break or a 16 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 16 minute break to walk while playing Pokémon Go

4. Would you prefer a 20 minute walking break or a 20 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 20 minute break to walk while playing Pokémon Go

5. Would you prefer a 20 minute walking break or a 10 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 10 minute break to walk while playing Pokémon Go

6. Would you prefer a 20 minute walking break or a 14 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 14 minute break to walk while playing Pokémon Go

7. Would you prefer a 20 minute walking break or a 4 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 4 minute break to walk while playing Pokémon Go

8. Would you prefer a 20 minute walking break or a 18 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 18 minute break to walk while playing Pokémon Go

9. Would you prefer a 20 minute walking break or a 6 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 6 minute break to walk while playing Pokémon Go

10. Would you prefer a 20 minute walking break or a 12 minute break to walk while playing Pokémon Go?

- ○ 20 minute walking break
- ○ 12 minute break to walk while playing Pokémon Go

Appendix D: Study Instructions Handout

UGA Pokémon Go Study Instructions

- If you have any questions, please call or text Jared Jashinsky at (720) 431-7848. Questions can also be asked over email at jared.jashinsky25@uga.edu.

- **Meet to return study equipment, complete a survey, and answer questions.**
  - You will meet on _____ at _____ at _____.

- **Respond to gameplay questionnaires twice per day.**
  - You will receive texts with links to questionnaires that can be completed on your phone twice per day at _____ and _____.

- **Wear the movement monitor for eight days.**
  - Start wearing the device when you wake up and take it off before you go to bed
  - Do not let the device get wet, so please remove it for bathing and swimming
  - The device tracks how fast you move, but does not track what activity you are doing, where you are, or any sound.
  - Wear the belt on the hip with the meter placed over the middle of the right thigh.

Example of where to place the monitor (Shade et al.)

Appendix E: Screenshot of Recruitment Page