

Systematic Literature Review on Health Effects of Playing Pokémon Go

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Abstract: Pokémon Go is one of the most successful mobile games of all time and has motivated its users to become physically active, socialize, and spend more time outdoors. There have been published some systematic literature reviews related to Pokémon Go, but few address health effects beyond the physical health of playing the game. This paper presents the results from a systematic literature review on how the game affects physical, mental, and social health and the players' motivation for starting, keep on, and stop playing the game. The literature review identified fifty-nine studies related to the topic, which were accepted according to the inclusion and exclusion criteria and the critical appraisal. The main conclusion is that Pokémon Go has an apparent positive effect on its player's physical, mental, and social health, although this effect only lasts as long as the player plays the game. Further, the motivation and motives for playing the game include having a fun and immersive experience, getting physical exercise, social reasons, and nostalgia related to the Pokémon universe. The reasons for why people stopped playing the game included technical challenges, slow progress in the game that required more effort increasingly, and lack of variation and content.

Keywords: Augmented Reality Games; Physical Health; Mental Health; Social Health; Motivation; Pokémon Go

1. INTRODUCTION

Pokémon Go is by far the most successful augmented reality game ever released, and also one of the most successful mobile games of all time grossed more than \$4 billion in revenue and has nearly 600 million unique installs [1]. To play the game, the players must move around in the physical world to catch Pokémon, collect items at Pokéstops, and fight battles at Gyms. When the game was released in July 2016, crowds of players could be observed worldwide, walking around and staring down on their smartphones, eager to “catch them all”. An article in Forbes from February 2018 gives five reasons for why the game is good for you: you are getting sunshine, it makes you physically active, you will explore nature, you will initiate social interactions, and it will improve your cognitive performance [2]. This article suggests that playing Pokémon Go will affect your general wellbeing, including your physical, mental, and social health. Research has also documented positive effects from playing the game, including improved social life and wellbeing [3], improved family-bonding and being outdoor more [4], and reduced sedentary behavior [5, 6]. However, studies also have found adverse effects from the game, including drivers and pedestrians distracted from playing the game [7], traffic accidents [8, 9], disadvantages for minority population playing the game due to geographical biased distribution of Pokéstops and

Gyms [10], privacy and data collection issues [11], and trespassing and law-breaking behavior [12]. Although much of the hype around Pokémon Go has faded, the game is still popular and has in 2020 achieved its best calendar year yet with players spending more than \$1 billion [1].

This article will investigate how Pokémon Go affects the player's health and wellbeing and investigate how the player's motivation and motive affect the attitude towards the game through a systematic literature review. Specifically, the focus will be on how the game affects the player's physical, mental, and social health, and the player's motivation towards playing and stopping to play the game. Although we are aware that the game also can have negative consequences for the player, this paper will not address these issues. The motivation for this work has been to investigate if augmented reality games such as Pokémon Go can significantly improve the player's life in several areas and serve purposes beyond pure entertainment.

The paper is organized as follows: Section 2 describes the game, and the research goal, questions, and approach. Section 3 presents the results of the systematic literature review. Section 4 discusses the results and addresses the validity of the results. Finally, Section 5 concludes the article.

2. MATERIAL AND METHODS

This section describes the Pokémon Go game, it presents related work, and it describes the research goal, questions, and approach for the systematic literature review.

2.1 *Pokémon Go*

Pokémon Go is an augmented reality location-based game where monsters of the Pokémon universe is augmented onto the real world seen on the player's smartphone screen. The game lets you play as a Pokémon trainer where the goal is to catch virtual Pokémon by walking around in the real world and using your Pokémon in battles against others in particular locations known as Gyms. The game shows a map of the surrounding area where the player's avatar is displayed on top of a map of the player's current physical location by using the GPS on the smartphone. The Pokémon spawns (appear) randomly in various locations, and the player has to be in the vicinity of the monsters to catch them. The Pokémon that appear are visible for up to 30 minutes to all players at that location.

To catch the virtual monsters, the player must throw Pokéballs. Pokéballs exist in three different varieties related to how good they are for catching and can be found at Pokéstops. There are also additional items such as Razzberries, which can be used to increase the capture rate for the next Pokéball. Pokéstops are unique locations that drop consumable objects such as Pokéballs, Razzberries, potions, revives, and eggs. The player can claim items from each Pokéstop once every five minutes by spinning a picture related to the physical location of the Pokéstop, and the player can place lures on Pokéstops to attract Pokémon. Potions and revives are used to heal Pokémon, who has been damaged in battle. In combination with an egg incubator, the eggs can be used to hatch Pokémon by walking a certain distance. The distance the player has to walk to hatch an egg depends on the chance to get a rare Pokémon (longer distance for rarer Pokémon).

The game also provides an in-game shop where the player can buy in-game items using coins. These coins can be purchased in the same shop using real money or earned in Gym battles. In the in-game shop, players can buy Pokéballs, incense (attracting Pokémon, but

only for one player), eggs, lures, egg incubators, as well as storage for Pokémon or items. Figure 1 shows screenshots from capturing Pokémon in Pokémon Go. The screenshot to the left shows a wild Gyarados in its natural habitat (water), the middle screenshot shows Nidoking in its natural habitat (woods), while the screenshot to the right shows a successful catch where the AR-mode has been turned off.

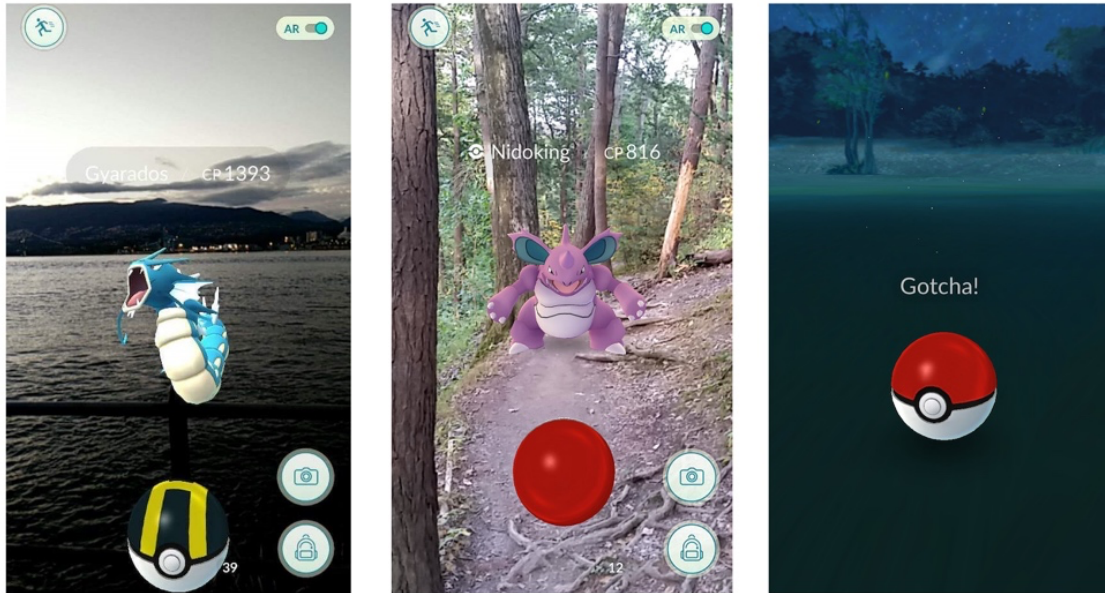


Fig. 1. Screenshots from Pokémon Go

2.2 Related Work

Some literature reviews have been published on Pokémon Go, including some reporting on health effects from playing the game. Literature reviews or reviews focusing on other issues include illness and injury [13, 14], development of location awareness and gesture [15], legal issues [16], and social withdrawal [17]. In [18], Chong et al. discuss early publications on Pokémon Go and reports on examples of increased physical activity and improved social and psychological wellbeing. This paper cannot be classified as a systematic literature review but rather a summary of sixteen early studies on the game's health effects. This paper's conclusion aligns with our literature review: Pokémon Go has a positive effect on physical and social health, but the effect does not last over time.

Baranowski and Lyons have published a literature review investigating physical activity change from playing Pokémon Go based on seventeen studies [19]. The review concludes that the game only had a small effect of increased physical activity among youth and young, and the effect lasted for a short duration (less than two months). However, a modest increase in physical activity was found for older adults that lasted up to seven months. Pokémon Go was also attributed to have mental and social health benefits. Baranowski and Lyons' review findings are similar to our findings but highlight different effects on the players' age.

In [20], Khamzina et al. conducted a systematic review and meta-analysis on the impact of Pokémon Go on physical activity, which included an analysis of seventeen studies. Playing

Pokémon Go was found to have a statistically significant but clinically modest increase in the number of steps taken among players. Similar to results found in our review, a challenge was to retain active engagement once the initial novelty wears off. The paper further suggested additional studies for a more extended period to assess how Pokémon Go and similar games can promote physical activity for a sustained time period.

Laato et al. have published a systematic literature review of twenty studies on the physical activity effects of playing Pokémon Go [21]. The findings revealed that 60% of the studies showed an increase in the number of steps taken (500-1500 daily steps), and 30% of the studies reported only short-term improvements. These results are also in alignment with the results in our literature review. One interesting finding in this review was that the game had a more substantial effect on physically inactive individuals. As suggested in [20], Laato et al. addressed the problem that longitudinal studies of Pokémon Go are missing.

In [22], Cartlidge aims to take a snapshot of the Pokémon Go phenomenon reviewing 120 web articles and 36 academic articles to examine the influence of augmented reality game players' use of public space. The analysis is of themes in the increased physical and social activity of gamers in public spaces. The review revealed that the academic articles mainly focused on the gamers' social, physical, and mental wellbeing. The majority of academic articles were on social relationships and physical activity focusing on adolescents' behavior patterns when playing. Other topics mentioned in the review include contextual and psychosocial factors that affect gameplay, conflict experience Pokémon players in playing in public space, and urban design and planning for augmented reality gaming. The article does not explicitly focus on specific and measurable effects on health from playing the game.

Comunello and Mulargia conducted a literature review on intergenerational and pervasive gaming to form a research design to do an intergenerational gaming study focusing on Pokémon Go [2]. Intergenerational gaming describes playing games that foster a relationship between younger and older players and overcoming generational gaps. The literature review does not focus on Pokémon Go, but a research methodology for conducting intergenerational research on the game.

There are other literature reviews where Pokémon Go is one of several games being examined. Ferreira, Trovo, and Nesteriuk have published a literature review focusing on emergence in game design including the games Tibia, Pokémon Go, and The Sims [23]. The study investigates the usage of methodologies that incorporate meta-design and the gamer as co-designer, which are more appropriate when dealing with emergent characters in games. Further, the use of AI expands possibilities of interaction in the game, multiplying the system's number of active agents. One example of how Pokémon Go provides emergence in game design is the way the game allows the connection between players of the community and the formation of teams where the players can meet and explore physical and virtual environments through the use of augmented reality and GPS navigation that triggers series of emergent phenomena.

Another literature review on augmented reality games examined the positive implications and negative consequences of such games, where Pokémon Go was one of the games considered [24]. The positive implications found were increased socialization, exergaming, healthy behavior promotion, and a positive impact on education and teaching practices. These findings are in alignment with our literature review. The negative implications included physical safety, mental safety, and ethical issues related to augmented reality game usage. In [25], Pyae presents a literature review on adapting digital games to different languages and cultures where Pokémon Go was mentioned as an example. Unlike

other games, adapting Pokémon Go to various regions needed to pick the right physical locations carefully. Finally, we found a systematic literature review on commercial and non-commercial location-based games related to their connections to affordances and restrictions on urban game arenas [26]. This review provides a good overview of location-based games, and Pokémon Go is one of the many applications reviewed. Pokémon Go is described as a competitive multiplayer, high attendance game where player names last for an undefined timespan, and it has a global geographical scope. The game's affordance and restrictions are described as great freedom of movement, fixed coordinates for locations, in-game warning on driving and playing, no pre-defined paths, and that the game entwines with daily life.

2.3 Research Questions and Research Approach

The research goal of the literature review presented in this article was to investigate research studies on the health effects of playing Pokémon Go. Specifically, we wanted to investigate how playing Pokémon Go affects the player's physical, mental, and social health. The research method used is based on the Goal, Question Metrics (GQM) approach [27] where we first define a research goal (conceptual level), then define a set of research questions (operational level), and finally, describe a set of metrics to answer the defined research questions (quantitative level). In our case, the metrics used to give answers is data extracted from the literature review.

2.3.1 Research Goal and Research Questions

The research goal of this study was defined as the following using the GQL template [27]:

The purpose of this study was *to investigate the health effects of playing Pokémon Go* from the point of view of *a researcher* in the context of *Pokémon Go players*.

The following research questions (RQs) were defined by decomposing the research goal:

- **RQ1: How does playing Pokémon Go affect the player's physical health?** This research question investigates if playing Pokémon Go affects the player's physical activity level and if the game affects the player's physical health in general in the short and long term.
- **RQ2: How does playing Pokémon Go affect the player's mental health?** This research question examines how playing Pokémon Go affects the player's psychological wellbeing.
- **RQ3: How does playing Pokémon Go affect the player's social health?** This research question investigates how playing Pokémon Go affects the player's social life and relationships. It also examines the social components of the game.
- **RQ4: How does the player's motivation affect the attitude towards playing Pokémon Go?** This research question looks at how the player's motivation and motives affect her or his attitude towards the game, including motivation to continue playing and spending money on in-game purchases.

2.4 Data Sources and Metrics: Systematic Literature Review

The data source to find answers to the four research questions was a literature review on Pokémon studies. The literature review was carried out as the systematic review method

of six stages presented in [28]: 1) Development of review protocol, 2) Identification of inclusion and exclusion criteria, 3) Search for relevant studies, 4) Critical appraisal, 5) Data extraction, and 6) Synthesis. The following sections will describe each stage.

2.4.1 Development of Review Protocol

The review protocol developed to achieve the following goals:

- 1) to maximize the literature coverage;
- 2) to identify and include the related work that can be classified as a study (experiments, surveys, case studies, or similar);
- 3) to collect and synthesize meaningful data from the sources related to the defined research questions (see Section 2.3.1).

The first goal was achieved by using a two-step search to find the relevant sources. In the first step, we searched online databases to find an initial set of sources, and in the second step, we went through the references of the primary sources to check if relevant sources were not included in the initial set. To meet the second goal, we went through all found papers to check whether they contained a study where data was collected. The third goal was achieved by analyzing papers and collecting data based on the defined research questions. This protocol specified the research questions, search strategy, inclusion, exclusion and quality criteria, data extraction, and synthesis methods.

2.4.2 Identification of Inclusion and Exclusion Criteria

The identification of inclusion and exclusion criteria was optimized to find as many articles as possible and avoid having to read all papers in the initial search for relevant studies. A more elaborate inclusion and exclusion were to be carried out in the critical appraisal step. The inclusion criteria used in the search for relevant studies were:

- The article is an article and not a report, book chapter, letter, or abstract.
- The article is published in an international journal or conference proceedings.
- The article is written in English.
- The article refers to Pokémon Go in the title or abstract.

The exclusion criteria were:

- The article is not accessible through university services or memberships.
- The article is only accessible behind a paywall.
- Pokémon Go is only mentioned as an example and is not the focus of the paper.

2.4.3 Search for Relevant Studies

The search for relevant studies was initially conducted from September 7th to 28th, 2018, and later extended with a second search from May 29th to June 19th, 2019. The literature search was carried out in two steps. In the first step, digital research databases were searched for relevant studies, and in step two, references in found studies were checked for additional studies. The search string for this review was “Pokémon Go” or “Pokemon Go”, and the following five research databases were searched in sequence: Google Scholar, Science Direct, Wiley InterScience, Web of Science, and Scopus. Table I shows the results

of the search for articles in the five research databases. At this stage, the title and the abstract of the papers were checked, and if a paper fulfilled the inclusion and exclusion criteria, the pdf and site data for the paper was downloaded, and citation data and keywords were added as an entry in a spreadsheet. The main reason for the many papers found in Google Scholar is that the search engine does not have a proper way of filtering out presentations, letters, reports, or other documents that are not scientific articles. We found a total of 263 qualified articles at this stage. Note that most articles were found through the Google Scholar search (222), and 41 articles were added from the other four research databases. Most rejected articles were rejected because they were either behind a paywall or articles in another language where the title and abstract were given in English. In some cases, the whole article was checked when “Pokémon Go” was not mentioned in the title and abstract not to exclude relevant articles that looked relevant.

Table I. Search Results from Digital Research Databases

Research Database	Number of articles found	Number of articles added to the review
Google Scholar	994	222
Science Direct	139	8
Wiley InterScience	30	0
Web of Science	154	17
Scopus	217	16
Total	1,534	263

2.4.4 Critical Appraisal

The search for relevant studies using the defined inclusion and exclusion criteria resulted in 263 articles. The next step was to have a more thorough check of the articles looking at the whole article and not only the title and abstract. The focus of this stage was on relevance, rigor, and credibility. For articles to have relevance, they had to describe a study (experiment, survey, case study, or similar). It was also crucial that the main focus of the study and article was on the game itself. The studies were evaluated for rigor by checking if an appropriate approach had been applied and that the study described the research context, scope, design, and method, including the number of subjects and where and how the study was conducted. To check for credibility, the articles had to be explicitly and meaningfully presented, and the conclusions had to be based on some analysis or reasoning. Table II shows the results from the critical appraisal step. Of the 263 articles, fifty-nine were accepted as they provided sufficient relevance, rigor, and credibility. Eighty-four were excluded due to limited scope or results, thirty-one were excluded as they were not studies, eighty-seven were excluded as they did not focus on the game’s health effects, and two articles were excluded due to bad experimental design or invalid conclusions.

Table II. Results from the Critical Appraisal

Group	# of articles	Description
Accepted studies	59 (22%)	Studies with relevance, rigor, and credibility
Limited results/scope	84 (32%)	Articles with limited results or scope
Not study	31 (12%)	Articles that are not studies

Non-health articles	87 (33%)	Articles with a focus other than health
Rejected studies	2 (1%)	Invalid results due to research design or execution, conclusions not based on data or analysis
Total	263 (100%)	

2.4.5 Data Extraction

Data were extracted from all the 59 accepted articles during this stage by reading through the whole articles in detail. The data was entered into a spreadsheet, and the following data was captured: Type of article, Number of subjects in the study (N), a short description of the study, a description of the results, the theme of the article, the context of the study, and a summary of the article. Also, the articles' main contribution was highlighted in the PDFs to make it quicker to check later for details in the articles.

2.4.6 Synthesis

For the synthesis step, all articles in the review were classified by six attributes (PA, PS, M, SO, E, and ST) corresponding to the research questions defined in Section 2.3.1 and to whether the studies could be classified as experiments and if they included a statistical significance test. Further, the articles were thematically analyzed and described by keywords. This information was added to the spreadsheet, which enabled a systematic process of synthesizing the studies' findings according to the research questions. Table III shows an overview of the attributes used for classifying the articles in this step.

Table III. Attributes Used in the Synthesis of Data

Attribute	Description
PA	Studies investigating how Pokémon Go affects the Physical Health
PS	Studies investigating how Pokémon Go affects the Psychological Health
M	Studies investigating how players' motivation affects the attitudes toward the game
SO	Studies investigating how Pokémon Go affects the Social Health
E	Studies that can be classified as experiments
ST	Studies that include testing of statistical significance

3. RESULTS

The initial search for articles on Pokémon Go gave 1,534 articles, 263 of these articles were accepted for further investigation based on the inclusion and exclusion criteria, and after the critical appraisal, 59 articles were accepted for this literature review. All the latter were studies that addressed one or more of the research questions described in Section 2.3.1. Fig. 2 gives an overview of the number of articles published per year and the number of citations per year. Pokémon Go was released in July 2016, which is why only five articles were published in 2016. Many more Pokémon Go articles were published in 2016, but not studies and not related to health. Note also that almost half of the accepted studies on health in our literature review was published in 2017. This is because the game was the most popular summer and fall 2016, which meant that most studies were conducted in fall

2016/spring 2017. The articles in the literature review have 2289 citations, and each paper has, on average, 38.8 citations. Further, the studies in our review have, on average, 433.8 respondents/subjects in their study, where one study has 3,915 respondents.

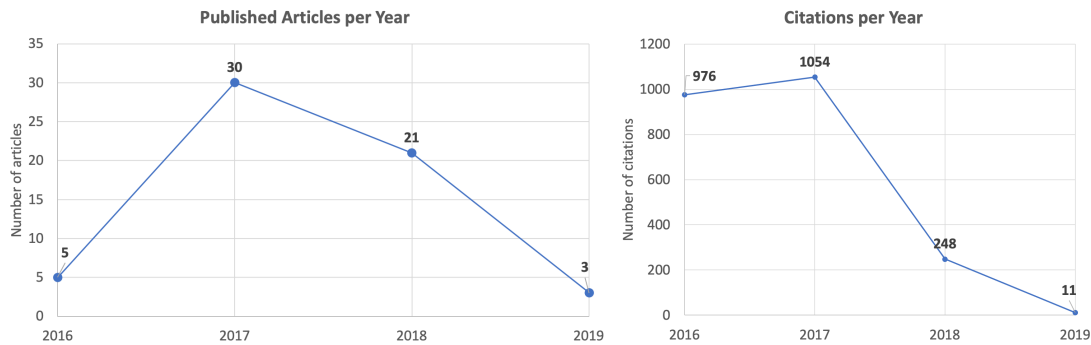


Fig. 2. Charts on the number of published articles and citations per year

Fig. 3 shows the results from the synthesis of data presenting the coverage of the research questions' themes and the percentage of studies that can be classified as experiments and include an analysis of statistical significance. The figure shows that most of the articles include results on physical health and that about half or less include results on mental health, social health, and motivation to play the game. Further, most studies include statistical significance analysis, and about a third of them can be classified as experiments.

All the systematic review articles were thematically analyzed, which resulted in subthemes addressed in the four research questions. However, there were also other topics the articles addressed that were directly related to one of the research questions. These topics included augmented reality games (ARGs), location-based applications, utilization of public spaces, influence on environment and consumption, game design, and work performance. There were also topics related to general health or the focus of the studies themselves, including long-time effects of playing Pokémon Go, overall health and well-being effects of playing the game (not specific to physical, mental, or social), life changes, how Pokémon Go changed the perception of health, and the games effect on public health.

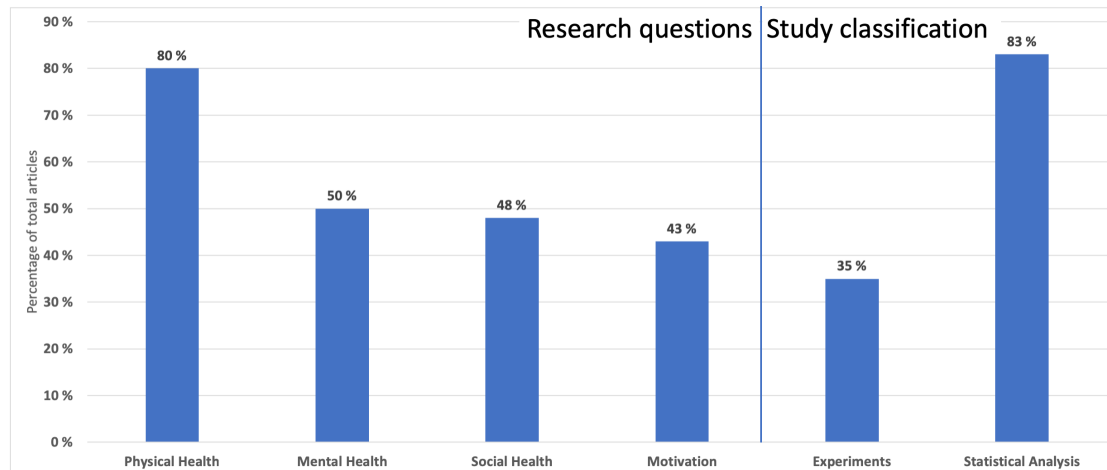


Fig. 3. Percentage of total articles that focused on the four research questions, that could be classified as experiments, and that included statistical analysis

3.1 RQ1: Pokémon Go's Effect on Physical Health

Sixty-six percent of the articles in our literature review have a focus on physical health. Sub-themes addressed include how the game affects physical activity, Pokémon Go as an exergame and exercise, how the game affects sedentary behavior, how the game affects physical mobility, how the game affects obesity, how the game affects the perception of physical activity, the physical risks of playing the game and step-counts.

Thirty-eight percent of the articles on physical health describes results from an experiment where they investigate how the physical activity level changes over time or a comparison of the physical activity level at two or more measurements. In these studies, the physical activity levels are measured through step-counts or similar activity measurements from stored health data on smartphones, using specific hardware such as Microsoft bands, accelerometers, pedometers or heart rate monitors, or analyzing data from mobile phone networks. Some of the experiments use specialized software to collect the data from the players' devices, while for others, the players report their physical activity data in surveys. The measurements of physical activity used in the papers include step-counts, time spent on physical activity (e.g., on walking or running), distance traveled, frequency of physical activities, and answers using a Likert's scale on statements related to how physical activity level has changed or statements related to the level of physical activity.

The primary trend of the articles that report step-counts is that active Pokémon Go players have a higher number of step-counts than non-players and that Pokémon Go players significantly increased their step-count from before playing the game. In a study comparing players with non-players, the players increased their daily step-count by 995 steps the first week and then increased the following weeks gradually until week six, where they were back to the step-count before they started to play the game [29]. One study found that playing Pokémon Go significantly increased the physical activity level in a period over 30 days, where engaged players increased their daily step counts with an average of 1473 steps (25% increase) [6]. Other studies reported that players increased the number of steps to 1600 per day [30], an average increase of 1976 steps (35%) after starting to play the game [31], an increase of 1525 steps per day [32], and that playing Pokémon Go had a statistically significant increase on step counts for middle-aged and elderly players compared to non-players after one month of playing, and the effect lasted seven months after release [33]. The studies in our review also showed that there are different effects on different players. One study found that playing Pokémon Go had a statistically significant effect on the number of steps walked on players who could be classified as Pokémon Go fans and those who could be classified as physical activity seekers, but not for those who played the game only out of curiosity and for social reasons [34]. Another study showed that the number of steps walked from playing the game varied when the game was played, where the most substantial effect was on weekdays and daytime [32].

There are also several studies that reports on how playing Pokémon Go affects the distances walked per day or week, including walking on average 2.5 miles when playing the game and that active players walked 5.6 extra miles per week [30]; players walked on average 383km over 14 weeks [35]; compared to non-players, Pokémon Go players walked 1.5, 1.2, 0.9 and 0.6km more daily on 3rd, 4th, 5th and 6th day of the game (significant), but the effect lasted only one week [36]; players walked 54km over eight weeks [37]; and on average daily walking and running distances increased by 18.1% (0.96km) in 21 days after Pokémon Go was installed compared to 14 days before the installment [38]. For the latter, the positive effect on physical activity disappeared 24 days after game installment.

Another approach for measuring changes in physical activity levels was measuring the time spent on physical activities. Studies in this categories report statistical significantly more time spent on exercise after starting to play Pokémon Go and more time walking the dog [39]; spend 3 additional hours per week exercising [30]; players who rarely walked or jogged before, spent on average 108 minutes exercising per week [40]; Pokémon Go players increased mild-intensity physical activity with 30 min/day, moderate to vigorous physical activity by 50min/week, strenuous physical activity with 14 min/week and reduced sedentary behavior with 30min/day [41]; doubled the amount of time spent on physical activity one week after starting to play the game [5]; based on mobile network data, more people spent time outside walking after Pokémon Go was released [42]; more active players spent more time on physical activity and more time being outdoor [43]; Pokémon Go players reported fewer days of vigorous physical activity than non-players, but more days of moderate physical activity and walking [44]; parents playing Pokémon Go with their children had a significant increase of 23 min/day spent on mild physical activity and 22 min/day on moderate physical activity [45]; and players of Pokémon Go walked 2.25 hours/day compared to non-players who walked 1.25 hours/day. The studies in our review show that those who played Pokémon Go increased their daily physical activity by at least 30 minutes per day and that it is mild to moderate physical activity that is increased the most. All the results presented in this paragraph are statistically significant, but they are related to the short-time effect of playing the game.

The majority of the studies in our review show that playing Pokémon Go has a positive effect on physical activity, but this effect is related to playing the game and not changing the player's attitude towards physical exercise. A study of the long-time effect showed that active Pokémon Go players were less physically active than former and non-players [46]. Active users were only motivated by physical activity related to playing the game. Accordingly, a study showed no statistically significant increase in physical activity from playing Pokémon Go after three months than not playing [47]. Similarly, one study showed that the distance walked decreased significantly after playing the game for six months [48]. Finally, a study showed that the physical activity levels increased when playing the game but did not change people's behavior after they had stopped playing the game [49].

Our literature review showed that *Pokémon Go has an obvious positive immediate effect on physical health in terms of increased steps, increased distance moved, and increased time spent on physical activity. However, the results indicate that physical health's positive effect decreases over time and disappears when the player stops playing the game.*

3.2 RQ2: Pokémon Go's Effect on Mental Health

Forty-two percent of the articles in the literature review has a focus on mental health issues including topics such as personality traits including the big five (openness, conscientiousness, extraversion, agreeableness, neuroticism) [50], behavioral change, motives for playing the game, video game addiction, cognitive aspects of playing Pokémon Go, emotional aspects, game transfer phenomena, how impulsivity affects in-game purchase and motivation for playing the game, mental benefits, psychological benefits, psychological drivers, psychological distress, psychological wellbeing, psychometric scale development, player types, and social anxiety. Of the twenty-five papers focusing on mental health, nineteen report positive effects from playing the game, four studies have a neutral view of the game (both positive and negative), while two report mainly on negative issues. One positive example showed a strong relationship between playing the game and improved wellbeing, described as feeling better, gaining more energy, losing weight,

getting better sleep, distracting negative thoughts, and reducing anxiety [51]. Other positive findings include more positive emotions and more motivated to explore surroundings [52, 53]; improved mood [34, 54, 55]; higher motivation for being social, being outdoor (leaving the house), and physical activity [35, 43, 53, 56-58]; promote face-to-face interactions [59]; significant improvement of psychological distress [60]; reduced neuroticism [61]; positive impact on general wellbeing including daily and psychosocial functions (strong correlation between playing Pokémon Go and personal wellbeing) [3]; improved cognitive performance by significantly increasing players selective attention, concentration levels and social levels against those who did not play [37]; significant positive effect on social anxiety and nostalgia regret, and indirect significant effect on reducing depression and resilience [62]; that people exercise subconsciously while playing Pokémon Go without the will or motivation to exercise [63]; changes in behavior resulting in more openness toward socialization, being outdoor, exploring surroundings and day-to-day movement [64]; and meet personal needs and provide social benefits [55, 65].

The studies that portray a more neutral view of the effects of playing the game (both positive and negative) reports that for parents playing Pokémon Go with their children, gameplay could trigger both positive and negative emotional parent response [45]; that the probability of still playing after six months is positively predicted by agreeableness, perseverance, and premeditation [48]; and game transfer phenomena was less common for Pokémon Go than for previous studies, and that 82.4% experienced this phenomenon at least once [66]. The two negative studies showed that players that kept playing the game for a more extended period of time were less motivated for physical activity than others [46], and that addictive behavior related to the Pokémon Go game was significantly related to awareness and attitude, but the level of addiction behavior was significantly low [67].

The results from our literature review show that *playing Pokémon Go has a significantly positive effect on mental health-related to many areas, including motivation to physical activity, cognitive performance, wellbeing, reduced anxiety, reduced social anxiety, and openness. These results are related to the time playing the game, and no studies indicate a long-term effect (similar to physical health).* Potential adverse effects of playing the game can be an addiction and reduced motivation for physical activity after playing the time over a more extended period.

3.3 RQ3: Pokémon Go's Effect on Social Health

Over half of the articles in our literature review focus on social health and include social interaction, bonding, family, social anxiety, social competence, and social capital. Most of the papers report that playing Pokémon Go significantly improves the social health of the player. Examples of how the game improve the social health include spending more time with family and friends, getting to know new people, and reducing social anxiety, making it easier to interact with people [51, 68]; making new friends [69]; spending more time with the dog, less anxious leaving the house and less anxious interacting with strangers [39]; increased social interaction [3, 52, 54, 70]; significant positively affects bridging social capital, bonding social capital, and face-to-face interaction [59]; improved social motivation [43]; improved social relationships [37]; positively affects friendship formation and friendship intensification [62]; produce a sense of belonging and facilitating conversations with strangers [71, 72]; and stronger bonding between parents and children [4, 45, 64, 73].

One study analyzing tweets related to Pokémon Go found that of the tweets related to social, 76% positive were positive, and 24% were negative [57]. Another study looked at

how the game encourages socialization through lures that can be shared by players to develop a sense of community, Gyms, and Pokéstops where players will meet at the same location, and the lack of information and the total picture that encourages players to compare and discuss tactics and locations [58]. Further, one study showed that 27.9% of the players played Pokémon Go alone, and 69.8% played together with friends or family [52], while another study showed that 54% played the game alone vs. 46% together with friends or family [68].

Based on the studies in our review, *Pokémon Go has a positive effect on the player's social health in terms of strengthening bonding between friends and family, increasing social interaction, reducing social anxiety, and making new friends.*

3.4 RQ4: Player's Motivation and Attitude Towards Playing

About half of the articles in our literature review investigate how the player's motivation and motives affect the attitude towards playing Pokémon Go and stopping to play the game. The motivation and motives for playing Pokémon Go include recreation and nostalgia motives [74]; enjoyment, physical activity, flow, nostalgia and social image [54, 55, 70, 75]; having fun and getting exercise [37, 52]; being social, experience immersion and experience achievement [61, 76]; being fans of Pokémon (previous games or anime), enjoy collecting Pokémon, excuse to get exercise, and being curious and social [34, 56, 77]; comparing Pokédex with others, being a habit and attending special events [35]; health motivation operates in parallel with motives for gaming [43]; winning battles and catching Pokémon [3]; catching all Pokémon and reaching high levels [46, 53]; previous exposure to Pokémon and social pressure [62]; spending time together and motivation to go outdoors [45]; recognition, ease of use, flow and competition [63, 78]; gratification [79]; invitation from friends, family or social connections [64]; and personal needs, social needs, and recreation [65, 80]. The reason people played less or stopped playing Pokémon Go was found to be that they caught all Pokémon, that the game required much physical activity, and the game consumed too much time and energy [56, 75]; it was cumbersome to reach new levels, too high battery consumption, being less fun, having less time and technical malfunctions [35]; and boredom [45, 80].

One study found that personality did not affect whether a person started to play or stopped playing the game [46]. However, other studies reported variations among groups of players related to the motivation of playing the game. In one study, the Pokémon Go players scored lower in conscientiousness and higher in player motivations, social, immersion, and achievement than non-player [61]. One study showed that early adopters of the Pokémon Go game were more introverted, closed persons with high agreeability, and conscientiousness [81]. Another study showed that highly involved Pokémon Go players are introverted, low agreeableness, and conscientiousness people driven by personal social and recreational needs [65]. We also found two studies that show differences in motivation for playing the game related to gender, where men played more and derived more benefits from the game [43], and boys played more than girls [37].

The results from our literature review show that there are many different reasons why people play Pokémon Go as well as playing the game less or stopping. *The main motivations for playing the game include nostalgia and familiarity with the Pokémon franchise, an excuse to exercise and go outdoors, and socializing with old friends, family, and making new friends. The primary motivation for playing less or stopping to play the game includes*

slow progression in the game, the gaming requiring too much time and effort, and technical issues.

4. DISCUSSION

This section discusses the results and addresses the threats to the validity of the systematic literature review.

4.1 Discussion of the Results

The majority of the articles in our systematic literature review portray a positive view of the Pokémon Go game and reports positive results related to physical, mental, and social health.

The studies on *physical health* show a statistically significant increase in the number of steps [6, 29-34], time spent on physical activities [5, 30, 37, 39-47, 62, 63], and on distance moved [30, 35-38, 48]. Based on all these studies, there is strong evidence that Pokémon Go has a significant and positive effect on physical health (RQ1). Other positive health effects include being more outdoor, losing weight, and getting better sleep [51]; reducing sedentary behavior [5, 41]; going for long walks with the dog [39]; and exploring new physical locations [34, 39, 42, 58, 64]. Another significant result is that Pokémon Go is one of the few apps that has reached the part of the less physically active [6, 46]. However, the studies also show that the positive effect on physical health disappears or gets reduced over time or when the player stops playing the game [38, 40, 46, 49]. The results are mixed in terms of how long the positive physical health effects last from playing Pokémon Go. One study showed that the game's positive physical effect increased gradually weekly until it was back to the status quo at week six [29]. Another study showed that the distance walked decreased daily from day one [36]. For some Pokémon Go players, there is a novelty effect that wears off quickly [82]. However, many studies showed that the positive effects on physical activity from playing the game lasted at least between three weeks and nine months [5, 6, 29, 31, 38, 41, 44, 48, 58, 69]. Finally, the positive effects on physical health from playing do not last after the player has stopped playing the game [49]. Thus, for games such as Pokémon Go to have a lasting impact on public physical health, they must provide enough re-playability and content for players to come back for more or provide a variety of similar games to keep the game experience fresh and innovative. Such games can motivate other physical activities than walking, biking, or running, e.g., strength training [83].

The articles that addressed how Pokémon Go affects *mental health* (RQ2) also reported mainly positive results, including improved wellbeing and emotions [3, 34, 51, 52, 54], increased motivation for being outdoors, being social and physical active [35, 43, 56-59, 63-65], reduced psychological distress [60-62], and improved cognitive performance [37]. The negative results related to the game included parents' negative emotions to children playing the game [45], some players experience the game transfer phenomena [66], and one study found some addictive behavior related to the Pokémon Go game [67]. Although some articles addressed some challenges related to mental health and Pokémon Go, the overall picture is that the game has a very positive effect on mental health (RQ2). Some articles also even suggest using Pokémon Go for therapeutic purposes to reduce social anxiety [51], to promote face-to-face interactions, and to help people with Hikikomori (acute social withdrawal) [59].

Improved *social health* is another benefit of playing Pokémon Go (RQ3). The social benefits from playing the game include increased social motivation and reduced social anxiety [39, 43, 51, 59], increased social interaction [3, 52, 54, 69, 70], and improved social relationships [37, 45, 62, 64]. One study showed that close to 70% of the respondent in a survey played Pokémon Go together with someone else [52]. Many played the game together with friends, but Pokémon Go is also a game that bridged generations, providing a game that could be enjoyed and played by parents and children [4, 45, 73]. One unexpected social benefit from the game was that dog owners spent more time with their dogs [39]. Another social effect from Pokémon Go was that many players found new friendships by playing the game [51, 62, 64, 65, 69]. The design of Pokémon Go encourages social gameplay through physical meetings at Gyms and Pokéstops, an essential part of the gameplay is to hike, comparing and discuss tactics and locations, competitive fighting in Gyms, joining one of the four teams, lures, and that not all information about the game is available from the game itself [35, 40, 56]. The lack of information encourages players to exchange information and share experiences [58, 68, 84]. More specifically, Pokémon Go's game design encourages social interaction by promoting encounters between players, providing idle time during the game, allowing for a variety of forms of social interaction, ambiguity (encourage information sharing), a persistent world (enables information sharing), positive-sum (one player has only a part of the information), intermittent engagement, simple to start with hidden mechanics, lack of in-game communication and gather players through Gyms and Pokéstops [68].

There are many *motives* for why people start and keep on playing Pokémon Go (RQ4). The reasons include experience fun and immersive gameplay [3, 35, 46, 61, 63], getting physical exercise [37, 43, 52], for social reasons [45, 62, 64, 65], and nostalgia and being a fan of the Pokémon franchise [34, 54, 56, 70, 74]. Those who kept playing the game over a longer time (six months or more) were characterized by agreeableness, perseverance, and premeditation [48]. The reasons people played less or stopped playing Pokémon Go were found to be slow progression at higher levels that required too much effort, technical issues, and boredom [35, 45, 56]. There were several major challenges in the game design for the initial release of the game that made players stop playing the game. One problem was the steep progress curve from level 20, where the amount of XP needed to reach the next level increased rapidly.

Further, the game's initial version lacked variation in gameplay that made it boring for players to continue, especially the lack of more competitive and collaborative play. For the most eager players, the lack of content was also a problem when they had caught all the Pokémon. After its initial release, Niantic has fixed many of the technical problems with the game, added more variation in gameplay, and added more Pokémon.

4.2 Threats to Validity

To address the validity of the systematic literature review, the work was carried out according to a review protocol to maximize the literature coverage, to identify and include the related work that can be classified as a study, and to collect and synthesize meaningful data from the sources related to the defined research questions. The literature review was carried out thoroughly using the systematic review method presented in [28] consisting of the six stages: development of review protocol, identification of inclusion and exclusion criteria, search for relevant studies, critical appraisal, data extraction, and synthesis. By using this method, the results of the review can be reproduced and tested.

The main threat to the validity of the systematic literature review is the coverage of literature. We searched for papers in Google Scholar, Science Direct, Wiley InterScience, Web of Science, and Scopus to counter this problem. Although there might be articles we have missed, we believe that the literature coverage should be sufficient. One problem is that there were articles behind a paywall that were not accessible through personal and university memberships and societies or the university library. Most of the articles excluded because of being behind a paywall were from the International Journal of Gaming and Computer-Mediated Simulations and the International Journal of Game-Based Learning.

5. CONCLUSION

The goal of the systematic literature review presented in this paper was to investigate the health effects of playing the augmented reality game Pokémon Go and how the players' motivation affected the attitude towards the game. The initial search resulted in 1,534 articles, but after filtering the articles through inclusion and exclusion criteria and critical appraisal, 59 articles remained. Eighty percent of these studies included results related to how the game affected physical health, and about half of them contained results related to mental and social health and how motivation affects the attitude towards the game.

The studies in our review showed that *the game has a very positive effect on physical activity, including an increased number of steps walked or jogged, distance traveled, and time spent on physical activity.* Other effects of playing the game include reduced time on sedentary activities, being more outdoor, losing weight, getting better sleep, spending more time with the dog, and exploring new physical locations. One especially encouraging result was that Pokémon Go is among the few apps that have managed to motivate people who do little or no physical activity to become physically active. However, *the review also shows that the positive physical effects of playing the game only last as long as people are playing the game, and it does not change the general attitude towards physical activity.*

Similarly to physical health, *Pokémon Go has a positive effect on mental health. The studies show that the game can result in improved wellbeing and emotions, increased motivation for being outdoors, being socially and physically active, reduced psychological distress, and improved cognitive performance.* We did not find many negative results related to mental health apart from some parents who had negative emotions related to children playing the game, few players experienced the game transfer phenomena, and one study found hints of addictive behavior from playing the game. The overall picture was very positive, and two studies even suggested to use Pokémon Go for therapeutic purposes to reduce social anxiety.

Further, our review results showed that *the game increased social motivation, reduced social anxiety, increased social interaction, and improved and strengthened social relationships.* The social benefits were found for friends, families, dogs and dog-owners, and between generations and strangers. The studies also showed that the game design of Pokémon Go encourages social play and encounters.

Finally, our systematic literature review revealed various *motivations and motives for why people play Pokémon Go, including having a fun and immersive experience, getting physical exercise, social reasons, and nostalgia related to the Pokémon universe.* The reasons for why people stopped playing the game included technical challenges, slow progress in the game that required more effort increasingly, and lack of variation and content.

Augmented reality games such as Pokémon Go show benefits beyond entertainment. It can be regarded as the most successful exergames of all times, motivating millions of players to become physically active and engage socially. For many players, Pokémon Go had an apparent positive effect on their wellbeing related to physical, mental, and social health. It is important to do further research on such games' effect as they evolve in the future. As more games will be released, it will be possible to discover how various game designs will affect the player's wellbeing.

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