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Citation:

Broom, DR and Flint, SW (2018) 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. Games for Health Journal, 7 (6). ISSN 2161-783X DOI: <https://doi.org/10.1089/g4h.2018.0002>

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

3

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5

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8

9 **Running title** – Pokémon Go, Physical Activity and Sitting Time

10

11 Word count: 4623

12

13 **Keywords:** Pokémon Go, physical activity, sitting time, gamification, mobile health.

14

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18

19 **Abstract**

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

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

28 **Results:** At baseline, mixed models ANOVA revealed main effects for Pokémon Go users' versus non-
29 users' in the amount of days of vigorous physical activity, moderate physical activity and walking (All
30 $p < 0.01$). Users' reported that they undertook less days of vigorous physical activity than non-users'
31 but more days of moderate physical activity and walking. There were no differences in BMI, minutes
32 of vigorous or moderate physical activity, and walking, or sitting on weekdays (All $p > 0.05$). Repeated
33 measures ANOVA identified increased sitting on weekdays ($p < 0.05$), but maintained vigorous,
34 moderate and walking physical activity behaviours in users' who remained users'.

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

38 **Objective**

39

40 Mobile phone applications to increase physical activity and encourage healthy eating behaviour have
41 been evaluated, with reports that the most effective are those that incorporate virtual avatars, gaming
42 and social media.¹ The use of technological devices has great potential given the possibility of reaching
43 large populations at low cost. For instance, Ofcom² reported that 93% of UK adults personally own or
44 use a mobile phone. One such intervention delivered via a smartphone application is Pokémon Go,
45 which is a free-to-play, location-based augmented reality game that was released globally in July 2016.
46 Using Global Positioning System (GPS) and the mobile phone camera, the application encourages
47 users' to collect animated Pokémon characters by moving to locations within their environment. The
48 aim is to collect as many characters as possible which is encapsulated by the developer's slogan 'Gotta
49 catch 'em all'. When a user is near a Pokémon character, the mobile phone vibrates to alert the user to
50 move to the characters location and catch it by throwing a Pokéball. To level up, users' need to be
51 physically active, travelling 2-10 km, and by doing so, hatch the eggs they have incubated on the
52 application.

53

54 To date, few articles have examined the impact of Pokémon Go. One study estimated that Pokémon Go
55 users' have accrued 144 billion steps in the US³. Likewise, Xian et al⁴ reported an increase in physical
56 activity from pre- to post-launch and that the number of users' reaching the $\geq 10,000$ daily steps
57 recommendation significantly increased from 15.3% to 27.5%. They also reported the greatest increase
58 in physical activity for those using the application most often, people who are overweight or with
59 obesity and those with the lowest pre-launch physical activity levels. Similarly, Wong⁵ reported the
60 greatest increases in physical activity amongst users' who were classified as sedentary prior to the
61 launch of Pokémon Go.

62

63 To the authors' knowledge, only one study has reported data representing the impact of Pokémon Go
64 over time. Howe et al.⁶ examined Pokémon Go's impact on physical activity for 6-weeks. The initial

65 increase in users' steps dissipated and returned to pre-launch levels. As this is the only study to examine
66 Pokémon Go users' physical activity over time, this has not been confirmed.

67 As sedentary behaviour is an independent risk factor for non-communicable diseases⁷, the potential of
68 Pokémon Go to reduce sitting time warrants examination. It was hypothesised that Pokémon Go users'
69 would report higher levels of physical activity than non-users' at baseline (hypothesis 1). Whilst no
70 research has presented data on sitting time, in line with previous research reporting increased physical
71 activity, it was hypothesised that sitting time would be lower in Pokémon Go users' (hypothesis 2).
72 Finally, in line with Howe et al.⁶ it was hypothesised that increased physical activity, would have
73 reduced at 3-months follow up (hypothesis 3).

74

75 **Materials and Methods**

76

77 **Design**

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

80

81 **Participants**

82 Participants could complete the 'Physical Activity and Pokémon Go Questionnaire' during a four-week
83 period after Pokémon Go was released in the UK. After 4 weeks, 461 participants (n = 193 male, n =
84 265 female, n = 3 transgender), predominantly white (n = 420), not self-reporting a disability (n = 443).
85 None reporting a disability were excluded as it was deemed that it would not impact on their physical
86 activity. Users' and non-users' mean \pm SD age, height, body mass and body mass index (BMI) at
87 baseline is highlighted in Table 1

88

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

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

95

96 **Measures**

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

100

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

103

104 2) IPAQ, with the addition of the weekend sitting time question taken directly from the self-
105 administered long version of the 7-day recall IPAQ⁸ - completed by all participants.

106

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

112

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

115

116 **Procedures**

117 Following approval from Sheffield Hallam University's Faculty of Health and Wellbeing ethics
118 committee, the questionnaire was distributed through social media from 22nd July 2016 using a bespoke
119 link.¹⁰ Participants were informed not to complete the questionnaire if during the last 7 days they had

120 not been able to undertake their typical amount of physical activity due to injury, illness or for any other
121 reason. After 3-months, participants who provided an email were contacted again.

122

123 **Data Analysis**

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

130

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

134

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

141

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

145

146 **Results**

147

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

152

153 **Baseline**

154 Mixed model ANOVA highlighted main effects for Pokémon Go users' or non-users' on the amount of
155 days of vigorous and moderate physical activity and walking ($F(1, 418) = 24.52, p < 0.01, \eta_p^2 = 0.03$;
156 $F(1, 418) = 4.25, p < 0.05, \eta_p^2 = 0.01$; $F(1, 418) = 10.52, p < 0.01, \eta_p^2 = 0.03$ respectively). Users'
157 reported less days of vigorous physical activity than non-users'. However, users' also reported they
158 undertook more days of moderate physical activity and walking compared to non-users'. There were no
159 differences in BMI, minutes of vigorous and moderate physical activity or walking between Pokémon
160 Go users' and non-users' ($p > 0.05$). Likewise, there were no differences in sitting time on weekdays or
161 weekends ($p > 0.05$).

162

163 Main effects of gender were observed on the amount of days participants reported undertaking vigorous
164 and moderate physical activity and walking ($F(2, 418) = 6.56, p < 0.01, \eta_p^2 = 0.03$; $F(2, 418) = 3.26, p$
165 $< 0.05, \eta_p^2 = 0.01$; $F(2, 418) = 4.76, p < 0.01, \eta_p^2 = 0.02$ respectively), and the amount of minutes of
166 vigorous physical activity ($F(2, 418) = 8.02, p < 0.01, \eta_p^2 = 0.03$). Males reported more days of
167 vigorous and moderate physical activity, and walking and more minutes of vigorous physical activity
168 than females. There were no gender differences for BMI, minutes of moderate physical activity or
169 walking ($p > 0.05$). There were also no gender differences for sitting time on weekdays or weekends (p
170 > 0.05).

171

172 There was an interaction between using Pokémon Go and gender on BMI and minutes of moderate
173 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
174 interactions demonstrated that female users' reported a higher BMI than non-users', whilst male users'
175 reported a lower BMI compared to non-users'. The interaction also demonstrated that male users'
176 reported more minutes of moderate physical activity than non-users', whilst female users' reported less
177 minutes of moderate physical activity compared to non-users'. There were no interaction effects for
178 Pokémon Go use and gender on the amount of days of vigorous physical activity and walking, or
179 minutes of vigorous physical activity and walking ($p > 0.05$). Likewise, there were no interactions for
180 sitting time on weekdays or weekends ($p > 0.05$).

181

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

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

189

190 There was a main effect of gender on perceptions of whether Pokémon Go can improve health ($F(2,$
191 $422) = 3.65, p < 0.05, \eta_p^2 = 0.02$), where males reported a stronger perception that Pokémon Go use
192 can improve health compared to females ($p < 0.05$). There was no main effect at baseline for gender on
193 perceptions that Pokémon Go use can increase physical activity ($p > 0.05$). There was no interaction
194 between Pokémon Go use and gender for perceptions of whether Pokémon Go use can increase physical
195 activity and improve health ($p > 0.05$).

196

197 *Physical activity and reduced sitting time specifically due to Pokémon Go*

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

202

203 **Three months follow up**

204 Mixed models ANOVA highlighted main effects for Pokémon Go use or not on days of vigorous
205 physical activity, minutes of vigorous physical activity, and minutes walking ($F(1, 104) = 4.71, p <$
206 $0.05, \eta_p^2 = 0.04$; $F(1, 104) = 4.24, p < 0.05, \eta_p^2 = 0.04$; $F(1, 104) = 4.48, p < 0.05, \eta_p^2 = 0.04$
207 respectively). Users' reported less days and minutes of vigorous physical than non-users'. Users'
208 reported more minutes of walking compared to non-users'. There were no significant differences for
209 BMI, days of moderate physical activity or walking between users' and non-users' ($p > 0.05$). Likewise,
210 there was no significant differences in sitting time on weekdays or weekends between users' and non-
211 users' ($p > 0.05$).

212

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

216

217 There was a significant interaction between using Pokémon Go or not and gender on BMI and the
218 amount of days of walking ($F(1, 104) = 4.76, p < 0.05, \eta_p^2 = 0.04$; $F(1, 104) = 5.45, p < 0.05, \eta_p^2 =$
219 0.05 respectively). The interactions demonstrated that female users' reported a higher BMI than non-
220 users', whilst male users' reported a lower BMI compared to non-users'. Interactions also demonstrated
221 that male users' reported more days of walking than non-users', whilst female users' reported less days
222 of walking compared to non-users'. There were no interactions between Pokémon Go use and gender
223 for the amount of days or minutes of vigorous and moderate physical activity ($p > 0.05$). Likewise, there

224 were no interactions between Pokémon Go use and gender for sitting time on weekdays and weekends
225 ($p > 0.05$).

226

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

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

236

237 *Physical activity and reduced sitting time specifically due to Pokémon Go*

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

242

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

244 Repeated measures ANOVA revealed that there was a main effect of sitting time on a weekday from
245 baseline to 3-months, where participants reported more sitting at 3-months ($F(1, 20) = 5.37, p < 0.05,$
246 $\eta_p^2 = 0.21$). Repeated measures ANOVA highlighted that there was no main effect of time (baseline vs
247 3-months) on BMI, days or minutes of vigorous and moderate physical activity, and walking ($p > 0.05$).
248 Likewise, there was no main effect of time (baseline vs 3-months) on sitting time at weekends ($p >$
249 0.05).

250

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

255

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

260

261 *Physical activity and reduced sitting time specifically due to Pokémon Go*

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

268

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

270 Repeated measures ANOVA highlighted there was a main effect of time (baseline vs 3-months) where
271 participants reported more sitting at 3-months ($F(1, 31) = 6.97, p < 0.05, \eta_p^2 = 0.18$). However, there
272 was no main effect of time on BMI, the days or minutes of vigorous and moderate physical activity,
273 and walking, ($p > 0.05$). Likewise, there was no main effect of time for sitting time on weekdays ($p >$
274 0.05).

275

276 There were no gender differences between baseline and 3-months for BMI, the amount or days or
277 minutes of vigorous and moderate physical activity, and walking ($p > 0.05$). Likewise, there were no
278 gender differences between baseline and 3-months for sitting time on weekdays or weekends ($p > 0.05$).
279
280 There were interactions between baseline and 3-months for gender and days of vigorous physical
281 activity and sitting time on weekends ($F(1, 31) = 5.52, p < 0.05, \eta_p^2 = 0.15$; $F(1, 31) = 6.97, p < 0.05,$
282 $\eta_p^2 = 0.18$; $F(1, 31) = 7.35, p < 0.05, \eta_p^2 = 0.19$ respectively). Males reported more days of vigorous
283 physical activity and maintained their sitting time on weekends at 3-months compared to baseline,
284 whilst females reported more days of vigorous physical activity and less sitting time on weekends at
285 baseline compared to 3-months follow up. There were no gender interactions between baseline and 3-
286 months for BMI, the amount or days of moderate physical activity, and walking, or minutes of vigorous
287 and moderate physical activity and walking ($p > 0.05$). Likewise, there were no gender interactions
288 between baseline and 3-months for sitting time on weekdays ($p > 0.05$).

289

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

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

294

295 Repeated measures ANOVA highlighted there was a gender effect of BMI, days of vigorous physical
296 activity from baseline to 3-months ($F(1, 69) = 6.36, p < 0.05, \eta_p^2 = 0.09$; $F(1, 69) = 7.97, p < 0.05, \eta_p^2$
297 $= 0.10$). Follow up independent t-tests revealed males reported a higher BMI at baseline and at 3-months
298 compared to females ($t(67) = 2.92, p < 0.01$; $t(65) = 2.14, p < 0.05$). There was no difference at baseline
299 between males and females for the amount of days of vigorous physical activity ($p > 0.05$), however,
300 there was a difference at 3-months follow up ($t(69) = 3.00, p < 0.01$). There were no gender differences
301 between baseline and 3-months follow up for moderate physical activity, and walking, or minutes of
302 vigorous and moderate physical activity and walking ($p > 0.05$). Likewise, there were no gender

303 differences between baseline and 3-months follow up for sitting time on weekdays or weekends ($p >$
304 0.05).

305
306 There was a gender interaction between baseline and 3-months for minutes of moderate physical activity
307 ($F(1, 69) = 4.55, p < 0.05, \eta_p^2 = 0.06$). Females reported more minutes of moderate physical activity at
308 baseline compared to 3-months, whilst males reported less minutes of moderate physical activity
309 compared to 3-months. There were no gender interactions between baseline and 3-months for BMI, the
310 amount or days of vigorous and moderate physical activity, and walking, or minutes of vigorous
311 physical activity and walking ($p > 0.05$). Likewise, there were no gender interactions between baseline
312 and 3-months for sitting time on weekdays or weekends ($p > 0.05$).

313

314 **Discussion**

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

325

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

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

331

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

338

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

350

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

355

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

367

368 This study is the first to examine the impact of Pokémon Go on sitting time. Given the evidence
369 demonstrating the importance of reducing sitting time, particularly in people who are already inactive,
370 interventions are warranted and require evaluation. This study has also reported the longest follow up
371 period, providing an indication of use and impact of Pokémon Go and compared to Howe et al.⁶,
372 collected data at two time points rather than assessing drop off. The only significant difference between
373 baseline and 3-months, was in the minutes of sitting time on weekdays for users' who remained users'
374 at 3-months. Thus, physical activity was maintained, yet users' reported sitting more at 3-months
375 compared to baseline. Increased sitting time suggests that users' are replacing light intensity physical
376 activity with more sitting, which the IPAQ⁸ does not measure.

377

378 Pokémon Go is a fad where the number of users' has reduced over time. Therefore, the potential of
379 Pokémon Go to be an effective intervention to increase physical activity, as seen in the current study,
380 is likely to be short lived. Once participants have collected all Pokémon characters, they would no
381 longer be motivated to continue using the application for this reason. This would make sense given that
382 the motivation to continue using Pokémon Go is likely to be low, as the application does not evolve,
383 and the challenge of the application is lost when the objective has been completed. However, with

384 timely evolution, Pokémon Go might encourage behaviour change and continued motivation, and this
385 should be a focus for future work. Future work should also examine the use of Pokémon Go in younger
386 people, given the likely appeal to children and adolescents.

387

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

401

402 **Conclusion**

403 This is the first study to examine the use of Pokémon Go to reduce sitting time and both users' and non-
404 users' perceptions on whether the application can benefit physical activity and health. Additionally, the
405 follow up is greater compared to other studies examining Pokémon Go use. Key findings are that users'
406 spent less days engaging in vigorous physical activity but more days engaging in moderate physical
407 activity and walking compared to non-users'. Despite the number of users' declining, there was no
408 change in physical activity over the 3-months follow up period for users', and thus, physical activity
409 was maintained from baseline. Importantly, this sustained physical activity level was evident for users'
410 who maintained use, but also those who stopped using the application suggesting that an alternative
411 means of engaging in physical activity was found. Finally, the study demonstrated that users' at baseline

412 who remained users' at 3-months follow up, reported more sitting time on weekdays at 3-months
413 compared to baseline. Thus, the application did not prevent increased sitting time on weekdays
414 highlighting the need for other interventions.

415

416 **Abbreviations**

417 ANOVA: Analysis of Variance; BMI: Body Mass Index

418

419 **Acknowledgements**

420 The authors would like to express thanks to the participants and Tom Parkington, Matt Debney, Chloe
421 Rodgers, Rob Wilson and Jessica Sharpe for piloting the questionnaire. The authors would like to thank
422 the delegates of the 'gamification' session at the International Society of Behavioral Nutrition and
423 Physical Activity (ISBNPA) 2017 conference who provided ideas for analysis during question time.

424

425 **Author Disclosure Statement**

426 The authors declare no conflicts of interest and have received no funding for this research.

427

428 **Availability of data**

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

430

431 **Author contributions**

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

435

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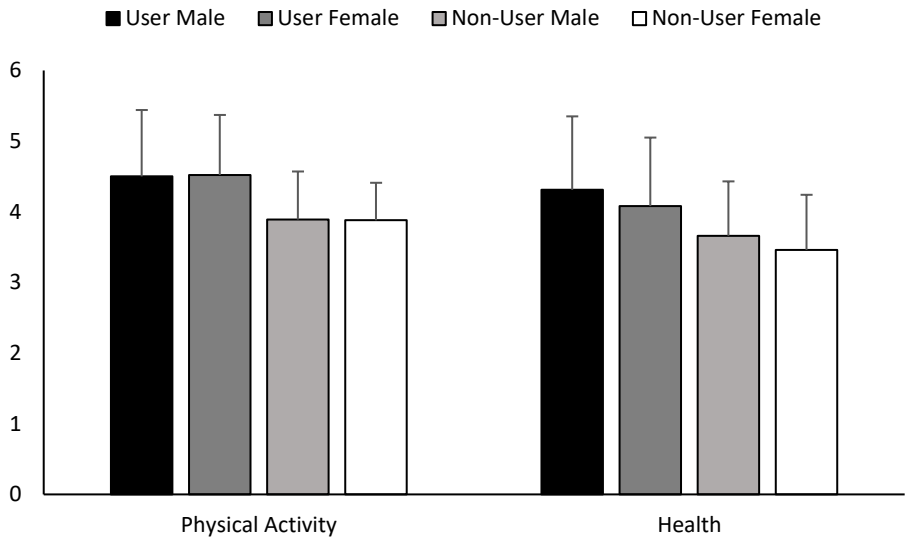
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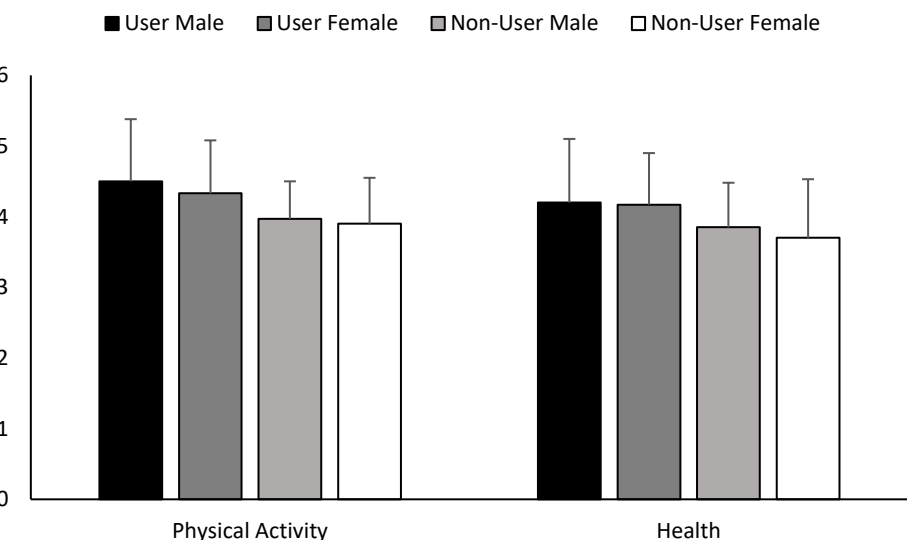
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486 Figure 1 - Mean and standard deviation of Pokémon Go users' and non-users' perception that
 487 the application can increase physical activity and improve health at baseline (Panel A) and 3-
 488 months follow up (Panel B). All mean scores are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

491

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

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

493 * $p = < 0.05$

494

495

496 **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	Walk	Sitting	Sitting	Vig	Mod	Walk	Sitting	Sitting	Vig	Mod	Walk	Sitting	Sitting
	(n = 304)			WKD	WKE				WKD	WKE				WKD	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)		

497

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

501

502

503 **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)	-	-

504

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

508

509 **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)	-	-

510

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

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