# 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 of the study 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.

Method Based on a two-group pre-post experimental design, 12 women and 6 men were randomly assign to an experimental (mean age = 51.9 years) and an control group (mean age = 48.9 years) based on the inclusion criteria: (a) having a primarily sedentary job, (b) limited exercise activity in the past year and (c) employed within the Halmstad Municipal Council. Physical activity data were collected continuously 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 (time to exhaustion) were also taken pre to post. The experimental group was supported through individual MI coaching sessions and individual resistance-training programs specifically designed 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 MBI analysis of baseline measures showed differences in body fat between the groups. The experimental group had a small and beneficial increase in in physical activity behaviour (steps). Moreover, the control group had a medium decrease in identified regulation, but the experimental group maintained the same level at the post-measure.

Conclusion Participation in the outdoor physical activity and MI intervention resulted in a small increase in in physical activity behaviour (steps) as well as a maintained level of identified regulation in the experimental group. The latter result may be related to a possible combined effect of MI and continuous feedback from the activity tracker. Although there are many questions that remain unanswered, the public health implications of using fitness technology to promote behaviour change seem worthwhile to study. Potential implications for future studies are provided.

## Background

The benefits of active living are widely documented in the literature and public health guidelines recommend that adults engage in a minimum of 150 minutes of moderate-intensity physical activity (PA), 75 minutes of vigorous-intensity PA, and 2 days of muscle strengthening activity every week [1]. Engaging in regular PA is important for physical and psychological well-being for people of all ages [2]. Regular PA can, for example, lead to: (a) reduced body mass index [3], and (b) improved cardiorespiratory fitness in sedentary populations [4]. Numerous intervention programs, aimed to facilitate physical activity in non-active people, have been developed and tested; for a summary see [5]. One finding from such research is that outdoor environmental exercise interventions result in an overall increase in PA [6], and access to outdoor exercise equipment has been found to help increase activity levels in people who do not usually exercise [7]. More specifically, studies have suggested that open-air environments (e.g., outdoor fitness centre), placed in urban green areas, may have direct and positive impacts on well-being [8] and promote autonomous motivation to PA [9].

The public health implications of using fitness technology to promote behaviour change are promising [10], and 10,000 steps a day is a typical goal used to foster PA [11]. Systematic reviews [12] suggest that the use of a pedometer is associated with significant increases in PA and significant decreases in body mass index among adults. The use of modern health technology can have important potentiating effects [13], and the use of activity-tracking devices has been found to increase PA motivation [14]. Most activity-tracking devices offer immediate feedback tied to goals (e.g., 10,000 steps) [15] and tracking changes in PA can motivate steady progress towards goals and increased self-efficacy. Then again, there is evidence to suggest that it is feelings of competition, guilt, and internal pressure that underlie short-term increases in motivation among adolescents [16]. More research is needed to investigate the motivational influence of popular commercial activity monitors in relation to PA.

New innovative designs using modern health technology (e.g., PA apps for smartphones) applied to outdoor exercise might attract new users and promote sustainable health behaviours within communities [17]. 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 [18].

One framework, commonly used to understand behavioural, as well as social factors and their effects on exercise motivation, is self-determination theory (SDT), which is an organismic theory of human motivational processes encompassing different aspects of human social life [19]. According to SDT, individuals are most effective and persistent in pursuing healthy living when they are autonomously motivated [20]. 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 [21]. SDT posits that individuals will develop autonomous motivation for a particular behaviour when significant others adopt a need-supportive approach toward the person [20]. When basic psychological needs for autonomy (i.e., feeling volitional and self-endorsed), competence (i.e., feeling mastery and effective), 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 [21]. SDT has a considerable amount of research supporting its validity in health behaviour change settings [22] and in the exercise field [23].

Based on the SDT framework, one approach that has been effective to support behaviour change is motivational interviewing (MI) [24]. More specifically, MI targets the three key components in SDT (autonomy, competence, and relatedness). In MI the interaction between the counsellor and client should be based on collaboration, non-judgement, and autonomy [25]. The purpose of the study 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 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 health (reduced body weight) and cardiorespiratory fitness.

# Methods

## 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 sedentary 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 ten participants including six women and four men in each group. At the end of the intervention period, one man from both the experimental and control group dropped-out, mainly due to changed work routines or an exit from employment. 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.

## 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).

## 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) [26] and psychological health (i.e., well-being, illness) collected using General Health Questionnaire–12 (GHQ-12) [27]. 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.

## 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

## Exercise intervention

The participants took part in the two-groups 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 especially designed for use in an outdoor gym. 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 sustainable 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 exercise intervention, see Johnson et al. [9].

## 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).

Table 1 about here

## Data analysis

Magnitude based inference (MBI) was calculated using an online published spread sheet [28], and inferences were based on the 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 [29]. 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 [28]. Pre-test pooled standard deviations were calculated using pre-test values from the sample as a whole (both experimental group and control group) [30]. 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 ESw and control ESw. 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 [31]. 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 [32] we used an ES = 0.50 as a threshold for the smallest important effect, rather than using Cohens threshold of 0.2 which is the effect size generally recommended for MBI by Hopkins [33]. Using Hopkins [33] guidelines for calculating sample size and Cohen’s threshold of 0.5 for a standard difference as the smallest important effect, based on physical activity (steps) as the main outcome measure, a minimum sample size of 15 is recommended.

## 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 Table 2).

Table 2 about here

## 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.

## Intervention effects

The between group changes for the BREQ-2 were less clear, but there was a possibly trivial (< 99%) reduction in identified regulation ($ES_{between}$ = 0.72) in the control group. After the three-month intervention, there was a likely (84%) small ($ES_{between}$ = 0.40) beneficial increase in PA in the experimental group compared to the control group. The experimental group showed a near small reduction in that body fat ($ES_{between}$ = -0.18) that was possibly beneficial, but no change in time to exhaustion within or between group ($ES_{between}$ = 0.05) (see Table 2).

## Discussion

### Main findings and comparisons within existing literature

The beneficial increase in PA (steps) for the experimental group could be due to motivation, positive expectations and the combination of MI and novel health technology equipment [13, 34]. Because both the experimental and control group were given the wrist-worn activity sensors at the same time (see Table 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 [35]. 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. The results from our study indicate that the experimental group maintained a similar level of identified regulation, as opposed to a decreased level in the control group at the post measure. This result may indicate that the participants continued to engage in an activity that they deemed personally valuable and important. In a similar way, Silva et al. [36] 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 [9]. Similar results have been found in sedentary and middle-age samples, based on 12-week exercise training and lifestyle intervention [37]. Some studies have also found significant improved physical and mental health status compared to controls after a three-month MI-based health coaching intervention [38] and positive changes in self-efficacy and PA for adult populations [39].

Although some promising results were generated from the three-month intervention period for the experimental group, we expected to find some positive influences on cardiorespiratory fitness because of the increased amount of steps for the experimental group. A potential explanation for the very small ES for time to exhaustion is that steps give a guide to the amount of PA but do not describe the intensity of PA, and the experimental group did not have a high enough intensity of PA to induce changes in cardiorespiratory fitness. Another observation is that the experimental group had a near small (ES = 0.18) reduction in fat mass. The reduction in fat mass could be explained by the greater amount of PA in the experimental group (13,369 steps a day) compared to the control group (10803 steps a day). Unfortunately, we did not use fat mass or body weight as a weighting factor during the selection and assignment of participants to groups, and due to the between-group differences in the pre-test, it is difficult to draw any conclusions from these findings.

## 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 the 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 [40–41]. Qualitative probability and description of clinical inference based on threshold chance of harm and effect [42] along with a vaguely Bayesian approach, according to Hopkins [43], is another hallmark of MBI. However, it is unclear if MBI interpretations can be classified as non-frequentist or as Bayesian statistics. 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.

On a positive note, only two participants (10%) dropped out, which suggests that the majority found this study/intervention meaningful. A final potential study limitation is that we used the number of steps as a measure for PA, but this measure does not account for level and total PA (such as cycling, swimming, and heavy lifting) and may underestimate total PA for some participants. Clearly, the findings in the current study need to be replicated in new samples.

## 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 [44]. Still another potential implication is that mobile tracking technology for middle-aged people interested in improving their PA has to be user-friendly to attract a wider population. It seems like today, mostly active and middle-aged (mostly men) people, with a high interest in technology, are using electronic tracking devices. 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 wellbeing in a middle-aged sedentary population. Our results indicate a need for further studies on motivational and usability aspects regarding the use of mobile health tracking devices by adults. See Seifert, Schlomann, Rietz [45].

Future research should ensure that fitness technology continues to include theoretically derived behaviour change techniques. Strategies such as social support and coaching seem to be especially helpful in increasing activity and healthy behaviours; see also Parker et al. [46]. 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.

## Abbreviations

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

## Declarations

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**Authors' contributions**

All authors contributed to study conception and design. UJ, AI, JP analysed the data and interpreted the results. UJ was responsible for drafting the manuscript, which was critically revised by JP, AI, IS and MBA. All authors have read and approved the final manuscript.

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**Conflicts of interest**

The authors declared that no competing interest exists.

**Ethics approval and consent to participate**

Ethical approval for the study was granted by the regional ethics committee (reference number 2016/843). Informed consent was obtained from all participants.

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## Tables

Table 1

Time plan for the study.

| Week/s | Working issue |
|---|---|
| 0 | Distribution of smart watches (pre-test), anthropometric and physical tests and psychological questionnaires. |
| 3 | Introduction to outdoor gym (Experimental group). |
| 4-19 | Intervention period and motivational interviewing session (week 6). |
| 19 | Post-test - anthropometrics and physical tests, and psychological questionnaires. |

Table 2

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

| | Pre Mean ± *SD* | Post Mean ± *SD* | Change $ES_{between}$ | Magnitude of inference | |
|---|---|---|---|---|---|
| | | | | Harmful | Trivial |
| **Physical activity** (Steps) | | | | | |
| 90 day average | | | | | |
| Control | | | 0.40 | 16% | 0% |
| Experimental | | 10803 ± 5767 | | unlikely | very unl |
| | | 13369 ± 4597 | | | |
| **Psychological measures** | | | | | |
| *GHQ-12* | | | | | |
| Positive items (wellb.) | | | 0.40 | 0% | 98% |
| Control | 2.9 ± 0.6 | 2.9 ± 0.7 | | very unlikely | very like |
| Experimental | 3.0 ± 0.3 | 3.3 ± 0.3 | | | |
| Negative items (illn.) | | | -0.23 | 0% | 99% |
| Control | 1.9 ± 0.7 | 1.8 ± 0.5 | | very unlikely | very like |
| Experimental | 1.6 ± 0.5 | 1.4 ± 0.4 | | | |
| *BREQ-2* | | | | | |
| Amotivation | | | -0.06 | 1% | 98% |
| Control | 1.4 ± 0.6 | 1.5 ± 0.9 | | very unlikely | very like |
| Experimental | 1.1 ± 0.2 | 1.2 ± 0.4 | | | |
| External regulation | | | 0.29 | 8% | 91% |
| Control | 1.5 ± 0.7 | 1.3 ± 0.6 | | very unlikely | likely |
| Experimental | 1.5 ± 0.9 | 1.5 ± 0.9 | | | |
| Introjected regulation | | | 0.56 | 24% | 74% |
| Control | 2.8 ± 0.8 | 2.2 ± 0.8 | | possibly | possibly |
| Experimental | 2.4 ± 1.0 | 2.3 ± 0.8 | | | |
| Identified regulation | | | 0.72 | 1% | 64% |
| Control | 2.7 ± 1.0 | 2.0 ± 0.9 | | very unlikely | possibly |
| Experimental | 3.5 ± 1.0 | 3.6 ± 0.8 | | | |
| Intrinsic regulation | | | -0.06 | 9% | 80% |
| Control | 3.5 ± 0.7 | 3.7 ± 0.8 | | very unlikely | possibly |
| Experimental | 3.6 ± 1.1 | 3.8 ± 1.0 | | | |
| **Physical measures** | | | | | |
| | | | -0.10 | 3% | 24% |
| Body weight (kg) | 76.9 ± 16.7 | 76.9 ± 16.5 | | very unlikely | possibly |
| Control | 89.3 ± 17.8 | 87.4 ± 18.7 | | | |

| | | | | | |
|---|---|---|---|---|---|
| Experimental | | | | | |
| Body Fat (kg) | | | -0.18 | 2% | 31% |
| Control | 23.2 ± 6.1 | 22.4 ± 6.8 | | very unlikely | possibly |
| Experimental | 31.3 ± 8.2 | 29.1 ± 7.5 | | | |
| | | | | | |
| Time to exhaustion test (s) | | | | | |
| Control | | | 0.05 | 38% | 5% |
| Experimental | 577 ± 16 | 588 ± 95 | | possibly | unlikely |
| | 572 ± 59 | 573 ± 50 | | | |

Note: *ES* = mean difference of effect sizes between groups, wellb = well-being, illn = Illness.