

ARTICLE

A study on the benefits of participation in an electronic tracking physical activity program and motivational interviewing during a three-month period

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Abstract-Background: The purpose was to investigate if participation in a three-month electronic tracking outdoor physical activity and a motivational interviewing (MI) intervention led to positive behavioural, psychological, and physiological outcomes. **Methods:** Based on a two-group pre-post design, 12 middle-aged women and 6 men were randomly assigned to an experimental and a control group. Physical activity data were collected by wrist-worn activity sensors, and pre-post data were collected on the GHQ-12, the BREQ-2, body mass, body fat mass and total body muscle. Measures of cardiovascular fitness were taken pre to post. The experimental group was supported through individual MI coaching sessions and resistance-training for use in an outdoor gym. Magnitude based inferences (MBI) were calculated based on the disposition of the confidence limits for the mean differences to the smallest worthwhile changes. **Results:** The experimental group had a beneficial increase in its physical activity behaviour (steps). The control group had a medium decrease in identified regulation, the experimental group maintained the same level at the post-measure. **Conclusion:** Few studies have investigated how the combination of MI and the use of activity-tracking devices affect physical and mental health. This study investigates the use of both MI and activity-tracking devices on psychological well-being, motivation, and physical health in an outdoor context. Future research recommendations are given.

Keywords: physical activity, physiological health, psychological well-being, computerized exercise intervention, motivational interviewing, experimental design

Résumé- Une étude sur les avantages de la participation à un programme de suivi électronique de l'activité physique et d'entretiens motivationnels pendant une période de trois mois. Introduction: L'objectif était de déterminer si la participation à une intervention d'activité physique extérieure avec suivi électronique et d'entretiens motivationnels (MI) d'une durée de trois mois conduisait à des résultats positifs sur les plans comportementaux, psychologiques et physiologiques. **Méthodes:** Suivant un design d'étude pré-post à deux groupes, 12 femmes d'âge moyen et 6 hommes ont été assignés par randomisation à un groupe expérimental ou à un groupe contrôle. Les données relatives à l'activité physique ont été collectées au moyen de capteurs d'activité portés au poignet. Les données pré- et post-intervention concernaient le GHQ-12, le BREQ-2, la masse corporelle, la masse grasse et la masse musculaire. La condition cardiovasculaire a également été mesurée pré- et post-intervention. Le groupe expérimental a bénéficié de MI individuels et d'ateliers de renforcement musculaire en plein air. Des *magnitude based inferences* (MBI) ont été calculées à partir de la disposition des limites de confiance concernant les différences moyennes des plus petits changements significatifs. **Résultats:** Le groupe expérimental présentait une augmentation bénéfique du comportement d'activité physique (nombre de pas). Le groupe contrôle présentait une diminution moyenne de la régulation identifiée, tandis que cette valeur est restée stable dans le groupe expérimental. **Conclusion:** Peu d'études ont examiné comment la combinaison de MI et de dispositifs de suivi de l'activité affectent la santé physique et mentale. Cette étude a examiné l'influence de l'utilisation conjointe de MI et de dispositifs de suivi d'activité sur le bien-être psychologique, la motivation et la santé physique dans un contexte de pratique extérieure. Des recommandations relatives aux recherches futures ont été formulées.

Mots clés : activité physique, santé physiologique, bien-être psychologique, computerized exercise intervention, entretien motivationnel, design expérimental

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1 Introduction

The benefits of active living are widely documented and engaging in regular physical activity (PA) is important for physical and mental health for people of all ages (Warburton, Nicol, & Bredin, 2004). Numerous intervention programs, aimed to facilitate PA in non-active people, have been developed and tested (for a summary, see Bock, Jarczok, & Litaker, 2014; Conn, Adam, Hafdahl, & Mehr, 2011). Del Campo Vega, Tutte, Bermudez, and Parra (2017) found statistically significant increases in people who engaged in moderate to vigorous physical activity from baseline to follow-up in areas where outdoor gyms had been installed, and Cranney *et al.* (2016) also found the proportion of people engaging in moderate to vigorous physical activity in the outdoor gym area increased significantly from baseline (6%) to post-installation (36%) and to follow-up (40%). Also, intervention studies have suggested that open-air environments (*e.g.*, outdoor fitness centre), placed in urban green areas, may have direct and positive impacts on mental health and promote autonomous motivation to PA (Johnson, Ivarsson, Parker, Andersen, & Svetoft, 2019).

The public health implications of health technology solutions can have important potentiating effects. Examples of the implications of technologies on public health within the recent digital revolution is the potential for telehealth to improve health care delivery (Dorsey & Topol, 2016). Moreover, examples of health technology solutions are activity-tracking devices such as Nike Fuelband (Bice, Ball, & McClaran, 2016). The use of activity-tracking devices has, for example, been found to increase PA and PA motivation (Bice *et al.*, 2016; Bravata *et al.*, 2007). Most activity-tracking devices offer immediate feedback tied to goals (*e.g.*, 10,000 steps) and tracking changes in PA can motivate steady progress towards goals and increased self-efficacy. More research is needed to investigate the motivational influence of popular commercial activity monitors in relation to PA.

New innovative designs using health technology (*e.g.*, PA apps for smartphones) applied to outdoor exercise might attract new users and promote sustainable health behaviours (Shane, Lowe, & Ólaighin, 2014). Earlier research on App-based initiatives, outside the public outdoor exercise zones, relate to carpooling (users share the same car) and bicycle sharing systems. Generally, these initiatives had positive effects on, for example, empowerment and back up technology-mediated activities combined with in-person collaboration activities (Christensen & Shaheen, 2014).

One framework, commonly used to understand why people engage in different behaviours (*e.g.*, PA), is self-determination theory (SDT). According to SDT, individuals are most elective and persistent in pursuing healthy living when they are autonomously motivated (Ryan & Deci, 2002). Autonomous motivation (*e.g.*, identified regulation) is largely internal and based on conscious values that are personally important to the individual. Such individuals engage in activities because they find

them intrinsically satisfying or because they identify with and value the outcomes (Williams, Niemiec, Patrick, Ryan, & Deci, 2009). SDT posits that individuals will develop autonomous motivation for a particular behaviour when significant others adopt a need-supportive approach toward the person (Ryan & Deci, 2002). When basic psychological needs for autonomy (*i.e.*, feeling volitional and self-endorsed), competence (*i.e.*, feeling mastery and elective), and relatedness (*i.e.*, feeling of belonging and being cared for) are supported, this will facilitate a process of internalization resulting in more autonomous forms of self-regulation (Williams *et al.*, 2009). SDT has a considerable amount of research supporting its validity in health behaviour change settings and in the exercise field (Fortier, Duda, Guerin, & Teixeira, 2012).

Based on the SDT framework, one approach that has been effective to support behaviour change is motivational interviewing (MI) (Lundahl, Kunz, Brownell, Tollefson, & Burke, 2010). More specifically, MI targets the three key components in SDT (autonomy, competence, and relatedness). The purpose of the study was to investigate if participation in a three-month electronic tracking outdoor physical activity and a MI intervention compared to a control group without MI led to positive behavioural, psychological, and physiological outcomes based on a two-group pre-post experimental design. An expected result of the study is that participation in the intervention, that is MI, outdoor physical activity and guided by a smartphone application, will lead to higher autonomous motivation, elevated physical activity (more steps), improved physical and psychological health (reduced body weight) and cardiorespiratory fitness.

2 Methods

2.1 Participants and inclusion criteria

Altogether 20 participants, working within the municipality of Halmstad, Sweden, were selected for the study. The inclusion criteria were: (a) having a primarily inactive job, (b) limited exercise activity in the past year, and (c) employed within Halmstad Municipal Council. Based on the pool of 66 participants who met the inclusion criteria, a random selection of participants, where a weighting for gender was carried out due to an overbalance of women, resulted in two groups (experimental and control) of 10 participants including six women and four men in each group. None of the participants knew each other at the start of the study as they worked at completely different institutions within Halmstad Municipality Council, which indicates no biased association between employees. That is, all participants were randomly drawn from the total number of interested participants for the study and, thus, randomly divided into two groups with the same number of participants. At the end of the intervention period, one man from both the experimental and control groups dropped-out, mainly due to changed work routines or an exit from employment.

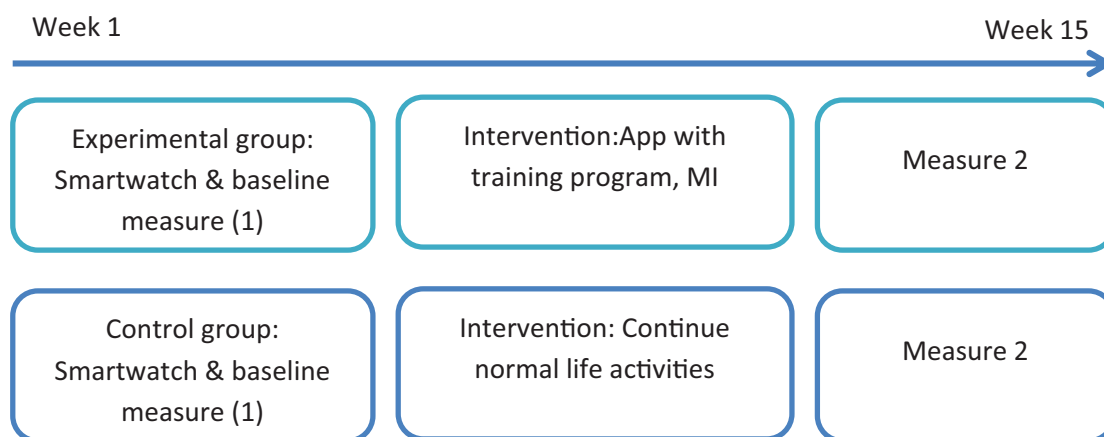


Fig. 1. The two-group pre-post experimental design.

Consequently, the final group of participants for the experimental group consisted of six women and three men with a mean age of 51.9 years \pm 4.8, and the control group consisted of six women and three men with a mean age of 48.9 years \pm 10.9.

2.2 Physical activity

PA data were gathered by wrist-worn activity sensors (Apple Watch1, software version and iPhone) that collect information about each day's physical activity (steps taken). All participants were, at the start of the study, given one of these activity sensors. Data were first stored locally on the participants' smartphones and then downloaded from the Health Data App using the QS Access application (Quantified Self Labs, California, USA).

2.3 Psychological measurements

In the study, two psychological constructs were measured. The two constructs were motivation regulations (*i.e.*, amotivation, external motivation, introjected motivation, identified motivation, intrinsic motivation) collected using the Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2) (Markland & Tobin, 2004), and psychological health (*i.e.*, well-being, illness) collected using General Health Questionnaire-12 (GHQ-12) (Goldberg *et al.*, 1997). McDonald's ω ranged between 0.77 and 0.91 for the BREQ-2 and between 0.72 and 0.93 for the GHQ-12.

2.4 Physiological measurements

A bioimpedance analysis of body mass (weight kg), total body fat mass, and total body muscle mass were measured and the modified Bruce Treadmill Test (time to exhaustion) was used to measure cardiovascular fitness. All body-composition measurements were performed in the morning, and each participant abstained from eating and drinking for at least six hours prior to the testing.

2.5 Exercise intervention

The participants took part in the two-group pre-post experimental design aimed to increase PA and well-being (see Fig. 1). Both the experimental and control groups were instructed on how to use the basic functions on their wrist-worn activity sensors (steps, active calories, time, and synchronization with iPhone). The control group participants received no other support to increase their PA and were asked to continue their normal life activities during the three-month control period. For the experimental group, PA was supported through individual MI coaching sessions and resistance-training programs specially designed for use in an outdoor gym. In the beginning and at the end of the intervention, the individual MI coaching was conducted with about 30 minutes of conversation for each participant. When the intervention started, the participants were introduced to an outdoor gym and instructed on how to use it (instructors were present at the start of the intervention for each participant) to further promote PA. Also, the participants were advised to track PA through the default functions on their watches.

For detailed information about the method used to measure physical activity, psychological questionnaires, physical measurements, as well as the exercise intervention see Johnson *et al.* (2019).

2.6 Procedures

Table 1 outlines the time plan for the study procedures from the first contact with the participants until the final testing session three-months later. Ethical approval for the study was granted by the regional ethics committee (reference number 2016/843). However, we did not pre-register our study in open science.

2.7 Data analysis

Non-clinical magnitude based inference (MBI) was calculated using an online published spread sheet (Hopkins, 2003), and inferences were based on the

Table 1. Time plan for the study.

Week/s	Working issue
1	Distribution of smartwatches anthropometric and physical tests and psychological questionnaires
1–15	Intervention period and motivational interviewing session for experimental group
15	Anthropometrics and physical tests, and psychological questionnaires

disposition of the confidence limit for the mean difference to the smallest worthwhile change (0.2 between-subject SD). The probability that a change in testing score was beneficial, harmful or trivial was identified according to the magnitude-based inferences approach (Batterham & Hopkins, 2006). Descriptors were assigned using the following scales: 0–4.9% very unlikely; 5–24.9% unlikely; 25–74.9% possibly; 75–94.9% likely; 95–99.49% very likely; >99.5% most likely (Hopkins, 2017). Pre-test pooled standard deviations were calculated using pre-test values from the sample as a whole (both experimental group and control group). Within-group standardized mean difference effect sizes (ES_w) were calculated by using the mean change of the group (Δ experimental or Δ control) in the numerator of the equation and using the pre-test pooled standard deviation in the denominator. Between-group standardized mean difference effect sizes (ES) were calculated by using the difference between experimental ES_w and control ES_w . Effect sizes of 0.20–0.50 are considered *small* in magnitude; those between 0.50–0.80 are *medium*, and those above 0.80 are *large* by Cohen’s conventions for the behavioural sciences (Hopkins, 2017). An expected outcome of the study is that participation in MI and outdoor physical activity will lead to higher autonomous motivation and elevated physical health (more steps and lower body fat). Given the common method biases associated with the use of self-report measures we used an $ES=0.50$ as a threshold for the smallest important effect, rather than using Cohen’s threshold of 0.2, which is the effect size generally recommended for MBI by Hopkins (2017). Using Hopkins’ guidelines for calculating sample (Hopkins, 2017) and Cohen’s threshold of 0.5 for a standard difference as the smallest important effect, the chance for a type 1 error was set at 0.5% and type 2 error at 25%, based on physical activity (steps) as the main outcome measure, a minimum sample size of 15 is recommended.

3 Results

In this study, PA (steps), psychological well-being and motivation, as well as anthropometrics and physical tests were measured before and after the intervention (see Tab. 2).

3.1 Baseline comparison

Baseline measurements showed a statistically significant ($P=0.03$) difference in body fat between groups, but no other differences were obtained. Effect size statistics together with MBI confirmed the large ($ES=1.0$) very

likely (MBI = 97%) difference in fat mass between groups and showed a medium ($ES=0.69$) likely (MBI = 91%) difference in body weight between groups.

3.2 Intervention effects

The between group changes for the BREQ-2 were less clear, but there was a possibly trivial (<99%) reduction in identified regulation ($ES_{\text{between}}=0.72$) in the control group. After the three-month intervention, there was a likely (84%) small ($ES_{\text{between}}=0.40$) beneficial increase in PA in the experimental group compared to the control group (see Tab. 2). There was no missing data in this study and the internal dropout was 0%. Inspection of the interaction between time and PA for both groups showed a negative interaction between PA and time for the experimental group ($R^2=0.17$) and almost no interaction between PA and time for the control group ($R^2=0.03$) (see Fig. 2).

4 Discussion

4.1 Main findings and comparisons within existing literature

The beneficial increase in PA (steps) for the experimental group could be due to motivation, and the combination of MI and novel health technology equipment. Because both the experimental and control groups were given the wrist-worn activity sensors at the same time (see Tab. 1), it is likely that a combination of factors, as outlined above, together influenced the increase in PA behaviour at the end of the intervention. More specifically, the possibility for the participants to take part in individual MI coaching sessions might have been a central part of the increases in PA behaviour (steps). Previous studies have also shown that MI can strengthen a person’s self-efficacy for behaviour change to increase PA (Hardcastle, Taylor, Bailey, Harley, & Hagger, 2013). Also, in this case, the potential mechanisms for the link between MI and PA may perhaps increase levels of basic psychological needs as well as extend the level of motivation for an already autonomously motivated person. Successful internalization involves the integration of formerly external regulations into one’s sense of self, typically in the form of important personal values. This might be particularly relevant in relation to changes in motivation and behavior on individual MI coaching since it is a function of intervention content and the interpersonal style in which the present content was delivered (see also Hardcastle, Fortier, Blake, & Hagger, 2017). The results from our study indicate that the experimental group maintained a similar

Table 2. Physical activity behaviour (steps), psychological well-being and motivation, anthropometrics and physical measures pre- and post-intervention period.

	Pre Mean \pm SD	Post Mean \pm SD	Change ES _{between}	Magnitude of inference		
				Harmful	Trivial	Beneficial
Physical activity (steps)						
<i>90-day average</i>						
Control		10,803 \pm 5767	0.40	16% unlikely	0% very unlikely	84% Possibly
Experimental		13,369 \pm 4597				
Psychological measures						
<i>GHQ-12</i>						
Positive items (wellb.)			0.40	0% very unlikely	98% very likely	2% very unlikely
Control	2.9 \pm 0.6	2.9 \pm 0.7				
Experimental	3.0 \pm 0.3	3.3 \pm 0.3				
Negative items (illn.)			-0.23	0% very unlikely	99% very likely	1% very unlikely
Control	1.9 \pm 0.7	1.8 \pm 0.5				
Experimental	1.6 \pm 0.5	1.4 \pm 0.4				
<i>BREQ-2</i>						
Amotivation			-0.06	1% very unlikely	98% very likely	1% very unlikely
Control	1.4 \pm 0.6	1.5 \pm 0.9				
Experimental	1.1 \pm 0.2	1.2 \pm 0.4				
External regulation			0.29	8% very unlikely	91% likely	2% very unlikely
Control	1.5 \pm 0.7	1.3 \pm 0.6				
Experimental	1.5 \pm 0.9	1.5 \pm 0.9				
Introjected regulation			0.56	24% possibly	74% possibly	2% very unlikely
Control	2.8 \pm 0.8	2.2 \pm 0.8				
Experimental	2.4 \pm 1.0	2.3 \pm 0.8				
Identified regulation			0.72	1% very unlikely	64% possibly	35% possibly
Control	2.7 \pm 1.0	2.0 \pm 0.9				
Experimental	3.5 \pm 1.0	3.6 \pm 0.8				
Intrinsic regulation			-0.06	9% very unlikely	80% possibly	11% possibly
Control	3.5 \pm 0.7	3.7 \pm 0.8				
Experimental	3.6 \pm 1.1	3.8 \pm 1.0				
Physical measures						
Body weight (kg)			-0.10	3% very unlikely	24% possibly	73% possibly
Control	76.9 \pm 16.7	76.9 \pm 16.5				
Experimental	89.3 \pm 17.8	87.4 \pm 18.7				
Body Fat (kg)			-0.18	2% very unlikely	31% possibly	67% possibly
Control	23.2 \pm 6.1	22.4 \pm 6.8				
Experimental	31.3 \pm 8.2	29.1 \pm 7.5				
Time to exhaustion test (s)			0.05	38% possibly	5% unlikely	57% possibly
Control	577 \pm 16	588 \pm 95				
Experimental	572 \pm 59	573 \pm 50				

ES: mean difference of effect sizes between groups; wellb: well-being; illn: illness.

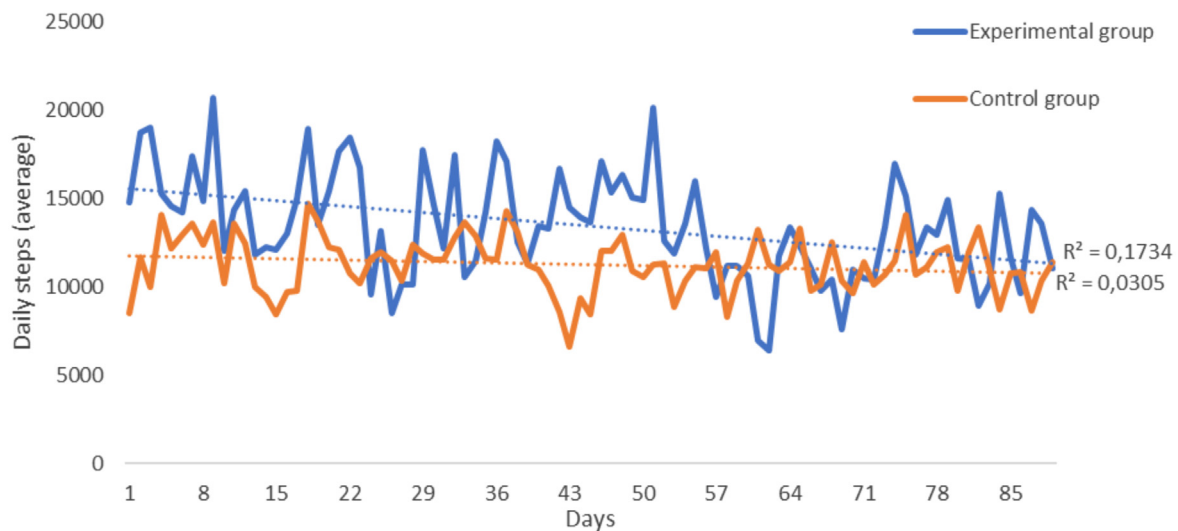


Fig. 2. Average daily steps over the 90-day intervention period for both experimental (solid blue) and control (solid orange) groups. Note: dotted blue line: trendline for the experimental group; dotted orange line: trendline for the control group..

level of identified regulation, as opposed to a decreased level in the control group at the post-measure. For the control group, it is suggested that since the individual MI coaching has not yet started, combined with the fact that the participants have not yet started their physical training in relation to the study, this could potentially explain the decrease in identified regulation. For the experimental group, this result may indicate that the participants continued to engage in an activity that they deemed personally valuable and important. In a partly similar way, [Silva et al. \(2008\)](#) also reported that need-supportive interventions to enhance autonomous motivation and competence for PA resulted in important improvements in cardiorespiratory fitness as well as positive changes in other health factors. In this context, we speculate that the difference in PA (steps) for the experimental group at the post-measurement also reflects the effect that the MI dialogue probably had, and not least in relation to the last process (planning), which involves both developing commitment to change and formulating an action plan for the on-going intervention. In a pre-study to the current study, a six-week intervention programme with sedentary adults showed promising results regarding PA changes and motivation, along with decreases in body weight and stress symptoms ([Johnson et al., 2019](#)). Similar results have been found in sedentary and middle-age samples, based on a 12-week exercise training and lifestyle intervention ([Kozey-Keadle et al., 2014](#)). Some studies have also found significant improved physical and mental health status compared to controls after a three-month MI-based health coaching intervention ([Butterworth, Linden, McClay, & Leo, 2006](#)).

4.2 Study limitations

One potential limitation could be that the participants may not have benefited from MI as much as we thought because they were already motivated to change, which

highlights the importance of pre-treatment assessment. There was a statistical difference in the pre-test observed in body fat between groups, but no other differences were obtained. It is possible that the group with greater pre-test body fat might be more prone to a reduction in body fat and this may have influenced the between-group change in body fat. Due to the lack of change in muscle mass in the current study, we speculate that muscular strength training did not greatly influence the outcomes between groups. Still another study limitation has to do with the limited number of participants in the intervention, which places challenging demands on statistical analysis. In our case, we selected MBI analysis because conventional null hypothesis significance testing often has high type II error rates for small sample sizes, and publication bias associated with these errors are a weakness, which MBI has been reported not to have ([Hopkins & Batterham, 2016](#)). Many of the issues with MBI are common to all statistical analysis and may not be a problem when analyses are performed with these weaknesses in mind. MBI analysis is, however, content-rich and allows for relatively meaningful interpretation. One of the strengths of the study is the combination of both physical and psychological measurements, allowing a multifactorial assessment of the intervention program and the usefulness of the results.

5 Conclusion

One possible implication of the study is that more studies that elucidate the feasibility and accuracy of smartphone applications that motivate PA should be conducted. As for now, limited research exists with adequately constructed designs. In line with previous recommendations, we argue that large-scaled, experimental, and long-term randomized control trials should be conducted to explore the effects of exercise app-based interventions. Another practical implication is that

following the 10,000 steps per day goal over three months may not induce enough PA to improve health and well-being in a middle-aged sedentary population.

Future research should ensure that fitness technology continues to include theoretically derived behaviour change techniques, perhaps based on a SDT framework, to promote and potentially increase motivation, mental health and well-being. Strategies such as social support and coaching seem to be especially helpful in increasing activity and healthy behaviours although there are many questions that remain unanswered, the public health implications of using fitness technology to promote behaviour change seem worthy of future study.

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Abbreviations

MBI	magnitude based inference
MI	motivational interviewing
PA	physical activity
SDT	self-determination theory

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