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Health and social impacts of playing Pokémon Go on various player groups

Alf Inge Wang *, Audun Skjervold

Dept. of Computer and Information Science, Norwegian University of Science and Technology (NTNU), Sem Sælandsvei 7-9, N7491 Trondheim, Norway

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ABSTRACT

Pokémon Go might be considered to be one of the most successful exergames ever released. When the game was released in the summer of 2016, Pokémon Go players spent more time exercising, being outdoors, and socializing with the unknown, family, and friends. There have been many papers that report on how playing Pokémon Go affects the player's health. However, few studies report how playing the game has different health and social impact on different groups of players. Specifically, the paper investigates how Pokémon Go has different health and social effects on gender, where the game is played, how much video games players play, their initial physical activity level, and occupation. The survey results of over two thousand active Pokémon Go players show that playing Pokémon Go has a statistically significant positive effect on physical and social activity. It was also found that the game had a different effect on various groups of players and that 50% of the players reported positive health benefits, including weight loss, loss in body fat, and gain in muscle mass. The paper's most significant result is how Pokémon Go managed to motivate groups who are hard to motivate to be physically and socially active.

1. Introduction

Pokémon Go had a significant impact when it was launched in summer 2016. An article in Forbes asks why Pokémon Go is the world's most important game as it grossed almost $2 billion in revenue and had been downloaded 800 million times [1]. Further, the article gives five reasons 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. Research has documented positive effects from playing the game, including improved social life and wellbeing [2], improved family bonding and being more outdoor [3], reduced sedentary behavior [4], and players becoming more physically active [5]. However, there have also been found adverse effects including drivers, passengers, and pedestrians distracted by the game [6], traffic accidents caused by the game [7], disadvantages for minority population playing the game due to biased geographical distribution of Pokéstops and Gyms [8], privacy and data collection issues related to the game [9], and trespassing and law-breaking while playing [10]. The Pokémon Go game was a massive hit in the summer of 2016 and has lost many players since. However, the game had 147 million active users in May 2018 [11], it had been downloaded over one billion times in March 2019 [12], and players spent more than $1 billion in the calendar year 2020 [13].

One could argue that Pokémon Go is one of the *most successful exergames ever made*. The game significantly impacts the players' physical activity levels from playing the game [5,14,15]. An exergame combines exertion and video games, including strength training, balance, and flexibility activities. Exergaming is playing exergames or any other video games to promote physical activity [16]. Unlike many other attempts at designing and creating exergames, the physical effect of Pokémon Go can be seen as a side-effect of the game design [17]. Pokémon Go was not designed to use video game mechanisms in an exercise activity or optimize exergaming's dual flow by balancing gameplay challenge and physical intensity [18]. Instead, the game was designed to experience a hunt of Pokémon in both the virtual and real worlds. Pokémon Go's success is related to a playing experience with an augmented reality interface for reality [19]. The game does not try to add physical movement to an existing game, but rather embrace the story of Pokémon and gameplay of previous Pokémon games, where a Pokémon hunter needs to explore the world and walk around to catch Pokémon. For many Pokémon players, Pokémon Go is a way to live out their childhood dream of becoming a Pokémon hunter in the real world [20]. The game's novelty is a combination of a well-known franchise, location-awareness, and the inspiration potential of AR-based apps [21].

Many studies published have shown positive health effects from playing Pokémon Go. However, few studies have investigated whether

* Corresponding author.
E-mail address: alfw@idi.ntnu.no (A.I. Wang).

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the game has a different effect on various groups of players [22]. Of more extensive studies comparing the impact of Pokémon Go on various groups, there are two investigating the variation of health effects from playing the game related to gender, age, weight, and previous physical activity level [5,23]. As far as we know, no studies have researched the health effects of playing Pokémon Go related to the amount of spent on time playing video games and whether the player is unemployed, working, or studying. This paper presents results from a survey where the research goal was to identify the physical and social effects of playing Pokémon Go on the following classification groups: gender, the play area, how much video game the respondents play, what their initial physical activity levels were, and their occupation.

The rest of this article is organized as follows. Section 2 presents related work, research questions, and the research approach. Section 3 presents the results. Section 4 discusses the results found and the validity of the results. Finally, Section 5 concludes the article.

2. Material and methods

This section presents the related work, research method, research goal, research questions, and metrics.

2.1. Related work

Many studies on Pokémon Go have been published on health [5,14,24,25], user and social issues [2,26,27], and game-related issues [17,28,29]. Most papers on physical health report positive health effects from playing the game, such as increased physical activity, being more outdoor, and promoting active living [15]. There are extensive studies with over 1000 participants, where two are surveys [27,30] and three are experiments that measured physical activity using activity trackers [5,14,31]. Specifically, reported physical effects from the game include 35% more steps per day [32], 50 min more vigorous physical activity per week [24], and a 25% increase of physical activity level over 30 days [31]. Regarding Pokémon Go's physical effect on the various group, studies report that the game had a positive effect on all groups of players across gender, weight, status, and prior physical activity levels [5] and that it had a higher increase of physical activity on boys than girls [33]. Also, studies show that the groups of Pokémon Go fans and Physical activity seekers had a higher number of steps than the Curious & social [34], and playing in a green space has a positive impact on daily walking/running distance [35]. All the studies we have found on this topic show a significant increase in physical activity from playing the game, but the effect does not last beyond playing the game. Although some studies investigate how Pokémon Go affects various groups of players differently, these are few. Also, we did not find other studies investigating how playing other games and the player's occupation affect the physical and social effect of playing Pokémon Go.

Similarly, some extensive studies on the social effects of playing Pokémon Go [36–38]. These are all online surveys focusing on social interaction and play, privacy, and collaboration. Some of these studies report improved social life because of the game without being specific [2,23,33,39–42]. However, few studies present empirical data on how or to what extent Pokémon Go improved the players' social life. For example, one study reports that 43% of the players spent more time with family, 52% spent more time with the dog, 39% were less anxious leaving the house, 40% were less anxious interacting with strangers, and 40% visited new places [43]. Another study showed that Pokémon Go might prevent hikikomori, a psychological condition that makes people shut themselves off from society (socially isolated) [44,45]. Other positive effects from playing the game related to wellbeing include 30 min reduction of sedentary behavior per day [24], improved family bonding between parents and children [3], increased number of friendships and intensification of friendships [39], and 14% more people spent more time outside (based on cellphone usage data) [46].

Also, there have been published literature reviews that summarize the health effects of playing Pokémon Go. Cartlidge examined the influence of Pokémon Go players' use of public space and found increased physical and social activity of gamers in public space [47]. This review combined 36 peer-review articles with 120 web articles (blogs, news articles, reports, and other web pages). Laato et al. carried out a systematic literature review of 20 empirical studies on Pokémon Go's effects on physical activity [48]. They found that a majority (60%) of the studies showed an increase in daily steps, whereas 30% of studies reported only short-term improvements, which diminished soon after. Baranowski and Lyons did a scoping review that included 16 studies on how Pokémon Go affected physical activity change [49]. The main conclusion was that the increase in physical activity from playing the game among young and young adults appeared small and of short (less than two months). Further, they found modest increases in physical activity for up to seven months after the game's release among older adults. The review also found that Pokémon Go may increase face-to-face interaction among players and other local residents. Finally, Wang did a systematic literature review on playing Pokémon Go, which included 59 studies [22]. The main conclusion of this review was that Pokémon Go has an apparent positive effect on its players' physical, mental and social health, although this effect only lasts as long as the player plays the game. The study found that the positive effect on physical health was increased steps, increased distance moved, and increased time spent on physical activity. The positive effect of playing the game on social health was strengthening bonding between friends and family, increased social interaction, reduced social anxiety, and making new friends.

2.2. Research method and research questions

The research method used in our survey is based on the Goal, Question Metrics (GQM) approach [50], 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 answer the research questions are a mixture of quantitative and qualitative data.

The research goal of this study described using the GQM template [50] was:

The purpose of this study was to *investigate the health and social effects of playing Pokémon Go* from the point of view of *a player* in the context of *society*.

The research aims to identify whether playing Pokémon Go has any physical and social effects on the players and what these effects are. This research goal was decomposed into the following research questions:

- RQ1 How did playing Pokémon Go affect the physical activity level of the players?
- RQ2 How was various groups' physical activity level affected by playing Pokémon Go?
- RQ3 How did playing Pokémon Go affect weight loss or other health benefits?
- RQ4 How did playing Pokémon Go affect the social activity level of the players?
- RQ5 How was various groups' social activity level affected by playing Pokémon Go?

2.3. Data sources and metrics

The primary data source of this study was a survey targeting active Pokémon Go players. The metrics used were qualitative and quantitative data, where most questions used a multi-point Likert's scale [51] (e.g., for stating time spent on playing games and on playing Pokémon Go) or multi-select (e.g., for stating what features of Pokémon Go used), while others were open-ended. The survey consisted of forty-seven questions about demographics, gaming habits, physical activity and health, social

activity and health, and adverse behavior. Sixteen questions were open-ended. The authors designed, reviewed, and tested the survey in a trial survey that resulted in adjustments. The survey had a scope beyond the physical and social effects presented in this article, including questions about mental health, why players started to play Pokémon Go, what features of the game they regarded as most important, and why they stopped playing the game [52]. The respondents reported physical and social activity levels by specifying how much time they spent weekly on physical and social activities before and during playing the game. Specifically, for statements on time spent on a physical and social activity before and during playing Pokémon Go, an eight-point scale was used (see Appendix for details on statements related to physical and social activity in the questionnaire).

The survey was distributed online using Google Forms in September 2016 at Pokémon events and targeted Facebook groups and Reddit forums with around 20 000 members. The survey was open from September 9th to October 20th, 2016. The survey did not have a randomized sampling. Out of the 2320 responses received, 2191 were evaluated to be valid. To be accepted as a valid response, the response had to be complete.

The results presented in this paper are a combination of descriptive statistics, comments from the survey, and three statistical analysis methods for ordinal data: the Wilcoxon Signed-Rank test, the Mann-Whitney test, and the Kruskal-Wallis test [53]. The Wilcoxon Signed-Rank test was used to test the physical and social activity level before and after playing Pokémon Go. It is a nonparametric test for the significance of the difference between the distribution of two non-independent samples involving repeated measures or matched pairs [53]. For testing physical and social effects on various groups, the Mann-Whitney test was used as a nonparametric test for significance for gender as it had two independent samples of different sizes. For testing the remaining groups, the Kruskal-Wallis test was used as a nonparametric test for the significance of the difference of 3 or more independent samples of varying size, as these groups had 3 or 4 items. The limit set for statistical significance was 5%. The effect sizes were found by computing Cohen's effect size d and interpretation using Cohen's rule of thumb [54] and Sawilowsky's classification [55]. The effect size was used to compute the magnitude of the experimental effect.

The qualitative data were analyzed using a two-step process. The first step was data reduction, where the raw data is transformed into a simplified format understood in the context of the research questions through focus and abstraction [56]. The second step was to do a content analysis by coding the data for certain words or content and identifying their patterns. The main activity in this step was to find keywords that would fit several entries and remove unnecessary words. The raw data started as sentences ended up as a limited set of unique and non-overlapping keywords or key sentences that could be interpreted. The coding was carried out by the second author only.

Table 1 presents a mapping of research questions, data sources, metrics, and analysis methods.

Table 1
Research questions, data sources, metrics, and analysis methods.

Research Question	Data Sources	Metrics	Analysis Methods
RQ1 Physical effect before and after	Quantitative and Qualitative survey data	Likert's scale	Descriptive statistics Wilcoxon Signed-Rank test Cohen's effect size Qualitative analysis
RQ2 Physical effect on various groups	Quantitative survey data	Likert's scale	Descriptive statistics Mann-Whitney test Kruskal-Wallis tests Cohen's effect size
RQ3 Weight loss and health effect	Qualitative survey data	Open-ended	Qualitative analysis
RQ4 Social effect before and after	Quantitative survey data	Likert's scale	Descriptive statistics Wilcoxon Signed-Rank test Cohen's effect size
RQ5 Social effect on various groups	Quantitative survey data	Likert's scale	Descriptive statistics Mann-Whitney test Kruskal-Wallis tests Cohen's effect size

3. Results

This section presents the results related to the research questions presented in Section 2.2.

3.1. Demographics

Our survey had 2191 valid responses, and the gender distribution was 57% male and 43% female, which is reasonably representative of the player population (56.4% male and 43.6% female in the US) [57]. Fig. 1 shows a histogram of all respondents' ages, ranging from 5 to 67 years old, where most respondents were 24 ± 6 years old. Our demographic data did not show a significant difference in the age distribution for gender.

Table 2 shows the distribution of respondents per continent, where the majority of the respondents came from Europe (65%), almost one-third from North America (30%), and about 5% from the remaining continents. The majority of the respondents came from Norway, the USA, Canada, the UK, Ireland, Germany, Australia, and the Netherlands.

Table 3 shows the demographics of the respondents' occupations, which shows that almost half of them (48%) were working, over one-third (34%) were studying at college or university, 10% in schools (K-12), and the remaining 8% were unemployed.

The demographic data also showed that the average player level was slightly above 23, where 80% were in the range between level 21 and 30 with an average Pokédex count of 108 (number of unique Pokémon caught), 18% between level 11 and 20 with an average Pokédex count 71, 2% on level 31 or above with an average Pokédex count 139, and 1% at level 10 or below with average Pokédex count 37. Again, this means that the vast majority of respondents had played the game for a significant amount of time.

3.2. The amount of physical activity from playing (RQ1)

In Fig. 2 shows the distribution of respondents' spent hours of physical activity per week before and after playing Pokémon Go. The figure shows that more time was spent on being physically active after starting to play Pokémon Go. Before starting to play the game, the average time spent on physical activities was about 3 h per week compared to 7 h per week after. A Wilcoxon Signed-Rank test with $n = 2191$ was used test for a significant difference in the time spent on physical activities before and after playing Pokémon Go, and Cohen's effect size was calculated [54]. The test result is shown in Table 4 and concludes that there is a significant difference in physical activity level before and after playing the game ($P < 0.0001$). The effect size was found to be *very large* ($d_{Cohen} = 2.060$).

Table 5 shows how respondents in each physical activity level increased, did not change or decreased their physical activity level. The eight physical activity (PA) levels correspond to the pre-defined scale

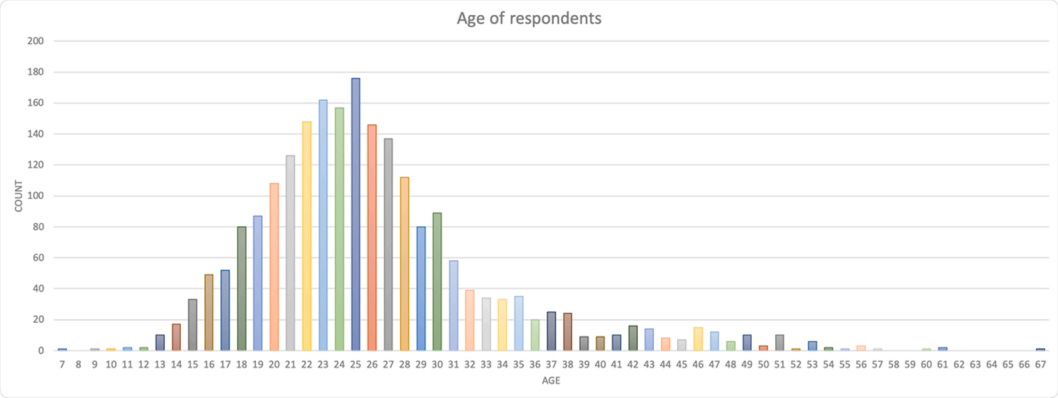

Fig. 1. Histogram of the Ages of the Respondents.

Table 2
Distribution of Respondents per Continent.

Europe	North America	Oceania	Asia	South America	Africa
65.1%	29.8%	2.3%	1.7%	1.1%	0%

Table 3
Distribution of Respondents Occupations.

Lower Education	Higher Education	Employed	Unemployed
10%	34%	48%	8%

the respondents used when reporting on their physical activity and social activity level in the questionnaire. The table shows that the vast majority increased their activity level in the categories they exercised the least (Low and Medium). For example, those who initially just exercised from 30 to 120 min per week, from 84% to 94%, increased their physical activity level. In contrast, less than half of those who exercised for more than 12 h a week, increased their physical activity level.

World Health Organization (WHO) recommends that adults (18–64 years old) do at least 150–300 min (2.5–5 h) of moderate-intensity physical activity per week [58]. We have used this recommendation to categorize our respondents into three categories: *Low activity*, where they do 2 h or less physical activity per week; *Moderate activity* where they do more than 2 to 8 h of physical activity per week; and *High activity* where they do more than 8 h of physical activity per week (see Table 5). Table 6 shows changes in the distribution of the activity levels before and after playing Pokémon Go. The table shows that many moved from Low to Moderate and from Moderate to High.

Our survey showed that the main reason for increased physical activity was to go Pokémon hunting, make unnecessary detours, and choose walking, running, or biking instead of public transport. Many physically inactive players used Pokémon Go as a motivation to get outside and move around. Others enjoyed moving more and were motivated to start with more rigorous exercise. However, the results also showed that most players who no longer played the game did not maintain increased physical activity.

Table 4
Results from the Wilcoxon Signed-Rank Test on Physical Activity Level Before and After Playing Pokémon Go.

W = -1295105			
$n_{s/r} = 1646$ $z = -33.58$	P(1-tail) <0.0001	P(2-tail) <0.0001	d_{Cohen} 2.060

Table 5
Percentage of respondents who have changed physical activity category.

Activity level	PA Level	Initial Category	Increased	The Same	Decreased
Low	1	30 min or less	94%	6%	n/a
	2	1 h or less	85%	14%	1%
	3	2 h or less	84%	15%	1%
Medium	4	4 h or less	70%	28%	2%
	5	8 h or less	56%	42%	2%
High	6	12 h or less	45%	49%	6%
	7	20 h or less	41%	52%	7%
	8	More than 20 h	n/a	88%	12%

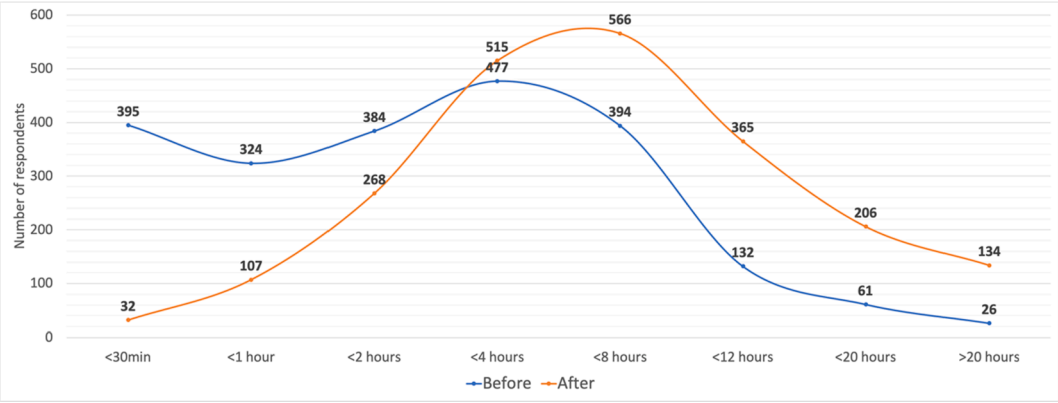

Fig. 2. Distribution of Physical Activity Level before and after Playing Pokémon Go.

Table 6
Change of Percentage of Respondents in Activity Levels.

Activity level	Before	After	Change
Low	50%	19%	− 63%
Moderate	40%	49%	+ 24%
High	10%	32%	+ 222%

3.3. Physical effect on various groups of players (RQ2)

Table 7 shows descriptive statistics on the distribution of population, average Pokémon level, the average number of Pokémon collected, the average distance walked in the game, the average physical activity level before and after playing the game (see Table 5), the average change in the physical level, and percentage of the group that has improved physical level (one level or more) respectively. The table summarizes the descriptive statistics for five distinct groups of players classified by *gender*, *play area*, *gamer type*, *physical activity level* (PA level) before playing Pokémon Go, and *occupation*. The gamer type classification is deduced by how much time, on average, the respondents played video games per week before playing Pokémon Go. The PA level classification is according to the categories in Table 5.

Table 7 shows some noticeable variations among the different groups related to physical activity levels before and after Pokémon Go. The more densely populated the area the game was played in, the more the players' physical activity level and distance walked increased. This makes sense as the game is more playable and fun to play in urban settings where there are more Pokéstops, gyms, and Pokémon [8]. Regarding the *type of gamer*, the more video game the respondent plays, the more significant is the positive physical effect. Pokémon Go had the most substantial increase in physical activity level for those in the *Low* category (twice as much as the *Medium* category). Besides, for respondents in the *Low* category, 88% increased their physical activity level compared to 63% for *Medium* and 39% for *High*. Regarding *occupation*, the game had a huge physical impact on unemployed people, as shown both in increased physical activity level and distance walked.

Table 8 shows the distribution of respondents related to recommended activity levels before and after playing the game related to gender, the play area, gamer type, physical activity level, and occupation. *Medium* means those who meet WHO's minimum recommended physical activity level for adults, *Low* means those below, and *High* means those who exercise more than the minimum recommendations.

Table 8
Distribution on Recommended Activity Levels for Various Groups.

	Before playing Pokémon Go			After playing Pokémon Go		
Gender	Low	Medium	High	Low	Medium	High
Female	53%	37%	9%	22%	51%	27%
Male	48%	42%	11%	16%	48%	36%
Area	Low	Medium	High	Low	Medium	High
Rural	53%	36%	11%	26%	46%	27%
Suburban	51%	40%	9%	19%	52%	29%
Urban	49%	40%	11%	17%	47%	36%
Gamer type	Low	Medium	High	Low	Medium	High
Non-gamer	45%	46%	9%	35%	51%	14%
Casual gamer	51%	41%	9%	20%	53%	27%
Gamer	50%	37%	13%	13%	41%	45%
Physical activity level	Low	Medium	High	Low	Medium	High
Low	100%	0%	0%	36%	64%	0%
Medium	0%	100%	0%	1%	60%	39%
High	0%	0%	100%	1%	5%	94%
Occupation	Low	Medium	High	Low	Medium	High
Employed	48%	41%	11%	16%	50%	34%
Higher education	51%	40%	9%	20%	50%	29%
School	54%	33%	12%	25%	47%	28%
Unemployed	58%	36%	7%	17%	47%	36%

The most noticeable results from Table 8 are related to gamer type, initial physical activity level, and occupation. The results show that Pokémon Go was especially effective for gamers, where 50% were less physically active than recommended by WHO before playing the game, compared to 13% after. Further, 45% of the gamers had a higher physical activity level after playing Pokémon Go than WHO's minimum recommendation. The results also show that 64% of respondents previously in the *Low* physical activity level moved to *Medium* (recommended) physical activity level. Similarly, for those in the *Medium* physical activity level, 39% moved from *Medium* to *High*. Finally, the most significant change was found for unemployed people, where 43% met WHO's minimum requirements for physical activity before Pokémon Go, compared to 83% after.

Table 9 shows results from statistical tests for the significant

Table 7
Descriptive Statistics on Physical Effect on Various Groups of Players.

	Distr.	Level	# Pokémon	Distance	PA before	PA after	Change	% Change
All	100%	23	103	455 km	3.42	4.85	+1.43	73%
Gender								
Female	43%	22	97	473 km	3.32	4.62	+1.30	71%
Male	57%	24	107	441 km	3.49	5.03	+1.54	75%
Area								
Rural	10%	22	95	163 km	3.30	4.56	+1.27	64%
Suburban	42%	23	102	205 km	3.37	4.78	+1.41	75%
Urban	48%	24	105	734 km	3.49	4.98	+1.49	74%
Gamer type								
Non-gamer	6%	18	79	90 km	3.52	3.98	+0.47	40%
Casual gamer	62%	23	99	517 km	3.38	4.67	+1.29	71%
Gamer	32%	25	113	398 km	3.48	5.36	+1.89	82%
PA level								
Low	50%	23	102	411 km	1.99	4.05	+2.06	88%
Medium	40%	23	103	566 km	4.45	5.37	+0.92	63%
High	10%	24	106	235 km	6.51	6.82	+0.31	39%
Occupation								
Employed	48%	24	106	518 km	3.46	4.88	+1.42	73%
Higher Ed	34%	23	100	326 km	3.37	4.77	+1.40	75%
School K-12	10%	21	95	143 km	3.33	4.55	+1.21	64%
Unemployed	8%	23	101	1017 km	3.08	5.00	+1.92	82%

difference of increased time spent on physical activity from Pokémon Go for the various classification groups of respondents and the calculated effect size using Cohen's d. The Mann-Whitney test was used for gender and the Kruskal-Wallis tests for the others. The results show a statistically significant difference ($p < 0.05$) in increased time spent on physical activity for gender, the play area, gamer type, initial activity level, and occupation. The effect size was found to be *very small* for gender ($d = 0.150$) and play area ($d = 0.098$), *small* for occupation ($d = 0.214$), *moderate* for gamer type ($d = 0.513$) and *large* for initial activity level ($d = 1.037$).

3.4. Weight loss and other health benefits (RQ3)

In Fig. 3 shows the summary of the main findings of the qualitative analysis related to health issues. Half of the respondents (50%) said that Pokémon Go had caused weight loss or other health benefits. Out of this group, 21% reported they had lost weight. Other respondents reported a loss in body fat and gain in muscle mass while remaining at the same weight, while some noted a decrease in pant size while being uncertain about changes to their weight. Besides weight loss and feeling healthier, the most commonly reported improvement was improved stamina and endurance and walking or running faster, farther, and longer than before. Other reported improvements include eating and drinking better (drinking more water to stay hydrated and less inclined to eat junk food), improved motivation to exercise, better sleep, less stress, easier breathing, and more alertness. Some players reported that playing the game had helped them quit smoking. A few had lowered their blood pressure, experienced a positive effect on illnesses such as anemia, or got an improved effect from their medication. Several also mentioned an improvement in mental health.The survey also asked if the respondents had skipped any *unhealthy activities* in favor of playing Pokémon Go. A quarter of the participants (25%) said that they had skipped unhealthy activities in favor of playing Pokémon Go, such as was watching too much TV or playing too much video games at home in combination with eating snacks (reported by 38%). Another unhealthy activity mentioned by many (26%) was that they played Pokémon Go instead of going to bars or otherwise consume alcohol. However, some players started drinking more because their local bars had good access to Pokéstops. Others reported that they cut down on junk food and snacks and reduced overeating because of the game.

The results of the survey also revealed some adverse physical effects of playing Pokémon Go. Nearly 10% of the respondents neglected sleep, did not eat enough, or did not stay sufficiently hydrated when playing the game. A more severe problem is players who ignore the surroundings while playing and therefore cause accidents. 11% of the respondents said they had experienced dangerous situations related to playing Pokémon Go. Further, 4% of the respondents said they had experienced accidents. The majority (97%) of these accidents were minor accidents. However, few participants also had experienced more severe accidents from playing the game while driving a car or riding a bike. The majority of accidents reported in the survey included crashing into signs, lamp posts, parked cars, low balconies, kicking things, or misplacing their steps.

Table 9
Results from a Mann-Whitney/Kruskal-Wallis Tests on Increased Physical Activity for Various Groups.

Mean Ranks for Mann-Whitney Test on **Increased PA and Gender**					
$n_a = 1243$ (male)	$n_b = 948$ (female)				
Sample A	Sample B	UA = 537955.5	$P_{(1)}$	$P_{(2)}$	d_{Cohen}
1137.2	1042	Z = 3.49	0.0002	0.0005	0.150
Mean Ranks for Kruskal-Wallis Test k = 3 on **Increased PA and Play Area**					
$n_a = 1048$ (urban)	$n_b = 917$ (suburban)	$n_c = 226$ (rural)			
Sample A	Sample B	Sample C	h = 7.21		
1119.6	1093.8	995.2	df = 2		
			P = 0.0272	d_{Cohen} = 0.098	
Mean Ranks for Kruskal-Wallis Test k = 3 on **Increased PA and Gamer Type**					
$n_a = 1363$ (casual)	$n_b = 704$ (gamer)	$n_c = 124$ (non-gamer)			
Sample A	Sample B	Sample C	h = 136.85		
1039.2	1285.2	645.5	df = 2		
			P = <0.0001	d_{Cohen} = 0.513	
Mean Ranks for Kruskal-Wallis Test k = 3 on **Increased PA and Physical Activity Level**					
$n_a = 1103$ (Low)	$n_b = 870$ (Medium)	$n_c = 218$ (High)			
Sample A	Sample B	Sample C	h = 465.85		
1373.4	874.6	876	df = 2		
			P = <0.0001	d_{Cohen} = 1.037	
Mean Ranks for Kruskal-Wallis Test K = 4 on **Increased PA and Occupation**					
$n_a = 1056$ (empl.)	$n_b = 747$ (higher ed)	$n_c = 219$ (K12)	$n_d = 169$ (unempl.)		
Sample A	Sample B	Sample C	Sample D	h = 27.66	
1089.3	1089.3	981.6	1315.3	df = 2	
			P = <0.0001	d_{Cohen} = 0.214	

In Fig. 4 shows the distribution of respondents on how many hours they spent on social activities per week before and after Pokémon Go. The figure shows that the respondents spent more time on social activities after starting to play the game. On average, the respondents spent about 4 h on social activities before Pokémon Go, compared to about 6 h after.

The sources for social activity related to the game were 47% friends, 19% family, and 34% strangers. In addition, 81% of the respondents reported they had talked to a person they otherwise would not have talked to because of the game, and 31% said they had made new friends by playing the game. Further, the results showed that Pokémon Go improved existing relationships with friends (38% of the respondents), family (17% of the respondents), and the significant other (19% of the respondents). Comments made included playing the game for playing it together with their children, and that Pokémon Go was a great way of finding new friends or hanging out with existing friends and family at Pokéstops or gyms.

A Wilcoxon Signed-Rank test with $n = 2191$ was used to investigate if there was a significant difference in the time spent on social activity level before and after Pokémon Go, and Cohen's effect size was calculated. Table 10 shows a significant difference in social activity level before and after playing the game ($P < 0.0001$). In addition, the effect size using Cohen's d was found to be *large* ($d = 1.002$).

3.5. The amount of time being social from playing (RQ4)

3.6. Social effect on various groups of players (RQ5)

Table 11 shows descriptive statistics on average social activity level before and after playing Pokémon Go and the change of social activity level for gender, play area, gamer type, initial physical activity level, and occupation. The number describing the social activity level points to the amount of time spent on social activities per week where 1 is 30 min or less, 2 is 1 h or less, 3 is 2 h or less, 4 is 4 h or less, 5 is 8 h or less, 6 is 12 h or less, 7 is 20 h or less, and 8 is more than 20 h. The most noticeable results are related to the gamer type, initial physical activity level, and occupation. *Casual gamers* had a more substantial social boost than *gamers* and *non-gamers*, and *non-gamers* had a more extensive social boost than *gamers*. The results also show a tendency that respondents initially in the *Low* physical activity group were less social than those in *Medium* before playing Pokémon Go. Likewise, those in *Medium* were

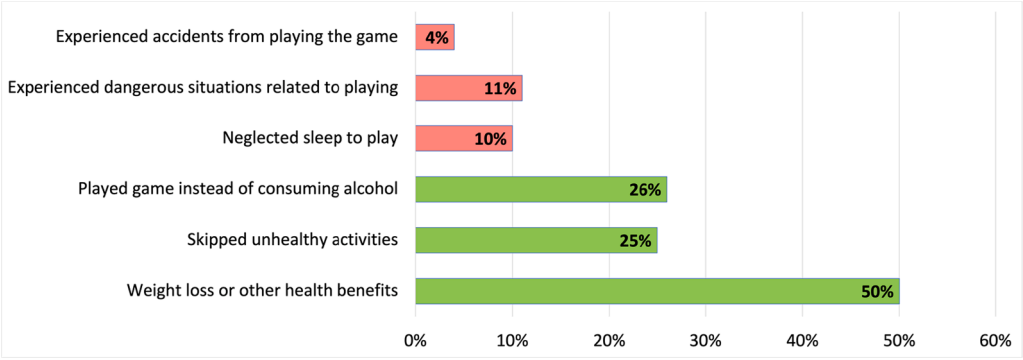

Fig. 3. Summary of Qualitative Analysis Related to Health Issues.

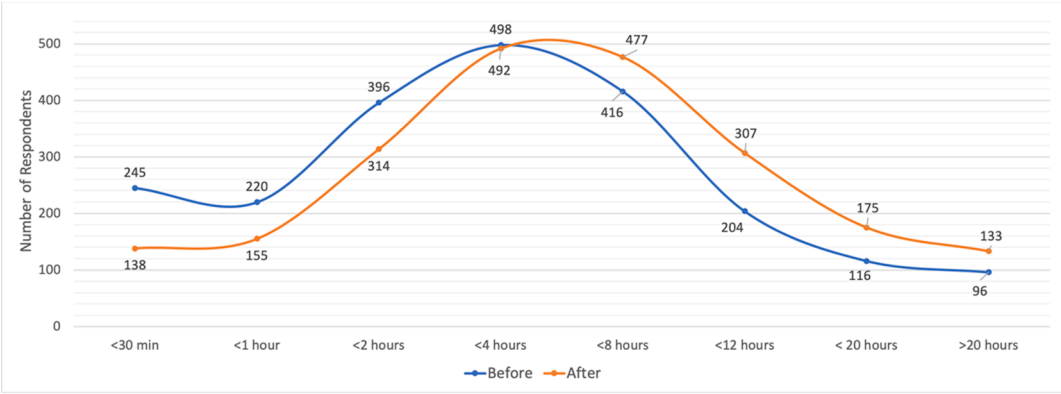

Fig. 4. Distribution of Time used on Social Activities before and After Playing Pokémon Go.

Table 10
Results from Wilcoxon Signed-Rank Test on Social Activity Level Before and After Playing Pokémon Go.

W = -293789 $n_{s/r}$ = 838	P(1-tail)	P(2-tail)	d_{Cohen}
z = -20.96	<0.0001	<0.0001	1.002

less social than those in *High*. However, if we consider the increase in social activity level for this classification group, the results are turned upside down. Regarding occupation, the *unemployed* had the most significant increase in social activity level.

Table 12 shows results from statistical tests on the significant difference of increased time spent on social activity from playing Pokémon Go for the various classification groups and the calculated effect size using Cohen's d. The Mann-Whitney test was used for gender, while the Kruskal-Wallis test was used for the others. The table shows a statistically significant difference ($p < 0.05$) in increased time spent on social activity for gamer type, initial activity level, and occupation. No statistical significance was found for the play area, while gender is borderline if we consider the most conservative p-value ($P_{(2)} = 0.05$). The effect size was found to be *very small* for gender ($d = 0.084$), initial activity level ($d = 0.170$) and occupation ($d = 0.138$), and *small* for gamer type ($d = 0.353$).

4. Discussion

This section discusses the results and limitations of the study.

4.1. Discussion of the results

Our study results show that Pokémon Go had a significant positive impact on the physical and social activity levels. This result is not controversial as it is strongly supported in the literature [2,5,14,23–25]. Although other studies have reported that Pokémon Go has a positive effect on all groups of players across gender, weight, status, and prior

Table 11
Descriptive Statistics on Social Effect on Various Groups.

	Distr.	Level	# Pokémon	Social before	Social after	Change
All	100%	23	103	3.99	4.51	+0.51
Gender						
Female	43%	22	97	3.96	4.43	+0.47
Male	57%	24	107	4.02	4.57	+0.54
Area						
Rural	10%	22	95	3.62	4.16	+0.54
Suburban	42%	23	102	3.85	4.35	+0.50
Urban	48%	24	105	3.99	4.51	+0.51
Gamer type						
Non-gamer	6%	18	79	3.91	4.29	+0.38
Casual gamer	62%	23	99	4.15	4.97	+0.83
Gamer	32%	25	113	4.04	4.22	+0.18
Physical activity level						
Low	50%	23	102	3.50	4.12	+0.61
Medium	40%	23	103	4.36	4.77	+0.42
High	10%	24	106	5.02	5.41	+0.39
Occupation						
Employed	48%	24	106	3.97	4.44	+0.47
Higher Education	34%	23	100	4.16	4.63	+0.47
School K-12	10%	21	95	3.95	4.61	+0.66
Unemployed	8%	23	101	3.48	4.27	+0.79

Table 12
Results from a Mann-Whitney/Kruskal-Wallis Tests on Increased Social Activity for Various Groups.

Mean Ranks for Mann-Whitney Test on **Increased SA and Gender**					
n_a = 1243(male)	n_b = 948(female)				
Sample A	Sample B	UA = 560417	$P_{(1)}$	$P_{(2)}$	d_{Cohen}
1119.1	1065.7	Z = 1.96	0.025	0.05	0.084
Mean Ranks for Kruskal-Wallis Test k = 3 on **Increased SA and Play Area**					
n_a = 1048(urban)	n_b = 917(suburban)	n_c = 226(rural)			
Sample A	Sample B	Sample C	h = 1.22		
1104.2	1079.7	1123.9	df = 2		
			P = 0.5434	d_{Cohen} = 0.038	
Mean Ranks for Kruskal-Wallis Test k = 3 on **Increased SA and Gamer Type**					
n_a = 1363(casual)	n_b = 704(gamer)	n_c = 124(non-gamer)			
Sample A	Sample B	Sample C	h = 68.23		
1033.7	1251.7	896.3	df = 2		
			P = <0.0001	d_{Cohen} = 0.353	
Mean Ranks for Kruskal-Wallis Test k = 3 on **Increased SA and Physical Activity Level**					
n_a = 1103(low)	n_b = 870(medium)	n_c = 218(high)			
Sample A	Sample B	Sample C	h = 17.75		
1152.3	1043	1022.7	df = 2		
			P = 0.0001	d_{Cohen} = 0.170	
Mean Ranks for Kruskal-Wallis Test K = 4 on **Increased SA and Occupation**					
n_a = 1056(empl.)	n_b = 747(higher ed)	n_c = 219(K12)	n_d = 169(unemployed)		
Sample A	Sample B	Sample C	Sample D	h = 13.34	
1067.2	1082.4	1187.2	1217.7	df = 3	
				P = 0.004	d_{Cohen} = 0.138

physical activity levels [5], few have investigated the different impacts on various groups. Regarding *gender*, our statistical tests indicated a significant difference for increased physical activity level ($p = 0.0002$) and a borderline case for increased social activity level ($p = 0.05$). However, the effect sizes for both were *very small*. The tendency is that male players increased their physical and social activity levels more than female players. Similar results were found in another study where boys played more, won more points, and reached a higher level in Pokémon Go than girls [33]. This difference can be explained by males, in general, spend *more time* playing games than females [59]. However, the results in our study related to being active in the game and physically active are a bit conflicting. On the one hand, male players have, on average, reached a higher level in the game (24 vs. 22) and gathered more Pokémon (107 vs. 97). However, on the other hand, female players report having walked longer distances (473 km vs. 441 km).

For the *play area*, the results indicate a significant difference in increased physical activity level ($p = 0.0272$) but not for social activity level ($p = 0.5434$). However, for the physical activity level, the effect size is *very small* ($d = 0.098$). Thus, the tendency is that players in rural areas had less increase in physical activity than suburban and urban areas. This not surprising as in rural areas, there are fewer game objects and other players [8,60].

For *gamer type*, the results indicate a significant difference both for increased physical activity level ($p < 0.0001$) and social activity level ($p < 0.0001$). The effect size for the physical activity level is *moderate* ($d = 0.513$), while it is *small* for the social activity level ($d = 0.353$). Interestingly, the *gamers* had the most substantial increase in physical activity level but the slightest increase in social activity level compared to *casual* and *non-gamers*. It seems that gamers focus more on progress in the game than the social part. As such, in our survey, the gamers could be classified as Killer and Achiever, and casual and non-gamers as Socializer and Explorer player types, according to Bartle [61]. The gamers focused more on acting in the game, while the casual and non-gamers focused more on interacting. This result aligns with a study that found that Pokémon Go fans had significantly more steps than the group Curious and social [34].

Regarding the respondents' *initial physical activity level*, those categorized as *Low* had a very large and significant increase in both physical and social activity levels ($p \leq 0.0001$). The effect size for increased physical activity level was *large* ($d = 1.037$) and *very small* for increased social activity level ($d = 0.17$). This result aligns with many stories on social media about physically inactive gamers starting to walk for hours outside to catch Pokémon, who also socialized with other players on the hunt [1]. This result is also supported in other studies [5,32]. Similarly, the *unemployed* had the most substantial increase in both physical and social activity levels.

Other studies have shown that Pokémon Go has a positive physical and social effect on players across gender, body weight status, and physical activity level [4,5,62]. Our study revealed that the game could have different effects on various groups. We found that Pokémon Go had a significantly more significant positive effect on *gamers'* physical activity level than *casual* and *non-gamers*, those with a *Low* initial physical activity level, and the *unemployed*. The *casual gamers*, those with a *Low* initial physical activity level, and the *unemployed* had the most considerable positive social effects from playing the game. These results are encouraging as they indicate that it is possible to improve the physical and social health of groups that are hard to reach using well-designed exergames [63,64].

4.2. Limitations

One potential threat to validity is the way the classification groups were established. The classification groups were constructed based on how the respondents answered five questions in the survey. Two of these classifications were directly related to demographical questions (gender and occupation). The three other classifications were based on questions related to reported time spent on playing video games, where they played Pokémon Go, and the amount of time spent on physical activities before Pokémon Go. These groups were randomized as that the authors did control how the respondents answered, and the authors did not focus on any particular groups when distributing the survey.

Another potential threat to validity is how the survey was designed and distributed. First, the GQM approach was used to detail our research goal into five research questions with supporting metrics. Second, the survey was tested for understandability with both closed and open questions was used to collect data. Finally, our approach to recruiting respondents was to target the most active Pokémon Go players through Pokémon Go events and social media.

A limitation of this study is that the physical and social activity levels were self-reported estimates of how much time the players spent on

physical and social activities before and after starting to play Pokémon Go. Some studies have solved measuring of physical activity by counting steps using accelerometers in smartwatches, smartphones, or activity trackers [5,14,65,66]. However, these studies had to use control groups with non-players to investigate the physical effect of playing Pokémon Go. Our study wanted to investigate both physical and social activity levels, where the latter cannot be measured in other ways than intrusive observations or self-reporting. Further, we wanted to investigate if the social and physical activity levels were changed for players playing the game, which was ruled out using a control group of non-players. Self-reporting of physical activity has commonly been used in many other Pokémon Go studies [2–4,23–25,67]. Another limitation with the self-reporting of physical activity is how the activity levels correspond to World Health Organization's guidelines on physical activity. WHO recommends that adults do at least 150–300 min of moderate-intensity or at least 75–150 min of aerobic physical activity per week [68]. Our survey did not collect any data on the intensity level of those participating in the survey.

A limitation of our study is that the data was collected in 2016 when Pokémon Go was released. This means that the study results not necessarily represent how the game is played today, especially after the COVID-19 pandemic occurred. Changes have been implemented in Pokémon Go to limit the spread of the virus by enabling stationary play and reducing social play. One specific example has been to develop ways to team up in Raid Battles from home. Surprisingly, recorded Pokémon Go player activity in Finland was more influenced by offered in-game rewards than the COVID-19 pandemic [69]. A cross-sectional study also from Finland showed that the perceived severity of the pandemic and a positive attitude towards both governmental measures and in-game changes for combatting COVID-19 predicted intention to reduce social playing [70]. Further, that fear of missing out and deficient self-regulation increased playing intensity, which negatively correlated with the intention to reduce social playing. These findings indicate that the positive effects on physical and social activity will be reduced in a pandemic. The results described in this article are only valid in the context of players who are invested in Pokémon Go in a non-pandemic environment. For this context, the results should be valid based on the number of respondents and the statistical analysis used.

5. Conclusion

This paper has presented physical and social improvement results from playing Pokémon Go from a survey with 2191 respondents.

The results show that playing Pokémon Go has a positive physical effect on the players (RQ1) and a variation of effects on different groups of players (RQ2). The game had a more substantial positive physical effect on players who were initially less physically active, male, unemployed, gamers than casual and non-players and played the game in denser populated areas. The main reasons for increased physical activity levels include hunting for Pokémon, making extra detours, walking, running, or biking instead of using other transport modes. In addition, the game was found by 50% to have other positive health benefits (RQ3), including weight loss, loss in body fat, gain in muscle mass, decrease pant size, improved stamina and endurance, improved eating and drinking, increased motivation to exercise, better sleep, less stress, easier breathing, lower blood pressure, feeling more alert and improved mental health.

Further, the survey results showed a statistically significant difference in the time the players spent on social activities before and after playing Pokémon Go (RQ4). However, considering the various groups of players (RQ5), we did not find a significant difference in the play area, and gender was borderline. For the remaining groups, *casual gamers* had a more considerable increase compared to *non-gamers* and *gamers*, those at an initially a *Low* physical activity level had a more substantial increase compared to those with initially *Medium* or *High* physical activity level, and that *unemployed* and *K-12 students* had a more considerable increase compared to *employed* and *students in higher education*.

This paper's most significant result is how Pokémon Go manages to motivate groups who are hard to motivate to be more physically and socially active. Our results and other studies show that this positive effect on physical and social health only is in effect as long as the game is played [14,30]. However, the results show considerable potential in using games as a positive force to promote health, especially targeting groups hard to reach. Future research will study the impact of other similar games and compare it to Pokémon Go's effect.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Excerpts from the questionnaire from the sections on activity and physical, and activity and social health.

Activity and physical health

18. **How many kilometers do you have on your "Jogger" medal in the game?**

The medal can be found by pressing the picture of your avatar in the lower left-corner and scrolling down.

_____

19. **How do you move around while playing? ***

If you utilize none of the listed options when playing, please choose "Other" and specify.
Check all that apply.

- ◯ Walking
- ◯ Running
- ◯ Bicycle or similar Car
- ◯ Tram
- ◯ Bus
- ◯ Train
- ◯ Wheelchair Other:

20. **In an average week, how much time did you spend on physical activities (e.g., walking, running, or biking) before you started playing Pokémon Go? ***

Please choose the smallest alternative that fits
Mark only one oval.

- ◯ 30 minutes or less
- ◯ An hour or less
- ◯ 2 hours or less
- ◯ 4 hours or less
- ◯ 8 hours or less
- ◯ 12 hours or less
- ◯ 20 hours or less
- ◯ More than 20 hours

21. **In an average week, how much time do you spend on physical activities since you started playing Pokémon Go? ***

Please choose the smallest alternative that fits
Mark only one oval.

- ◯ 30 minutes or less
- ◯ An hour or less
- ◯ 2 hours or less
- ◯ 4 hours or less
- ◯ 8 hours or less
- ◯ 12 hours or less
- ◯ 20 hours or less
- ◯ More than 20 hours

Activity and social health

25. **In an average week, during your spare time, how much time did you spend socializing with other people (in person, outside your home) before you started playing Pokémon Go? ***

Please choose the smallest alternative that fits
Mark only one oval.

- ◯ 30 minutes or less
- ◯ An hour or less
- ◯ 2 hours or less
- ◯ 4 hours or less
- ◯ 8 hours or less
- ◯ 12 hours or less
- ◯ 20 hours or less
- ◯ More than 20 hours

26. **In an average week, during your spare time, how much time do you spend socializing with other people (in person, outside your home) since you started playing Pokémon Go? ***

Please choose the smallest alternative that fits
Mark only one oval.

- ◯ 30 minutes or less
- ◯ An hour or less
- ◯ 2 hours or less
- ◯ 4 hours or less
- ◯ 8 hours or less
- ◯ 12 hours or less
- ◯ 20 hours or less
- ◯ More than 20 hours

27. **If you have increased the amount of time you spend socializing with people since you started playing Pokémon Go than before, what are the causes of this increase? ***

If you have not increased the amount of socializing you do in a week, please select "Not applicable". If none of the options describe your situation, please choose "Other" and specify the sources for the increased socializing.
Check all that apply.

- ◯ Not applicable
- ◯ Playing with friends
- ◯ Playing with family
- ◯ Talking to people you meet while playing
- ◯ Other: _____

28. **Have you talked to someone in person because of Pokémon Go that you otherwise would not have talked to? ***

Mark only one oval.

- ◯ Yes
- ◯ No

29. **Have you made new friends through playing the game? ***

Friends in this context are someone you would make an effort to meet again in person and who you believe might want to meet you again. It could be someone you met for the first time while playing or a previous acquaintance with whom you were not already friends.
Mark only one oval.

- ◯ Many
- ◯ A few
- ◯ One
- ◯ None

30. **Has playing Pokémon Go improved any of your existing relationships? ***

Check all that apply.

- ◯ Yes, with your family
- ◯ Yes, with your significant other
- ◯ Yes, with your friends
- ◯ No

…

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