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Maintenance of behaviour change following a community-wide gamification based physical activity intervention

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ABSTRACT

Gamification refers to the use of game mechanics (e.g. competition, point scoring, progress visualisation and task setting) to engage and motivate people to achieve an end goal. Public health programs that incorporate gamification-based approaches which aim to improve the public's health have grown in popularity, however most commonplace are individualistic, smartphone-based applications and few studies have been conducted on community-wide interventions. Furthermore, the few studies which have been conducted have relied on small sample sizes with short-term follow-up. In view of this gap in current understanding, this study explored the impact of a community-wide gamified intervention, called 'Beat the Street' (in Reading UK) on levels of physical activity at 1 and 2-years post-intervention (between 2014 and 2016). Data were available for N = 1567 participants at one-year post-intervention and N = 723 participants at 2-years post-intervention. A Pretest-Posttest analysis revealed a 11% and 13% decrease in levels of inactivity at 1 and 2-years post-intervention respectively. Furthermore, participants who were inactive at baseline reported undertaking 3.4 and 3.8 days of activity at 1 and 2-years post-intervention, respectively. These findings provide promising preliminary evidence that gamification may be effective for decreasing physical inactivity and game-design mechanisms which may support behaviour change are discussed.

1. Introduction

Physical inactivity is the fourth leading risk factor for death worldwide behind high blood pressure, tobacco use and high blood glucose and is responsible for 6% of deaths each year (World Health Organisation, 2012). The World Health Organization (2010) advocate adults should engage in 150 min of moderate physical activity each week and estimate achieving this level of exercise is attributable to approximately 30% reduced risk of ischaemic heart disease, 27% reduced risk of diabetes and 21–25% reduced risk of breast and colon cancer (World Health Organisation, 2009). However, the number of people who are physically active has decreased by 20%–22% from 1961 to 65 to 2005–2009 in developed countries and by 7–38% from 1991 to 2002 to 2008–09 in developing countries (Ng and Popkin, 2012). A recent study including data from 1.8 million participants concluded that 27.5% of adults were insufficiently active, globally, and that levels of inactivity in high-income western countries had increased by over 5% between 2001 and 2016 (Guthold et al., 2018). Community-wide, gamification-based interventions offer the potential to curtail current global trends in physical activity. Little is known, however, about the sustainability of increases in physical activity following initial engagement with these programmes.

1.1. Gamification and physical activity

Gamification refers to the use of game design elements in non-game contexts (Deterding et al., 2011). Gamification has gained considerable scholarly attention in recent years and there has been an upsurge in public and private sector organisations applying gamification principles to increase consumer/public engagement (Huotari and Hamari, 2017). In the field of public health, empirical support for gamified approaches is beginning to emerge, with applications which attempt to support people to become more physically active among the most promising early findings (King et al., 2013; Johnson et al., 2016; Corepal et al., 2018). A recent analysis of 2500 mobile walking competitions, capturing over 800,000 person-days of in-competition activity tracking, found the average user increased their physical activity by 23% during competition (Shameli et al., 2017). The authors furthered that competition incentivised users to increase their physical activity levels however groups dynamics (pre-competition activity levels, probability of winning, gender balance and inclusion of experienced competition participants) strongly affected the dynamics of the competition. Elsewhere, a recent systematic review on the use of gamification within online programmes concluded it to be effective approach for increasing programme engagement and highlighted several design elements

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pertinent to success (Looyestyn et al., 2017). The authors found leader boards were particularly effective for increasing engagement (compared to badges, points and rewards) and that gamification was more effective in short-term programmes given that the positive effect of extrinsic rewards dissipates over time.

The apparent success of Pokémon Go demonstrated the mass-appeal of community-wide gamification approaches which operate in an outdoor environment and preliminary evidence suggests participants became more active as a result of playing the game, at least in the short-term (McCartney, 2016; Liu and Ligmann-Zielinska, 2017). Furthermore, scholars have begun to untangle the varied motivations for taking part. Demetrovics et al. (2011) highlighted several motives for engagement with online games: social, escapism, competition, coping, skill development, fantasy and recreation. Whereas, Yang and Liu (2017) offered seven motives for taking part in Pokémon Go specifically: fun, friendship maintenance, relationship initiation, exercise, achievement, escapism, and nostalgia.

Many of the gamification-based approaches to improving the public's health to-date have focussed on individualistic, smartphone-based applications and little is known about the impact of community-wide approaches (King et al., 2013; Lister et al., 2014). Furthermore, the limited number of studies which have been conducted have relied on small sample sizes and short-term follow-ups which limits the conclusions which can be made from the current evidence-base (Johnson et al., 2016). In view of this paucity of attention, the aim of the current study was to explore the impact of a community-wide gamification-based intervention, called 'Beat the Street' on levels of physical activity at 1 and 2-years post-intervention.

2. Methodology

2.1. Intervention

'Beat the Street' is delivered by 'Intelligent Health', a health-technology company based in Reading, UK and aims to get people more physically active by turning a local area into a simplistic walking and cycling game for a six-week time-period. Physical Radio Frequency Identification (RFID) scanners called 'Beat Boxes' are placed on lamp-posts and in areas of blue and green spaces at roughly half-mile intervals throughout a town or city. Children are given a fob, pre-registered to their school, and adults are encouraged to register a card via an online portal and select a team to join (such as their child's school, workplace or community group). Each time two Beat Boxes are touched with a RFID card or fob in under an hour a player receives 10 points for themselves and their chosen team. At the end of the game highest scoring teams are rewarded with prizes, such as vouchers for sports equipment, craft or book vouchers. The game runs continuously for a six-week period and residents can take part at any time throughout each day.

2.2. Participants and procedure

Beat the Street was delivered for three consecutive years in Reading, UK, between 1st of May and 4th June in 2014, between 29th April and 24th June in 2015 and between 15th April and 29th May in 2016. Prior to each intervention, participants were encouraged to register their RFID card via an online portal which allowed them to select a team to join. During registration, participants completed a self-report questionnaire which included a range of sociodemographic questions (including age and gender) and a validated physical activity measure (Milton et al., 2011). There was a subgroup of 2015 and 2016 participants who also took part in Beat the Street in 2014 (N = 1567 and N = 722 respectively) and these provided the sample available for analysis. At 1-year post-intervention, participants had a mean age of 29, were more likely to be female (62%) and 13% had long-term medical condition. At 2-year post-intervention, participants had a mean age of 31, 60% were female and 17% had a long-term medical condition (see Table 1).

Table 1
Sample characteristics.

Sample characteristics	1 year post N = 1567	2 year post N = 722
Age group, n (%)		
18 years or under	721 (46%)	301 (42%)
19–29 years	40 (3%)	11 (2%)
30–39 years	146 (9%)	79 (11%)
40–49 years	403 (26%)	209 (29%)
50–59 years	158 (10%)	78 (11%)
60–69 years	65 (4%)	30 (4%)
70–79 years	30 (2%)	12 (2%)
80+ years	4 (< 1%)	2 (< 1%)
Female, n (%)	969 (62%)	432 (60%)
Long-term medical condition, n (%)		
Yes	205 (13%)	120 (17%)
Baseline activity, n (%)		
Inactive	367 (23%)	127 (18%)
Achieving 150 min	598 (38%)	271 (38%)
Beat Box activity, n		
Total taps by overall sample	96,231	58,619
Total taps by inactive participants at baseline	13,307	7334
Average taps by overall sample	61	81
Average taps by inactive sample	48	58

2.3. Outcome measures

2.3.1. Physical activity

Physical activity levels were measured using a validated single-item measure (Milton et al., 2011). Participants were asked "In the past week, on how many days have you done a total of 30 min or more of physical activity, which was enough to raise your breathing rate? This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job" and could report on an 8 point scale from zero to seven days.

2.4. Overview of analyses

Data were subjected to (1) a series of one-way within subjects ANOVAs to examine changes in physical activity over time and (2) a series of McNemar tests to explore changes in the proportion of people reporting being inactive and meeting the World Health Organization (2010) target of 150 min of moderate intensity activity per week.

3. Results

3.1. 1 year post-intervention

The proportion of participants reporting being physically inactive (0 days of activity per week) decreased from 18% at baseline to 7% 1-year post-intervention ($\chi 2 = 84.845$, df = 1566, $p < 0.0001$) (Fig. 1). The proportion of participants achieving 150 min of moderate intensity activity per week (5+ days of 30 min of activity) increased from 38% at baseline to 43% 1-year post-intervention ($\chi 2 = 11.306$, df = 1566, $p = 0.001$) (Fig. 2). Overall, average physical activity increased from 3.5 days per week at baseline to 3.9 days per week at 1-year post-intervention (($F(1, 1566) = 35.049$, $p < 0.001$). For people who were inactive at baseline, average days of activity increased to 3.5 days at 1-year post-intervention (($F(1, 274, = 675.728$, $p < 0.001$).

3.2. 2 year post-intervention

The proportion of participants reporting being physically inactive

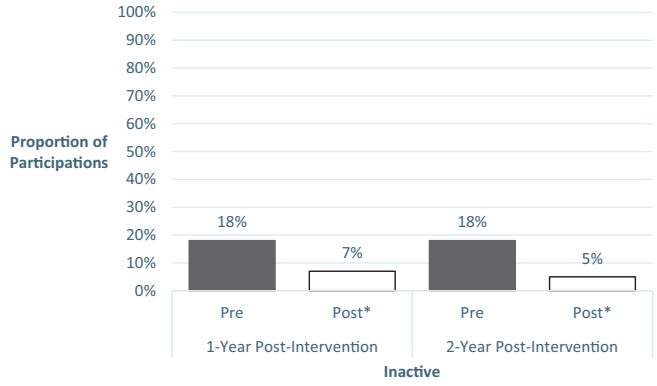

Fig. 1. Proportion of participants reporting being inactive 1 and 2-year post-intervention (Beat the Street, Reading UK, 2014–2016).
* = statistically significant at $p < 0.0001$.

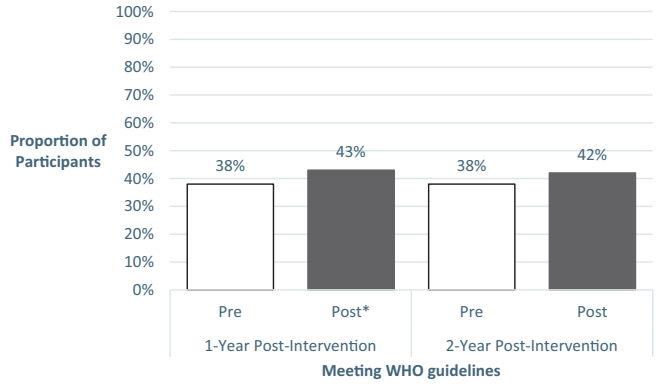

Fig. 2. Proportion of participants meeting World Health Organisation guidelines for physical activity 1 and 2-year post-intervention (Beat the Street, Reading UK, 2014–2016).
* = statistically significant at $p < 0.0001$.

(0 days of activity per week) decreased from 18% at baseline to 5% at 2-years post-intervention ($\chi 2 = 58.317$, df = 721, $p < 0.0001$) (Fig. 1). The proportion of people achieving 150 min of moderate intensity activity per week (5+ days of 30 min of activity) increased from 38% at baseline to 42% at 2-years post-intervention, however this was not statistically significant ($\chi 2 = 3.371$, df = 721, $p = 0.066$) (Fig. 2). Overall, days of physical activity increased from 3.4 days per week at baseline to 3.8 days per week at 2-years post-intervention ((F(1, 721) = 14.916, $p < 0.001$). For people who were inactive at baseline, average days of activity increased to 3.4 days at 2-years post-intervention ((F(1, 126) = 350.499, $p < 0.001$).

4. Discussion

The aim of this study was to investigate the impact of a community-wide gamification-based intervention, called 'Beat the Street' on levels of physical activity at 1 and 2-years post-intervention. The data revealed a significant 11% and 13% decrease in levels of inactivity at 1 and 2-years post-intervention respectively and a significant 5% increase in the proportion of participants meeting WHO guidelines for physical activity at 1-year post-intervention. Furthermore, participants who were inactive pre-intervention reported a significant increase in activity to 3.4 and 3.8 days at 1 and 2-years post-intervention respectively.

Recent evidence has shown individualistic and community-wide gamified interventions to be effective at increasing physical activity in the short term (Shameli et al., 2017; Looyestyn et al., 2017; McCartney, 2016; Liu and Ligmann-Zielinska, 2017). However, the extent to which these approaches lead to long-term changes in physical activity is often questioned and was yet to be explored. The findings of the current study suggest community-wide physical activity interventions may lead to sustained increases in physical activity. Whilst this research cannot account for participants who did not participate in the game in consecutive years, it indicated that 61% and 72% of inactive participants who took part in the intervention again had become active at 1 and 2-years post-intervention respectively.

4.1. Theoretical contributions

The concept of gamification has gained considerable scholarly attention in recent years, particularly in the fields of public health promotion and physical activity (cf. Cugelman, 2013; King et al., 2013; Zuckerman and Gal-Oz, 2014; LeBlanc and Chaput, 2017), however little is known about the motivating components which are key to engagement and subsequent behaviour change. Two recent qualitative studies in this field may help elucidate the game elements which attract substantial portions of the community into these interventions and lead to subsequent behaviour change. Harris and Crone (2018) conducted focus groups with 28 adult Beat the Street players post-intervention and found there were 4 alternative themes pertinent to the ways participants took part in the game, these were game reinvention, altering the game to suit individual ideas and preferences (such as role playing); social influence, taking part in an activity with or for family, friends and/or colleagues; exploration, which involved discovering the local area, finding new routes and greenspaces and orienteering to 'collect' 'Beat Boxes' and collective extrinsic reward, where players were motived by collective, rather than individual gain (for example, money for charity). Elsewhere, Lindqvist et al. (2018) with a study including 8 families, identified 2 themes pertaining to engagement with Pokémon GO. Firstly, the participant's recognised the positive benefits associated with gameplay and described the game as increasing outdoor physical activity and therefore parents and children encouraged each other to player along. Second, cooperation was recognised and valued over competition and participants appreciated the impact the game had on socialising and meeting new friends. These studies demonstrate the wide-ranging motivations for engaging with gamified initiatives and provide a possible explanation for why they have such mass-appeal.

There are several game-design elements specific to Beat the Street which have been shown to facilitate engagement and behaviour change, and these could explain the behaviour change reported by participants. The programme featured a series of online leader boards showing total points and average points for community and workplace groups, schools and fitness/sports clubs (Looyestyn et al., 2017); it provided feedback on individual and collective performance encouraging self-competition (Corepal et al., 2018) and encouraged social comparison and competitiveness with the use of team-based leader boards and incentives (Michie et al., 2013). Furthermore, the co-operative nature of teams may have functioned to facilitate social interaction, which in turn could have increased player experience and subsequent behaviour change (Johnson et al., 2016).

4.2. Strengths and limitations

The following strengths and limitations should be considered when interpreting the findings presented above. To the author's knowledge, this study was the first attempt to investigate the long-term changes in physical activity following a community-wide, gamification based physical activity intervention with an adequate sample size. However, without the use of a control population it cannot be concluded with certainty if the findings were associated with the intervention, or an alternative variable not included within the study design.

4.3. Future directions

Due to the novelty of community-wide, gamification-based

approaches to increasing physical activity, the evidence-base is at a premature stage. Whilst the current findings and several recent literature contributions have progressed understanding of the potential of these approaches and their underlying mechanisms there are still several unanswered questions. Firstly, the extent of behaviour change which stems from participation in gamified interventions at a community-wide level requires further examination. This ultimately requires a large-scale evaluation which at the least includes a control population and ideally randomises control and intervention areas. However, this design will be complex and require substantial resource. Second, there is still much to be learned from participant's experiences of taking part in these interventions and how the engaging mechanisms can be used to inform other individualistic interventions. There is still insufficient knowledge on the factors which enable individuals to maintain being physically active following the short-term gamified experience phase and such learning would help inform physical activity and general public health interventions more broadly. Third, there is scant evidence on how to effectively implement community-wide interventions. It has been noted that community-wide interventions often fail to reach a substantial portion of the community, which reduces their effectiveness and cost-effectiveness (Baker et al., 2015). Gamified approaches are clearly able to address this issue, however the components which enable such mass engagement are currently yet to be investigated systematically. Furthermore, these insights could be crucial for scaling up existing individualistic interventions.

5. Conclusions

The current study provides further evidence for the role gamification can play in increasing levels of physical activity at a community-wide level. These, combined with other recent literature contributions, demonstrate how these applications may engage individuals through several varied motivations, which extend beyond individual rewards. The mass appeal of gamification-based approaches highlights a pertinent need for large scale, controlled trials to reveal the true extent of behaviour change associated with engagement. Furthermore, more research is needed into the factors which support initial engagement and into the factors which support transition into sustainable behaviour change following the game period.

Conflict of interest

At the time of writing this paper the author was employed by Intelligent Health, who delivered the intervention. However, the data was collected via an automated online portal and prior to the author starting employment.

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