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Longitudinal trajectories of physical activity among employees participating in a worksite health promotion intervention: A latent class growth approach☆

Cathrine Pedersen[1,*], Hallgeir Halvari[1,2], Bård Erlend Solstad[1], Marte Bentzen[3]

[1] Department for Coaching and Psychology, Norwegian School of Sport Sciences, PB 4014 Ullevål Stadion, 0806 Oslo, Norway
[2] Faculty of Education in Business Administration, University College of Southeast Norway, Bredalsveien 14, 3511 Hønefoss, Norway
[3] Department for Physical Education, Norwegian School of Sport Sciences, PB 4014 Ullevål Stadion, 0806 Oslo, Norway

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ABSTRACT

Objectives: This study investigated different patterns of physical activity (PA; frequency, intensity, and duration) among employees during and after participating in a worksite health-promotion intervention over a period of one year. The study aimed to assess whether different patterns of PA were associated with perceived competence and motivational regulations for PA.

Design: A cluster randomized controlled trial with a delayed-intervention control group. The design of the group-based intervention was based on the tenets of Self-determination theory (SDT).

Method: The study consisted of employees ($N = 202$, M age = 42.5) working with manual labor in an (*Anonymized)* transport and logistics company. A person-centered approach was applied in order to explore if there were different latent trajectories within the sample related to PA. The data was analyzed with latent class growth analysis (LCGA) and the modified BCH method.

Results: The LCGA identified three PA trajectories: (1) employees high at baseline who declined significantly ($n = 16$), (2) employees who remained stable at a moderate level ($n = 55$), and (3) the majority of employees who reported low levels at baseline and increased significantly ($n = 128$). High levels of PA were associated with higher levels of perceived competence and autonomous forms of motivation for, which is in line with the tenets of SDT. Contrary to study hypothesis, controlled forms of motivation increased in all three trajectories after the intervention.

Conclusions: Different trajectories of PA were found, and the intervention was able to attract employees with low levels of PA.

1. Introduction

Despite great media attention and increased public awareness, people struggle to be physically active at the level required to maintain their health and well-being, and reduce their risk of chronic diseases. A national survey among (*Anonymized nationality*) adults revealed that only 35% reported being sufficiently physically active as recommended by the (*Anonymized nationality)* health authorities (150 min of moderate physical activity [PA], or 75 min of vigorous PA, per week; Hansen et al., 2015). Participating in a health promotion program can provide the necessary structure and support to initiate changes related to regular PA or objective measures of PA effects such as cardiorespiratory fitness (CRF). Composite interactive interventions that apply self-management and motivational enhancement approaches have demonstrated the most promising results in terms of effectiveness (Hutchinson & Wilson, 2011; Michie, Abraham, Whittington, McAteer, & Gupta, 2009). However, program participation is typically limited in time, particularly in non-treatment contexts. In order to produce changes in health and well-being of clinical relevance to the individual and to society in general, participants must be able to persist with lifestyle changes over a longer period of time – and on their own. Consequently, it is of importance that they develop a sense of competence and an

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* Corresponding author. Department for Coaching and Psychology, Norwegian School of Sport Sciences, PB 4014 Ullevål Stadion, 0806 Oslo, Norway. Tel.: +47 952 80 687; Fax: +47 222 34 220.

E-mail addresses: cathrine.pedersen@nifu.no (C. Pedersen), Hallgeir.Halvari@usn.no (H. Halvari), b.e.solstad@nih.no (B.E. Solstad), marte.bentzen@nih.no (M. Bentzen).

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autonomous motivation to persist with PA.

Over the last four decades, the field of health promotion research has called attention to the worksite context because programs here have the potential to reach a large number of people, usually before they develop health problems (Abraham & Graham-Rowe, 2009; Rongen, Robroek, van Lenthe, & Burdof, 2013). Employers are willing to invest financial resources in programs because they appreciate the potential benefits of increased PA for health and well-being, such as decreased sickness absence (Cancelliere, Cassidy, Ammendolia, & Côté, 2011) and improved work productivity (Pronk & Kottke, 2009). Moreover, the presence of natural and lasting social networks offers a source of social support that can be incorporated into programs, and may persist after the program has finished (Linnan, Fisher, & Hood, 2012). Meta-analyses have demonstrated that worksite PA interventions can offer important albeit variable changes in health, well-being, and certain worksite outcome measures such as reduced job stress (Conn, Hafdahl, Cooper, Brown, & Lusk, 2009). There is a growing number of systematic reviews and meta-analyses of worksite PA promotion studies. Overall, they report positive effects albeit small effect sizes (Cohen's $d = 0.10–0.27$) for self-reported measures of PA (Abraham & Graham-Rowe, 2009; Conn et al., 2009; Dishman, DeJoy, Wilson, & Vandenberg, 2009; Malik, Blake, & Suggs, 2014; Proper et al., 2003). The research evidence related to objective measures of fitness, such as CRF or muscle strength, is inconclusive and divergent (Proper et al., 2003). For instance, meta-analyses have reported positive effect sizes for CRF ranging from $d = 0.29$ (Abraham & Graham-Rowe, 2009) to $d = 0.57$ (Conn et al., 2009). High-quality randomized controlled trials tended to report lower effect sizes or non-significant effects compared to quasi-experimental and pre-post studies, and to studies with less rigorous methodology (e.g., randomization procedure poorly implemented or described, lack of intention-to-treat analysis, lack of control for confounders, lack of objectively measured outcome variables, and short follow-up assessments; Rongen, Robroek, van Lenthe, & Burdorf, 2013; To, Chen, Magnussen, & Kien, 2013). Moreover, Taylor, Conner, and Lawton (2012) reported findings indicating that worksite PA intervention studies using theory in an explicit and systematic manner were considerably more effective (Cohen's $d = 0.34$) compared to studies which did not ($d = 0.21$).

However, a systematic review concluded that worksite programs had relatively low participation rates ($M = 33\%$, the majority below 50%), and males, blue-collar workers, and smokers were less likely to participate (Robroek, van Lenthe, van Empelen, & Burdorf, 2009). Studies have revealed that employees have mixed feelings towards worksite health-related PA programs. For example, Fletcher, Behrens, and Domina (2008) found that employees perceived social support and their own levels of PA self-regulation to be the most important enabling factors for participating in worksite PA programs. The most frequently reported barriers, apart from lack of time, were increased self-consciousness and a lack of belief in their own ability to perform PA. Rossing and Jones (2015) found that employees were sensitive to the possible loss of credibility and stigmatization from colleagues if they appeared less competent or fit during collective exercise sessions at work. We argue that in order to attract employees broadly, and particularly those who will benefit the most due to their low levels of PA and an unfavorable health risk profile, PA promotion programs must offer support in a manner that makes employees comfortable, and increases their competence, and self-regulation regarding PA.

The theoretical foundation of the present worksite PA intervention was based on the tenets of Self-determination theory (SDT; Deci & Ryan, 1985; 2000) in combination with elements from Motivational interviewing (MI; Markland, Ryan, Tolbin, & Rollnick, 2005; Miller & Rollnick, 2013). SDT is a theory of motivation that emphasizes the importance of the *quality* of motivation towards a specific behavior, or what people hope to obtain by doing the behavior. SDT presents a multidimensional approach to motivation, distinguishing between three types of motivational qualities: autonomous, controlled, and amotivation (Deci & Ryan, 2000). Autonomous motivation is characterized by a sense of choice and freedom from external pressure. Here, people engage in a behavior because they find it inherently satisfying (intrinsic regulation) or because they identify with the behavior and find it personally meaningful (identified regulation). When motivation for a specific behavior is contingent on the presence of external factors, such as a reward or the expectations or demands of others, it is termed extrinsic regulation. Once the external control is partially assimilated, people will typically experience a sense of guilt or shame if they fail to perform the behavior in question. This is termed introjected regulation. Both extrinsic and introjected regulations are controlled forms of motivation, and are characterized by a low level of internalization (Deci & Ryan, 1985; 2000). Amotivation is characterized by a lack of motivation for a behavior, and hence a lack of intention to act (Markland & Tobin, 2004). According to SDT, these different forms of motivation are not mutually exclusive, and people can simultaneously endorse controlled and autonomous motives for a behavior (Deci & Ryan, 1985; 2000). However, review studies have demonstrated that autonomous motivation has a consistent and positive effect on outcome variables related to health and well-being (Ng et al., 2012). The SDT based health model of behavior change postulates that in order to make lifestyle changes, such as increased PA, people need to perceive themselves as sufficiently competent as well as motivated (Williams, Gagné, Ryan, & Deci, 2002). When people feel unfit, unskilled, inexperienced, or restricted by health limitations or lifestyle situations that they struggle to overcome, their sense of competence will be affected (Ryan, Williams, Patrick, & Deci, 2009).

A review of 53 PA studies demonstrated a consistent and rather strong association between autonomous forms of motivation for PA and prolonged PA (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). However, the presence of a strong association between controlled forms of motivation and PA has not received consistent empirical support. The majority studies (57%) found no significant association, whereas the remainder (43%) reported a negative relation (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). The same was found for the association between amotivation and PA. Teixeira and colleagues revealed that studies reporting negative associations between extrinsic regulation and PA considered regular exercisers, as opposed to non-exercisers. In line with SDT, regular exercisers have been found to report higher levels of autonomous motivation for PA compared to exercise initiates and non-exercisers (Thøgersen-Ntoumani & Ntoumanis, 2006). A study of four longitudinal datasets investigated the process of becoming a regular exerciser and how this is related to motivational regulation (Rodgers, Hall, Duncan, Pearson, & Milne, 2010). Participants who had completed a PA intervention program reported increases in intrinsic and identified regulation eight weeks after baseline. Despite a steady increase, autonomous motivation remained significantly lower among exercise initiates compared to regular exercisers six months after baseline. Changes in controlled motivation were non-significant during the study period.

To date, there are a limited number of SDT-based intervention studies that incorporate follow-up assessments of motivational regulation and PA several months or years after the intervention. Silva and colleagues found that autonomous motivation predicted enhanced maintenance of behavioral change two years after the intervention (Silva et al., 2011). Duda et al. (2014) reported improvements in PA of clinical relevance immediately after an intervention, and the changes were sustained at six months follow-up. Moreover, changes in motivational processes during the intervention were significantly related to PA levels at follow-up. Sweet, Fortier, and Blanchard (2014) investigated the longitudinal effects of a PA intervention on sedentary patients by means of hierarchical linear modeling of growth trajectories. The study found a curvilinear trend for PA (increased at 13 weeks, and decreased post-intervention between 13 and 25 weeks). In line with the tenets of SDT, both intrinsic and identified regulation demonstrated a pattern of linear increase during the 25-week study period. However, the changes in extrinsic regulation followed the same curvilinear trend as PA. No fluctuation was found for introjected regulation, and the two controlled forms of motivation were not significantly related to changes in PA. We need more knowledge about the nuances of longitudinal fluctuations in PA and their relationships with motivational regulations, particularly in the period after PA interventions when participants are expected to persist with their PA habits without the support of a program.

The majority of SDT-based PA intervention studies have been carried out in the context of health care, often incorporating patients in need of treatment, such as those who are overweight or obese (Silva et al., 2011), have type 2 diabetes (Sweet et al., 2009), or require cardiac rehabilitation (Mildestvedt, Meland, & Eide, 2008). Fortier and colleagues recommend that future studies assess intervention effects on groups that are more diverse in terms of demographic characteristics, such as age and gender, motivational regulation, and physical characteristic related to health (Fortier, Duda, Guerin, & Teixeira, 2012). The number of SDT-based PA intervention studies has grown in numbers, particularly studies with children (Owen et al., 2016) and adolescents (e.g., Lonsdale et al., 2016). However, PA intervention studies directed at adults are limited in numbers and participants are by and large patients in treatment contexts. There is a need for SDT-based intervention studies in non-treatment contexts targeting a more heterogeneous population in terms of PA levels, health risk profile, and motivation for PA. It can be argued that this will contribute to the applicability and effectiveness of SDT based intervention principles. Two SDT-based PA interventions have been carried out in the worksite context, and they both reported increases in PA in addition to positive associations between adherence, autonomous motivation for PA, and increases in cardiorespiratory fitness (Thøgersen-Ntoumani, Loughren, Duda, Fox, & Kinnafick, 2010; Thøgersen-Ntoumani, Ntoumanis, Shepherd, Wagenmakers, & Shaw, 2016). Both studies incorporated university administrative personnel. This study is the first to include a sample of employees working with manual labor.

In the present study, we applied latent class growth analysis (LCGA) in order to explore if there were meaningful subpopulations related to PA behavior over a period of one year. Latent growth modeling techniques, such as LCGA, are person-centered methods suited for the estimation of between-person differences in within-person change, often referred to as trajectories (Bollen & Curran, 2006). These techniques offer the possibility to "model unobserved heterogeneity in a population by identifying different latent classes of individuals based on their observed response pattern" (Clark & Muthén, 2009, p. 3). Latent growth modeling has become increasingly popular because it is highly flexible and able to incorporate complexity such as partially missing data, nonlinear change, unequal time-points, and heterogeneous growth processes (Curran, Obeidat, & Losardo, 2010).

Studies using LCGA related to PA are growing in numbers. A large cohort study explored the long-term patterns of PA involvement over a period of 22 year (Barnett, Gauvin, Craig, & Katzmarzyk, 2008). The analyses identified four distinct patterns ("inactive", "increasers", "active", and "decreasers"). The results indicated that people with lower income levels and educational levels were less likely to follow the "active" trajectory and more likely to follow the "decreasing" trajectory. A recent study applied person-centered analysis to the PA levels of senior citizens resident in assisted living facilities (Park et al., 2018). Three distinct profiles were found in relation to autonomous motivation and perceived support for PA. The profile characterized as "high in both" also reported significantly higher levels of PA and more favorable impressions of exercise facilities in their physical neighborhood. The study indicates that person-centered approaches are suitable for detecting and analyzing differences in PA and their relationship to SDT based constructs, such as motivational regulations.

Several studies have explored the associations between individual motivational profiles and PA among adult exercisers and athletes applying a more traditional person-centered approach; cluster analysis (e.g., Gillet, Vallerand, & Paty, 2013; Guérin & Fortier, 2012; Matsumoto & Takenaka, 2004). The studies based their clustering on motivational regulation, and all studies reported between two and five-cluster solutions related to PA (Friederichs, Bolman, Oenema, & Lechner, 2015). Friederichs et al. (2015) carried out a study on adults who did not comply with the PA recommendations, applying cluster analysis and one-way ANOVA to assess differences between clusters with regard to PA. Three clusters were found: (1) "autonomous motivation" (high on autonomous and low on controlled forms of motivational regulation), (2) "controlled motivation" (high on controlled and moderate on autonomous forms of motivational regulation), and (3) "low motivation" (moderate on controlled and low on autonomous forms of motivational regulation). Cluster (1) reported the highest levers of PA, and cluster (3) the lowest. The results indicate that low levels of autonomous motivation is more predictive of inactivity than high levels of controlled motivation. Moreover, the motivational profiles reported were in fact similar to those found in other studies, both among non-exercisers (Guérin & Fortier, 2012) and regular exercisers (Matsumoto & Takenaka, 2004). Cluster (1) accounted for 52.9% of the sample, and the sample could possibly be biased by the fact that the participants were recruited among individuals who had agreed to participate in a web-based PA intervention. The present study applied PA levels as the basis for a person-centered approach and included the perceived competence and motivational regulations for PA as distal outcome variables. We used a rather modern approach, the BCH method, to assess how the distal outcome variables related to underlying patterns of PA. This is a tree-step approach recommended by Asparouhov and Muthén (2014) because it avoids the undesirable shift in the latent class variables caused by the direct inclusion of the distal outcome variable in the analyses. Moreover, the above-mentioned studies applied cross-sectional data, whereas the present study explored if there were latent classes explaining different patterns of PA change during the course of an intervention.

1.1. Study aim and research questions

First, we aimed to explore whether there were latent classes or trajectories in the sample related to PA over a period of one year (prior to, during, and after a worksite PA promotion intervention). Second, we aimed to investigate whether the intervention was able to recruit employees with different levels of PA, particularly those with low levels. Moreover, we examined whether the possible changes during the study period were clinically relevant according to the recommendations of the Norwegian health authorities. Third, we aimed to assess whether demographic characteristics of the participants could predict differences in PA patterns. Fourth, we aimed to explore whether different patterns of PA were associated with the participants' perceived competence and motivational regulation for PA at baseline and follow-up. Regarding the fourth aim, the following hypotheses were tested:

(1) Employees reporting higher levels of PA were expected to have higher levels of perceived competence for PA compared to those employees reporting lower levels of PA.
(2) Employees reporting higher levels of PA were expected to have higher levels of autonomous motivation for PA (intrinsic and identified regulation) compared to those employees reporting lower levels of PA.
(3) Employees reporting higher levels of PA were expected to have lower levels of controlled motivation (introjected and extrinsic regulation) for PA compared to employees reporting lower levels of PA.
(4) Employees reporting higher levels of PA were expected to have lower levels of amotivation for PA compared to employees reporting lower levels of PA.

2. Method

2.1. Participants and procedures

The study sample consisted of employees participating in a worksite health promotion program designed to support them in increase their PA. They were employed in the logistics sector working as drivers, mail carriers, and terminal workers. The study sample consisted of predominantly male participants (76.2%). The participants were between 19 and 68 years, and mean age was 42.5 years ($SD = 11.65$). Education levels were relatively low, and only 14.3% had a college degree. Participants were recruited during team-based information meetings at six worksites. A total of $N = 320$ were defined as eligible (working more than 20%), and $n = 202$ (68%) agreed to participate (written informed consent). Participants were assessed at three time-points; at baseline, post-test (5 months), and at follow-up (12 months). Questionnaires were applied to measure regular PA in addition to the motivational and demographic variables at all three time-points. The baseline and post-test assessments were in the form of health screenings that assessed their cardiorespiratory fitness, biomedical health markers (e.g., blood pressure, waist circumference, and cholesterol levels), and their lifestyle. A health practitioner presented them with the results (health status and risk factors), recommended lifestyle changes, and in some cases advised them to consult their physician for further testing and medical treatment. They received an individual, written report of their health profile. After baseline assessments in January, participants were randomized by means of six clusters (worksites) into an intervention condition ($n = 113$, 56%) and a control condition ($n = 89$, 44%). The former received a group-based intervention consisting of six sessions (two workshops and four exercise support-group meetings) and a booklet. The sessions were dialogue-based, and PA was expected to be self-organized, primarily during leisure time due to shift work and a lack of onsite exercise facilities.

The design of the intervention elements were based on a model that combined the tenets of SDT with techniques from MI, which had previously been applied in PA intervention studies (Fortier et al., 2012). The workshops were facilitated by two health and exercise advisors (physiotherapists) who were trained to provide the workshops in a manner that supported the basic psychological needs according to study protocol. Pre-post intervention effects related to cardiorespiratory fitness, PA, cholesterol, blood pressure, and waist circumference have previously been published together with statistical power calculations and detailed intervention protocol descriptions (*Anonymized*).

Participants in the control condition were offered a delayed group-based intervention eight months after baseline. The delayed intervention consisted of standard group-based sessions offered by the worksite health promotion program. Both conditions were presented with a follow-up assessment 12 months after baseline, and a total of $n = 114$ (55%) agreed to participate, of these n = 62 (55%) were from the intervention condition and $n = 52$ (45%) were from the control (delayed intervention) condition. A total of $n = 195$ participants completed the assessments at baseline, $n = 155$ completed at post-test, $n = 114$ completed at follow-up, and $n = 101$ (50%) completed all three assessments. The study was approved by the Data Protection Official for Research in (*Anonymized*).

2.2. Measures

2.2.1. Educational level

Education level was assessed with a one-item questionnaire applying the following scale: (1) primary and secondary school (10 years), (2) high school (13 years), (3) college/university degree (1–4 years), and (4) college/university degree (more than 4 years).

2.2.2. Physical activity

PA was measured with the three-item questionnaire International Physical Activity Index (IPAI), which was previously applied and validated on a large sample in (the HUNT study; Kurtze, Rangul, Hustvedt, & Flanders, 2008). The questionnaire assesses the frequency (number of sessions per week), the duration (the length of the PA sessions in minutes), and the intensity (the amount of energy expended during the sessions). Frequency was assessed with the item: "How frequently do you exercise?" using the following scale: 0 (*Never*), 1 (*Less than once a week*), 2 (*Once a week*), 3 (*2–3 times* per *week*), and 4 (*Almost every day*). Intensity was assessed with the item: "How hard do you push yourself?" using the following scale: 0 (*I do not exercise*), 1 (*I take it easy without breaking into a sweat or losing my breath*), 2 (*I push myself so hard that I lose my breath and break into a sweat*), and 3 (*I push myself to near-exhaustion*), Duration was measured with the item: "How long does each session last?" using the following scale: 0 (*I do not exercise*), 1 (*Less than 15 min*), 2 (*16–30 min*), 3 (*30 min to 1 h*), and 4 (*More than 1 h*). According to protocol, each item's score was multiplied with a weighing factor listen in parenthesis: frequency 0 (0), 1 (0,5), 2 (1), 3 (2.5), and 4 (5), intensity 0 (0), 1 (1), 2 (2), and 3 (3), and duration 0 (0.1), 1 (0.38), 2 (0.75), and 3 (1). The weighted scores were then multiplied to calculate a summary index (Kurtze et al., 2008).

2.2.3. Perceived competence for PA

Participants rated their sense of perceived competence regarding PA by means of the Perceived Competence in Exercise Scale (PCES; Williams & Deci, 1996). The questionnaire consists of four items (e.g., "I feel confident in my ability to exercise on a regular basis", Cronbach's $\alpha_{time1} = 0.90$; $\alpha_{time3} = 0.94$), and was answered on a seven-points Likert-scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

2.2.4. Motivational regulations for PA

The quality of motivational regulations was measured with the Behavioral Regulation in Exercise Questionnaire (BREQ-2; Markland & Tobin, 2004). The questionnaire consists of five subscales: intrinsic regulation for PA by four items (e.g., "I exercise because it's fun", $\alpha_{time1} = 0.86$; $\alpha_{time3} = 0.89$); identified regulation for PA by four items (e.g., "I value the benefits of exercise", $\alpha_{time1} = 0.76$; $\alpha_{time3} = 0.73$); introjected regulation for PA by three items (e.g., "I feel guilty when I don't exercise", $\alpha_{time1} = 0.64$; $\alpha_{time3} = 0.77$); extrinsic regulation for PA four items (e.g., "I exercise because other people say I should", $\alpha_{time1} = 0.80$; $_{time3} = 0.83$; and amotivation for PA by four items ("I don't see the point in exercising", $\alpha_{time1} = 0.78$; $\alpha_{time3} = 0.80$). Integrated regulation was not included in the present study because BREQ-2 does not contain the subscale. Participants responded according to a 5-point Likert scale, ranging from 0 (*not true for me*) to 4 (*very true for me*).

2.3. Data analysis

Preliminary analyses were performed to identify possible patterns of missing data. Dropout rates were $n = 7$ (3.5%) at baseline, $n = 47$ (23%) at post-test (5 months), and $n = 88$ (44%) at follow-up (12 months). Little's test of missing completely at random (MCAR) indicated that the data were not missing completely at random ($x^2 = 1036$, $df = 917$, $p = .004$). One-way ANOVA, performed using IBM SPSS Statistics 21 (IBM Corp., Boston, Mass, USA), tested whether there were significant differences regarding the study variables between those participants who completed all three assessments and those who completed one or two. No significant differences were found, and data was assumed to be missing at random (MAR). We decided to include all $N = 202$ participants in the subsequent analyses applying M*plus* version 8 (Muthén & Muthén, 1998–2012), and the missing data were handled by means of full information maximum likelihood estimation (FIML; Enders & Bandalos, 2001).

Prior to the main analyses, the distal outcome variables (perceived competence and motivational regulation for PA) were assessed to evaluate the scale factor structure and measurement invariance (see

Supplementary Material, Appendix A).

LCGA were conducted on data collected at all three time-points to explore the different trajectories. The estimates of variance and covariance for the growth factor, PA, were fixed to zero assuming that all growth trajectories within each class were identical. An exploratory approach was chosen, and we did not hypothesize an expected number of classes. A stepwise model comparison approach was conducted to compare a one-class model to models with successively more classes (Nylund, Asparouhov, & Muthén, 2007). According to recommendations, a combination of goodness of fit indices (GOF) should be considered together with class sizes (> 5%), theoretical justification, and interpretability in order to decide on the appropriate model (Jung & Wickrama, 2008). These following GOF indices were considered: the smallest Bayesian information criteria (BIC) and Aikaike's information criterion (AIC) to assess model fit, followed by the highest possible entropy to assess precision/quality of classification, and finally a significant p-value on the bootstrap likelihood ratio test (BLRT) and the Lo-Mendell-Rubin adjusted likelihood ratio test (L-M-R). The latter tests indicate whether the *k*-1 class model is rejected in favor of the *k* class model (Jung & Wickrama, 2008; Nylund, Asparoutiov, & Muthén, 2007). We examined the plot of each model to consider whether the differences between trajectories were logical. Finally, we considered the sample size of the trajectories. Based on the following procedure, we decided on the best model. Because PA was measured with a summary index, a manifest variable was applied as a continuous indicator of a latent class variable.

We proceeded to consider the clinical relevance of the reported PA levels and changes related to the recommendations of the Norwegian health authorities (PA ≥ 150 min of MVPA per week). PA frequency scores were multiplied with duration scores (both weighted) to obtain minutes per week. The amount of participants with ≥150 m/w of moderate-to-vigorous intensity was calculated.

Next, we tested whether there were differences regarding the probability of class-membership in relation to the covariates in the study. The automatic BCH approach was used for the continuous covariate (age and educational levels), while for the categorical covariates (onset of intervention and gender) the DCAT approach was used (Asparouhov & Muthén, 2014).

Finally, we conducted a series of analyses to explore whether there were differences between the trajectories related to distal outcome variables (perceived competence and motivational regulations for PA). We applied the three-step BCH approach in M*plus*, which offers an omnibus test that includes differences between the three classes on each distal outcome variable (Bolck, Croon, & Hagenaars, 2004). According to a comparative analysis of different approaches, the findings indicated that BCH was the most robust and flexible approach, yielding the least biased estimates (Bakk & Vermunt, 2016). Effect sizes were calculated for the differences between trajectories using Cohen's d for continuous variables and Cramer's v for categorical variables.

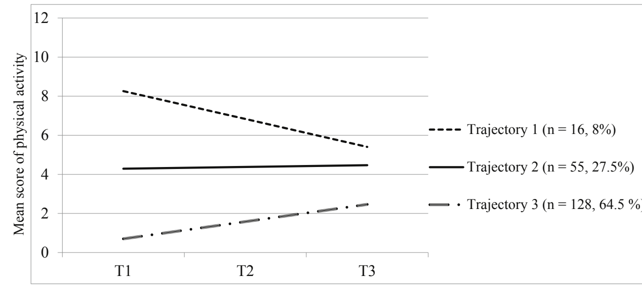

Figure 1. The three trajectories related to physical activity at baseline (T1), post-test (T2), and follow-up (T3).

3. Results

3.1. Latent trajectories in the sample

The stepwise comparisons of the LCGA favored a solution with three classes (Table 1). The entropy values of 0.96 indicated that both a three-class and a four-class model were able to accurately place subjects into classes. Both the AIC and the BIC decreased consistently for one-class to four-class models. However, the four-class model did not obtain a significant p-value on the L-M-R test, favoring the three-class model. In addition, the four-class model contained a class with a sample size of 4.2%, which is less than the recommended level of 5% (Jung & Wickrama, 2008). The identified classes represented three distinctly different and meaningful course trajectories (Figure 1):

(1) Trajectory 1 (prevalence: $n = 16$, 8% of the total sample) is labelled "Decrease from high", and refers to subjects with the highest levels of PA and with scores significantly decreasing over a period of one year (intercept: $M = 8.269$, $SE = 0.294$, $p < .001$; slope: $M = -1.433$, $SE = 0.579$, $p = .013$).
(2) Trajectory 2 (prevalence: $n = 55$, 27.5% of the total sample) is labelled "Stable moderate", and refers to subjects with moderate levels of PA and no significant change over a period of one year (intercept: $M = 4.288$, $SE = 0.115$, $p < .001$; slope: $M = 0.090$, $SE = 0.227$, $p < .691$).
(3) Trajectory 3 (prevalence: $n = 128$, 64.5% of the total sample) is labelled "Increase from low", and refers to subjects with the lowest levels of PA and with scores significantly increasing over a period of one year (intercept: $M = 0.700$, $SE = 0.070$, $p < .001$; slope: $M = 0.882$, $SE = 0.126$, $p < .001$).

3.2. Clinical relevance of physical activity levels and changes

At baseline, 40% of the total sample reported PA levels consistent with or above the recommendations of the Norwegian health authorities (PA ≥ 150 min of moderate-to-vigorous physical activity per week). This percentage increased to 50.4% at post-test and to 55.7% at follow-up (Table 2). The large majority of participants in trajectories (1) "Decrease from high" and (2) "Stable moderate" remained within or close to the recommended levels of PA during all three time-points.

Table 1
Fit indices for latent class growth models of physical activity.

No. of trajectories	No. of free par.	AIC	BIC	BLRT (*p*)	L-M-R (*p*)	Entropy	Latent class size (*n*)
1	6	2.164.125	2.183.885				
2	9	2.121.621	2.151.261	.000	.037	0.82	41/158
3	12	2.055.234	2.094.753	.000	.004	0.96	16/55/128
4	15	2.026.775	2.076.175	.000	.225	0.96	4/16/51/128

Note. N = 199, AIC = Akaike's information criterion, BIC = Baysian information criterion, BLRT = bootstrap likelihood ratio test, L-M-R = Lo-Mendell-Rubin adjusted likelihood ratio test.
A growth mixture model was estimated in order to assess the robustness of the findings, and the model demonstrated almost identical results to the LCGA.

Table 2
Physical activity levels measured by mean, standard deviation, and percentage of participants adhering to health recommendations of moderate-to-vigorous physical activity ≥150 min.

	Total sample	Trajectory 1 (n = 16)	Trajectory 2 (n = 55)	Trajectory 3 (n = 128)
Baseline	2.36 (2.52)	8.28 (1.20)	4.33 (0.75)	0.71 (0.76)
	30% (n = 59/194)	100% (n = 16/16)	78% (n = 43/55)	0% (n = 123)
Post-test	2.99 (2.91)	6.43 (3.04)	4.67 (3.36)	1.70 (1.60)
	38% (n = 59/155)	92.3% (n = 12/13)	61% (n = 28/46)	20% (n = 19/96)
Follow-up	3.34 (2.99)	5.95 (3.24)	4.27 (2.95)	2.50 (2.63)
	47% (n = 54/114)	100% (n = 10/10)	62% (n = 21/34)	36% (n = 25/70)

Note. PA = physical activity, MVPA = moderate-to-vigorous physical activity.

Participants in trajectory (3) "Increase from low" reported low levels of regular PA at baseline, and 93.5% did not meet the PA levels recommended. However, they reported considerably higher levels of PA during the study period. At post-test, 31.3% met PA recommendations, increasing to 40.5% at follow-up.

3.3. Controlling for the onset of the intervention

We controlled for the onset of the intervention period (primary intervention group and delayed-intervention control group). The differences were non-significant and Cramer's v effect size was small between trajectories (1) "Decrease from high" and (2) "Stable moderate" (X^2 = 0.03, p = .859, ES = 0.19), between trajectories (1) "Decrease from high" and (3) "Increase from low" (X^2 = 0.76, p = .385, ES = 0.19), and between trajectories 2 and 3 (X^2 = 2.97, p = .085, ES = 0.13).

3.4. Sociodemographic covariates

We proceeded to test whether sociodemographic variables differed according to class membership. There were no significant differences between the trajectories (1) "Decrease from high" and (2) "Stable moderate" related to age, gender, or level of education. However, Cramer's v effect sizes were moderate for gender and age, and small for educational levels. There were more men in trajectory (2) "Stable moderate", and they were somewhat older. The same pattern was found for the difference between (1) "Decrease from high" and (3) "Increase from low" (Table 3). The difference between (2) "Stable moderate" and (3) "Increase from low" were non-significant and effect sizes were small.

3.5. Distal outcome variables related to competence and motivational regulation

The trajectories demonstrated a linear pattern of PA across three time-points. Hence, distal outcome variables were analyzed at baseline (T1) and at follow-up 12 months after baseline (T3). Several sets of analyses, which applied the BCH method, were carried out in order to assess whether the distal outcome variables (perceived competence for PA and motivations for PA) differed across the three trajectories.

At baseline, five of the six omnibus tests were significant (p < .05), with the exception of extrinsic regulation for PA (Table 4). Employees in trajectory (3) "Increase from low" were significantly lower in perceived competence for PA compared to employees in trajectory (1) "Decrease from high" and (2) "Stable moderate", and Cohen's d effect sizes (ES) were very large (1.20–1.57). Moreover, employees in trajectory (3) "Increase from low" reported significantly lower levels of autonomous motivation compared to the other two, and the ES were large to very large (intrinsic: 1.13–1.37; identified: 0.98–1.05; Sawilowsky, 2009). Regarding the more controlled forms of motivation, the differences were not as consistent. Employees in trajectory (3) "Increase from low" demonstrated significantly lower levels of introjected motivation, and ES were moderate (0.46–0.51). However, there were no significant differences between the trajectories related to extrinsic regulation. Employees in trajectory (3) "Increase from low" were considerably higher on amotivation compared to the two others, and ES were large (0.80–0.83). None of the distal outcome variables demonstrated a significant difference between trajectory (1) "Decrease from high" and trajectory (2) "Stable moderate", and ES were small to very small (0.00–0.22).

At follow-up, the pattern of significant differences between trajectories related to autonomous motivation for PA remained the same. Employees in trajectory (3) "Increase from low" reported considerably higher levels of autonomous motivation, and ES were moderate compared to baseline (intrinsic: 0.46–0.74; identified regulation: 0.65–0.71). The same pattern was found for perceived competence for PA, but ES were still moderate to large (0.49–0.87). Considering introjected regulation, the difference between trajectories (1) "Decrease from high" and (3) "Increase from low" was no longer significant. All the differences between trajectories that were related to extrinsic regulation were still non-significant. At follow-up, employees in trajectory (3) "Increase from low" reported lower levels of amotivation for PA compared to baseline. The difference between trajectories (1) "Decrease from high" and (3) "Increase from low" was no longer significant, and ES were small (0.00–0.35). Differences between employees in trajectories (1) "Decrease from high" and (2) "Stable moderate" remained non-significant on all distal outcome variables, and ES were very small to small (0.00–0.44).

4. Discussion

In the present study, a person-centered approach was able to

Table 3
Demographic covariates at baseline per trajectory measured by percentage, mean, and standard deviation. Difference between trajectories measured by Cramer's v effect size (gender) and Cohen's d effect size (age and educational levels).

Covariates	Trajectory 1 n = 16	Trajectory 2 n = 55	Trajectory 3 n = 128	1vs 2 X^2/p-value	1vs 2 ES	1 vs 3 X^2/p-value	1 vs 3 ES	2 vs 3 X^2/p-value	2 vs 3 ES
Gender (men)	62.5%	80%	78.1%	1.82/.178	0.37	1.45/.228	0.27	0.15/.695	0.02
Age (years)	38.25 (12.39)	42.53 (12.77)	43.09 (11.00)	1.53/.215	0.34	2.36/.124	0.41	0.08/.775	0.05
Educational levels	1.94 (0.44)	1.96 (0.58)	2.02 (0.63)	0.04/.850	0.05	0.43/.512	0.14	0.30/.581	0.09

Note. P-value * < 0.05, ** < 0.01, *** < 0.001. Cohen's d effect size: 0.01–0.19 (very small), 0.20–0.49 (small), 0.50–0.79 (moderate), 0.80–1.19 (large), 1.20–1.99 (very large), and 2.00 (huge). Cramer's v effect size: small = 0.10, moderate = 0.30, and large = 0.50.

Table 4
Distal outcome variables at baseline and follow-up measured by mean and standard variation. Difference between trajectories measured by Cohen's d effect size.

Distal outcome variables *Baseline*	Trajectory 1 $n = 16$	Trajectory 2 $n = 55$	Trajectory 3 $n = 128$	Global X^2/p-value	1vs 2 X^2/p-value	1vs 2 Cohen's d ES	1 vs 3 X^2/p-value	1 vs 3 Cohen's d ES	2 vs 3 X^2/p-value	2 vs 3 Cohen's d ES
Perceived comp.	6.00 (0.92)	5.64 (1.11)	4.08 (1.47)	**83.69*****	1.73/.189	0.35	**52.37/.000**	**1.57**	**58.79/.000**	**1.20**
Intrinsic mot.	3.28 (0.48)	3.20 (0.74)	2.19 (1.02)	**81.13*****	0.25/.620	0.01	**54.61/.000**	**1.37**	**58.53/.000**	**1.13**
Identified mot.	2.83 (0.76)	2.84 (0.67)	2.01 (0.90)	**48.90*****	0.00/.962	0.01	**15.02/.000**	**0.98**	**43.69/.000**	**1.05**
Introjected mot.	2.03 (0.72)	2.01 (0.82)	1.61 (0.90)	**10.43****	0.01/.907	0.03	**4.72/.000**	**0.51**	**8.19/.004**	**0.46**
Extrinsic mot.	0.42 (0.48)	0.55 (0.67)	0.64 (0.90)	2.38	0.65/.421	0.22	2.31/.128	0.30	0.63/.427	0.11
Amotivation	0.15 (0.30)	0.18 (0.49)	0.76 (0.94)	**36.71*****	0.09/.762	0.00	**30.35/.000**	**0.83**	**28.61/.000**	**0.80**
Follow-up										
Perceived comp.	5.98 (1.04)	5.40 (1.56)	4.45 (2.26)	**22.85*****	2.94/.086	0.44	**21.07/.000**	**0.87**	**10.30/.001**	**0.49**
Intrinsic mot.	3.22 (0.52)	3.03 (1.11)	2.46 (1.36)	**19.79*****	0.93/.335	0.22	**18.47/.000**	**0.74**	**8.33/.004**	**0.46**
Identified mot.	2.82 (0.84)	2.92 (0.96)	2.18 (1.12)	**22.24*****	0.14/.704	0.11	**7.94/.005**	**0.65**	**19.30/.000**	**0.71**
Introjected mot.	2.37 (0.72)	2.38 (1.04)	1.96 (1.36)	**6.17***	0.00/.972	0.01	3.54/.060	0.38	**4.78/.029**	**0.35**
Extrinsic mot.	1.46 (0.40)	1.49 (0.96)	1.36 (0.90)	0.98	0.04/.836	0.04	0.58/.447	0.14	0.73/.394	0.14
Amotivation	0.30 (0.43)	0.19 (0.46)	0.48 (0.78)	5.61	0.52/.469	0.00	1.39/.239	0.14	**6.00/.018**	**0.35**

Note: p-value * < .05, ** < .01, *** < .001. Cohen's d effect size (ES): 0.01–0.19 (very small), 0.20–0.49 (small), 0.50–0.79 (moderate), 0.80–1.19 (large), 1.20–1.99 (very large), and 2.00 (huge).

distinguish between three distinct and linear trajectories. The trajectories differed considerably in sample size, and one trajectory accounted for 65.5% of the participants. Other studies with a person-centered approach, such as Barnett et al. (2008), have found support for a four-trajectory model with a higher degree of stability. The latter study was a 22-year cohort study whereas the present study was an intervention study over a shorter period of time; just one year. Despite the considerable increase in PA among participants in trajectory (3) "Increase from low" across one year, they could possibly have returned to a stable "inactive" state after the study period. The effect of PA interventions reduces with time, and especially when the structural and social support are removed.

We also explored whether the program was able to recruit employees with different levels of PA, particularly low levels. The findings indicate that the present intervention was able to attract employees who initially did not comply with the PA recommendations (70%). Moreover, they belonged to a population considered to be underrepresented in health promotion interventions, particularly in the worksite context; male employees with low educational levels and low occupational prestige (Marshall, 2004; Wong, Gilson, Van Uffelen, & Brown, 2012). Moreover, the findings indicate that the program was able to recruit a diverse sample, including a number of employees with moderate levels of PA, as represented by (2) "Stable moderate". However, we question whether the intervention appealed to employees who were already highly active, as represented by (1) "Decrease from high". This group could possibly have been underrepresented in the present context of eligible employees. However, this population of highly active employees was not the primary target of the program.

Employees in (3) "Increase from low" initially reported considerably lower levels of PA, compared to the other employees. However, the mean value of perceived competence for PA at baseline could be characterized as moderate. According to Standage and Ryan (2012, p. 263) "feelings of competence are essential for any intentional behavior, irrespective of whether the action is motivated by extrinsic, introjected, identified, integrated, or intrinsic regulations". The finding could indicate that the present intervention was unable to attract employees who felt inexperienced, incompetent, or unable to exercise on a regular basis. Employees in (3) "Increase from low" reported what we would describe as low-to-moderate levels of autonomous motivation, albeit significantly lower than the rest. These findings are in line with other SDT-based PA promotion intervention studies in the context of health care, which mainly attracted participants with elevated levels of autonomous motivation (Fortier et al., 2012).

Third, the study aimed to test whether the associations between perceived competence, motivational regulation, and PA were in line with the tenets of SDT. Employees in trajectory (3) "Increase form low" exhibited a motivational profile and development comparable to exercise initiates previously found in a study comparing exercise initiates to regular exercisers (Rodgers et al., 2010). Both samples reported moderate levels of intrinsic and identified regulation at baseline. A review of worksite health-promotion programs reported that positive effects were mainly found in samples of motivated employees who volunteered to participate (Marshall, 2004).

Employees in (1) "Decrease from high" reported significantly lower levels of PA at follow-up compared to baseline. We find it somewhat surprising that their levels of perceived competence and autonomous motivation for PA remained moderate-to-high and consistent throughout the whole period of one year. The results indicate that employees moderate-to-high on perceived competence and autonomous motivation for PA seem less vulnerable to fluctuations in PA and remain self-endorsed and confident that they are able to be physically active on a regular basis. This is in line with the findings of Sweet et al. (2014).

The participation rate (68%) was considerably higher than mean values previously reported for worksite intervention programs (33%; Robroek et al., 2009). This could indicate that employees felt obligated to take part, possibly because the whole team was invited. If this was the case, we would expect the participants to exhibit relatively high levels of controlled motivation and amotivation for PA at baseline, particularly among employees in (3) “Increase from low”, in line with the tenets of SDT. However, all three trajectories reported what we considered to be low levels of amotivation and extrinsic regulation at baseline, although (3) “Increase from low” did exhibit somewhat higher levels of extrinsic regulation compared to the rest. Their initial level of introjected regulation was more apparent: the participants reported low-to-moderate levels, particularly employees in trajectories (1) “Decrease from high” and (2) “Stable moderate”. These findings indicate that participants were sensitive to and partially recognized the importance of taking part in the program and making lifestyle changes. Employees in (1) “Decrease from high” and (2) “Stable moderate” reported moderate-to-high levels of autonomous motivation for PA, particularly intrinsic regulation. This could possibly counteract their low-to-moderate levels of introjected regulation, reflecting a wish to participate in the program for their own reasons. We question whether the fact that they were not expected to participate in collective PA sessions during the intervention could have made them more comfortable since they may have felt less exposed to social comparison and loss of credibility from co-workers (Rossing & Jones, 2015).

Given their moderate levels of PA at follow-up, it is not surprising that employees in the sample reported low levels of amotivation at all three time-points. However, they reported considerably higher levels of controlled motivation at follow-up compared to baseline, particularly extrinsic regulation. Employees in (2) “Stable moderate” and (3) “Increase from low” demonstrated the same pattern with regard to extrinsic regulation with an increase in mean values of around 1. Given their diverse development in PA over a period of one year, the findings did not support hypothesis 3, which was related specifically to controlled forms of motivation. Furthermore, the findings are not in line with other PA intervention studies in the health care context, which found non-significant changes in controlled forms of motivation (Rodgers et al., 2010; Sweet et al., 2014). We question whether participating in the program could actually have enhanced their controlled motivation for PA, even though their autonomous motivation remained moderate-to-high. The health screening results and recommendations together with the information, discussions and response they received during the intervention sessions could possibly have increased their awareness of the opinions and expectations of important others in their environment (e.g., family, co-workers, health practitioners, and health and exercise advisors). Participating in the program is likely to make them more sensitive to the fact that their employer invested time and money on the program in order to obtain organizational benefits, such as reduced sickness absence and increased work productivity. Although the intervention was designed to support the basic psychological needs and thereby increase autonomous motivation, it appears that aspects of the context were perceived as controlling. This is not surprising given the element of professionalism and mutual dependency between employer and employee. We argue that this is a challenge inherent in the worksite context, particularly at follow-up after the intervention period. This must be taken into consideration when designing worksite health promotion programs.

4.1. Limitations and future direction

The present study has methodological limitations. First, we completed statistical power calculations prior to recruitment in order to specify the sample size required to detect a between-groups effect size. We chose to include all participants in the LCGA, but separate power analyses were not completed. Having a too small sample size increases the risk of choosing an inadequate model with too few classes (Dziak, Lanza, & Tan, 2014). Despite of acceptable model fit indices and distinct differences between the trajectories, the three-class model could be subject to underextraction. Given the moderate sample size, we chose to explore the relationship between PA trajectories and distal outcome variables separately using manifest variables rather than latent (Andruff, Carraro, Thompson, & Gaudreau, 2009). This approach reduces the complexity but also the strength of the findings.

Second, the dropout rates were considerable, particularly at follow-up, and data were not missing completely at random. Information not included in the study, such as general health condition or reasons given for not attending, may have provided a better understanding of what caused employees to drop out and what characterized those who were able or willing to participate at all three time-points. Third, in the present study, we were not able to assess PA using objective methods (e.g., accelerometers). A large number of studies have reported low-to-moderate agreement between self-reported and objectively measured PA levels (Prince, Adamo, Hamel, Hardt, Gober, & Tremblay, 2008). Both sources of PA information have the potential for under and over-estimation, and a combination is recommended (Steene-Johannessen et al., 2016). For instance, self-reported measures are biased by subjective interpretation and social desirability, whereas accelerometers do not capture all activities precisely depending on the placement on the body. Hence, the results of the present study should be interpreted cautiously.

Finally, the present study also has limitations related to study design. We question whether the recruitment process could have been altered to better attend to the needs of employees with low levels of perceived competence and autonomous motivation for PA. For example, the information meetings, during which participants were recruited, could have been more dialogue-based, inviting participants to express their doubts and ambivalence more explicitly. Participants and co-workers may perceive such dialogue as being supportive of the basic psychological needs, and it may encourage them to reflect on their motivation toward PA before a decision to participate is made (Markland et al., 2005).

5. Conclusions

To our knowledge, this is the first study to apply LCGA to the investigations of the associations between longitudinal developmental trajectories of PA and SDT-based concepts of motivational regulation and perceived competence for PA using data from a PA intervention in the worksite context. The findings indicate that LCGA is a useful approach for detecting longitudinal trajectories in heterogeneous samples of both exercise initiates and regular exercisers. The present findings emphasize the effectiveness of the SDT-based intervention design and the generalizability of the results to non-treatment populations.

Declaration of interest

We would like to inform the Editor of the fact that the following PhD research project was financed by the Industrial Ph.D. scheme, administered by The Research Council of Norway:

The Industrial Ph.D. scheme for funding for industry-oriented doctoral research fellowships was established to facilitate the recruitment of researchers to Norwegian industry. Funding for industry-oriented doctoral research fellowships will help many companies to step up their research efforts. The Industrial Ph.D. scheme does not represent a new type of doctoral degree, but is designed to support long-term, industry-oriented research that has the same level of scientific merit as the general doctoral degree education.

The Industrial Ph.D. scheme is designed to enhance interaction between companies and research institutions, increase research activity in industry, and equip newly-educated researchers with knowledge of relevance to their company.

Under the Industrial Ph.D. scheme, companies receive an annual grant equal to maximum 50 per cent of the applicable rate for doctoral research fellowships for a three-year period. The candidate must be an employee of the company and be formally admitted to an ordinary doctoral degree programme.

The present PhD project was a cooperation between the Post Norway and The Norwegian School of Sport Sciences (NSSS) as the degree-conferring institution, and the candidate followed the PhD program at NSSS. For more information, please visit the web-page: https://www.forskningsradet.no/prognett-naeringsphd/About_the_PhD_scheme/1253952592832.

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Appendix A. Supplementary data

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