

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

BROOM, David <<http://orcid.org/0000-0002-0305-937X>> and FLINT, Stuart

Available from Sheffield Hallam University Research Archive (SHURA) at:

<https://shura.shu.ac.uk/22109/>

This document is the Accepted Version [AM]

Citation:

BROOM, David and FLINT, Stuart (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), 401-408. [Article]

Copyright and re-use policy

See <http://shura.shu.ac.uk/information.html>

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

4 Broom, D.R.^{1*} and Flint, S.W.²

5

6 ¹Academy of Sport and Physical Activity, Sheffield Hallam University, United Kingdom.

7 ²School of Sport, Leeds Beckett University, Fairfax Hall, Headingley Campus, Leeds, United
8 Kingdom.

9

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

11

12 Word count: 4623

13

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

15

16 *Correspondence: D.R.Broom@shu.ac.uk

17

18

19

20 **Abstract**

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

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

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

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

39 **Objective**

40

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

54

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

63

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

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

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

75

76 **Materials and Methods**

77

78 **Design**

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

81

82 **Participants**

83 Participants could complete the 'Physical Activity and Pokémon Go Questionnaire' during a four-
84 week period after Pokémon Go was released in the UK. After 4 weeks, 461 participants (n = 193
85 male, n = 265 female, n = 3 transgender), predominantly white (n = 420), not self-reporting a
86 disability (n = 443) completed the questionnaire. No participants reporting a disability were excluded
87 as it was deemed the disability would not impact on their physical activity. Users' and non-users'
88 mean \pm SD age, height, body mass and body mass index (BMI) at baseline is highlighted in Table 1

89

90 When invited to participate in future research, 234 participants provided their email addresses. At
91 follow up, 127 (55%; n = 54 male, n = 72 female, n = 1 transgender), predominantly white (n = 117),
92 not self-reporting a disability (n = 122), provided consent and repeated the questionnaire at 3-months.

93 Users' and non-users' mean \pm SD age, height, body mass and BMI at 3-months is also highlighted in
94 Table 1.

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

97

98 **Measures**

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

102

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

105

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

108

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

114

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

117

118 **Procedures**

119 Following approval from Sheffield Hallam University's Faculty of Health and Wellbeing ethics
120 committee, the questionnaire was distributed through social media from 22nd July 2016 using a

121 bespoke link.¹⁰ Participants were informed not to complete the questionnaire if during the last 7 days
122 they had not been able to undertake their typical amount of physical activity due to injury, illness or
123 for any other reason. After 3-months, participants **who provided an email** were contacted again.

124

125 **Data Analysis**

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

133

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

137

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

145

146 Statistical significance was accepted if $p < 0.05$. Effect sizes were quantified using partial eta squared
147 (η^2), with 0.01, 0.03, and > 0.05 considered small, medium, and large effects, respectively. Data are
148 presented as mean \pm standard deviation unless otherwise stated.

149

150 **Results**

151

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

156

157 *Baseline*

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

166

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

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

184

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

186 Perceptions of whether Pokémon Go use can increase physical activity and improve health at baseline
187 are highlighted in Figure 1. Mixed models ANOVA revealed a main effect for using Pokémon Go or
188 not on perceptions of whether Pokémon Go can increase physical activity and improve health at
189 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).
190 Users' had a stronger perception that Pokémon Go use can increase physical activity and improve
191 health compared to non-users' at baseline ($p < 0.05$).

192

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

199

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

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

205

206 **Three month follow up**

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

215

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

219

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

227 0.05). Likewise, there were no interactions between Pokémon Go use and gender for sitting time on
228 weekdays and weekends ($p > 0.05$).

229

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

231 Perceptions of whether Pokémon Go use can increase physical activity and improve health at 3-
232 months are highlighted in Figure 1. Mixed models ANOVA highlighted a main effect of Pokémon Go
233 use on perceptions of whether Pokémon Go can increase physical activity and improve health at 3-
234 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).
235 Users' had a stronger perception that Pokémon Go use can increase physical activity and improve
236 health compared to non-users' ($p < 0.05$). At 3-months, there was no main effect of gender on
237 perceptions of whether Pokémon Go use can increase physical activity or improve health ($p > 0.05$).
238 There were no interactions between gender and Pokémon Go use at 3-months ($p > 0.05$).

239

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

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

245

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

247 Repeated measures ANOVA revealed that there was a main effect of sitting time on a weekday from
248 baseline to 3-months, where participants reported more sitting at 3-months ($F(1, 20) = 5.37, p < 0.05,$
249 $\eta_p^2 = 0.21$). Repeated measures ANOVA highlighted that there was no main effect of time (baseline vs
250 3-months) on BMI, days or minutes of vigorous and moderate physical activity, and walking ($p >$
251 0.05). Likewise, there was no main effect of time (baseline vs 3-months) on sitting time at weekends
252 ($p > 0.05$).

253

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

258

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

263

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

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

271

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

273 Repeated measures ANOVA highlighted that there was a main effect of time (baseline vs 3-months)
274 where participants reported more sitting at weekends at 3-months ($F(1, 31) = 6.97, p < 0.05, \eta_p^2 =$
275 0.18). However, there was no main effect of time on BMI, the days or minutes of vigorous and
276 moderate physical activity, and walking, ($p > 0.05$). Likewise, there was no main effect of time for
277 sitting time on weekdays ($p > 0.05$).

278

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

281 gender differences between baseline and 3-months for sitting time on weekdays or weekends ($p >$
282 0.05).

283

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

293

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

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

298

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

307 Likewise, there were no gender differences between baseline and 3-months follow up for sitting time
308 on weekdays or weekends ($p > 0.05$).

309

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

317

318 **Discussion**

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

329

330 There was a significant interaction between using Pokémon Go or not and gender, where BMI and
331 moderate physical activity differed for males and females. Interestingly, female users' had a higher
332 BMI than the non-users', whilst male users' had a lower BMI than non-users'. In both instances, a
333 lower BMI was associated with more minutes of moderate physical activity, which in this case was

334 evident for male users' and female non-users'. This suggests that Pokémon Go use is not determined
335 by BMI.

336

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

343

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

355

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

360

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

373

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

383

384 Pokémon Go is a fad where the number of users' has reduced over time. Therefore, the potential of
385 Pokémon Go to be an effective intervention to increase physical activity, as seen in the current study,
386 is likely to be short lived. Once participants have collected all Pokémon characters, they would no
387 longer be motivated to continue using the application for this reason. This would make sense given
388 that the motivation to continue using Pokémon Go is likely to be low, as the application does not

389 evolve, and the challenge of the application is lost when the objective has been completed. However,
390 with timely evolution, Pokémon Go might encourage behaviour change and continued motivation,
391 and this should be a focus for future work. Future work should also examine the use of Pokémon Go
392 in younger people, given the likely appeal to children and adolescents.

393

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

407

408 **Conclusion**

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

417 suggesting that an alternative means of engaging in physical activity was found. Finally, the study
418 demonstrated that users' at baseline who remained users' at 3-months follow up, reported more sitting
419 time on weekdays at 3-months compared to baseline. Thus, the application did not prevent increased
420 sitting time on weekdays highlighting the need for other interventions.

421

422 **Abbreviations**

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

424

425 **Acknowledgements**

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

431

432 **Author Disclosure Statement**

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

434

435 **Availability of data**

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

437

438 **Author contributions**

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

442

443 **References**

- 444 1. Hswen Y, Murti V, Vormawor AA, et al. Virtual avatars, gaming, and social media:
445 Designing a mobile health app to help children choose healthier food options. *J Mob Technol*
446 *Med* 2013; 2(2):8.
- 447 2. Ofcom. Fast facts. 2017. <https://www.ofcom.org.uk/about-ofcom/latest/media/facts>.
448 [Last accessed 12 March 2018].
- 449 3. Althoff T, White RW, Horvitz E. Influence of Pokémon Go on physical activity: study and
450 implications. *J Med Internet Res* 2016; 18(12).
- 451 4. Xian Y, Xu H, Xu H, Liang L, Hernandez AF, Wang TY, Peterson ED. An Initial Evaluation
452 of the Impact of Pokémon GO on Physical Activity. *J Am Heart Assoc* 2017; 6(5):e005341.
- 453 5. Wong FY. Influence of Pokémon Go on physical activity levels of university players: a cross-
454 sectional study. *Int J Health Geogr* 2017; 16(1):8.
- 455 6. Howe KB, Suharlim C, Ueda P, et al. Gotta catch 'em all! Pokémon GO and physical activity
456 among young adults: difference in differences study. *BMJ* 2016; 355: i6270.
- 457 7. Owen N, Bauman A, Brown W. Too much sitting: a novel and important predictor of chronic
458 disease risk? *Br J Sport Med* 2009; 43(2):81-83.
- 459 8. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-
460 country reliability and validity. *Med Sci Sp Ex* 2003; 35(8):1381-1395.
- 461 9. Qualtrics. (2017). Qualtrics. www.qualtrics.com. [Last accessed 27 December 2017].
- 462 10. Pokémon Go Physical Activity Questionnaire. 2017. Physical Activity & Pokémon Go.
463 https://shusls.eu.qualtrics.com/SE/?SID=SV_4Git5qVSH4ZA1a. [Last Accessed 27
464 December 2017].
- 465 11. Bort-Roig J, Gilson ND, Puig-Ribera A, et al. Measuring and influencing physical activity
466 with smartphone technology: a systematic review. *Sports Med* 2014; 44(5):671-86.
- 467 12. Payne HE, Lister C, West JH, et al. Behavioral functionality of mobile apps in health
468 interventions: a systematic review of the literature. *JMIR mHealth and uHealth*. 2015; 3(1).

469 13. Schoeppe S, Alley S, Van Lippevelde W, et al. Efficacy of interventions that use apps to
470 improve diet, physical activity and sedentary behaviour: a systematic review. Int J of Behav
471 Nutr and Phys Act 2016; 13(1): 127.

472

473 Correspondence to: David Robert Broom

474 Academy of Sport and Physical Activity,

475 Sheffield Hallam University,

476 Sheffield,

477 UK,

478 S10 2BP

479

480 T: 0044 114 2254369

481 F: 0044 114 2254356

482 E: D.R.Broom@shu.ac.uk

483

484

485

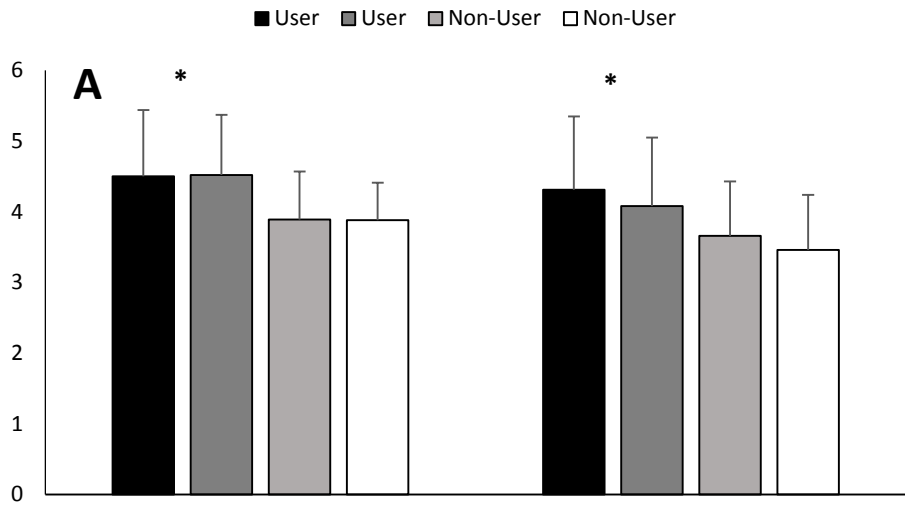
486

487

488

489

490



491

492

493

494

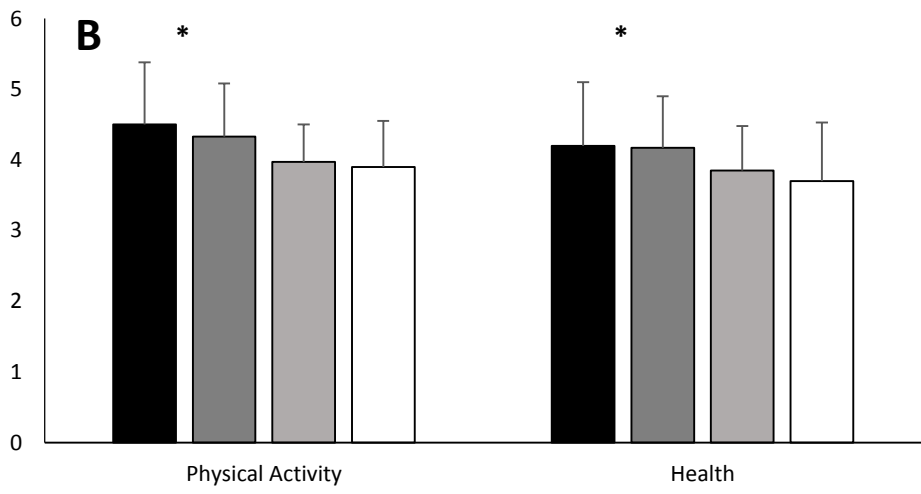
495

496

497

498

499



500

501 Figure 1

502

503

504

505

506

507

508

509

510

512 Table 1: Demographic characteristics of Pokémon Go users' and non-users' at baseline and 3 months
 513 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)

514 **p* = < 0.05

515

516

517

518

519

520

521

522

523

524

525

526

527

528

529

530

531

532

533 **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)		

534

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

538

539

540

541

542

543

544

545 **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)	-	-

546

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

550

551

552

553

554

555

556

557

558 **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)	-	-

559

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

563