Gotta catch 'em all: Impact of Pokémon Go on physical activity, sitting time and perceptions of physical activity and health at baseline and three months follow up

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Abstract

Objective: The objective was to examine differences in physical activity, sitting time and perceptions of physical activity and health between Pokémon Go users' and non-users' at baseline (launch of the application in the UK) and 3-months follow up.

Materials and Methods: The self-administered, short version of the 7-day recall, International Physical Activity Questionnaire was adapted to develop the 'Physical Activity and Pokémon Go questionnaire' which was distributed using social media. Four weeks after the launch of the application, 461 participants (n = 193 male, n = 265 female, n = 3 transgender), had completed the questionnaire. At 3-months follow up, 127 participants repeated the questionnaire.

Results: At baseline, mixed models ANOVA revealed main effects for Pokémon Go users' versus non-users' in the amount of days of vigorous physical activity, moderate physical activity and walking (All $p < 0.01$). Users' reported that they undertook less days of vigorous physical activity than non-users' but more days of moderate physical activity and walking. There were no differences in BMI, minutes of vigorous or moderate physical activity, and walking, or sitting on weekdays (All $p > 0.05$). Repeated measures ANOVA identified increased sitting on weekdays ($p < 0.05$), but maintained vigorous, moderate and walking physical activity behaviours in users' who remained users'.

Conclusion: Pokémon Go use can increase the frequency of days of physical activity benefitting health. Users' at both time points maintained their physical activity behaviour but increased sitting time on weekdays, highlighting that another intervention to prevent sitting is needed.

Objective

Mobile phone applications to increase physical activity and encourage healthy eating behaviour have been evaluated, with reports that the most effective are those that incorporate virtual avatars, gaming and social media.[1] The use of technological devices has great potential given the possibility of reaching large populations at low cost. For instance, Ofcom[2] reported that 93% of UK adults personally own or use a mobile phone. One such intervention delivered via a smartphone application is Pokémon Go, which is a free-to-play, location-based augmented reality game that was released globally in July 2016. Using Global Positioning System (GPS) and the mobile phone camera, the application encourages users' to collect animated Pokémon characters by moving to locations within their environment. The aim is to collect as many characters as possible which is encapsulated by the developer's slogan 'Gotta catch 'em all'. When a user is near a Pokémon character, the mobile phone vibrates to alert the user to move to the characters location and catch it by throwing a Pokéball. To level up, users' need to be physically active, travelling 2-10 km, and by doing so, hatch the eggs they have incubated on the application.

To date, few articles have examined the impact of Pokémon Go. One study estimated that Pokémon Go users' have accrued 144 billion steps in the US[3]. Likewise, Xian et al[4] reported an increase in physical activity from pre- to post-launch and that the number of users' reaching the ≥10,000 daily steps recommendation significantly increased from 15.3% to 27.5%. They also reported the greatest increase in physical activity for those using the application most often, people who are overweight or with obesity and those with the lowest pre-launch physical activity levels. Similarly, Wong[5] reported the greatest increases in physical activity amongst users' who were classified as sedentary prior to the launch of Pokémon Go.

To the authors' knowledge, only one study has reported data representing the impact of Pokémon Go over time. Howe et al.[6] examined Pokémon Go's impact on physical activity for 6-weeks. The initial increase in users' steps dissipated and returned to pre-launch levels. As this is the only study to examine Pokémon Go users' physical activity over time, this has not been confirmed.

As sedentary behaviour is an independent risk factor for non-communicable diseases[7], the potential of Pokémon Go to reduce sitting time warrants examination. It was hypothesised that Pokémon Go users' would report higher levels of physical activity than non-users' at baseline (hypothesis 1). Whilst no research has presented data on sitting time, in line with previous research reporting increased physical activity, it was hypothesised that sitting time would be lower in Pokémon Go users' (hypothesis 2). Finally, in line with Howe et al.[6] it was hypothesised that increased physical activity, would have reduced at 3-months follow up (hypothesis 3).

Materials and Methods

Design

A repeated measures design was used to examine the impact of Pokémon Go on physical activity, sitting time and perceptions of physical activity and health.

Participants

Participants could complete the 'Physical Activity and Pokémon Go Questionnaire' during a four-week period after Pokémon Go was released in the UK. After 4 weeks, 461 participants (n = 193 male, n = 265 female, n = 3 transgender), predominantly white (n = 420), not self-reporting a disability (n = 443). None reporting a disability were excluded as it was deemed that it would not impact on their physical activity. Users' and non-users' mean ± SD age, height, body mass and body mass index (BMI) at baseline is highlighted in Table 1

When invited to participate in future research, 234 participants provided their email addresses. At follow up, 127 (55%; n = 54 male, n = 72 female, n = 1 transgender), predominantly white (n = 117), not self-reporting a disability (n =122), provided consent and repeated the questionnaire at 3-months. Users' and non-users' mean ± SD age, height, body mass and BMI at 3-months is also highlighted in Table 1.

There were 23 users' and 104 non-users'; 56 were users' at baseline and 71 were non-users'. Thus, 33 participants ceased using Pokémon Go within 3-months and nobody became users'.

Measures

The self-administered, short version of the 7-day recall, International Physical Activity Questionnaire (IPAQ)[8] was adapted to develop the 'Physical Activity and Pokémon Go Questionnaire' and was distributed via, Qualtrics™.[9] Questions were presented in four sections as follows:

1) Demographics, anthropometrics and confirmation of whether participants had used Pokémon Go - completed by all participants.

2) IPAQ, with the addition of the weekend sitting time question taken directly from the self-administered long version of the 7-day recall IPAQ[8] - completed by all participants.

3) IPAQ adapted to ascertain the amount of physical activity undertaken solely when using Pokémon Go. Thus, for each item of the IPAQ, the statement, 'because you used the Pokémon Go™ app' was added. Questions were developed in-house to examine perceptions of the benefits of Pokémon Go on physical activity and health. Likert scales were used ranging from 'Strongly Disagree' to 'Strongly Agree' - completed by Pokémon Go users' only.

4) Perceptions of the benefits of Pokémon Go on physical activity and health. (as in section 3) - completed by non-users' only.

Procedures

Following approval from Sheffield Hallam University's Faculty of Health and Wellbeing ethics committee, the questionnaire was distributed through social media from 22nd July 2016 using a bespoke link.[10] Participants were informed not to complete the questionnaire if during the last 7 days they had not been able to undertake their typical amount of physical activity due to injury, illness or for any other reason. After 3-months, participants who provided an email were contacted again.

Data Analysis

Mixed models Analysis of Variance (ANOVA) examining between subject factors (e.g. user versus non- user) and within subject factors (e.g. baseline versus 3-months) were used. Bonferroni correction for confidence interval adjustment and follow up post-hoc tests with Scheffé correction were used to examine the impact of Pokémon Go use and gender on self-reported BMI, days and minutes of vigorous and moderate physical activity and walking, sitting on weekdays and weekends, and perceptions of the impact of Pokémon Go on physical activity and health, at baseline and 3-months follow up.

Mann-Whitney U tests were used to examine gender differences in users' perceptions of the specific impact that using the application had on physical activity and sitting time at baseline and 3-months follow up.

Repeated measures ANOVA with Bonferroni correction for confidence interval adjustment and follow up post-hoc tests with Scheffé correction were used to examined gender differences in self-reported BMI, days of vigorous and moderate physical activity and walking, and minutes of vigorous and moderate physical activity and walking, sitting on weekdays and weekends at baseline compared to 3-months follow up for: 1) users' who remained users'; 2) users' who became non-users'; and 3) non-users' who remained non-users'. Follow up independent t-tests examined significant gender effects.

Statistical significance was accepted if $p < 0.05$. Effect sizes were quantified using partial eta squared (η^2), with 0.1, 0.3, and > 0.5 considered small, medium, and large effects, respectively. Data are presented as mean ± SD unless otherwise stated.

Results

Descriptive statistics for study population physical activity and sitting time at baseline are shown in Table 2; study population physical activity and sitting time at 3-months are shown in Table 3; and users' physical activity and reduced sitting time reported specifically due to Pokémon Go use are shown in Table 4.

Baseline

Mixed model ANOVA highlighted main effects for Pokémon Go users' or non-users' on the amount of days of vigorous and moderate physical activity and walking ($F(1, 418) = 24.52$, $p < 0.01$, $\eta_p^2 = 0.03$; $F(1, 418) = 4.25$, $p < 0.05$, $\eta_p^2 = 0.01$; $F(1, 418) = 10.52$, $p < 0.01$, $\eta_p^2 = 0.03$ respectively). Users' reported less days of vigorous physical activity than non-users'. However, users' also reported they undertook more days of moderate physical activity and walking compared to non-users'. There were no differences in BMI, minutes of vigorous and moderate physical activity or walking between Pokémon Go users' and non-users' ($p > 0.05$). Likewise, there were no differences in sitting time on weekdays or weekends ($p > 0.05$).

Main effects of gender were observed on the amount of days participants reported undertaking vigorous and moderate physical activity and walking ($F(2, 418) = 6.56$, $p < 0.01$, $\eta_p^2 = 0.03$; $F(2, 418) = 3.26$ $p < 0.05$, $\eta_p^2 = 0.01$; $F(2, 418) = 4.76$, $p < 0.01$, $\eta_p^2 = 0.02$ respectively), and the amount of minutes of vigorous physical activity ($F(2, 418) = 8.02$, $p < 0.01$, $\eta_p^2 = 0.03$). Males reported more days of vigorous and moderate physical activity, and walking and more minutes of vigorous physical activity than females. There were no gender differences for BMI, minutes of moderate physical activity or walking ($p > 0.05$). There were also no gender differences for sitting time on weekdays or weekends ($p > 0.05$).

There was an interaction between using Pokémon Go and gender on BMI and minutes of moderate physical activity ($F(1, 418) = 4.08$, $p < 0.05$, $\eta_p^2 = 0.10$; $F(1, 418) = 7.11$, $p < 0.01$, $\eta_p^2 = 0.02$). The interactions demonstrated that female users' reported a higher BMI than non-users', whilst male users' reported a lower BMI compared to non-users'. The interaction also demonstrated that male users' reported more minutes of moderate physical activity than non-users', whilst female users' reported less minutes of moderate physical activity compared to non-users'. There were no interaction effects for Pokémon Go use and gender on the amount of days of vigorous physical activity and walking, or minutes of vigorous physical activity and walking ($p > 0.05$). Likewise, there were no interactions for sitting time on weekdays or weekends ($p > 0.05$).

Perceptions of whether Pokémon Go use can increase physical activity and improve health

Perceptions of whether Pokémon Go use can increase physical activity and improve health at baseline are highlighted in Figure 1. Mixed models ANOVA revealed a main effect for using Pokémon Go or not on perceptions of whether Pokémon Go can increase physical activity and improve health at baseline ($F(1, 422) = 5.95$, $p < 0.05$, $\eta_p^2 = 0.01$; $F(1, 422) = 4.32$, $p < 0.05$, $\eta_p^2 = 0.01$ respectively). Users' had a stronger perception that Pokémon Go use can increase physical activity and improve health compared to non-users' at baseline ($p < 0.05$).

There was a main effect of gender on perceptions of whether Pokémon Go can improve health ($F(2, 422) = 3.65$, $p < 0.05$, $\eta_p^2 = 0.02$), where males reported a stronger perception that Pokémon Go use can improve health compared to females ($p < 0.05$). There was no main effect at baseline for gender on perceptions that Pokémon Go use can increase physical activity ($p > 0.05$). There was no interaction between Pokémon Go use and gender for perceptions of whether Pokémon Go use can increase physical activity and improve health ($p > 0.05$).

Physical activity and reduced sitting time specifically due to Pokémon Go

When users' were specifically asked how the application impacted their physical activity and sitting time, Mann-Whitney U tests revealed that there was no gender difference for the days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there was no gender difference on sitting time on weekdays and weekends ($p > 0.05$).

Three months follow up

Mixed models ANOVA highlighted main effects for Pokémon Go use or not on days of vigorous physical activity, minutes of vigorous physical activity, and minutes walking ($F(1, 104) = 4.71$, $p < 0.05$, $\eta_p^2 = 0.04$; $F(1, 104) = 4.24$, $p < 0.05$, $\eta_p^2 = 0.04$; $F(1, 104) = 4.48$, $p < 0.05$, $\eta_p^2 = 0.04$ respectively). Users' reported less days and minutes of vigorous physical than non-users'. Users' reported more minutes of walking compared to non-users'. There were no significant differences for BMI, days of moderate physical activity or walking between users' and non-users' ($p > 0.05$). Likewise, there was no significant differences in sitting time on weekdays or weekends between users' and non-users' ($p > 0.05$).

There were no significant gender differences for BMI, or days and minutes of vigorous and moderate physical activity and walking ($p > 0.05$). Likewise, there were no significant gender differences for sitting time on weekdays or weekends ($p > 0.05$).

There was a significant interaction between using Pokémon Go or not and gender on BMI and the amount of days of walking ($F(1, 104) = 4.76$, $p < 0.05$, $\eta_p^2 = 0.04$; $F(1, 104) = 5.45$, $p < 0.05$, $\eta_p^2 = 0.05$ respectively). The interactions demonstrated that female users' reported a higher BMI than non-users', whilst male users' reported a lower BMI compared to non-users'. Interactions also demonstrated that male users' reported more days of walking than non-users', whilst female users' reported less days of walking compared to non-users'. There were no interactions between Pokémon Go use and gender for the amount of days or minutes of vigorous and moderate physical activity ($p > 0.05$). Likewise, there were no interactions between Pokémon Go use and gender for sitting time on weekdays and weekends ($p > 0.05$).

Perceptions of whether Pokémon Go use can increase physical activity and improve health

Perceptions of whether Pokémon Go use can increase physical activity and improve health at 3-months are highlighted in Figure 1. Mixed models ANOVA highlighted a main effect of Pokémon Go use on perceptions of whether Pokémon Go can increase physical activity and improve health at 3-months ($F(1, 102) = 6.67$, $p < 0.05$, $\eta_p^2 = 0.06$; $F(1, 102) = 4.50$, $p < 0.05$, $\eta_p^2 = 0.04$ respectively). Users' had a stronger perception that Pokémon Go use can increase physical activity and improve health compared to non-users' ($p < 0.05$). At 3-months, there was no main effect of gender on perceptions of whether Pokémon Go use can increase physical activity or improve health ($p > 0.05$). There were no interactions between gender and Pokémon Go use at 3-months ($p > 0.05$).

Physical activity and reduced sitting time specifically due to Pokémon Go

When users' were specifically asked how the application impacted their physical activity and sitting time, Mann-Whitney U tests revealed that there was no gender difference for the days or minutes of vigorous physical activity, moderate physical activity, and walking ($p > 0.05$). Likewise, there was no gender difference for sitting on weekdays or weekends ($p > 0.05$).

Comparison of Pokémon Go users' at baseline and 3-months

Repeated measures ANOVA revealed that there was a main effect of sitting time on a weekday from baseline to 3-months, where participants reported more sitting at 3-months ($F(1, 20) = 5.37$, $p < 0.05$, $\eta_p^2 = 0.21$). Repeated measures ANOVA highlighted that there was no main effect of time (baseline vs 3-months) on BMI, days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there was no main effect of time (baseline vs 3-months) on sitting time at weekends ($p > 0.05$).

There were no gender differences at baseline compared to 3-months follow up for BMI, the amount of days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there were no gender differences at baseline compared to 3-months follow up for sitting time on weekdays and weekends ($p > 0.05$).

There were no gender interactions of Pokémon Go use and time (baseline vs 3-months) for BMI, the amount or days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there were no gender interactions of Pokémon Go use and time (baseline vs 3-months) for sitting time on weekdays and weekends ($p > 0.05$).

Physical activity and reduced sitting time specifically due to Pokémon Go

When users' were specifically asked how the application impacted their physical activity and sitting time, repeated measures ANOVA revealed that there were no main effects, gender differences or interactions for the impact of Pokémon Go and gender between baseline and 3-months on the days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there were no main effects, gender differences or interactions for the impact of Pokémon Go and gender between baseline and 3-months for sitting time on weekdays and weekends ($p > 0.05$).

Comparison of Pokémon Go users' at baseline who became non-users' at 3-months

Repeated measures ANOVA highlighted there was a main effect of time (baseline vs 3-months) where participants reported more sitting at 3-months ($F(1, 31) = 6.97$, $p < 0.05$, $\eta_p^2 = 0.18$). However, there was no main effect of time on BMI, the days or minutes of vigorous and moderate physical activity, and walking, ($p > 0.05$). Likewise, there was no main effect of time for sitting time on weekdays ($p > 0.05$).

There were no gender differences between baseline and 3-months for BMI, the amount or days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there were no gender differences between baseline and 3-months for sitting time on weekdays or weekends ($p > 0.05$).

There were interactions between baseline and 3-months for gender and days of vigorous physical activity and sitting time on weekends ($F(1, 31) = 5.52$, $p < 0.05$, $\eta_p^2 = 0.15$; $F(1, 31) = 6.97$, $p < 0.05$, $\eta_p^2 = 0.18$; $F(1, 31) = 7.35$, $p < 0.05$, $\eta_p^2 = 0.19$ respectively). Males reported more days of vigorous physical activity and maintained their sitting time on weekends at 3-months compared to baseline, whilst females reported more days of vigorous physical activity and less sitting time on weekends at baseline compared to 3-months follow up. There were no gender interactions between baseline and 3-months for BMI, the amount or days of moderate physical activity, and walking, or minutes of vigorous and moderate physical activity and walking ($p > 0.05$). Likewise, there were no gender interactions between baseline and 3-months for sitting time on weekdays ($p > 0.05$).

Comparison of non-users' at baseline and at 3-months

Repeated measures ANOVA highlighted there was no main effect of time (baseline vs 3-months) on BMI, the days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there was no main effect of time for sitting time on weekdays and weekends ($p > 0.05$).

Repeated measures ANOVA highlighted there was a gender effect of BMI, days of vigorous physical activity from baseline to 3-months ($F(1, 69) = 6.36$, $p < 0.05$, $\eta_p^2 = 0.09$; $F(1, 69) = 7.97$, $p < 0.05$, $\eta_p^2 = 0.10$). Follow up independent t-tests revealed males reported a higher BMI at baseline and at 3-months compared to females ($t(67) = 2.92$, $p < 0.01$; $t(65) = 2.14$, $p < 0.05$). There was no difference at baseline between males and females for the amount of days of vigorous physical activity ($p > 0.05$), however, there was a difference at 3-months follow up ($t(69) = 3.00$, $p < 0.01$). There were no gender differences between baseline and 3-months follow up for moderate physical activity, and walking, or minutes of vigorous and moderate physical activity and walking ($p > 0.05$). Likewise, there were no gender differences between baseline and 3-months follow up for sitting time on weekdays or weekends (p > 0.05).

There was a gender interaction between baseline and 3-months for minutes of moderate physical activity ($F(1, 69) = 4.55$, $p < 0.05$, $\eta_p^2 = 0.06$). Females reported more minutes of moderate physical activity at baseline compared to 3-months, whilst males reported less minutes of moderate physical activity compared to 3-months. There were no gender interactions between baseline and 3-months for BMI, the amount or days of vigorous and moderate physical activity, and walking, or minutes of vigorous physical activity and walking (p > 0.05). Likewise, there were no gender interactions between baseline and 3-months for sitting time on weekdays or weekends (p > 0.05).

Discussion

This study examined the impact of Pokémon Go on physical activity, sitting time and perceptions of the physical activity and health benefits. It was hypthesized that users' would report higher levels of physical activity and less sitting time than non-users' at baseline. Significant differences were identified for the amount of days of vigorous physical activity, moderate physical activity and walking at baseline. Users' reported more days of moderate physical activity and days of walking compared to non-users'. However, they also reported less days of vigorous physical activity, which only partially supports hypothesis 1. This is understandable, given that the objective of using Pokémon Go is to find Pokémon characters, which is unlikely to involve vigorous physical activity. The exploratory nature of the application, where users' need to search to find characters, means there is a greater likelihood of moderate physical activity or walking.

There was a significant interaction between using Pokémon Go or not and gender, where BMI and moderate physical activity differed for males and females. Interestingly, female users' had a higher BMI than the non-users', whilst male users' had a lower BMI than non-users'. In both instances, a lower

BMI was associated with more minutes of moderate physical activity, which in this case was evident for male users' and female non-users'. This suggests that Pokémon Go use is not determined by BMI.

At baseline, there was a gender difference in perceptions of whether Pokémon Go can improve health, where males reported a stronger perception that the application can improve health compared to females. Whilst males had a more favourable perception compared to females, both genders reported positive perceptions of the potential impact of Pokémon Go. A systematic review of physical activity applications, reported that there is high potential for such technology to encourage physical activity based on positive user perceptions of their usefulness and viability. [11]

At 3-months, only 18% of participants continued to use Pokémon Go, 56% were non-users' at baseline and at 3-months follow up, and 26% were users' that became non-users'. Zero participants were non-users' that became users'. Thus, the number of users' from baseline to 3-months follow up decreased. Despite this, for users' who remained users', there were no differences in physical activity at baseline compared to 3-months follow up. Thus, any impact of Pokémon Go on physical activity was sustained over time. Our study lends support for previous work that has also identified the potential benefits of utilising smartphone applications to encourage behaviour change over time.[12-13] However, participants reported an increase in sitting time on weekdays at 3-months compared to baseline, suggesting that any benefit in reducing sitting time on weekdays dissipates. There were no significant gender differences in physical activity or sitting time when comparing baseline to 3-months follow up suggesting males and females respond and interact the same with Pokémon Go.

There was no difference in physical activity or sitting time amongst users' at baseline who became non-users' at 3-months follow up. Thus, ceasing Pokémon Go use did not significantly effect physical activity or sitting time. This suggests that these participants have replaced Pokémon Go with another form of physical activity given that at baseline users' reported more physical activity than non-users'.

At 3-months, there were no significant gender differences in physical activity, sitting time or perceptions of whether Pokémon Go can increase physical activity and improve health. However, there was an interaction between using Pokémon Go or not and gender on BMI and days of walking. Akin to baseline, female users' reported a higher BMI than non-users', whilst male users' reported a lower BMI than non-users' at 3-months follow up. Thus, Pokémon Go usage at both baseline and 3-months was evident for males with a lower BMI and females with a higher BMI. Male users' reported more days of walking compared to non-users', whilst female users' reported less days of walking compared to non-users' at 3-months. Thus, Pokémon Go use appears to have a beneficial impact on the amount of days' that males engaged in walking, but this effect was not observed in females where they engaged in significantly less days of walking compared to non-users'. The current study findings therefore suggest that Pokémon Go can therefore be a useful application to encourage walking behaviour in males.

This study is the first to examine the impact of Pokémon Go on sitting time. Given the evidence demonstrating the importance of reducing sitting time, particularly in people who are already inactive, interventions are warranted and require evaluation. This study has also reported the longest follow up period, providing an indication of use and impact of Pokémon Go and compared to Howe et al.[6], collected data at two time points rather than assessing drop off. The only significant difference between baseline and 3-months, was in the minutes of sitting time on weekdays for users' who remained users' at 3-months. Thus, physical activity was maintained, yet users' reported sitting more at 3-months compared to baseline. Increased sitting time suggests that users' are replacing light intensity physical activity with more sitting, which the IPAQ[8] does not measure.

Pokémon Go is a fad where the number of users' has reduced over time. Therefore, the potential of Pokémon Go to be an effective intervention to increase physical activity, as seen in the current study, is likely to be short lived. Once participants have collected all Pokémon characters, they would no longer be motivated to continue using the application for this reason. This would make sense given that the motivation to continue using Pokémon Go is likely to be low, as the application does not evolve, and the challenge of the application is lost when the objective has been completed. However, with timely evolution, Pokémon Go might encourage behaviour change and continued motivation, and this should be a focus for future work. Future work should also examine the use of Pokémon Go in younger people, given the likely appeal to children and adolescents.

This study is not without its limitations including self-selection bias which was unavoidable due to collecting the data using an online questionnaire. There is also a reliance on participants accurately self-reporting their physical activity (which is typically prone to over-reporting) and body mass (which is typically prone to under reporting). The physical activity and sitting time data was recalled for the week prior to completion rather than a continuation of data collection. Objective measures of physical activity and sitting time could have provided more valid data, although such measures have their own limitations. Whilst the IPAQ has strong psychometric properties we acknowledge that results specifically from the adapted section need to be interpreted with caution since validity and reliability may have been compromised. We are confident that including the weekend sitting time item was appropriate to measure overall sitting time for the week. Finally, whilst the sample size of users' who continued to be users' was small it was pleasing that there was an even representation of users' and non-users' at baseline and attrition of participants was favourable compared to other research utilising online questionnaires.

Conclusion

This is the first study to examine the use of Pokémon Go to reduce sitting time and both users' and non-users' perceptions on whether the application can benefit physical activity and health. Additionally, the follow up is greater compared to other studies examining Pokémon Go use. Key findings are that users' spent less days engaging in vigorous physical activity but more days engaging in moderate physical activity and walking compared to non-users'. Despite the number of users' declining, there was no change in physical activity over the 3-months follow up period for users', and thus, physical activity was maintained from baseline. Importantly, this sustained physical activity level was evident for users' who maintained use, but also those who stopped using the application suggesting that an alternative means of engaging in physical activity was found. Finally, the study demonstrated that users' at baseline who remained users' at 3-months follow up, reported more sitting time on weekdays at 3-months compared to baseline. Thus, the application did not prevent increased sitting time on weekdays highlighting the need for other interventions.

Abbreviations

ANOVA: Analysis of Variance; BMI: Body Mass Index

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Author Disclosure Statement

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Availability of data

Data will be deposited in SHURA and is available on request.

Author contributions

DRB conceived the idea and developed the initial questionnaire. Both DRB and SWF then contributed equally to all remaining aspects of the development of the research and the manuscript and agree to be accountable.

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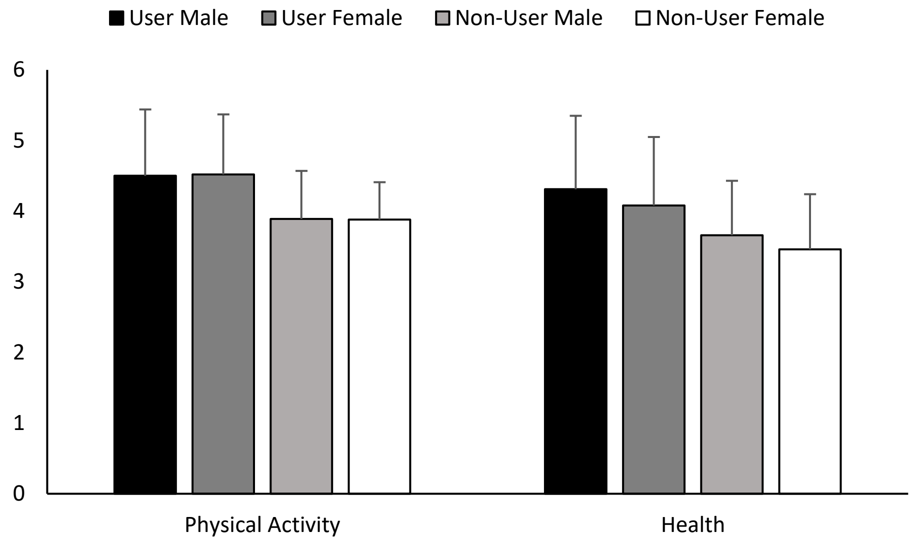

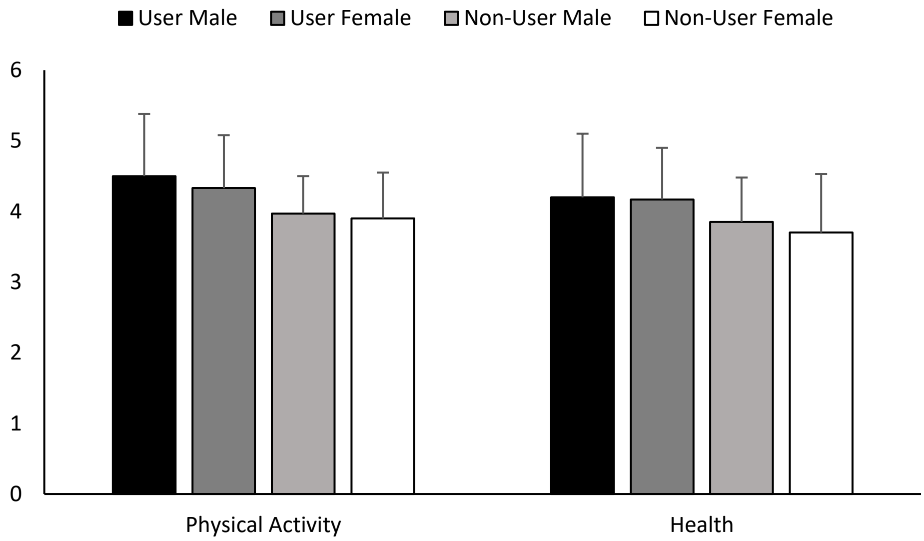

Figure 1 - Mean and standard deviation of Pokémon Go users' and non-users' perception that the application can increase physical activity and improve health at baseline (Panel A) and 3-months follow up (Panel B). All mean scores are based on Likert scales ranging from 1 'strongly disagree' – 5 'strongly agree'. * Denotes significant difference between Pokémon Go users' and non-users'.

Table 1: Demographic characteristics of Pokémon Go users' and non-users' at baseline and 3 months follow up. Values are mean (standard deviation)

	Baseline (n = 461)		**3 months (n = 127)**	
Participant characteristics	**Pokémon Go users (n = 236)**	**Non-users (n = 225)**	**Pokémon Go users (n = 23)**	**Non-users (n = 104)**
Age (years)	26.8	31.0*	31.4	29.6
	(8.2)	(11.0)	(12.1)	(9.0)
Height (m)	1.7	1.7	1.7	1.7
	(0.1)	(0.1)	(0.1)	(0.1)
Body mass (kg)	74.9	71.5*	78.5	72.0
	(16.4)	(16.7)	(15.4)	(15.5)
BMI (kg/m^2)	25.2	24.1*	27.0	24.3*
	(5.4)	(4.6)	(6.7)	(4.1)

*p = < 0.05

Table 2: Study population physical activity and sitting time at baseline

	Whole sample (n = 461)					Pokémon Go users' (n = 236)					Non-users' (n = 225)				
	Vig	Mod (n = 304)	Walk	Sitting WKD	Sitting WKE	Vig	Mod	Walk	Sitting WKD	Sitting WKE	Vig	Mod	Walk	Sitting WKD	Sitting WKE
Min	66.58	64.57	105..51	372.52	312.99	64.24	69.45	111.97	386.04	328.33	69.03	59.44	98.73	358.27	297.02
	(71.03)	(103.00)	(126.18)	(208.77)	(181.23)	(74.14)	(117.98)	(117.47)	(200.50)	(188.92)	(67.68)	(77.50)	(134.63)	(216.67)	(171.84)
Days	2.53	2.26	5.85	-	-	2.07	2.12	6.18	-	-	3.02	2.41	5.50	-	-
	(2.07)	(2.28)	(1.88)			(2.06)	(2.33)	(1.56)			(1.97)	(2.21)	(2.12)		

Mean and standard deviation of the whole sample, Pokémon Go users' and non-users' vigorous physical activity, moderate physical activity, walking, sitting on weekdays and sitting on weekends at baseline. Vig = Vigorous physical activity; Mod = Moderate physical activity; Walk = Walking; WKD = Weekday; WKE = Weekend; Min = Minutes

Table 3: Study population physical activity and sitting time at 3-months

	Whole sample (n = 127)					**Pokémon Go users' (n = 23)**					**Non-users' (n = 104)**				
	Vig	Mod	Walk	Sitting WKD	Sitting WKE	Vig	Mod	Walk	Sitting WKD	Sitting WKE	Vig	Mod	Walk	Sitting WKD	Sitting WKE
Min	61.73 (55.33)	59.68 (83.35)	80.08 (81.87)	403.70 (172.70)	338.94 (176.00)	42.17 (46.61)	61.74 (83.22)	100.00 (91.70)	446.09 (174.06)	336.87 (176.32)	66.06 (56.36)	59.23 (83.77)	75.59 (79.29)	394.33 (171.82)	339.41 (176.80)
Days	2.46 (2.03)	2.28 (2.15)	5.95 (1.77)	-	-	1.78 (1.86)	2.61 (2.27)	5.30 (1.96)	-	-	2.61 (2.04)	2.21 (2.12)	6.10 (1.71)	-	-

Mean and standard deviation of the whole sample, Pokémon Go users' and non-users' vigorous physical activity, moderate physical activity, walking, sitting on weekdays and sitting on weekends at 3-months follow up. Vig = Vigorous physical activity; Mod = Moderate physical activity; Walk = Walking; WKD = Weekday; WKE = Weekend; Min = Minutes

Table 4: Users physical activity and reduced sitting time reported specifically due to Pokémon Go

	Baseline (n = 236)					3-months follow up (n = 23)				
	Vig	Mod	Walk	Reduced sitting WKD	Reduced sitting WKE	Vig	Mod	Walk	Reduced sitting WKD	Reduced sitting WKE
Min	13.64 (49.30)	27.45 (63.06)	85.93 (100.11)	85.43 (92.53)	97.90 (102.53)	5.87 (15.79)	11.09 (28.05)	53.26 (56.31)	28.26 (46.76)	69.57 (104.61)
Days	0.38 (1.17)	0.84 (1.74)	4.77 (2.20)	-	-	0.17 (0.48)	0.48 (1.21)	3.30 (2.42)	-	-

Mean and standard deviation of Pokémon Go users' perceptions of the amount of vigorous physical activity, moderate physical activity, walking, reduced sitting on weekdays and sitting on weekends due to Pokémon Go use Vig = Vigorous physical activity; Mod = Moderate physical activity; Walk = Walking; WKD = Weekday; WKE = Weekend; Min = Minutes