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# Worksite intervention effects on motivation, physical activity, and health: A cluster randomized controlled trial

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ABSTRACT

*Objectives:* The current study tested the hypothesis that a physical activity (PA) intervention in the worksite would lead to increases in autonomous motivation and perceived competence for PA, self-administered regular PA, and cardiorespiratory fitness (CRF), as well as improvements in health (i.e., reduced blood pressure (BP), waist circumference, and improved cholesterol levels). Moreover, the study tested the self-determination theory (SDT) model of health behaviour change.
*Design:* Cluster randomized controlled trial.
*Method:* Participants from a population of employees working within the area of transport and distribution ($n$ = 202) were cluster randomized ($n$ = 6 worksites) to an intervention and a control condition. The 16-week group-based worksite intervention was designed based on the tenets of SDT combined with techniques from motivational interviewing (MI). Participants were assessed at baseline and at post-test five months later.
*Results:* Complete-case analyses applying multivariate and univariate analysis of variance indicated an overall intervention effect, and moderate to small effect sizes (Cohen's *d*) in favour of the intervention group on CRF, diastolic BP, and high-density lipoprotein cholesterol (HDL-C), as well as need support for PA, autonomous motivation for PA, and perceived competence for PA. Intention-to-treat analyses demonstrated the same pattern with smaller effect sizes. Path analysis obtained a good fit between the data and the SDT model of health behaviour change.
*Conclusions:* Offering need supportive interventions to enhance autonomous motivation and competence for PA among employees resulted in important improvements in CRF as well as positive changes in health.
*Trial registration:* "My Exercise. A Team-based Workplace Intervention for Increased Exercise", clinicaltrials.gov, NCT02429635, April 14, 2015.

## 1. Introduction

Recommended levels of PA are known to prolong life, reduce risk for cardiovascular diseases (heart attack, stroke, and atherosclerosis), risk of type 2 diabetes, obesity, clinical depression, and certain types of cancer (American College of Sports Medicine [ACSM], 2014). The most recent national survey on PA habits among Norwegian adults found that only 32% satisfied the health authorities' recommendations of 150 min of moderate PA (in bouts of at least 10 min), or 75 min of high intensity PA per week (Hansen et al., 2015). Despite the public education campaigns and intensive media attention to health benefits of regular PA, the national survey demonstrated that improvements in activity levels among Norwegians have been surprisingly small over the last 10 years (Hansen et al., 2015). Considerable research effort has been dedicated to the development of effective health promotion approaches building on relevant theoretical frameworks and incorporating behavioural change techniques. However, more studies are needed to understand how these approaches can be adjusted to specific community settings in order to be perceived as practical and sustainable, without compromising the effectiveness in terms of behavioural change and improved health conditions (Heath et al., 2012).

For several decades, the worksite has been regarded as an important community setting for health promotion initiatives aimed at increasing PA levels of the adult non-clinical population (Abraham & Graham-Rowe, 2009; Rongen, Robroek, van Lenthe, & Burdorf, 2013). Capitalizing on the presence of natural social networks, employer-initiated programs can potentially enhance the degree of commitment to lifestyle changes due to social support from co-workers and management (Conn,

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Hafdahl, Cooper, Brown, & Lusk, 2009). Despite the apparent advantages of the worksite context, employer-initiated health promotion programs can potentially be perceived as controlling and an intrusion to private life. Fear of negative reactions or pressure from co-workers and supervisors is a common reason for not participating in such programs (Linnan, Weiner, Graham, & Emmons, 2007). We find that SDT (Deci & Ryan, 1985, 2000) represents a theoretical framework for behavioural change especially relevant to the context of a group-based employer-initiated health promotion program. Employees can easily feel ambivalent or even reluctant about participating if the program is perceived as "one size fits all" with little room for individual adjustment and freedom of choice (Linnan, Fisher, & Hood, 2012; Ryan & Deci, 2002). Hence, carefully designing the programs to offer support in an autonomous supportive manner is of pivotal importance, both for long-term behavioural change and for the well-being of employees. Moreover, due to the existing social networks, a group-based program can be designed to incorporate interpersonal involvement and need support from significant others like co-workers or managers, in addition to the program providers, typically occupational healthcare professionals.

SDT is an organismic theory of human motivational processes encompassing all aspects of human social life (Ryan & Deci, 2017). According to SDT, individuals are most effective and persistent in pursuing a healthy lifestyle when they are autonomously motivated (Ryan & Deci, 2002). Autonomous motivation entails that they engage in the activity because they find it intrinsically satisfying or because they truly identify with and value the outcomes (Deci & Ryan, 2000). Further, 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 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 (Deci & Ryan, 1985, 2000; Ryan, Williams, Patrick, & Deci, 2009).

The intervention was designed to provide the participants with a social environment perceived as need supportive according to three dimensions: autonomy support (Deci, Eghrari, Patrick, & Leone, 1994; Reeve, 2002; Williams, Cox, Kouides, & Deci, 1999), structure, and involvement (Markland, Ryan, Tobin, & Rollnick, 2005; Markland & Vansteenkiste, 2007). The operationalization of active ingredients was inspired by a model integrating SDT with motivational interviewing (MI; Markland et al., 2005), and previously applied in SDT-based PA intervention studies (Fortier, Duda, Guerin, & Teixeira, 2012). MI offer techniques that are inherently practical and process-oriented, and aim to increase the awareness of potentially conflicting motivations and explore the ambivalence related to making lifestyle changes (Markland et al., 2005). This process is important in order to help participants internalize autonomous forms of motivation, increase their readiness for change, and become self-regulated. This group-based intervention did not allow for individual in-depth counselling. Hence, suitable MI techniques were also incorporated into non-human material like plenary presentations held by a health and exercise advisor (HEA), and a booklet consisting of reflection tasks that were completed individually and discussed in small groups.

Autonomous motivation for PA has consistently shown to predict increased PA frequency, improved physical fitness, and increases in behaviour related to regular PA (Edmunds, Ntoumanis, & Duda, 2007; Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Teixeira and colleagues call for more SDT-based randomized controlled trials that include biomedical markers, like CRF or health risk factors such as high blood pressure, in order to assess the success of behavioural changes (Teixeira et al., 2012). Moreover, there is a need for more intervention studies that last for at least 12 weeks, preferably more than six months, allowing the internalization process to unfold (Rodgers, Hall, Duncan, Pearson, & Milne, 2010). SDT-based intervention studies aimed at increasing PA among adults have primarily been carried out in the context of community health services and primary care (Ng et al., 2012; Teixeira et al., 2012). SDT has previously been applied in the context of a worksite PA promotion intervention among university staff members with a sedentary lifestyle (Thøgersen-Ntoumani, Loughren, Duda, Fox, & Kinnafick, 2010; Thøgersen-Ntoumani, Ntoumanis, Shepherd, Wagenmakers, & Shaw, 2016). The studies obtained promising results related to increased PA, and autonomous motivation for PA was positively associated with adherence, which predicted higher levels of CRF and lower levels of body fat. However, the present study is the first SDT-based intervention designed specifically to suit employees working shifts doing manual labour. According to Quintiliani, Sattelmair, and Sorensen (2007), consistent findings indicate that male, blue collar workers are less likely to take part in worksite health promotion program, compared to white collar workers and women in general. There are structural barriers to participation like shift work, time pressure, and productivity demands related to working within logistics and production lines. Moreover, according to Norwegian national surveys, people working within transport have the highest levels of sickness absence among male employees, and the second highest among female employees (Nygård, 2015).

Due to financial and practical reasons, worksite health promotion programs are often offered to organizational teams or groups of employees rather than individually. In general, meta-analyses and review studies have reached inconclusive and often contradictory results regarding the effectiveness of individually-based versus group-based approaches (Carron, Hausenblas, & Mack, 1996; Van der Bij, Laurant, & Wensing, 2002). Meta-analytic findings make an argument for the importance of personal contact and group cohesion, rendering group-based programs that incorporate principles of group dynamics the most effective in terms of adherence and physiological effects (Burke, Carron, Eys, Ntoumanis, & Estabrooks, 2006).

In the current worksite context, a group-based intervention was designed to offer a need supportive environment that would facilitate the participants' autonomous motivation for self-organized PA sessions. This was preferred over collective PA classes since employees worked shifts and a majority were "on the road" during workings hours. This was supported by interviews with representatives of the target population, carried out prior to the intervention design phase, who were found to be reluctant to the idea of collective PA classes because of the lack of onsite facilities and irregular working hours. In addition, they felt uncomfortable exercising with co-workers because they perceived them to differ too much in terms of exercise habits and PA competence levels.

Incorporating co-workers as an active ingredient in worksite health promotion programs is rather common (Linnan et al., 2012). Co-workers are expected to offer support that facilitates behavioural change during the intervention period, and to develop a culture that supports the maintenance of change after program termination. Intervention studies assessing the effects of co-worker peer support on health behaviour outcomes have obtained promising results; however peers are rarely evaluated separately from the overall intervention effects (Linnan et al., 2012). In the majority of SDT based intervention studies the provider of need support, the "significant other", is represented by a figure of authority such as a physician (Williams, McGregor, Zeldman, Freedman, & Deci, 2004), an exercise instructor (Edmunds, Ntoumanis, & Duda, 2008), or a dentist (Münster Halvari, Halvari, Bjørnebekk, & Deci, 2012). The core of their profession is the expert helper, which makes them a natural and efficient source of need support, especially in terms of competence, assuming they are able to provide the required time. There are considerably fewer SDT-based studies where peers, someone who is of equal standing, are targeted as agents of need support. Peers are known to play an important role in terms of need support during team sports or collective PA sessions (Ntoumanis, Vazou, & Duda, 2007; Wilson & Rodgers, 2004). Rouse and colleagues assessed the unique contributions of several significant others on PA intentions prior to intervention start-up. Results indicated that both physicians as well as partners were more effective contributors compared to offspring (Rouse, Ntoumanis, Duda, Jolly, & Williams, 2011). However, there are few SDT based PA intervention studies designed specifically to influence the need supportive behaviour of peers, and none in the context of worksite health promotion.

### 1.1. Study aim and research questions

The main aim of the intervention was to increase participants' level of regular PA as well as their CRF (ACSM, 2014). The pivotal role of regular PA and CRF in terms of lowering the risk of cardiovascular diseases and premature mortality has been supported in both intervention trials and epidemiological studies (Gill & Malkova, 2006; Lee et al., 2012). This is especially the case for individuals with a risk profile defined as metabolic syndrome: abdominal obesity, raised triglycerides, an unfavourable combination of high-density lipoprotein cholesterol (HDL-C) and non-HDL-C levels, raised systolic and diastolic BP, and high levels of fasting plasma glucose (Alberti, Zimmet, & Shaw, 2006). Despite the importance of regular PA, recent studies have indicated that the cardio-metabolic benefits are negligible in terms of reduced risk of cardiovascular disease and premature mortality if CRF remains poor (Aspenes et al., 2011; Lee et al., 2012). Health promotion initiatives will have a stronger impact on physical health if they target the participants' motivation (e.g. awareness, willingness and ability) to engage in activities with moderate to vigorous intensity. In the present study, it was recommended that participants exercised at moderate intensity, and to explore whether they could increase their intensity levels in short bouts when the opportunity presented itself naturally, for instance increase their pace uphill during walks, and apply the principles of high-intensity interval training (HIT; Gaesser & Angadi, 2011). Accumulated evidence indicates that the effectiveness of HIT is surprisingly close to continuous PA in terms of cardio-metabolic adaptations (Gibala & McGee, 2008).

The present study tested the hypotheses that a need-supportive group-based PA intervention (relative to a standard control condition) would lead to increases in regular PA and CRF, as well as improvements in biomedical outcome variables related to health (i.e., reduced systolic and diastolic BP, waist circumference, increased HDL-C, and lower non-HDL-C levels). Moreover, the study assessed whether the data supported an SDT model of health behaviour change (Williams, Gagné, Ryan, & Deci, 2002) previously supported in a meta-analysis on studies in health related settings (Ng et al., 2012). The current adaption of the model posits that perceived need support for PA would have a positive effect on the participants' degree of autonomous motivation and perceived competence for PA, leading to increases in PA levels and CRF. These changes were expected to improve health related outcome variables (systolic and diastolic BP, waist circumference, and non-HDL-C). In order to reduce the complexity of the model, only non-HDL-C was chosen to represent the secondary outcome measure, cholesterol. Recent guidelines indicate that a change in non-HDL-C is a stronger predictor of cardiovascular disease risk compared to a change in HDL-C (Piepoli et al., 2016).

## 2. Method

### 2.1. Design and procedures

This was a parallel group randomized controlled trial with two conditions. Baseline assessments were carried out in January 2015, followed by a 16-week group-based intervention, and post-test assessments in June 2015. Cluster randomization was preferred due to the group-based nature of the intervention sessions and the role of co-workers as a source of need support for PA. In addition, individual-level randomization would considerably increase the risk of contamination and crossover between groups, and hence geographic worksite was chosen as the unit of randomization. The practical and financial scale of the study did not allow for more than six worksite locations. All procedures were defined in the research protocol, and approved by the Data Protection Official for Research in Norway. In addition, the project was presented to the Regional Committees for Medical and Health Research Ethics, Norway, who concluded that the project could proceed without further approval according to the Norwegian health research legislation.

### 2.2. Participants and recruitment

All participants were employed by the Norwegian Post delivering mail and logistic services. All participants did manual labour as terminal workers, drivers, and mail carriers. However, their level of regular occupational PA was expected to differ somewhat related to whether they applied vehicles and technical ergonomic equipment during working hours. All workplace locations were situated in the East of Norway, both rural and urban areas. First, local worksite management was presented to the research study, and approval was obtained prior to recruitment of local employees. Participants were recruited by means of information meetings at the workplace premises during working hours. Written information including the informed consent form was handed out and administered by the researcher. Inclusion criteria were defined as worksites that consisted of teams working shifts, and employees working full time or part time (a position of at least 20%). Having a health condition was not a criterion for exclusion as long as the employees were fit for work.

### 2.3. Sample size calculations

The study was powered in order to detect behavioural changes of clinical relevance to the participants' health, not just statistically significant changes (Campbell, Thomson, Ramsay, MacLennan, & Grimshaw, 2004). Sample size calculations were based on estimated Cohen's $d$ effect size (ES) of CRF derived from a meta-analysis of worksite PA intervention studies resulting in an estimated mean of true ESs of 0.51 (95% CI = 0.39 to 0.63; Conn et al., 2009). Based on this study, a conservative estimation of $d = 0.39$ was expected in the present study since participants initiated and organized their exercise sessions individually. An estimate of the intra-cluster correlation coefficient (ICC) was set to 0.040. This was based on a review of cluster randomized controlled trials in primary care since equivalent meta-analyses of ICC was not found for worksite interventions (Eldridge, Ashby, Feder, Rudnicka, & Ukoumunne, 2004). *SD* was set to 0.5 based on a clinically relevant change in CRF of one MET or 3.5 mL $kg^{-1} \cdot min^{-1}$ (Myers et al., 2004) combined with results from a large Norwegian study on healthy adults ($M$ = 40 mL $kg^{-1} \cdot min^{-1}$, $SD = 7$; Aspenes et al., 2011). In order to achieve a detectable effect size of $d = 0.39$ with 90% probability at 5% significance level, a sample size of $n = 27$ per cluster was required resulting in a total sample size of $n = 162$. The sample size was increased with 20% to $n = 194$ in order to account for attrition. Sample size calculations were carried out including cluster correction by means of an internet-based computation service (http://www.sample-size.net/).

### 2.4. Randomization

Participants were randomized in parallel to the intervention and control groups in six clusters based on worksite locations (three in each). The randomization sequence was created using a computer generated list offered at a randomization service website for clinical trials.

### 2.5. Intervention design

The groups received identical onsite health screening consisting of baseline assessments and an individual talk where health personnel offered explanations and health recommendations based on a written, individual health profile. Following randomization, the intervention group was offered six sessions of group-based intervention elements: two workshops and four PA support group meetings, a total of 7.5 h. All sessions were offered at the worksite premises. The intervention consisted of three sources of need support: co-workers, a health and exercise advisor (HEA), and a booklet consisting of reflection tasks. The workshops were provided and facilitated by a HEA. Initially, the HEA gave short talks on PA and health, and on health behaviour change and motivation according to the tenets of SDT. Participants received a booklet consisting of reflection tasks based on a combination of SDT and techniques from MI. Participants completed each individually, and discussed their answers in small groups of 2–3 participants in order to increase awareness, competence and relatedness, followed by plenary discussions facilitated by the HEA. The two HEAs were physiotherapists employed by the company occupational health service. They were both experienced and professionally trained in behavioural change counselling and facilitation of group processes. They received eight hours of training in how to facilitate the group workshops and provide participants with autonomy support, structure, and interpersonal involvement. Peer dialogue was incorporated in both workshops and PA support group meetings. The support groups (4–5 participants with similar PA levels and interests) were structured to facilitate mutual sharing of experiential knowledge connected to PA lifestyle changes. The groups were instructed to put one participant in focus at the time, and to offer support for autonomy, competence, and relatedness in their response and comments. During the first one hour meeting, participants were offered an introduction to the concept of need supportive behaviour, operationalized according to the short version of the Health Care Climate Questionnaire (HCCQ; Williams, Grow, Freedman, Ryan, & Deci, 1996), and structured as descriptions of need supportive or need thwarting behaviour. An example is "Explore different options and choices together with the person" versus "Offer strong opinions about what the person should choose or do". The groups were self-directed, and contacted the researcher present for questions or comments.

Participants in the control group were not offered any employer-initiated group-sessions between baseline and post-test assessments. However, for ethical reasons, they were encouraged to follow the recommendations they received during the individual health screening. In addition, they were offered similar group-based sessions after post-test. Both groups received a second identical health screening after five months where post-test assessments were compared to baseline. For a complete description of the intervention content and design, see supplementary material, Appendix A.

### 2.6. Primary outcome measures

CRF is often regarded as the main component of physical fitness, and it is defined by the ability to engage the respiratory, cardiovascular, and musculoskeletal systems in moderate to vigorous activity for a prolonged period of time (ACSM, 2014). Since participants were not excluded on the basis of their health condition, a submaximal test was considered less strenuous with a lower risk of overexertion and negative health reactions (ACSM, 2014). The Astrand-Ryhming ergometer bicycle test, a single-stage test lasting for six minutes, was administered by qualified health occupational therapists (ACSM, 2014; Astrand, 1960). An electronic cycle ergometer with a cadence meter and a heart rate monitor with chest strap was applied. CRF levels were estimated based on a steady pace with a heartrate between 120 and 170 bpm, and workload determined by the participants' gender and physical condition. An adjusted $VO2_{max}$ value was estimated using the modified Astrand-Ryhming monogram, correcting for age, gender, and weight. Validation studies have demonstrated a consistent difference between submaximal estimations and direct measures (in standard deviations) of approximately ± 15% in a population mixed in age and fitness level (Ekblom, Engstrom, & Ekblom, 2007).

Habitual PA in terms of the average frequency, duration, and intensity per week was assessed applying the three-item questionnaire International Physical Activity Index (IPAI), previously validated in a compatible population in Norway (i.e., the HUNT study; Kurtze, Rangul, Hustvedt, & Flanders, 2008).According to protocol, weighted scores are summed in a total index. In the present study, the reliability test obtained a satisfactory level at baseline (Cronbach's $\alpha = .80$), albeit a somewhat low level at post-test ($\alpha = .67$).

### 2.7. Secondary biomedical outcome measures

Systolic and diastolic BP were measured manually applying an auscultatory technique with a mercury column or mechanical aneroid sphygmomanometer. Blood samples were collected by means of capillary puncture. Non-HDL-C was calculated by subtracting HDL-C from total cholesterol. Blood samples were collected during working hours, and participants were not advised to fast before attending the test due to work safety considerations.

### 2.8. Motivation measures

Autonomous motivation for PA was measured by a composite construct of the two subscales intrinsic (e.g., "I exercise because it's fun") and identified motivation (e.g., "I value the benefits of exercise") from the Behavioural Regulation in Exercise Questionnaire (BREQ-2; Markland & Tobin, 2004). Participants responded according to a 5-point Likert-scale, ranging from 1 (*not true for me*) to 5 (*very true for me*). The reliability coefficients of the scales combined were satisfactory ($\alpha = .89$), and the two subscales highly correlated ($r = .75$). Perceived competence for PA was measured by the Perceived Competence in Exercise Scale (PCES; Williams & Deci, 1996), on a 7-point Likert-scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). An example item being: "I feel confident in my ability to exercise on a regular basis". The scale obtained high levels of reliability ($\alpha = .90$). Perceived need support for PA was assessed with the short version (seven items) of the Health Care Climate Questionnaire (HCCQ; Williams et al., 1996) adjusted to co-workers (e.g., "My co-workers listen to how I would like to do things regarding my regular exercise"). The items were completed on a 7-point Likert-scale, ranging from 1 (*not true*) to 7 (*very true*), and the scale obtained high levels of reliability ($\alpha = .92$).

### 2.9. Data analysis

Descriptive analyses of baseline data were executed by means of independent sample t-tests in order to assess significant differences between conditions and clusters after randomization. Attritions checks were carried out by means of binary logistic regression in order to assess whether baseline measurements predicted dropout or not. Due to attrition, analyses of intervention effects between conditions over time, multivariate (MANOVA) and univariate (ANOVA) analyses of variance repeated measures were executed on both intention-to-treat and complete-case samples. Missing data were accounted for by means of multiple imputation ($n = 15$ imputations). All analyses were undertaken using IBM SPSS Statistics 21 (IBM Corp., Boston, Mass, USA). Multilevel modelling methods were considered inappropriate due to the small number of clusters ($n =$ six) and cluster sample sizes ($n = 23$–$47$; Snijders & Bosker, 2012). All analyses applied worksite location as a covariate in order to control for the effects of the cluster randomization. Effect sizes were calculated applying Cohen's $d$ comparing two conditions (Morris, 2008).

The SDT model of health behaviour change was tested with a path analysis. The model consisted of five objective constructs (CRF, systolic and diastolic BP, waist circumference, and non-HDL-C) and one index construct (PA). As a consequence, change scores, calculated by linear regression, were preferred to latent constructs because a combination of latent and manifest constructs decreases the stability of complex models due to large reliability differences (Cole & Preacher, 2014). First, a zero order correlational analysis of linear regressions (change scores) was performed in SPSS applying the complete-case sample, in order to assess the pattern of relationships. Secondly, the motivation measures were assessed for model fit in M*plus* 7.4 (Muthén & Muthén, 1998–2012) by means of confirmatory factor analysis (CFA). Missing data were handled using full information maximum likelihood (FIML) estimation, and analyses were performed using the robust MLR-estimator (Muthén & Muthén, 1998–2012). Next, a covariance-based path analysis in M*plus* was applied in order to account for the potential effects of the cluster randomization variable. Given the small number of clusters to analyze (i.e., six), "type is complex" was chosen above a multilevel analysis, in accordance with the recommendations of McNeish and Stapleton (2016). Process evaluations and assessments of fidelity were included in the study, in accordance with RE-AIM. Results of these data will be published in a future paper.

## 3. Results

### 3.1. Baseline analyses

Six worksite locations were invited to participate, consisting of 320 eligible employees. A total of $n = 202$ (68%) employees agreed to participate in the study. After baseline assessments, $n = 113$ (56%) were randomly allocated to the intervention group, and $n = 89$ (44%) to the control group (Fig. 1). The mean cluster size was $n = 34$ (range from $n = 23$ to 47, with 65% between $n = 30$ and 36). The sample had a mean age of 42.5 years (*SD* 11.65), and consisted of 76.2% men. Independent sample *t*-test indicated there were no significant differences between the study sample and eligible employees who declined to participate ($n = 97$) in terms of age (t = 0.98, p = .328) and gender (t = 0.70, p = .482). There were significantly more men in the control group (13%, 95% CI = .00 to .24) at baseline. In addition, the control group obtained significantly higher levels of CRF (4.68 mL $kg^{-1} \cdot min^{-1}$, 95% CI = 1.72 to 7.64), and significantly lower levels of both systolic BP (1.89 mmHg, 95% CI = −8.37 to −.29) and diastolic BP (1.43 mmHg, 95% CI = −6 to-.54). In terms of motivation measures, both perceived competence for PA (0.64, 95% CI = 0.21 to 1.06) and autonomous motivation for PA (0.14, 95% CI = 0.07 to 0.59) were significantly higher in the control group. For all other measures, differences were non-significant (see supplementary material, Appendix B).

### 3.2. Attrition checks and missing data

A total of 22% ($n = 45$) were lost to post-test assessments. The Little's test did not support the hypothesis that data were missing completely at random (MCAR): $\chi^2 = 300$, $df = 233$, $p = .002$. Analysis of the groups separately demonstrated a MCAR pattern in the intervention group ($\chi^2 = 166$, $df = 152$, $p = .20$); however this was not the case in the control group ($\chi^2 = 266$, $df = 205$, $p = .003$). Attrition rates were significantly higher in the control group compared to the intervention group ($p = .042$). Analyses by means of binary logistic regression demonstrated that gender, educational level, autonomous motivation for PA, and perceived competence for PA significantly predicted dropout rates, albeit none of the outcome measures. Further analysis of the dropouts revealed that 12% ($n = 24$) chose to withdraw from the study, whereas 10% ($n = 21$) were not able to attend post-test assessments due to vacation (n = 13), sickness absenteeism ($n = 6$), absence due to training ($n = 1$), or ending employment ($n = 1$). Analysis comparing those who completed with those who were presumably willing but not able to attend, indicated that only education level (Wald = 4.51, $p = .034$, odds ratio [OR] = .402, CI = .174 to .932) significantly predicted dropout rates. However, comparing those who completed with those who actively withdrew, the latter were lower in education levels (Wald = 5.66, $p = .017$, OR = .372, 95% CI = .165 to .840) and this group included more men (Wald = 7.29, $p = .007$, OR = .291, 95% CI = .119 to .713). Moreover, participants in this latter group were considerably less autonomously motivated for PA (Wald = 9.75, $p = .002$, OR = .463, 95% CI = .286 to .751) and perceived themselves to be less competent related to PA (Wald = 5.26, $p = .022$, OR = .711, 95% CI = .531 to .952).

### 3.3. Intervention attendance rates

In the intervention group, average attendance rate was 50%, or three sessions ($M = 2.75$, $SD = 1.76$). A total of 56% ($n = 62$) attended the first and 44% ($n = 49$) the second workshop. Binary logistic regression analysis indicated that autonomous motivation for PA was the only baseline characteristic significantly predicting whether the participants attended sessions or not ($\chi^2 = 10.54$, p = .001). Moreover, hierarchical multiple regression analysis indicated that only 0.8% ($p = .42$) of the total variance in post-test CRF was explained by attendance rates, equivalent values for PA was 0% ($p = .92$).

### 3.4. Analysis of intervention effects

MANOVA repeated measures including all variables demonstrated an overall Intervention x Time effect in both intention-to-treat analysis ($F = 3.791$, $df = 10$, $p = .009$) as well as complete-case analysis ($F = 5.415$, $df = 10$, $p = .000$). ANOVA repeated measures for each of the variables are listed in Table 1. Regular PA did not yield any significant intervention effect but a significant effect of time (F = 7.60, p = .007). The secondary biomedical outcome measures related to health all indicated a positive development in the intervention group compared to the control group. Changes in systolic BP and waist circumference were non-significant and did not yield significant effects of time or intervention.

### 3.5. Testing the SDT model of health behaviour change

The zero order correlational analysis indicated a pattern that was in accordance with the research hypotheses, except that perceived competence for PA did not correlate with CRF (supplementary material, Appendix C). CFA demonstrated an acceptable model fit *for need* support *for PA* omitting three items (HCCQ2, HCCQ6, and HCCQ7): $\chi^2/df = 1.61$, RMSEA = .056 (95% CI = .000 to .164), CFI = .99, TLI = .99, SRMR = .012. The 4-items scale measuring *perceived competence for PA* received a good fit: $\chi^2/df = 1.36$, RMSEA = .043 (95% CI = .000 to .155), CFI = .99, TLI = .99, SRMR = .013. *Autonomous motivation for PA* obtained a strong model fit by omitting one item (BREQ3) from the identified motivation subscale: $\chi^2/df = 0.77$, RMSEA = .000 (95% CI = .000 to .075), CFI = 1, TLI = 1, SRMR = .048.

The direct effects over time among constructs in the model were assessed applying linear regressions. Attendance rates were excluded from the model due to the lack of significant effects on the primary outcome variables. The specified model obtained a good fit to the sample data: $\chi^2/df = 1.01$, RMSEA = .010 (95% CI = .000 to .069), CFI = .99, TLI = .99, SRMR = .052. Furthermore, 13 of 17 hypothesized links in the model were supported (Fig. 2). The hypothesized link between perceived competence for PA and CRF was not statistically significant ($p = .150$). Likewise, PA levels did not demonstrate significant links with diastolic BP ($p = .110$). Moreover, CRF had significant links with all secondary outcome measures except non-HDL-C ($p = .470$). Additional significant indirect effects were found from changes in autonomous motivation via PA on CRF ($Z = 2.445$, 95% CI = .005 to .061), systolic BP ($Z = -2.90$, 95% CI = −.123 to −.023), and non-HDL-C ($Z = -2.92$, 95% CI = −.166 to −.030; see supplementary material, Appendix D). Indirect effects were also found from changes in autonomous motivation via CRF on systolic BP

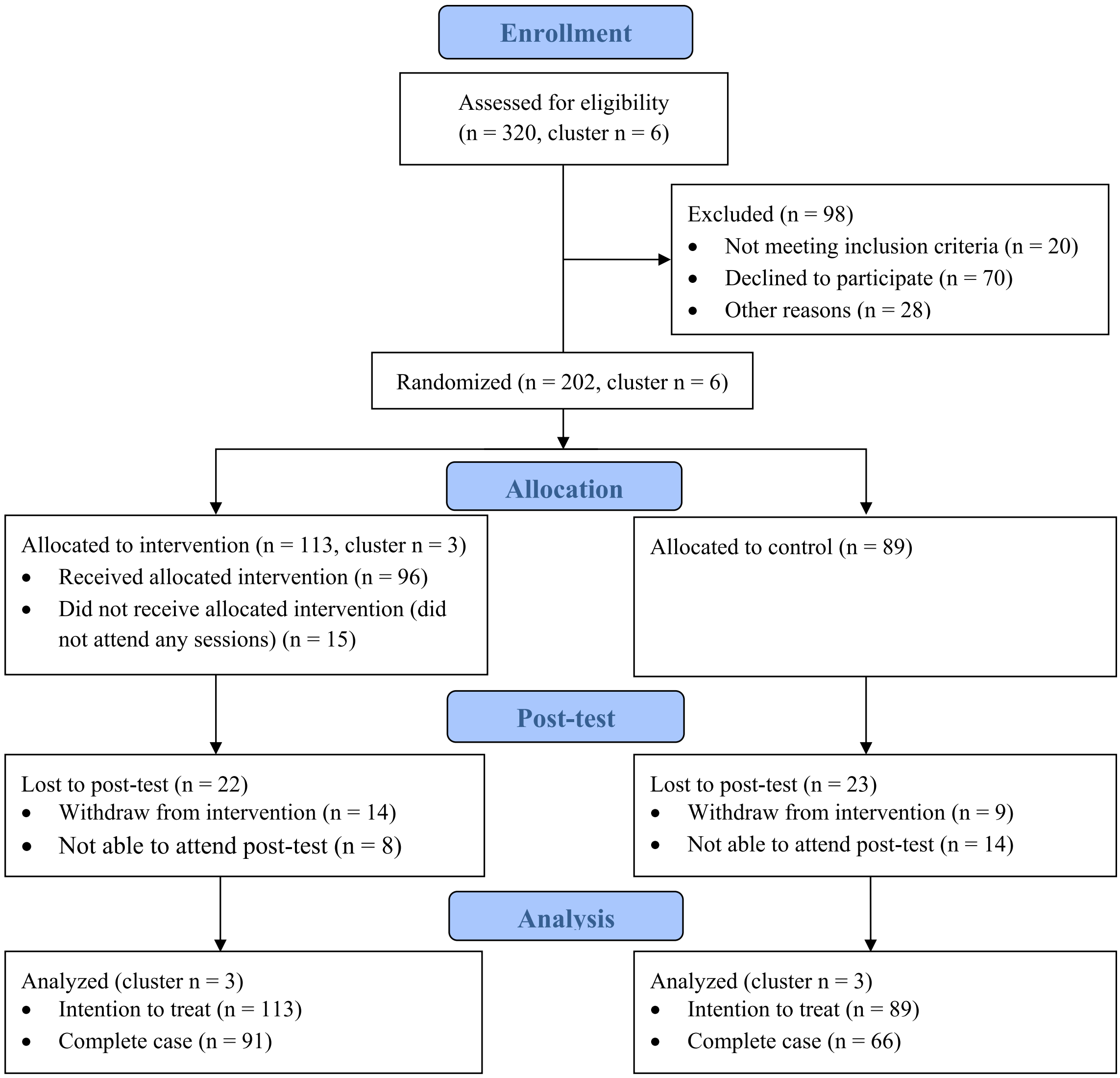


**Fig. 1.** CONSORT study flow diagram.

($Z = -3.36$, 95% CI = −.050 to −.014), and diastolic BP ($Z = -2.06$, 95% CI = −.096 to .000). In addition, the intervention had indirect effects on perceived competence for PA ($Z = 3.93$, 95% CI = .017 to .053), albeit not on autonomous motivation for PA.

## 4. Discussion

The present study offers important information on how the worksite and the community of co-workers can be incorporated in an intervention designed to move participants towards autonomous motivation for behavioural change, and the potential effects such an intervention has on PA, CRF and health. Furthermore, the study contributes to the understanding and applicability of SDT as a theoretical framework for the design of health promotion programs in non-treatment settings.

The primary aim of the study was to test the hypothesis that a need-supportive group-based PA intervention (relative to a standard control condition) would lead to increases in regular PA and CRF, as well as improvements in health (i.e., reduced BP, waist circumference, and improved cholesterol levels). Findings are in line with reviews of previous PA intervention studies in the worksite context reporting moderate albeit mixed effect sizes on CRF (Abraham & Graham-Rowe, 2009; Conn et al., 2009; Rongen et al., 2013). A key finding in the present study was the effectiveness of the intervention to help participants increase their CRF, with a mean increase in the intervention group of 3.8 mL $kg^{-1}$·$min^{-1}$. According to Myers et al. (2004), a change above 3.5 mL $kg^{-1}$·$min^{-1}$ (one MET) would be considered clinically relevant in terms of reduced risk of cardiovascular diseases and premature mortality. This is an important finding given the fact that PA was self-organized. The intervention was designed to merely help participants decide on the kind of activities they felt were most suited to their life-situation, preferences, and competence levels. Collective PA sessions, offering one kind of activity, were expected to be perceived as less autonomy supportive, and were not included. Findings indicate that the participants responded positively to the focus on autonomous motivation, as well as the information about the importance of CRF. We may also assume that they felt competent enough to increase the intensity of their activities of choice, possibly by means of HIT, which may explain their increases in CRF.

The intervention group reported a significant increase in regular PA from baseline to post-test, contrary to the control group. However, significant between-group effects comparing the two conditions were not found. This finding was somewhat surprising given the relatively strong between-group effects on CRF. Several studies have found a relatively small correlation between self-reported levels of PA and objective measures of fitness (Dyrstad, Hansen, Holme, & Anderssen, 2014). In the current study, 49.4% of the participants in the intervention group and 59.0% in the control group described their PA levels as high at baseline, something which increased to 62.9% at post-test in

**Table 1**
ANOVA Repeated Measures with means (M) and standard deviations (SD): Motivation variables, primary and secondary outcome measures.

| Variable | Complete case analysis | | | | Intention-to-treat analysis | | | |
|---|---|---|---|---|---|---|---|---|
| | Baseline (*M/SD*) | 5 months (*M/SD*) | Time x Interv. (*F/p*) | Effect size (Cohen's *d*) | Baseline (*M/SD*) | 5 months (*M/SD*) | Time x Inerv. (*F/p*) | Effect size (Cohen's *d*) |
| CRF (mL·kg$^{-1}$·min$^{-1}$) | | | | | | | | |
| Intervention (n = 85) | 32.33 (7.97) | 36.13 (9.31) | 18.14/.000 | 0.49 | 31.82 (8.37) | 36.51 (8.28) | 7.82/.007 | 0.39 |
| Control (n = 58) | 38.28 (12.59) | 37.09 (10.18) | | | 36.25 (11.66) | 36.99 (10.06) | | |
| PA levels | | | | | | | | |
| Intervention (n = 89) | 3.73 (2.22) | 4.41 (2.08) | 0.32/.136 | 0.15 | 3.67 (2.19) | 4.43 (1.99) | 0.25/.686 | 0.07 |
| Control (n = 61) | 4.29 (2.27) | 4.63 (2.15) | | | 3.95 (2.33) | 4.55 (1.96) | | |
| Waist circumference (cm) | | | | | | | | |
| Intervention (n = 87) | 96.37 (11.90) | 95.91 (12.24) | 2.26/.136 | −0.01 | 96.55 (13.16) | 95.88 (10.98) | 0.28/.642 | 0.02 |
| Control (n = 58) | 94.84 (12.83) | 94.47 (12.63) | | | 94.57(13.64) | 93.69 (11.15) | | |
| Non-HDL-C (mmol/L) | | | | | | | | |
| Intervention (n = 87) | 5.11 (2.37) | 5.13 (2.40) | 4.12/.044 | −0.04 | 5.07 (2.36) | 5.12 (2.41) | 1.56/.396 | −0.01 |
| Control (n = 53) | 5.59 (2.32) | 5.72 (2.42) | | | 5.64 (2.36) | 5.71 (2.48) | | |
| HDL-C (mmol/L) | | | | | | | | |
| Intervention (n = 87) | 1.26 (0.42) | 1.31 (0.48) | 10.73/.001 | 0.22 | 1.25 (0.40) | 1.30 (0.52) | 5.53/.006 | 0.12 |
| Control (n = 53) | 1.31 (0.37) | 1.27 (0.41) | | | 1.33 (0.42) | 1.32 (0.51) | | |
| Systolic BP (mmHg) | | | | | | | | |
| Intervention (n = 89) | 135.34 (16.85) | 131.70 (14.80) | 2.91/.091 | −0.13 | 135.47 (16.15) | 131.55 (13.15) | 0.17/.710 | −0.18 |
| Control (n = 62) | 131.29 (12.95) | 129.61 (23.08) | | | 131.26 (12.38) | 129.97 (15.16) | | |
| Diastolic BP (mmHg) | | | | | | | | |
| Intervention (n = 89) | 83.66 (9.82) | 81.83 (10.10) | 11.83/.001 | −0.30 | 84.26 (9.37) | 81.75 (9.12) | 7.18/.015 | −0.26 |
| Control (n = 62) | 80.26 (10.23) | 81.48 (8.44) | | | 81.06 (9.62) | 81.06 (7.93) | | |
| Need support for PA (peers) | | | | | | | | |
| Intervention (n = 88) | 3.95 (1.29) | 4.42 (1.26) | 10.03/.002 | 0.59 | 4.00 (1.31) | 4.39 (1.15) | 4.70/.034 | 0.29 |
| Control (n = 62) | 4.38 (1.18) | 4.11 (1.34) | | | 4.08 (1.34) | 4.09 (1.22) | | |
| Perceived competence for PA | | | | | | | | |
| Intervention (n = 88) | 4.46 (1.44) | 4.59 (1.52) | 7.72/.006 | 0.43 | 4.43 (1.50) | 4.60 (1.39) | 4.38/.043 | 0.24 |
| Control (n = 62) | 5.37 (1.36) | 4.89 (1.34) | | | 5.05 (1.43) | 4.86 (1.18) | | |
| Autonomous motivation for PA | | | | | | | | |
| Intervention (n = 88) | 3.40 (0.85) | 3.54 (0.80) | 13.86/.000 | 0.45 | 3.32 (0.87) | 3.55 (0.73) | 5.85/.020 | 0.29 |
| Control (n = 62) | 3.82 (0.79) | 3.59 (0.76) | | | 3.61 (0.84) | 3.59 (0.67) | | |

Note: CRF = cardiorespiratory fitness. PA = physical activity. Non-HDL-C = non-high-density lipoproteins cholesterol. HDL-C = high-density lipoproteins cholesterol. BP = blood pressure.

both groups. Comparing these findings to CRF measures, there is an apparent discrepancy. Only 8% of the participants in the intervention group and 16.3% in the control group obtained levels that would be defined as high or very high at baseline (Astrand, 1960). Doing manual labour could possibly mask their perceptions of the extent to which their level of PA during working hours actually satisfied the recommended level of regular PA, especially when it comes to intensity. Findings have indicated that there are systematic differences between occupational and leisure-time PA, especially when PA could be described as high. Occupational PA typically consists of heavy lifting and

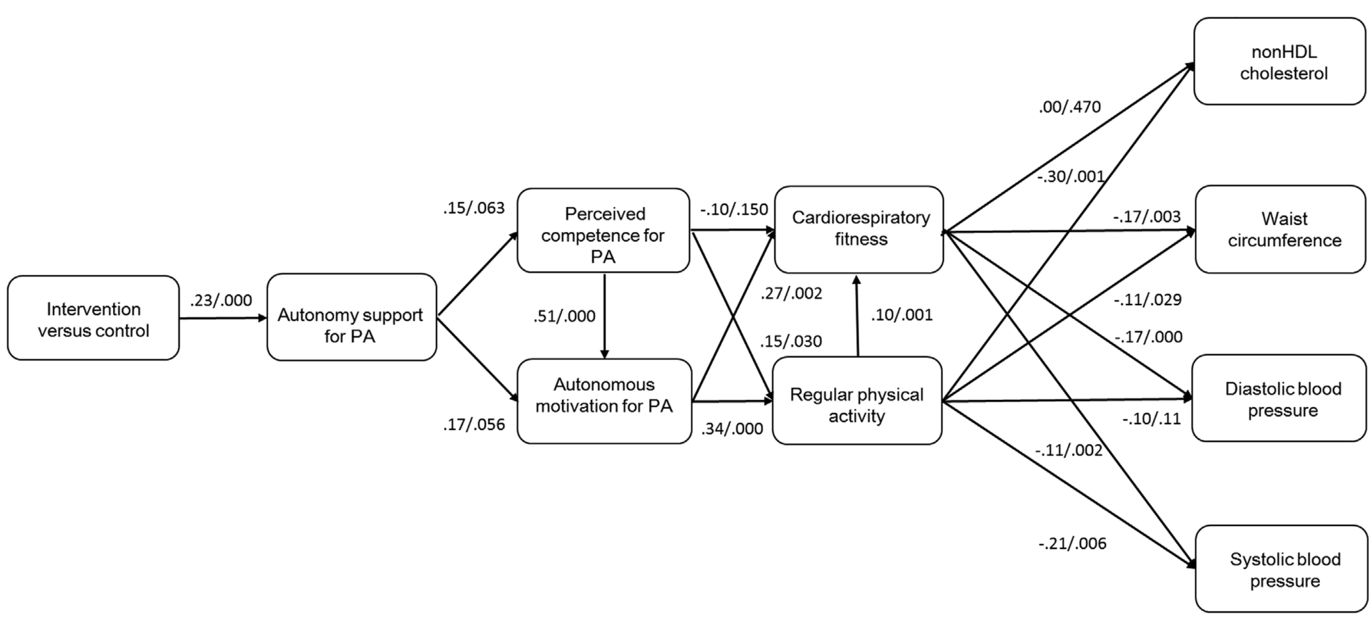


**Fig. 2.** The SDT health model of behaviour change. Path analysis of associations between change scores. Maximum likelihood estimation with robust standard errors to account for missing values. $\chi^2/df$ = 1.01, RMSEA = .010 (95% CI = .000 to .069), CFI = .99, TLI = .99, SRMR = .052. Single-tail *p*-values. CRF = cardiorespiratory fitness. PA = physical activity. Non-HDL-C = non-high-density lipoproteins cholesterol. HDL-C = high-density lipoproteins cholesterol. BP = blood pressure.

repetitive work, whereas leisure-time PA is often characterized by "dynamic contractions of large muscle groups increasing whole-body metabolism and cardia output with ability to rest when fatigue requires so" (Holtermann, Hansen, Burr, Søgaard, & Sjøgaard, 2012, pp. 293–294).

All secondary biomedical outcome measures demonstrated a positive development in the intervention group, and between group changes were significant for diastolic BP and HDL-C. Waist circumference, non-HDL-C, and systolic BP did not demonstrate any significant between-group changes (intention-to-treat); however, systolic BP did demonstrate a significant within subject effect. In terms of clinical relevance, the improvements in the intervention group on BP (systolic BP = −3.64 mmol/L and diastolic BP = −1.83 mmol/L) were compatible to the mean values found in a review study of randomized controlled trials related to PA (systolic BP = −3.84 mmol/L, 95% CI = −.4.97 to 2.72, and diastolic SP = −2.58 mmol/L, 95% CI = −3.35 to −1.81; Whelton, Chin, Xin, & He, 2002). In addition, these changes are consistent with the hypertension guideline expected effect of regular PA (Chobanian et al., 2003). Hence, the intervention proved effective in terms of clinically relevant changes in BP that reduced the risk of myocardial infarction, stroke, heart failure, and premature mortality. Changes in HDL-C levels in the intervention group (0.050 mmol/L) were close to, albeit somewhat lower than the findings in the review of Kodama and colleagues on PA intervention studies (0.065 mmol/L; Kodama et al., 2007).

Changes in waist circumference and non-HDL-C were too small to represent any clinically relevant changes in terms of reduced risk for diseases related to lifestyle. However, other factors besides regular PA have proven to determine these biomedical markers including calorie balance, macronutrient intake (saturated fats, carbohydrates) and genetic factors responsible for insulin resistance and non-HDL-C (Piepoli et al., 2016). In addition, blood samples were non-fasting which could obscure a possible effect on non-HDL-C.

The secondary aim of the study was to assess whether the data supported the SDT model of health behaviour change (Williams et al., 2002). The path analyses of both direct and indirect effects demonstrated an overall support; most of the paths are in line with the findings of the meta-analysis by Ng et al. (2012). The association between changes in need support from peers and autonomous motivation for PA was borderline significant, albeit considerably weaker than the findings in the above-mentioned review reporting r = .40. The relatively moderate dose offered in the current intervention, combined with the brief introduction (one hour) to need supportive behaviour that the participants received, could possibly explain the results. Direct and indirect paths indicated that the intervention as a whole, including two additional sources of need support (the booklet and the HEA), added to the effect on perceived competence for PA and autonomous motivation for PA. The current study offers a better understanding of need support in terms of who could effectively constitute the "significant other" in a non-treatment worksite setting. Results indicate that it is possible to effectively train co-workers to behave in a manner that is perceived as need supportive. Compared to health-care professionals, co-workers lack the formal training and authority regarding health care. On the other hand, faced with an expert helper participants can be sensitive to their authority, act obediently and feel a need to please. Hence, the dialogue may have the potential to enhance participants' controlled motivation for PA. Peers, in the form of co-workers, may be more prone to offer need support in a reciprocal manner, sharing their own experience with PA and lifestyle changes, unlike most experts.

### 4.1. Limitations and concerns

Despite promising findings, the current study has limitations that must be taken into consideration. Most importantly, the small number of clusters enhances the risk of bias in terms of high levels of ICC and reduced statistical power resulting in inflated effect size estimates (Snijders & Bosker, 2012). This risk is enhanced by the relatively large number of dropouts, albeit the fact that only the 12% who actively chose to withdraw were significantly different at baseline from those who completed. The overall sample size could be described as acceptable compared to what is common for experimental studies in the field of sport and exercise psychology (mean $n$ = 40, interquartile range from 24 to 72; Schweizer & Furley, 2016). However, the effects of the intervention should be interpreted cautiously and replications of the intervention study with a sufficient number of clusters are recommended.

Self-reported measures of regular PA are prone to bias like over-reporting due to social desirability (Dyrstad et al., 2014). Moreover, recalling regular PA, including organized exercise, occupational PA, and everyday activities like commuting to work, is a complex task (Sallis & Saelens, 2000). Objective assessment methods, like accelerometers, would have strengthened the present study, and possibly contributed to explain the discrepancy between changes in CRF and self-reported PA (ACSM, 2014). However, the study did not have the financial resources available to include accelerometers.

Attendance rates related to the workshops and PA support group sessions were modest, albeit similar to other group-based PA intervention studies (Hardcastle, Taylor, Bailey, Harley, & Hagger, 2013). Findings indicate that the group sessions failed to attract participants with low levels of autonomous motivation for PA. However, their general health status related to for instance CRF or blood pressure did not seem to affect their willingness to attend the sessions. Participation rates were relatively high (68% of eligible), and the fact that participants were offered a health screening free of charge during working hours could possibly have motivated some to participate in the study albeit not attend the group sessions. Participants in the current study worked shifts, and group sessions were offered immediately before and after working hours at the worksite premises. This may have affected their willingness and ability to attend the sessions. Conn et al. (2009) found that worksite PA interventions offered during paid working hours were more effective on some outcome measures like CRF. The results in the present study, especially on CRF, support the assumption that a modest dose intervention can be effective in bringing about meaningful changes on important mediating and outcome variables. The intervention consisted of short sessions every second week in order to give participants the necessary time to develop the ability and motivation to initiate and maintain lifestyle changes. Ideally, the intervention design could have included monthly or quarterly follow-up booster meetings after five months in order to offer some structure that facilitated need supportive interaction between participants (Rodgers et al., 2010). We argue that this is especially important for the current study population given the nature of the occupation, and the fact that they were working shifts which reduced both the formal and informal interaction during working hours.

### 4.2. Strengths

Worksite health promotion interventions are characterized by rather low participation rates. A review study found participation levels from 10 to 64%, with a median of 33% (Robroek, van Lenthe, van Empelen, & Burdorf, 2009). In addition, the programs are criticized for attracting only the healthy and fit employees (Linnan, Sorensen, Colditz, Klar, & Emmons, 2001). According to Rongen et al. (2013), worksite health promotion intervention studies were four times more effective when the participation rates were low. The current study obtained a reasonably high participation among eligible employees (68%). Although the study did not include any information about the health status of the 32% who chose not to participate, participants' health status was compared to a reference population of healthy Norwegian adults (men $n$ = 13.604 and female $n$ = 16.909; Aspenes et al., 2011). Although the sample in the current study was 5.61 years younger than the reference population, mean values on waist circumference, HDL-C, and BP were compatible. Non-HDL-C level were higher in the current study sample compared to the HUNT population (male = 4.27 mmol/L, female = 4.04 mmol/L; Aspenes et al., 2011). CRF was considerably higher in the male reference population (40.0 mL $kg^{-1} \cdot min^{-1}$, SD = 9.5), compared to the current study sample (33.85 mL $kg^{-1} \cdot min^{-1}$, SD = 10.45). CRF among females were compatible in the two samples. In conclusion, we argue that the current intervention managed to attract employees of average health, including those with low fitness levels. This strengthens the generalizability of the intervention in terms of acceptance among occupational groups susceptible to health risk, such as drivers and storage workers, and possibly to similar occupational groups.

## 5. Conclusions

Present study findings contribute to the understanding and applicability of SDT as a theoretical framework for the design of health promotion programs in non-treatment settings. In addition, the study offers important information on the theoretical understanding of need support, and the effectiveness of incorporating peers in the role of the "significant other" as a source of need support in addition to professional health personnel. In the context of a non-treatment health promotion program, the inclusion of peers as an active component is especially important since employers are less willing to dedicate time and resources to individual follow-up with health personnel.


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## Appendix. Equation used to estimate repeated measures Cohen's d ES with pooled SD:

$$d_{pp2} = C_p \left[ \frac{(M_{post,\ I} - M_{pre,\ I}) - (M_{post,\ C} - M_{pre,\ C})}{SD_{pre}} \right]$$

## Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.psychsport.2017.11.004.

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