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**Motivational Predictors of Increases in Physical Activity
Behaviour, Health, and Well-Being among Patients with
Diabetes Mellitus Type 2 and Cardiovascular Disease:**

Testing Self-Determination Theory in a Randomized Clinical Trial

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Motivational Predictors of Increases in Physical Activity Behaviour, Health, and Well-Being
among Patients with Diabetes Mellitus Type 2 and Cardiovascular Disease:
Testing Self-Determination Theory in a Randomized Clinical Trial

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Abstract

A randomized clinical trial tested an experimental model and the self-determination theory (SDT) process model of changes in physical activity (PA) behaviour, health, and well-being. Adult patients (N=137) of both sexes, all diagnosed with diabetes mellitus type 2 and cardiovascular disease, were recruited to a one-year experiment. They were randomly assigned to an organized exercise intervention group or to a non-exercise control group. At baseline and after 12 months we measured the following variables: perceived needs satisfaction and autonomy support, motivational regulations of PA, perceived competence for PA (PC), and perceived effort and quality of PA behaviour. In addition we measured general health and psychological well-being. Well-being was estimated by the subtraction of negative affect from the sum of positive affect, life satisfaction, and vitality. Of the patients who answered the questionnaire on baseline (65%, $n=89$), 70.8% ($n=63$) answered after one year. The experimental model was tested using a MANOVA repeated measures, followed with 7 ANOVA's repeated measures. The SDT process model was tested using multiple regression analysis and path analysis (bootstrapping). The intervention produced significant increases in all study variables in favour of the experimental group. In addition, the data supported the SDT process model. As hypothesized, the intervention was positively related to needs satisfaction, need satisfaction related positively to autonomous motivation and PC, and autonomous motivation related positively to PA. PC related positively to PA, health and well-being. Furthermore, the direct effect of the intervention on well-being was positive and significant.

Keywords: autonomous motivation, autonomy support, cardiovascular disease, diabetes perceived competence, psychological needs, self-determination theory, vitality, well-being

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Motivational Predictors of Increases in Physical Activity Behaviour, Health, and Well-Being among Patients with Diabetes Mellitus Type 2 and Cardiovascular Disease: Testing Self-Determination Theory in a Randomized Clinical Trial

In 2010 cardiovascular diseases (CVD) caused 37% of all deaths in Norway (Statistisk Sentralbyrå, 2011). The same year the prevalence of diabetes mellitus type 2 (DM2) was estimated to include 175,000 people in Norway, and a further 175,000 people who may have had the disease without knowing it (Helsedirektoratet, 2010). The two common diseases often occur together - the risk of heart attack or stroke is 3-4 times elevated for a person with DM2, and it is frequently detected DM2 in people with acute CVD (Østenson, Birkeland, & Henriksson, 2009).

From a population perspective behavioural pattern are the strongest influences on health, far exceeding genetics, social circumstances, environmental exposures, and medical health care (Schroeder, 2007). Since human behaviour potentially can be controlled, it holds a great opportunity for improved health. Lifestyle interventions are the most cost-effective means to enhance management of DM2 and CVD, and the importance of diabetes self-management is so recognized that it has been proposed that self-care behaviours could be used as standard diabetes quality indicators (Glasgow, Peeples, & Skovlund, 2008). Favourable behaviour patterns for patients with both CVD and DM2 involve appropriate regulation of physical activity (PA), diet and blood sugar. CVD can be reduced by targeting risk factors, such as tobacco use, unhealthy diet, obesity, physical inactivity, high blood pressure and raised lipids (WHO, 2013). Patients are advised to engage in regular PA and choose a diet rich in fruit and vegetables, as well as avoid foods that are high in fat, sugar and salt. PA can lower the blood sugar, blood pressure and obesity, and it prevents CVD (Helsedirektoratet, 2010; Amundsen, Slørdahl, Ståhle, & Cider, 2009). Fritz and colleagues

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(2006) suggested that an increase of regular PA equivalent to 45 min of walking 3 days/week may suffice to improve systolic and diastolic blood pressure, lipid metabolism and BMI in patients with DM2 (Fritz, Wändell, Åberg, & Engfeldt, 2006). The Norwegian Directorate of Health recommends at least 30 minutes of moderate daily activity for both groups (Helsedirektoratet, 2010), and there is a dose-response relationship between PA and health benefit, meaning that an increase in intensity or time beyond the 30 min would provide additional positive health effects. The intensity should be adjusted to match the individual's health condition. Pharmacotherapy (blood thinning, cholesterol decreasing and beta blockers) and operative treatment may also be necessary. Diabetics should stabilize their blood sugar by a regular meal pattern including ingredients that give a slow rise in blood sugar and are rich in fibre, and insulin dosages must be adjusted in relation to the activity level and carbohydrate intake. To be effective in self-management of DM2 and CVD patients must both initiate and maintain these activities.

Motivation encompasses self-regulatory processes involving in the selection, activation, and sustained direction of behaviour toward certain goals (Bandura, 1997). One of the theories that have been proposed to explain the processes of motivation and self-regulation of health behaviour is the process-oriented Self-Determination Theory (SDT; Deci & Ryan, 2000). Self-regulation of DM2 and CVD are not an end point, rather it is a continuing process, and thus SDT's perspective might be appropriate in this context (Shigaki et al., 2010). The approach of this theory to the study of personal growth and development is both organic and dialectical (Ryan & Deci, 2004). The organic perspective involves that people are acting voluntarily and purposefully with a desire to actualize their potential. People themselves - regulates and initiates its actions. This is one side of the dialectical view, the second means that even if individuals are actively navigating their course through the environment "like trade winds and currents, environments sometimes hinder, sometimes

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bolster, sometimes change the course of a developmental route" (Ryan & Deci, 2004, p. 390). According to the SDT-vision optimally functioning of an individual both influence and will be influenced by the social context.

The conception that people have basic psychological needs forms a strong foundation for SDT, and this is explained by the Basic Psychological Needs Theory (BPNT). The mini-theory was designed to provide an universal explanation of how motivation and goals relate to health and wellness. A basic need is "an energizing state that, if satisfied, conduces toward health and well-being but, if not satisfied, contributes to pathology and ill-being" (Ryan & Deci, 2000a, p. 74). Needs give goals their psychological potency and influence which regulatory processes that direct people's goal pursuit" (Deci & Ryan, 2000) By this, SDT can provide understanding of both goal-directed behaviour and psychological development and well-being. It is specified that all individuals, regardless of age, gender and culture, possess the need to experience autonomy, competence and relatedness. Needs represent "part of the common architecture of human nature" (Deci & Ryan, 2000, p. 252).

The need for autonomy refers to self-determination over own actions. This should not be confused with independence or detachment. Autonomy is the feeling of volition, and it can accompany both dependent and independent acts (Ryan & Deci, 2000a). What is important is that the experience of the desire and the initiation of an action come from the individual himself. No matter how little the culture and the individual value individuality, the need is always present, and if it is not satisfied results can be negative effects on motivation and wellness. When individuals are autonomous, they experience themselves as valuable by virtue of being themselves, rather than basing their self-worth on specific actions or how they appear (Hodgins & Knee, 2002).

The need for competence refers to "the desire to interact effectively with the environment" (Vallerand, 2004, p. 427). It derives from the human inherent nature to seek

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challenges to develop. People are more likely to adopt and internalize a goal if they believe they have the relevant skills to succeed at it (Ryan & Deci, 2000b). Perceived competence (PC) is considered necessary for all forms of self-regulation (Deci & Ryan, 2000). Consistent with the flow theory (Csikszentmihalyi, 2008), Deci and Ryan (2000) emphasize that challenges should be optimally adapted to the person's abilities to stimulate growth. A challenge too hard may lead to anxiety and disengagement, and a task too easy may be the source of boredom and alienation.

The need for relatedness refers to the need all people have to build interpersonal relationships and feel acceptance in a group. Deci and Ryan (2000) consider relatedness as an important need, but that it is subordinate to autonomy and competence, as people often engage in self-starting behaviour that does not contain this element (like playing solitaire and go walking in the woods alone). Ryan & Deci (2000b) argued that the primary reason people initiate extrinsically motivated behaviours is because they are valued by significant others. Thus, by facilitating a sense of belongingness to the person or group disseminating a goal might generate internalization of the goal.

Overall, SDT proposes that satisfaction of the three needs relates positively to autonomous types of motivation, integration of extrinsic motivation, PC in the activity, psychological growth, and well-being (Deci & Ryan, 2000)

Autonomous motivation implies that the patient has a clear understanding of their basic values and how one's habits stand in relation to these, and that the experience is a close relationship between values and habits. Intrinsic-, integrated- and identified regulations are motivational forms that encompass high levels of autonomy, and when we use the term "autonomous motivation" in this study we refer to integrated- and identified regulations.

Integrated regulation contains the highest degree of autonomy. The action harmonizes with the individual's philosophy of life and values (Deci & Ryan, 2000).

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Identified regulation occurs when the individual consider an act important in light of the instrumental effects it provides (Deci & Ryan, 2000).

The context whereas an individual initiate and regulate behaviour can appear autonomy supportive (i.e. promoting choice) or controlling (i.e. pressuring one toward specific outcomes). Autonomy-supportive contexts (relative to controlling ones) have generally been associated with more autonomous types of motivation and higher PC. As well, the literature has indicated that autonomy-supportive contexts are linked to greater interest, less pressure and tension, more creativity, more cognitive flexibility, better conceptual learning, a more positive emotional tone, higher self-esteem, more trust, greater persistence of behaviour change, and better physical and psychological health (Deci & Ryan, 1987; 2000). Thus, to the extent that the intervention in the present study was autonomy-supportive, it was expected to positively predict needs satisfaction, autonomous types of motivation, and PC among participants.

“Subjective well-being” (SWB) has been defined as “a person’s cognitive and affective evaluations of his or her life” (Diener, Lucas, & Oishi, 2005, p. 63). Thus, it is a broad concept that both include emotional reactions to events (experiencing pleasant emotions and low levels of negative moods) and cognitive judgements of satisfaction and fulfilment. WHO clearly states that well-being is a significant component of health through their definition of health as “A state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity” (1998, p. 1). They further emphasize that “to reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and realize aspirations, to satisfy needs, and to change or cope with the environment” (2009, p. 1). The relation between subjective well-being and health depends on whether the health measurements assessed are objective ratings or self-reported. Self-reported health correlates positively with subjective well-being, but weakly with objective

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health rating (Diener et al., 2005). Rather than based on objective circumstances, well-being seems to be dependent on the way people perceive the world.

Studies on patients in cardiac rehabilitation have shown that autonomous motivation is positively related to PA level (Kubitz, 2010; Sweet, Tulloch, Fortier, & Reid, 2010; Russell & Bray, 2010). There are to my knowledge no clinical trials that have tested the self-determination theory in an exercise domain with participants that all have both DM2 and CVD. However, for patients with DM2 research supports the importance of autonomy-supportive patient care for increases in autonomous motivation and PC for diabetes self-management and, in turn, these motivational variables improved glycemic control over 12 months (Williams, Freedman, & Deci, 1998; Williams, McGregor, Zeldman, Freedman & Deci, 2004) Other studies among DM2 patients indicate that autonomy-supportive care positively predicted autonomous motivation and PC, which, in turn, positively predicted medication adherence, and the latter construct predicted health (i.e., glycemic control and non-HDL cholesterol). In particular, PC positively predicted quality of life (Williams et al., 2009). The importance of PC was also supported in a study by Williams and colleagues (Williams, McGregor, King, Nelson & Glasgow 2005). In this study autonomy-supportive care positively predicted PC, which reduced blood sugar levels and depressive symptoms. Thus, PC may be important in particular for DM2 patients' physical health and well-being.

In sum, based on the theory and research reviewed, the following hypotheses were tested. First, regarding the experimental model, it was hypothesized that participation in an organized weekly exercise group, relative to a non-exercise control group, would lead to increases in perceived autonomy support and needs satisfaction in PA, increases in autonomous motivation and PC for PA, and increases in PA behaviour, as well as lead to increases in their general health and PWB. Second, regarding the SDT process model it was hypothesized that the intervention (relative to controls) would positively predict increases in

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needs satisfaction, which would positively predict changes in autonomous motivation and PC, which both, in turn, would predict increases in PA behaviour, health, and well-being.

METHODS

Participants

137 participants were recruited from the ASCET-study (Aspirin non-responsiveness and Clopidogrel clinical Endpoint Trial) that was conducted by the same research group that performed this research project "Physical fitness in people with coronary artery disease and type 2 diabetes." All participants included had both stable CVD and DM2. They were of both sexes aged 41-81 years.

Persons already in training more than 2 times a week were excluded from the study. Further exclusion criteria includes severe diabetic retinopathy, nephropathy or neuropathy, unstable angina, decompensated heart failure, severe ventricular arrhythmia, severe valvular heart disease, aortic-aneurysm, deep vein thrombosis, pulmonary embolism, stroke or mitral insufficiency in the last 3 months, cancer, arthritis, COPD, muscular-skeletal disorders, persistent infections, and other serious diseases.

Study Design and Intervention

The study was part of a clinical trial that took place at Ullevaal University Hospital from August 2010 to March 2013. Participants were randomized into an exercise- and a control group (see the study flowchart in Figure 1). The intervention group participated in a 12-month exercise program developed in collaboration with the Norwegian School of Sport Sciences (NSSS). They were offered group-based instruction twice per week, each workout lasting 60 minutes. The workouts took place at NSSS, both indoors and outdoors. Indoor training consisted of circuit training with different stations focusing on strengthening the

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major muscle groups in the body, as well as endurance. In addition, there were regular spinning classes. Pure strength training in the weight room was offered for those who preferred it. In summertime a training per week was held outdoors, focusing on interval training (walking/jogging uphill). It was desirable that the participants in the exercise group also trained once a week on their own, so that the total training volume reached a minimum of 150 minutes per week. There were no specific guidelines for the type of self-training that was conducted, participants could choose an activity they wanted to engage. Exercise intensity should be between moderate to intense. It was made occasional pulse records during organized training. All participants were encouraged to keep a training diary and deliver this regularly to instructors. There were two instructors, with a master degree in sports science from NSSS, present at almost all organized sessions, which gave the opportunity for individual monitoring of participants when necessary. There was arranged 2 x 2 training sessions per week, so that participants had some choice when it came to training times. For some participants, it was still difficult to participate in group trainings as they were held at daytime. It was therefore "accepted" that some participants only exercised on their own, if it was considered likely that they would conduct the exercise.

A questionnaire was distributed to the participants at baseline (T1) before they were randomized to control- or experiment groups and after the training period of 1 year (T2). Participants were only given brief practical information on how to fill out the survey and what was meant by the term "health-team". With few exceptions, the participants took the questionnaire home to fill it out and handed it to the doctor at the next meeting. Of the patients who answered the questionnaire on baseline (65%, $n=89$), 70.8% ($n=63$) answered after one year.

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Completers Versus Dropouts

Of the 89 participants that responded to the survey at baseline, 12 dropped out of the experimental group, and 14 dropped out of the control group from T1 to T2. Thus, 63 participants (70.8% of baseline respondents) completed the survey at both times. We used logistic regression to predict study continuation (0 = completers and 1 = dropouts) from experimental conditions and the 7 study variables measured at T1, and analysis of variance (ANOVA) to analyse whether dropouts differed from completers on demographics. Analyses indicated that randomization to intervention or control group did not predict dropout. 3 of the 7 baseline variables did predict dropout, that is autonomy support, $B=-0.52$ (Wald=7.18), $p=.007$, needs satisfaction, $B=-0.53$ (Wald=5.70), $p=.017$, and autonomous motivation, $B=-0.42$ (Wald=4.60), $p=.032$. Among completers, the experimental and control group was not significantly different in baseline measures (logistic regression). There were, however, significantly gender differences in the make-up of the two groups, $X^2 = 6.86$, $df=1$, $p=.009$, with more males in the experimental group (65.22%) than in the control group (34.78%), and more females in the control group (80.00%) than the intervention group (20.00%). Thus, we controlled for gender in subsequent multivariate analysis of variance (MANOVA).

Measurements

Perceived Autonomy Support for Physical Activity (T1 and T2). Measured with the 6-item version of the Health-Care Climate Questionnaire (Williams, Grow, Freedman, Ryan, & Deci, 1996). A sample item is: "I feel that my health team has provided me choices and options in relation to my physical activity." Responded to on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale, this measure indexed whether the intervention increased patients' perceptions of autonomy support. The 6 items were averaged to reflect autonomy support for PA.

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Basic Psychological Needs Satisfaction in Exercise (T1 and T2) was measured with the Basic Psychological Need Satisfaction in Exercise Scale (Vlachopoulos & Michalidiou, 2006). It consists of 12 items intended to measure satisfaction of the 3 basic needs for competence, autonomy, and social relatedness with 4 items each. Participants responded to the items following this stem: “When you exercise, how untrue or true are the following statements?” Sample items are: “I feel that I associate with the other exercise participants in a very pleasant way” (relatedness need), “I feel that I can manage with the requirements of the training program I am involved” (competence need), and “I feel that the way I exercise is definitely an expression of myself” (autonomy need). The 4 items for each need were averaged to reflect relatedness, competence, and autonomy needs satisfaction, and the sum of the three needs was termed total needs satisfaction. The participants indicated how true each item was for them on a 7-point scale varying from 1 (*not at all true*) to 7 (*very true*).

Autonomous Motivation for Physical Activity was measured with the 12-item Treatment Self-Regulation Scale (TSRQ) for PA (Levesque et al., 2007) somewhat modified to fit the context of the present study. Participants responded to the items following this stem: “I am physically active: ... “. Sample items are: “because it feels natural for me to do it” (integrated regulation) and “because I want to take responsibility for my own health” (identified regulation), responded to on a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*). The 12 items were averaged to reflect autonomous motivation for PA.

Perceived Competence for Physical Activity was measured with the Perceived Competence Scale (PCS), previous used in diabetes self-care studies (Williams, Freedman, & Deci, 1998) and learning among medical students (Williams & Deci, 1996). Participants responded to 4 items on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale. Each item asked the participants how skilled or effective they felt in carrying out their exercise. An example

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item is: “I feel confident in my ability to be regularly physically active”. The items were averaged to reflect PC for PA.

Physical Activity Behaviour was measured with the 10-item Effort and Quality of Performance Scale adapted to exercise from Kuvaas (2006). A sample item is: “I try to exercise as well as possible”. Participants responded on a 7-point scale ranging from 1 (*does not suit me at all*) to 7 (*suits me very well*). The items were averaged to reflect PA behaviour.

General health was measured with 4 questions. The first 2 questions are from SF-36 (Ware & Sherbourne, 1992). Sample item: “How would you say your health is now?” The third and fourth question is from a Swedish study (Femia, Zarit, & Johansson, 2001). Sample item: “How would you evaluate your health in relation to others of your own age?” Participants responded to the questions on a 5-point scale ranging from 1 (*bad*) to 5 (*excellent*). The items were averaged to reflect self-rated general health.

Well-being (T1 and T2) was assessed with scales measuring life satisfaction, vitality, positive affect, and negative affect. Life satisfaction was measured by the 5-item Satisfaction With Life Scale (SWLS) developed by Pavot and Diener (1993). Responses were given to statements like “I am happy with my life”. To measure the respondents’ physical and mental vitality, aliveness and vigor, the Subjective Vitality Scale (SVS) was applied. The scale consists of 6 items and was developed by Ryan and Frederick (1997). A sample item is: “I feel alive and vital”. These two scales were administered with the instruction: “Please respond to the following statements by indicating the extent to which the statement is true for you in general in your life” using a 7-point scale with anchors 1 (*Not at all true*), and 7 (*Very true*). The positive affect and negative affect scale (PANAS) developed by Watson, Clark & Tellegen (1988) was applied to measure the respondents mood or affect. In the present study 6 items was administered for each of the two types of affect with the instruction: “To what extent have you experienced the following mood during the last 4 weeks?” Sample adjectives

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are “excited” and “strong” for positive affect and “stressed” and “nervous” for negative affect. Each mood adjective was responded to by using a 7-point rating scale ranging from 1 (*Not at all*) to 7 (*Very much*). Well-being was estimated by subtracting the average score of negative affect from the sum of the average scores of life satisfaction, vitality, and positive affect.

Statistics and Data Analysis

The hypotheses were tested by statistical analyses in PASW Statistics 20.0. Change variables were calculated by linear regression of T2 measures onto T1 measures. Cronbach’s alpha was used as an internal consistency estimate of reliability of test scores on each item. We explored correlations between change variables, using Pearson’s bivariate correlation, to determine the strength and direction of linear relationships. Multiple regression analysis was used to assess which independent variables affected the dependent variable, and we applied that to path analysis on basis of the theory (Figure 2). We used MANOVA repeated measures and several repeated measures one-way ANOVA tests to analyse the differences between group means. Effect sizes of the interaction between time and intervention were calculated by using equation 8 in Morris (2008). Effect sizes for each group were calculated by using equation 4 in Morris & DeShon (2002). We examined total and specific indirect relationships of X on Y by multiple mediation analysis using bootstrapping. In this process we used the macro INDIRECT (Preacher & Hayes, 2008). The results were presented as path models (figure 3 & 4). Missing data were replaced using mean substitution combining main effects of items and subject (Roth, Switzer, & Switzer, 1999). Subjects responding to less than 50% of the items in each scale were omitted from analyses involving that variable.

RESULTS

Table 1 shows the means, standard deviations, effect size and reliability for all variables at T1 and T2. High levels of internal consistency (Cronbach's alpha) emerged (.78-.97).

Table 2 revealed that the intervention group (relative to the control group), and changes in autonomous motivation and PC were significantly positively correlated with changes in all the other variables. Furthermore, changes in autonomy support from the patient's health team were associated with changes in total needs satisfaction, autonomous motivation, PC and PA behaviour. Changes in total need satisfaction were associated with the same variables, and in addition to changes in general health. Changes in PA behaviour were positively correlated with all variables except autonomy support, and changes in PWB were associated with all variables except autonomy support and total needs satisfaction. Gender and age were not significantly correlated with any other variables in the study.

Test of the Experimental Hypothesis

The intervention was hypothesized to increase the following 7 variables from T1 to T2: perceived autonomy support and needs satisfaction in PA, autonomous motivation for PA, PC for PA, PA behavior, health, and well-being. Repeated measures multivariate analysis of variance (MANOVA) was used to examine the hypothesis for the 7 variables, followed by 7 repeated-measures analyses of variance (ANOVA). For the MANOVA the intervention versus control groups was the between-group factor crossed with the seven T1 and T2 assessments as the repeated-measures factor. Gender was used as a covariate and was not significant as a main effect or interaction. The analysis yielded two main effects and one interaction. For *condition*, $F(7,42) = 1.75, p = .125$; for *time*, $F(7,42) = 3.52, p = .005$; and for the interaction of condition by time $F(7,42) = 4.03, p = .002$. The significant interaction effect of condition by time indicates that the intervention group changed more from T1 to T2

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than did the control group, thus, supporting our experimental hypothesis. Because it was not significant, gender was not included in the ANOVAs.

Results of repeated measures ANOVAs (see Table 3) yielded seven significant interactions of the intervention by time, which indicates as expected that the intervention, relative to the control group, resulted in increases of all seven study variables from T1 to T2. The effect sizes were close to moderate or large for all dependent measures of change (Cohen, 1992). Thus, the first hypothesis was supported for all variables.

Test of the SDT Process Model of Changes in Physical Activity, Health, and Well-Being

We tested a process model of health behaviour change based on the self-determination theory. The beta coefficients in Figure 2 were estimated by 5 multiple regressions.

First, the beta coefficient between the intervention and total needs satisfaction is the same as the zero-order correlation, i.e., .60.

Second, change in autonomous motivation was regressed onto change in needs satisfaction and the intervention. The model was significant ($F_{2,53} = 20.03, p < .001, R^2 = .43$) with change in needs satisfaction predicting change in autonomous motivation (beta = .61, $p < .001$), whereas the beta coefficient for the intervention was nonsignificant (beta = .08, $p > .10$).

Third, change in PC was regressed onto change in needs satisfaction and the intervention. The model was significant ($F_{2,55} = 15.10, p < 0.001, R^2 = .35$) with change in needs satisfaction predicting change in PC (beta = .62, $p < .001$), whereas the beta coefficient for the intervention was nonsignificant (beta = -.05, $p > .10$).

Fourth, change in PA behaviour was regressed onto change in autonomous motivation, change in PC, change in needs satisfaction and the intervention. The model was

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significant ($F_{4,51} = 17.91, p < .001, R^2 = .58$) with change in autonomous motivation predicting change in PA behaviour ($\beta = .31, p = < 0.05$), and change in PC predicting change in PA ($\beta = .40, p = < 0.005$), whereas the beta coefficient for needs satisfaction was nonsignificant ($\beta = .07, p > .10$) as well as the beta coefficient for the intervention ($\beta = .14, p > .10$).

Fifth, change in general health was regressed onto change in autonomous motivation, change in PC, change in needs satisfaction and the intervention. The model was significant ($F_{4,50} = 5.46, p < .001, R^2 = .30$) with change in PC predicting change in general health ($\beta = .40, p = < 0.05$), whereas the beta coefficient for autonomous motivation was nonsignificant ($\beta = -.17, p = > 0.10$) as well as the beta coefficient for needs satisfaction ($\beta = .22, p = > 0.10$) and for the intervention ($\beta = .15, p = > .10$).

Sixth, change in psychological wellbeing was regressed onto change in autonomous motivation, change in PC, change in needs satisfaction and the intervention. The model was significant ($F_{4,50} = 3.98, p < .01, R^2 = .24$) with change in PC predicting change in psychological wellbeing ($\beta = .41, p = < .05$), and the intervention predicting change in psychological wellbeing ($\beta = .34, p = < .05$) whereas the beta coefficient for autonomous motivation was nonsignificant ($\beta = -.03, p = > .10$) as well as the beta coefficient for needs satisfaction ($\beta = -.16, p = > .10$).

Results of the tested mediations in figure 3 and 4 indicated that 6 of the 9 mediations (see Table 4) were significantly supported because of the bias-corrected 95% confidence intervals did not include zero or oppositely valued coefficients. All the 6 mediations were full – for each mediation the effect of the independent variable on the dependant variable was reduced from significant to nonsignificant when the mediator was added to the model.

DISCUSSION

The experimental test of the exercise intervention (relative to the non-exercise control group) and the test of the SDT process model were both supported. The intervention led to increases in perceived autonomy support, needs satisfaction, autonomous motivation and PC for PA, as well as increases in PA behaviour, general health, and psychological well-being. The effect sizes (Cohen, 1992) were close to moderate and large for all dependent measures.

Regarding the SDT process model, the intervention positively predicted increases in needs satisfaction, which predicted increases in both autonomous motivation and PC for PA. In turn, autonomous motivation predicted PA behaviour whereas PC predicted all three outcomes.

The links from the intervention to increases in motivation variables, behaviour, health, and psychological well-being are considered causal because the study was designed as a randomized controlled trial. However, causal conclusions among changes in motivation variables and changes in outcomes cannot be done because these changes were assessed at the same time.

The goal of this research was to examine possible psychological processes underlying CVD and DM2 patients' changes in exercise behaviour, health and well-being. We wanted to test if a proposed model of health behaviour change based on SDT could explain possible changes caused by the intervention. As seen, this model was supported. Additional results indicated that, of the three needs, the intervention led to strongest increases in the competence need (.62; see appendix Table 1), followed by relatedness (.54), and then autonomy (.34). Furthermore, competence was the need that correlated strongest to PA behaviour (.64). These findings are supported by a study by Russel and Bray (2009), which demonstrated that following cardiac rehabilitation psychological need satisfaction for competence predicted self-determined motivation to exercise, which was positively

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correlated with exercise frequency and duration. Research by Vlachopoulos and Neikou (2007) also supports the significance of the need for competence – they observed that exercise attendance at a fitness centre was predicted by satisfaction of this need. The need for competence predicted membership of a dropout or adherer group. A review in 2012 (Teixeira, Carraca, Markland, Silva, & Ryan, 2012) of 66 empirical studies on SDT and PA found that the literature was consistent in demonstrating that satisfaction of the need for competence positively predicts exercise. The same review and studies on cardiac patients specifically (Kubitz, 2010; Sweet et al., 2010; Russel & Bray, 2010), supports our findings of autonomous regulations for exercise positively predicting exercise outcomes. Sweet et al. (2010) observed that patients with controlled regulation, more frequently than those with more autonomous motivation, decreased their levels of PA over time. In sum, satisfaction of the needs for competence and autonomy seems to be essential for enhanced autonomous motivation and PA behaviour.

Integrated regulation correlated more strongly to the needs for autonomy and competence than identified regulation, but identified regulation related stronger to the need for relatedness than integrated regulation. This might be explained by the arguments of Ryan and Deci (2000b) who suggested that the primary reason people initiate extrinsically motivated behaviours is because they are valued by significant others. Thus, identified regulation might rely more on relatedness than integrated regulation.

In order to simplify the SDT process model tested, our model does not incorporate autonomy support, but the intervention appeared to be autonomy supportive by a significant positive correlation between the intervention and changes in reported autonomy support (.45). Furthermore, we observed a strong positive correlation between perceived autonomy support and PA behaviour (.49), and between autonomous motivation and PA behaviour (.65). This was also observed by Russell and Bray (2010) who found that autonomy support for exercise

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during cardiac rehabilitation was positively correlated with self-determined motivation for exercise, and that self-determined motivation predicted exercise volume and length of exercise session duration. Kubitz (2010) demonstrated that autonomy support was directly related to PA level.

In contrast to Kubitz (2010), this study revealed no associations between autonomy support and subjective vitality or between autonomous regulation and subjective vitality (see appendix Table 1). By multiple mediation analyses we found that autonomous motivation did not predict PWB or general health, and that total needs satisfaction did not predict PWB. On the other hand, we found that the intervention group directly predicted PWB, and in line with SDT, that PC predicted PWB (.41). Further support for SDT was observed by significant positive correlations between PWB and satisfaction of the need for relatedness (.27), and between vitality and satisfaction of the needs for relatedness (.33) and competence (.27). A study by Reinboth, Duda & Ntoumanis (2004) supports the significance of competence for well-being. They found that young athletes' satisfaction of this need was the most important need predictor of PWB. In contrary to our findings, they also observed that satisfaction of the autonomy need was a positive, but weak, predictor of subjective vitality and intrinsic satisfaction and that satisfaction of the need for relatedness did not predict any of the components of PWB. Thus, relatedness may be more important among CVD and DM2 patients than among athletes. Furthermore, we found that PC was significantly positively correlated with positive affect (.28) and negatively with negative affect (-.37). No correlations between satisfaction of the needs and positive and negative affect were observed. This suggests that it is PC to exercise *regularly*, and not so much competence satisfaction in PA in general, that relates to experienced emotions across life domains. McDonough and Crocker (2007) did though observe that positive affect was positively predicted by relatedness and competence, and that negative affect was negatively predicted by competence

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and weakly, but significantly, by autonomy. Overall, research show mixed results of which needs predict PWB the most, but our findings suggest that among patients with CVD and DM2 it is satisfaction of the needs for relatedness and competence, as well as PC, that relate strongest to PWB or components of the variable.

Participants with low levels of experienced autonomy support, needs satisfaction, and autonomous motivation at T1 were less likely to answer the survey at T2. At T1 participants had only experienced initial contact with the health-team of the EXCADI study, through physical tests and meeting with a doctor. They had been included in the study, but not yet been randomized. By this, it is likely that the motivational variables at T1 are predominantly shaped by their earlier experience with health care. The motivational variables revealed that patients who experience autonomy support, needs satisfaction, and autonomous motivation adhere better to interventions. These findings are in line with earlier research, which has clearly showed that more autonomous regulatory motives are conducive to greater long-term behavioural adherence in the exercise domain (Edmunds, Ntoumanis, & Duda, 2007; Fortier, Sweet, O'Sullivan, & Williams, 2007; Ingledew, Markland, & Ferguson, 2009), and the results provide further support for core constructs of SDT.

Practical Implications

Examining behavioural interventions on a motivational level give us access to underlying mechanisms, which in turn should be used as targets for more successful future interventions. Given the research suggests that autonomous motivation, needs satisfaction and PC foster positive health related outcomes, the question becomes how do we promote these processes? Providing a meaningful rationale for an uninteresting behaviour, in a setting with support for autonomy, competence and relatedness, might contribute to internalization and integration of motivation. If an exercise outcome as enhanced health not yet is an

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integrated value, outcomes as being able to be active with family might be. Participating in PA could be out of a patient's comfort zone, and by that hold the possibility of increased PC if mastered, a process that could be a life value in itself. To promote internalization and integration of motivation for PA, health care may help patients to see the link between the benefit of exercise and their individual life values. This should be done in an autonomy supportive way, e.g. giving options and taking a motivational interviewing approach (Markland, Ryan, Tobin, & Rollnick, 2005).

Limitations of the Study

Responding to this quite comprehensive survey took about 25-35 minutes, and it is by that plausible to believe that we lost some respondents due to the extensive amount of time required to answer it. Several respondents left a few to many items blank, and this may be because of the amount of questions. Another reason may be that they did not completely understand the questions, and some feedback points to this.

Since this SDT-study was conducted on the on-going EXCADI-study, the exercise instructors were not asked to appear autonomy supportive or facilitate SDT needs and autonomous motivation. Nonetheless, the intervention predicted needs satisfaction and autonomous motivation, and was positively correlated with autonomy support. If the constructs would have been actively targeted, the outcome effects on health, PA, and well-being might have been further enhanced.

Conclusion

In conclusion, the exercise intervention (relative to the non-exercise control group) which was perceived as autonomy-supportive among DM2 and CVD participants, led to increases in needs satisfaction and self-determined motivation, increases in effort and quality of PA, as well to increases in general health and psychological well-being. A SDT process model, and a BPNT process model in particular, appeared to be well suited to explain these changes in health behaviour and health outcomes among patients with DM2 and CVD. This suggests that future exercise interventions would benefit of facilitating satisfaction of the needs for autonomy, competence and relatedness in order to be successful.

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APPENDICES

for

Motivational Predictors of Increases in Physical Activity Behaviour, Health, and Well-Being
among Patients with Diabetes Mellitus Type 2 and Cardiovascular Disease:
Testing Self-Determination Theory in a Randomized Clinical Trial

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Appendix Table 1.

Pearson Correlations Among Variables of Change¹ T1→T2 (two-tailed).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Intervention	--																		
2. Autonomy support	.45	--																	
3. Competence need	.62	.66	--																
4. Autonomy need	.34	.47	.62	--															
5. Social-relatedness need	.54	.47	.51	.36	--														
6. Total needs satisfaction	.60	.60	.88	.80	.75	--													
7. Integrated regulation	.44	.43	.54	.56	.39	.62	--												
8. Identified regulation	.38	.38	.38	.45	.49	.53	.57	--											
9. Autonomous motivation	.46	.46	.53	.58	.47	.65	.92	.83	--										
10. Perceived competence	.37	.61	.62	.55	.33	.59	.63	.51	.65	--									
11. PA behaviour	.48	.49	.64	.49	.38	.61	.65	.50	.65	.64	--								
12. General health	.31	.07	.41	.30	.17	.39	.34	.15	.28	.46	.42	--							
13. Life satisfaction	.31	.22	.33	.14	.24	.24	.07	.33	.18	.29	.27	.28	--						
14. Vitality	.41	.12	.27	.09	.33	.30	.29	.06	.22	.31	.42	.55	.35	--					
15. Positive affect	.25	.03	.09	.04	.18	.08	.28	.28	.31	.28	.28	.38	.34	.46	--				
16. Negative affect	-.16	-.05	-.11	-.16	-.10	-.18	-.10	-.09	-.11	-.37	-.21	-.39	-.28	-.51	-.26	--			
17. Psychological well-being	.36	.08	.22	.12	.27	.24	.25	.22	.27	.40	.38	.56	.62	.83	.69	-.71	--		
18. Gender	-.12	-.20	-.20	.00	-.09	-.16	-.21	-.19	-.21	-.15	-.22	-.08	.05	-.14	-.09	.06	-.06	--	
19. Age	.05	.18	.27	.22	.17	.24	.10	.15	.12	.23	-.04	.22	.08	-.00	-.08	-.07	-.02	-.08	--

Note. Correlations in bold are significant at least at $p < .05$; two-tailed tests.

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Table 1 :

Descriptive Statistics for SDT-variables, Well-being, and Health (N=21 in the Control Group and 29 in the Intervention Group)

Variable Group	M+SD	M+SD	Effect size	Cron. Alpha	
	T1	T2	T1-T2	T1	T2
Autonomy support				.93	.94
Interv.	4.95±1.12	5.85±.79	.86		
Control	4.58±1.57	4.69±1.54	-.02		
Total needs satisfaction				.93	.96
Interv.	5.16±1.25	5.96±.94	.86		
Control	5.00±1.07	4.71±1.06	-.21		
Autonomous motivation				.95	.97
Interv.	5.19±1.24	5.73±1.01	.62		
Control	4.99±1.31	4.81±1.52	-.32		
Perceived competence				.92	.95
Interv.	5.33±1.28	5.77±1.15	.27		
Control	5.04±1.33	4.33±1.55	-.39		
PA behaviour				.96	.96
Interv.	4.17±1.44	4.99±1.15	.79		
Control	3.91±1.47	3.77±1.49	-.05		
General health				.78	.87
Interv.	2.93±.76	3.33±.80	.60		
Control	2.80±.68	2.67±.72	.05		
Psychological wellbeing				.95	.93
Interv.	10.16±2.83	10.96±3.14	.37		
Control	8.48±3.53	7.81±2.6	-.39		

Note. Effect sizes are calculated by using equation 4 in Morris & DeShon (2002).

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Table 2:

Pearson Correlations Among Variables of Change¹ T1→T2 (two-tailed).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10
1. Intervention	--									
2. Autonomy support	.45**	--								
3. Total needs satisfaction	.60**	.60**	--							
4. Autonomous motivation	.46**	.46**	.65**	--						
5. Perceived competence	.37**	.61**	.59**	.65**	--					
6. PA behaviour	.48**	.49**	.61**	.65**	.64**	--				
7. General health	.31*	.07	.39**	.28*	.46**	.42**	--			
8. Psychological well-being	.36**	.08	.24	.27*	.40*	.38**	.56**	--		
9. Gender	-.12	-.20	-.16	-.21	-.15	-.22	-.08	-.06	--	
10. Age	.05	.18	.24	.12	.23	-.04	.22	-.02	-.08	--

Note. N varies from 52-62. * $p < 0.05$ (2-tailed); ** $p < 0.01$ (2-tailed).

¹ Change scores (standardized residuals) were created by regression of T2 measures onto T1 measures.

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Table 3.

ANOVA of study variables

Effects	<i>F</i>	(<i>df</i>)	<i>p</i>	Effect Size
Autonomy support				
Intervention	6.27	1	.016	
Time (T1 & T2)	7.49	2	.009	
Intervention X time	4.49	2	.039	.59
Total needs satisfaction				
Intervention	5.98	1	.018	
Time (T1 & T2)	4.78	2	.034	
Intervention X time	21.22	2	.000	.91
Autonomous motivation				
Intervention	2.74	1	.105	
Time (T1 & T2)	2.29	2	.137	
Intervention X time	8.67	2	.005	.56
Perceived Competence				
Intervention	6.28	1	.016	
Time (T1 & T2)	.74	2	.394	
Intervention X time	13.98	2	.000	.87
PA behaviour				
Intervention	3.97	1	.052	
Time (T1 & T2)	6.10	2	.017	
Intervention X time	12.19	2	.001	.65
General health				
Intervention	4.19	1	.046	
Time (T1 & T2)	2.20	2	.144	
Intervention X time	7.94	2	.007	.72
Psychological wellbeing				
Intervention	8.57	1	.005	
Time (T1 & T2)	.05	2	.826	
Intervention X time	6.41	2	.015	.46

Note. Effect sizes are calculated by using equation 8 in Morris (2007).

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Table 4.

Tests of Mediation for the Links Emerging in Figure 3 & 4

Independent variable (IV)	Mediator (M)	Dependent variable (DV)	Point estimate	SE	Z	Bootstrapping	
						BC 95% CI	Lower Upper
<i>Indirect links in Figure 3</i>							
1. Interv	TNS	PAB	0.57	0.19	3.24****	0.23	0.96
2. Interv	TNS	GH	0.38	0.21	1.91*	0.03	0.95
3. Interv	TNS	PWB	0.49	0.19	0.30	-0.31	0.47
<i>Indirect links in Figure 4</i>							
4. Interv	AM	PAB	0.47	0.15	3.09****	0.20	0.79
5. Interv	PC	PAB	0.39	0.15	2.72****	0.14	0.76
6. Interv	AM	GH	0.14	0.11	1.05	-0.05	0.38
7. Interv	PC	GH	0.28	0.13	2.22**	0.11	0.63
8. Interv	AM	PWB	0.11	0.13	0.90	-0.15	0.37
9. Interv	PC	PWB	0.22	0.14	1.92*	0.21	0.60

Note. BC = bias corrected; 1000 bootstrap samples. a-path = IV → M; b-path = M → DV. * $p < .10$; ** $p < .05$; *** $p < .01$; **** $p < .001$.

FIGURE LEGENDS

Figure 1.

Study flowchart of respondents to the questionnaires

Figure 2.

The SDT process model of changes in motivational variables, physical activity behaviour, general health, and psychological well-being. * $p < .10$; ** $p < .05$; *** $p < .01$

Figure 3.

Bootstrapping of total needs satisfaction as a mediator between the intervention and outcomes. * $p < .10$; *** $p < .01$

Figure 4.

Bootstrapping of autonomous motivation and PC as mediators between the intervention and outcomes. * $p < .10$; ** $p < .05$; *** $p < .01$

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Figure 1.

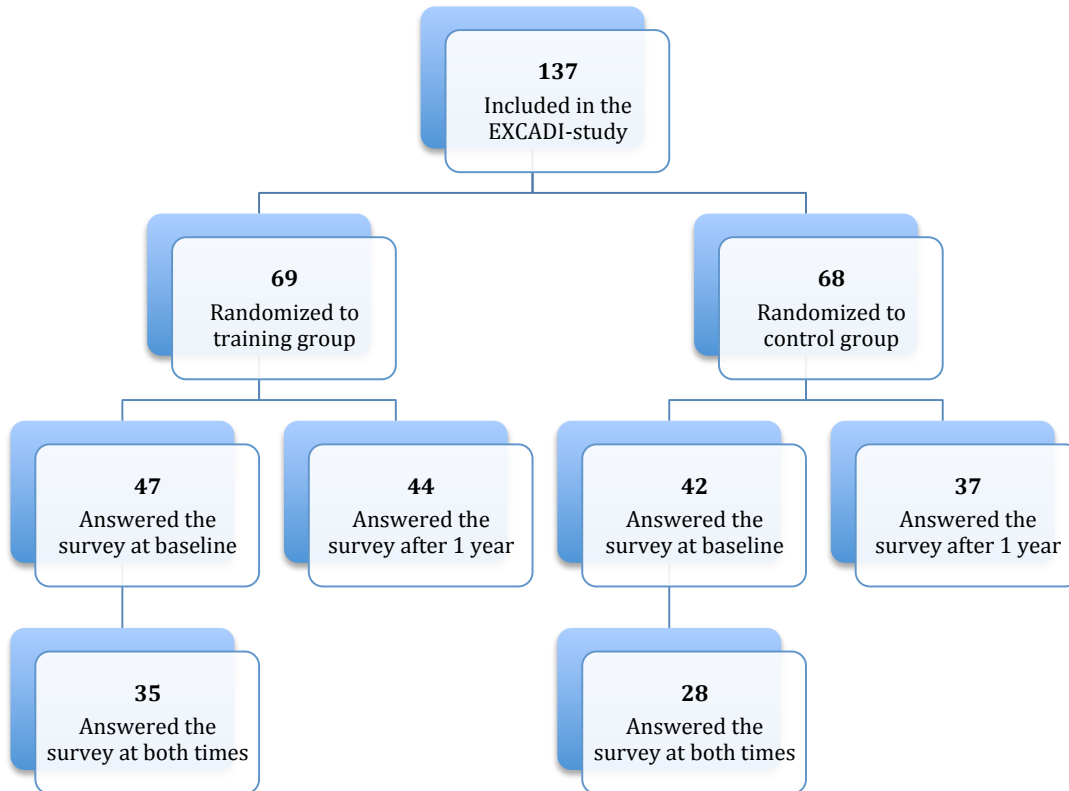


Figure 2.

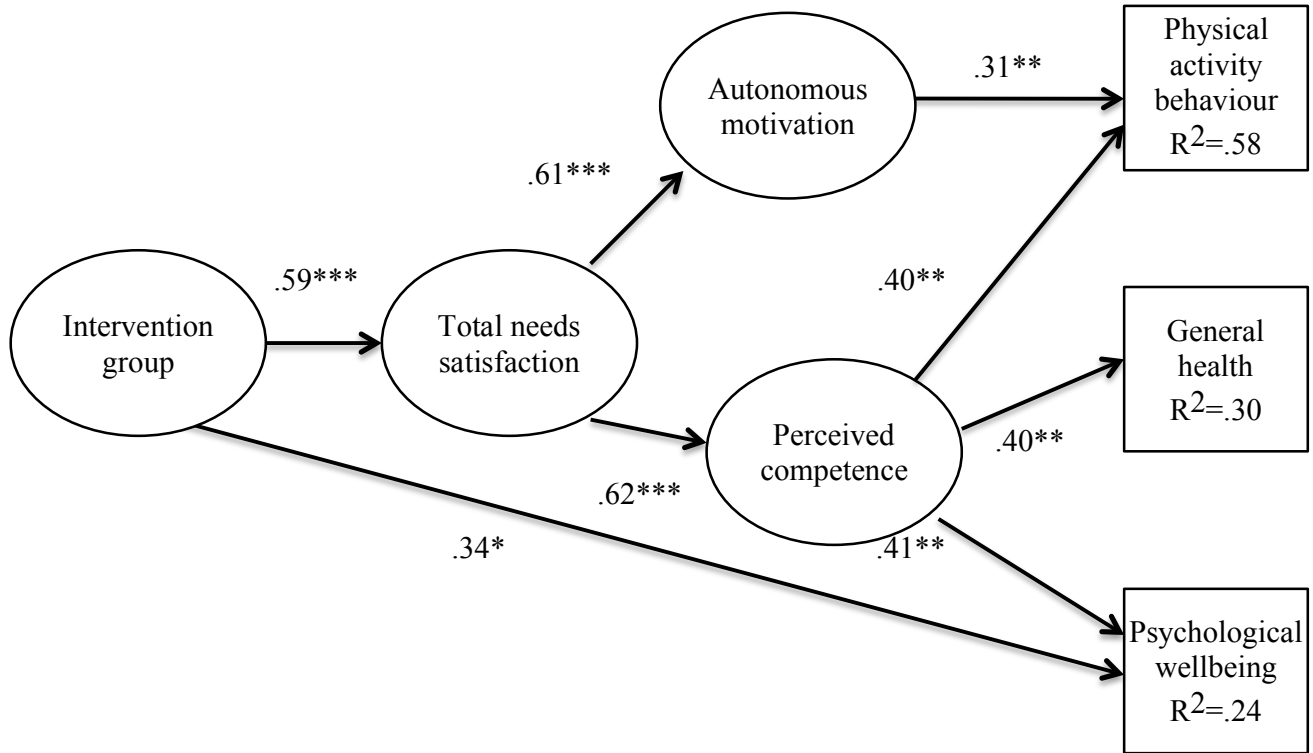


Figure 3.

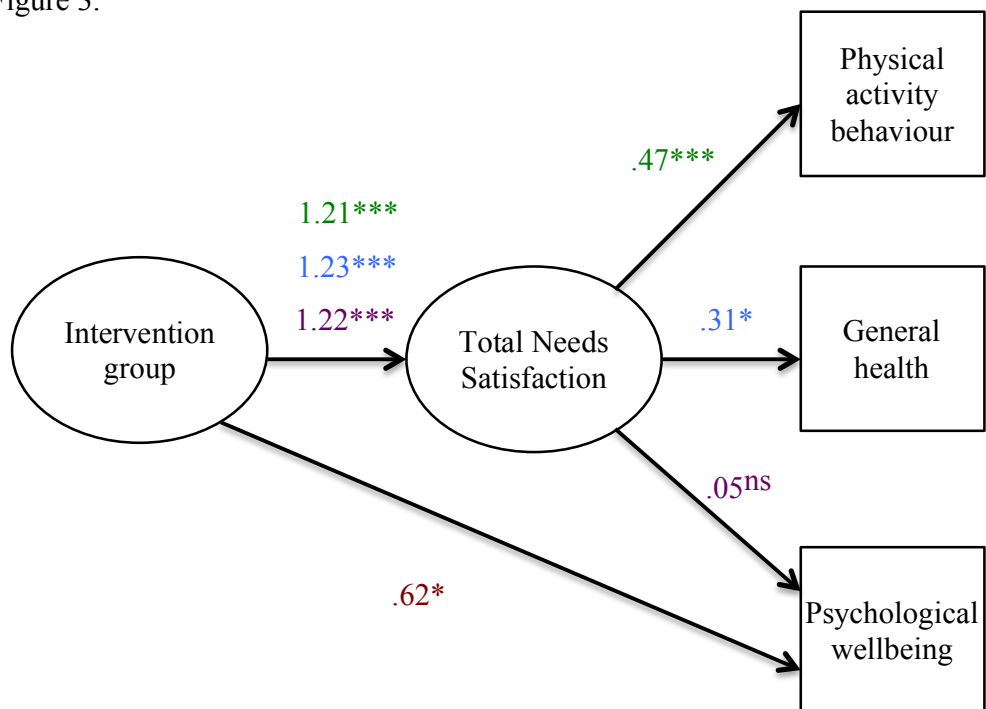
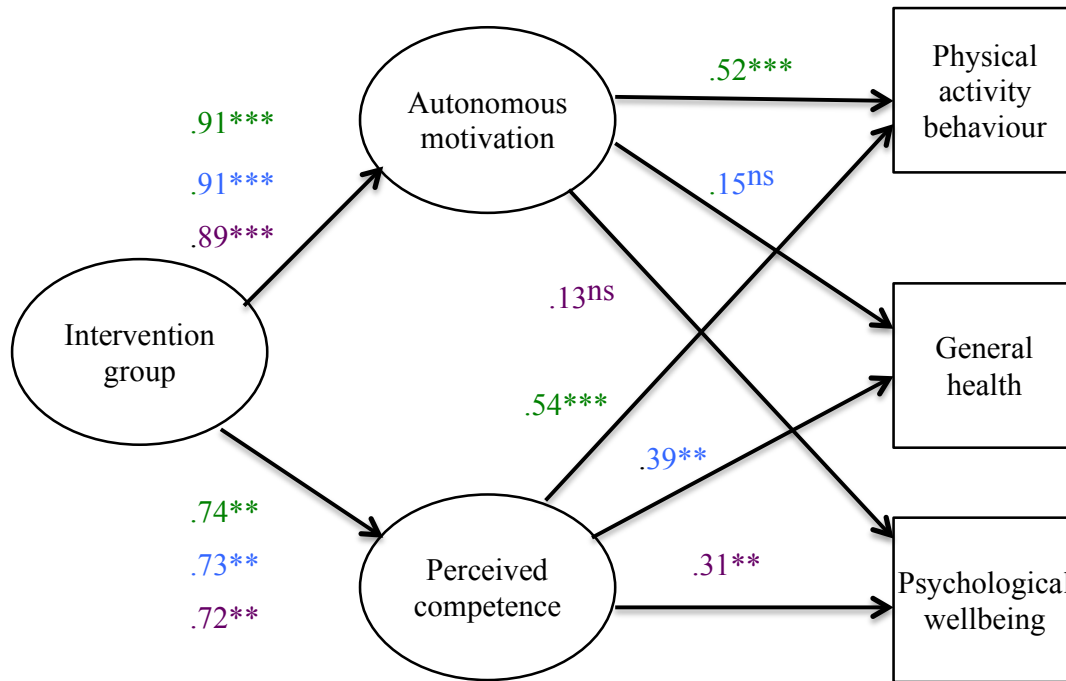


Figure 4.



THEORY AND METHOD

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1.0 Theory

1.1.0 Diabetes Mellitus type 2

1.1.1 Prevalence

In 2010 the prevalence of diabetes mellitus type 2 (DM2) was estimated to include 175,000 people in Norway, and a further 175,000 people who may have had the disease without knowing it (Helsedirektoratet, 2010).

1.1.2 Treatment

Favourable behaviour patterns for this group involve appropriate regulation of physical activity (PA), diet and blood sugar. PA can lower the blood sugar, blood pressure and obesity, and it prevents cardiovascular disease (Helsedirektoratet, 2010; Amundsen, Slørdahl, Ståhle, & Cider, 2009). Fritz and colleagues suggested that an increase of regular PA equivalent to 45 min of walking 3 days/week may suffice to improve systolic and diastolic blood pressure, lipid metabolism and BMI among patients with DM2 (Fritz, Wändell, Åberg, & Engfeldt, 2006). Diabetics should stabilize their blood sugar by a regular meal pattern including ingredients that give a slow rise in blood sugar and are rich in fibre, and insulin dosages must be adjusted in relation to the activity level and carbohydrate intake.

1.2.0 Cardiovascular disease

1.2.1 Prevalence

In 2010 cardiovascular diseases (CVD) caused 37% of all deaths in Norway (Statistisk Sentralbyrå, 2011), and CVD is the number one cause of death globally (WHO, 2011). Coronary heart disease and stroke are the most common CVD.

1.2.2 Treatment

CVD can be reduced by targeting risk factors, such as tobacco use, unhealthy diet, obesity, physical inactivity, high blood pressure and raised lipids (WHO, 2013). Individuals with CVD are advised to engage in regular PA and choose a diet rich in fruit and vegetables, as well as avoid foods that are high in fat, sugar and salt. Pharmacotherapy (blood thinning, cholesterol decreasing and beta blockers) and operative treatment may also be necessary.

1.3.0 DM2 & CVD

DM2 and CVD often occur together; the risk of heart attack or stroke is 3-4 times elevated for a person with DM2, and it is frequently detected DM2 among people with acute CVD (Østenson, Birkeland, & Henriksson, 2009). The Norwegian Directorate of Health recommends at least 30 minutes of moderate daily activity for both groups (Helsedirektoratet, 2010), and there is a dose-response relationship between PA and health benefit, meaning that an increase in intensity or time beyond the 30 min would provide additional positive health effects. The intensity should be adjusted to match the individual's health condition. To be effective in self-management of DM2 and CVD patients must both initiate and maintain the described favourable activities.

1.4 Lifestyle interventions

From a population perspective behavioural patterns are the strongest influences on health, far exceeding genetics, social circumstances, environmental exposures, and medical health care (Schroeder, 2007). Since human behaviour potentially can be controlled, it holds a great opportunity for improved health. Lifestyle interventions are the most cost-effective means to enhance management of DM2 and CVD, and the importance of diabetes self-management is so recognized that it has been proposed that self-care behaviours could be used as standard diabetes quality indicators (Glasgow, Peeples, & Skovlund, 2008).

1.5.0 Self-Determination Theory

Motivation encompasses self-regulatory processes involving in the selection, activation, and sustained direction of behaviour toward certain goals (Bandura, 1997). One of the theories that have been proposed to explain the processes of motivation and self-regulation of health behaviour is the process-oriented Self-Determination Theory (SDT). Self-regulation of DM2 and CVD are not an end point, rather it is a continuing process, and thus SDT's perspective might be appropriate in this context (Shigaki et al., 2010). The approach of this theory to the study of personal growth and development is both organic and dialectical (Ryan & Deci, 2004). The organic perspective involves that people are acting voluntarily and purposefully with a desire to actualize their potential. People themselves - regulates and initiates its actions. This is one side of the dialectical view, the second means that even if individuals are actively navigating their course through the environment "like trade winds and

currents, environments sometimes hinder, sometimes bolster, sometimes change the course of a developmental route" (Ryan & Deci, 2004, p. 390). According to the SDT-vision optimally functioning of an individual both influence and will be influenced by the social context.

1.5.1 Motivation and Autonomy

SDT has identified various forms of motivation for self-regulation of behaviour and grouped them along a continuum based on the extent they are self-determined (Deci & Ryan, 1985). One extreme is intrinsic motivation - a completely self-determined form of regulation. It involves execution of an action that the individual find pleasurable, satisfying and rewarding in itself. Deci & Ryan (2000) describes this by "intrinsic motivation involves people freely engaging in activities that they find interesting, that provide novelty and optimal challenge" (p. 235). Intrinsic motivation has been related to increased levels of PA and maintenance of behaviour (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997).

Among the four types of extrinsic motivation integrated regulation contains the highest degree of autonomy. The action harmonizes with the individual's philosophy of life and values (Deci & Ryan, 2000). Identified regulation occurs when the individual consider an act important in light of the instrumental effects it provides. Introjected regulation is a more enforced form of self-regulation. The individual initiates an action even though it doesn't comply with one's values. The motivation may be based on avoiding blame and shame (Ryan & Connell, 1989). External regulated behaviour is the most controlled form of extrinsic motivation and includes acting to avoid punishment or attain rewards. The other extreme is amotivation - the individual is not experiencing any form of motivation to perform an action.

Autonomous motivation implies that the patient has a clear understanding of their basic values and how one's habits stand in relation to these, and that the experience is a close relationship between values and habits. Intrinsic-, integrated- and identified regulations are motivational forms that encompass high levels of autonomy. When we use the term "autonomous motivation" in this study we refer to integrated- and identified regulations.

Controlled motivation is the term's counterpart, and it involves doing a task with a sense of pressure. External- and introjected regulations are the two forms of motivation that SDT consider to be controlled.

1.5.2 Autonomy support

The context whereas an individual initiate and regulate behaviour can appear autonomy supportive (i.e. promoting choice) or controlling (i.e. pressuring one toward specific outcomes). Autonomy support refers to the patient's experience of being given choices, understanding, encouragement, and being listened to. "Autonomy support has generally been associated with more intrinsic motivation, greater interest, less pressure and tension, more creativity, more cognitive flexibility, better conceptual learning, a more positive emotional tone, higher self-esteem, more trust, greater persistence of behaviour change, and better physical and psychological health than has control" (Deci & Ryan, 1987, p. 1024).

1.5.3 SDT and physical activity

Several studies have explored SDT in an exercise domain, and observed relations from autonomy support, motivational regulation, needs satisfaction, and perceived competence (PC), to health outcomes. For example, a study on cardiac rehabilitation patients showed that autonomy support was positively associated with PA level, and indirectly through autonomous motivation (Kubitz, 2010). Both autonomy support and autonomous regulation was positively correlated with subjective vitality. Another study on cardiac rehabilitation patients (Sweet, Tulloch, Fortier, & Reid, 2010) found that autonomous motivation was associated with higher levels of PA than controlled motivation, and that patients with controlled regulation more frequently than those with more autonomous motivation decreased their levels of PA over time. Russel & Bray (2009) observed that following cardiac rehabilitation psychological need satisfaction for competence predicted self-determined motivation to exercise, and that it was positively correlated with exercise frequency and duration. Vlachopoulos & Neikou (2007) highlighted the significance of the need for competence – they observed that exercise attendance at a fitness centre was predicted by satisfaction of this need. The need for competence also predicted membership of a dropout or adherer group. Russell & Bray (2010) found that autonomy support for exercise during cardiac rehabilitation was positively correlated with self-determined motivation for exercise, and that self-determined motivation predicted exercise volume and length of exercise session duration.

1.5.4 A macro theory of five mini-theories

SDT has gradually evolved into a macro theory consisting of currently 5 mini theories. Each sub theory constitutes an important part of the SDT-framework, and they are all coherent, organic, dialectical, and contains the assumption that people have inherent psychological needs.

1.5.4.1 Cognitive Evaluation Theory (CET)

CET, the first mini theory that was formulated, deals with the social environment's impact on individuals' intrinsic motivation. It suggests that intrinsically motivated behaviour allows individuals to feel autonomous and competent (Deci, Cascio, & Krusell, 1975). External rewards are assumed to have two important effects on this, they can change an individual's perception of the origins of behaviour, and they can change the perception of their own competence and self-determination. Rewards can affect the individual to gradually believe that he acts to receive them, and thus he no longer feels that the behaviour is intrinsically motivated, even though it might have been that earlier. This means that the reward must be expected for the significant adverse effects. Intrinsic motivation is believed to be supported or suppressed by significant others in their autonomy supportive or controlling behaviour. Autonomy support in an environment is proposed as a source of perceived autonomy and competence of the individuals in the context.

1.5.4.2 Organismic Integration Theory (OIT)

The human integration process involves that aspects of the self becomes more complex and related to each other, and related to aspects of the social world (Hodgins & Knee, 2002). People take in external regulations and integrate them with the conception of self. The extent to which this occurs depends on the experience of autonomy. The stronger regulation is internalized, the stronger it will provide a basis for self-determined behaviour.

1.5.4.3 Causality Orientations Theory

Causality Orientations Theory (COT) concerns individual differences in people's tendencies to be involved in self-determined behaviour. The theory assumes that people have relatively fixed characteristics in the way they govern their actions. Regulations can be informative, controlling or amotivating. Individual orientations

includes autonomy, control and impersonal. The informative events are the ones that facilitate self-determined behaviour (Deci & Ryan, 1985). Controlling events enhances extrinsic motivated and controlled behaviour. Amotivation undermines all forms of behaviour (Deci & Ryan, 1985).

1.5.4.4 Basic Psychological Needs Theory (BPNT)

The concept that people have basic psychological needs forms a strong foundation for SDT, and this is explained by the BPNT. The mini-theory was designed to provide a universal explanation of how motivation and goals relate to health and wellness. A basic need is “an energizing state that, if satisfied, conduces toward health and well-being but, if not satisfied, contributes to pathology and ill-being” (Ryan & Deci, 2000a, p. 74). Needs give goals their psychological potency and influence which regulatory processes that direct people’s goal pursuit” (Deci & Ryan, 2000) By this, SDT can provide understanding of both goal-directed behaviour and psychological development and well-being. It is specified that all individuals, regardless of age, gender and culture, possess the need to experience autonomy, competence and relatedness. Needs represent “part of the common architecture of human nature” (Deci & Ryan, 2000, p. 252).

Satisfaction of the SDT needs provides the nourishment for psychological growth, integrity and well-being (Ryan, 1995). Should they be undermined, it is argued that controlled motivation forms can regulate the individual, and it will not be able to function optimally in context. The psychological needs constitute a useful basis for describing characteristics in an environment that can promote or inhibit individuals in taking an active engagement.

The need for autonomy refers to self-determination over own actions. This should not be confused with independence or detachment. Autonomy is the feeling of volition, and it can accompany both dependent and independent acts (Ryan & Deci, 2000a). The need appears somewhat different in different cultures, as an autonomous action can be performed to achieve collective as well as individual goals. What is important is the experience of the desire and the initiation of an action comes from the individual himself. No matter how little the culture and the individual value individuality, the need is always present, and if it is not satisfied results can be negative effects on motivation and wellness. When individuals are autonomous, they

experience themselves as valuable by virtue of being themselves, rather than basing their self-worth on specific actions or how they appear (Hodgins & Knee, 2002).

The need for competence refers to “the desire to interact effectively with the environment” (Vallerand, 2004, p. 427). It derives from the human inherent nature to seek challenges to develop. People are more likely to adopt and internalize a goal if they believe they have the relevant skills to succeed at it (Ryan & Deci, 2000b). PC is considered necessary for all forms of self-regulation (Deci & Ryan, 2000). Consistent with the flow theory (Csikszentmihalyi, 2008), Deci and Ryan (2000) emphasize that challenges should be optimally adapted to the athlete’s abilities to stimulate growth. A challenge too hard may lead to anxiety and disengagement, and a task too easy may be the source of boredom and alienation. Optimal challenges hold the opportunity of the experience of flow – total absorption in an activity and the non-self-conscious enjoyment of it (Deci & Ryan, 2000). The purpose of the activity becomes the activity itself, and by this it is truly intrinsically motivated.

The need for relatedness refers to the need all people have to build interpersonal relationships and feel acceptance in a group. Deci and Ryan (2000) consider relatedness as an important need, but that it is subordinate to autonomy and competence, as people often engage in self-starting behaviour that does not contain this element (like playing solitaire and go walking in the woods alone). Ryan & Deci (2000b) argued that the primary reason people initiate extrinsically motivated behaviours is because they are valued by significant others. Thus, by facilitating a sense of belongingness to the person or group disseminating a goal might generate internalization of the goal.

1.5.4.5 Goal Contents Theory

The latest addition to the mini-theories is the GCT that describes how goals affect motivation and well-being. Extrinsic and intrinsic goals are differently related to the satisfaction of needs, and they will give different effects on the regulation and function. The argument implies that a greater emphasis on intrinsic goals will promote greater satisfaction of needs and hence increased well-being (Rijavec, Brdar, & Miljkovic, 2006). Extrinsic goals are believed to have no positive correlation with well-being (Deci & Ryan, 2000).

1.5.5 Well-being

“Subjective well-being” (SWB) has been defined as “a person’s cognitive and

affective evaluations of his or her life” (Diener, Lucas, & Oishi, 2005, p. 63). Thus, it is a broad concept that both include emotional reactions to events (experiencing pleasant emotions and low levels of negative moods) and cognitive judgements of satisfaction and fulfilment. WHO clearly states that well-being is a significant component of health through their definition of health as “A state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity” (1998, p. 1). They further emphasize that “to reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and realize aspirations, to satisfy needs, and to change or cope with the environment” (2009, p. 1). The relation between subjective well-being and health depends on whether the health measurements assessed are objective ratings or self-reported. Self-reported health correlates positively with subjective well-being, but weakly with objective health rating (Diener et al., 2005). Rather than based on objective circumstances, well-being seems to be dependent on the way people perceive the world. Early research on SWB focused on its relation to demographic variables, but we now know that although some demographic factors, such as age, gender, and income, are related to SWB, these effects are small (Diener et al., 2005). A review of research on SWB (Diener, Suh, Lucas, & Smith, 1999) concludes that the happy person is most likely one with a positive temperament, who tend to look on the bright side of things, does not ruminate excessively about bad events, is living in an economically developed society, has social confidants, and possesses adequate resources for making progress toward valued goals. They acknowledge though that, because of the rapidly progress of research on the area, this description will be changed.

According to SDT engaging in autonomous regulated activity can maintain and enhance subjective well-being, relative to engaging in more controlled activity (Nix, Ryan, & Manly, 1999). Satisfaction of the needs also result in increased vitality and well-being (Teixeira, Carraca, Markland, Silva, & Ryan, 2012) For example, a study of 410 adult exercisers (Sebire, Standage, & Vansteenkiste, 2009) observed that psychological need satisfaction was a positively predictive of well-being and physical self-worth while being negatively predictive of exercise anxiety. Vitality, a component of PWB, is an experience of being enthusiastic, alive, and having physical and mental energy available to the self (Ryan & Frederick, 1997), and it affects our

behaviour and objective health outcomes. When vital we are more active and productive, and we cope better with stress and the challenges we meet. Ryan & Deci (2008) argued that controlled self-regulation drain psychological energy and vitality whereas acts based on autonomous motivation do not. Reinboth, Duda & Ntoumanis (2004) found that among young athletes in a coaching setting satisfaction of the need for autonomy was a positive, but weak, predictor of subjective vitality and intrinsic satisfaction. Satisfaction of the need for competence emerged as strongly linked to the two indices of PWB, and they concluded it was the most important predictor of psychological and physical well-being. On the other hand, satisfaction of the need for relatedness did not predict any of the components of PWB. SDT argue that all the three needs are independently necessary for self-fulfillment; thus, each need provides a unique prediction of well-being (Church, et al., 2012). In a study on college students across 8 cultures (Church, et al., 2012), this was tested, and results revealed that in each culture generally one or two, but not all three, SDT needs provided unique prediction of well-being. Consistent with SDT they found that satisfaction of SDT needs was moderately related to most aspects of well-being in all cultures. They did not find significant cultural differences in the impact of SDT needs on well-being.

2.0 Objective

There are to my knowledge no clinical trials that have tested the self-determination theory in an exercise domain with participants that all have both DM2 and CVD. This study explored how participation in a PA intervention and needs satisfaction is related to motivational regulation, behavioural outcomes and psychological well-being (PWB). First, regarding the experimental effects it was hypothesized that participation in an organized weekly exercise group, relative to a non-exercise control group, would increase the exercisers' perceived autonomy support and needs satisfaction in PA, increase their autonomous motivation and PC for PA, increase their PA behaviour, as well as lead to increases in their general health and PWB. Second, regarding the SDT process model it was hypothesized that the intervention would positively predict increases in needs satisfaction, which would positively predict changes in autonomous motivation and PC, which both, in turn, would predict increases in PA behaviour, health, and well-being.

3.0 Method

3.1 Study Design and Intervention

The study was part of a clinical trial that took place at Ullevaal University Hospital from August 2010 to March 2013. Participants were randomized into an exercise- and a control group. The intervention group participated in a 12-month exercise program developed in collaboration with the Norwegian School of Sport Sciences (NSSS). They were offered group-based instruction twice per week, each workout lasting 60 minutes. The workouts took place at NSSS, both indoors and outdoors. Indoor training consisted of circuit training with different stations focusing on strengthening the major muscle groups in the body, as well as endurance. In addition, there were regular spinning classes. Pure strength training in the weight room was offered for those who preferred it. In summertime one of the weekly training sessions was held outdoors, focusing on interval training (walking/jogging uphill). It was desirable that the participants in the exercise group also trained once a week on their own, so that the total training volume reached a minimum of 150 minutes per week. There were no specific guidelines for the type of self-training that was conducted, participants could choose an activity they wanted to engage. Exercise intensity should be between moderate to intense. It was made occasional pulse records during organized training. All participants were encouraged to keep a training diary and deliver this regularly to instructors. There were two instructors, with a master degree in sport science from NSSS, present at almost all organized sessions, which gave the opportunity for individual monitoring of participants when necessary. There was arranged 2 x 2 training sessions per week, so that participants had some choice when it came to training times. For some participants, it was still difficult to participate in group trainings as they were held at daytime. It was therefore "accepted" that some participants only exercised on their own, if it was considered likely that they would conduct the exercise. A questionnaire was distributed to the participants at baseline before training (T1) and after the training period (T2).

3.2 Data Acquisition

The data collection took place at Ullevaal University Hospital from August 2010 to March 2013. Former NIH master student Marit B. Viestad, doctor Rune Byrkjeland and myself, Jeanette Healey, handed out the questionnaires. We only gave brief practical information on how to fill out the survey and explained what was

meant by the term "health-team". With few exceptions, the participants took the questionnaire home to fill it out and handed it to the doctor at the next meeting. All participants filled out the first questionnaire before they were randomized to control- or experiment group. Of the patients who answered the questionnaire on baseline (65%, $n=89$), 70.8% ($n=63$) answered after one year.

3.3 Participants

3.3.1 Inclusion Criteria

137 participants were recruited from the ASCET-study (Aspirin non-responsiveness and Clopidogrel clinical Endpoint Trial) that was conducted by the same research group that performed this research project "Physical fitness in people with coronary artery disease and type 2 diabetes." All participants included had both stable CVD and DM2. They were of both genders aged 41-81 years.

3.3.2 Exclusion Criteria

Persons with the following characteristics were excluded from the study:

- Severe diabetic retinopathy, nephropathy or neuropathy
- Unstable angina, decompensated heart failure, severe ventricular arrhythmia, severe valvular heart disease, aortic-aneurysm, deep vein thrombosis, pulmonary embolism, stroke or mitral insufficiency in the last 3 months.
- Cancer, arthritis, COPD, muscular-skeletal disorders, persistent infections, and other serious diseases.
- Already in training more than 2 times a week.

3.3.3 Background variables

The demographic data on participants includes gender and age and is taken from EXCADI study.

3.4 Measurements

Perceived Autonomy Support for Physical Activity (T1 and T2). Measured with the 6-item version of the Health-Care Climate Questionnaire (Williams, Grow, Freedman, Ryan, & Deci, 1996). A sample item is: "I feel that my health team has provided me choices and options in relation to my physical activity." Responded to on a 1 (strongly disagree) to 7 (strongly agree) scale, this measure indexed whether the

intervention increased patients' perceptions of autonomy support. The 6 items were averaged to reflect autonomy support for PA.

Basic Psychological Needs Satisfaction in Exercise (T1 and T2) was measured with the Basic Psychological Need Satisfaction in Exercise Scale (Vlachopoulos & Michalidiou, 2006). It consists of 12 items intended to measure satisfaction of the 3 basic needs for competence, autonomy, and social relatedness with 4 items each. Participants responded to the items following this stem: "When you exercise, how untrue or true are the following statements?" Sample items are: "I feel that I associate with the other exercise participants in a very pleasant way" (relatedness need), "I feel that I can manage with the requirements of the training program I am involved" (competence need), and "I feel that the way I exercise is definitely an expression of myself" (autonomy need). The 4 items for each need were averaged to reflect relatedness, competence, and autonomy needs satisfaction, and the sum of the three needs was termed total needs satisfaction. The participants indicated how true each item was for them on a 7-point scale varying from 1 (*not at all true*) to 7 (*very true*).

Autonomous Motivation for Physical Activity was measured with the 12-item Treatment Self-Regulation Scale (TSRQ) for PA (Levesque et al., 2007) somewhat modified to fit the context of the present study. Participants responded to the items following this stem: "I am physically active: ... ". Sample items are: "because it feels natural for me to do it" (integrated regulation) and "because I want to take responsibility for my own health" (identified regulation), responded to on a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*). The 12 items were averaged to reflect autonomous motivation for PA.

Perceived Competence for Physical Activity was measured with the Perceived Competence Scale (PCS), previous used in diabetes self-care studies (Williams, Freedman, & Deci, 1998) and learning among medical students (Williams & Deci, 1996). Participants responded to 4 items on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale. Each item asked the participants how skilled or effective they felt in carrying out their exercise. An example item is: "I feel confident in my ability to be regularly physically active". The items were averaged to reflect PC for PA.

Physical Activity Behaviour was measured with the 10-item Effort and Quality of Performance Scale adapted to exercise from Kuvaas (2006). A sample item is: "I try to exercise as well as possible". Participants responded on a 7-point scale ranging

from 1 (*does not suit me at all*) to 7 (*suits me very well*). The items were averaged to reflect PA behaviour.

General health was measured with 4 questions. The first 2 questions are from SF-36 (Ware & Sherbourne, 1992). Sample item: “How would you say your health is now?” The third and fourth question is from a Swedish study (Femia, Zarit, & Johansson, 2001). Sample item: “How would you evaluate your health in relation to others of your own age?” Participants responded to the questions on a 5-point scale ranging from 1 (*bad*) to 5 (*excellent*). The items were averaged to reflect self-rated general health.

Well-being (T1 and T2) was assessed with scales measuring life satisfaction, vitality, positive affect, and negative affect. Life satisfaction was measured by the 5-item Satisfaction With Life Scale (SWLS) developed by Pavot and Diener (1993). Responses were given to statements like “I am happy with my life”. To measure the respondents’ physical and mental vitality, aliveness and vigor, the Subjective Vitality Scale (SVS) was applied. The scale consists of 6 items and was developed by Ryan and Frederick (1997). A sample item is: “I feel alive and vital”. These two scales were administered with the instruction: “Please respond to the following statements by indicating the extent to which the statement is true for you in general in your life” using a 7-point scale with anchors 1: Not at all true, and 7: Very true. The positive affect and negative affect scale (PANAS) developed by Watson, Clark & Tellegen (1988) was applied to measure the respondents mood or affect. In the present study 6 items was administered for each of the two types of affect with the instruction: “To what extent have you experienced the following mood during the last 4 weeks?” Sample adjectives are “excited” and “strong” for positive affect and “stressed” and “nervous” for negative affect. Each mood adjective was responded to by using a 7-point rating scale ranging from 1: Not at all to 7: Very much. Well-being was estimated by subtracting the average score of negative affect from the sum of the average scores of life satisfaction, vitality, and positive affect.

3.5 Statistical analyses

The hypotheses were tested by statistical analyses in PASW Statistics 20.0. Change variables were calculated by linear regression analysis. Cronbach’s alpha was used as an internal consistency estimate of reliability of test scores on each item. We explored correlations between change variables, using Pearsons’ bivariate correlation,

to determine the strength and direction of linear relationships. Multiple regression analysis was used to assess which independent variables affected the dependent variable, and we applied that to path analysis on basis of the theory (figure 2). We used MANOVA and several repeated measures one-way ANOVA tests to analyse the differences between group means. Effect sizes (ES) of the interaction time-intervention were calculated by using equation 8 in Morris (2008). ES for each group were calculated by using equation 4 in Morris & DeShon (2002). Medium ES represent an effect likely to be visible to the naked eye of the observer, small ES is still larger than a trivial effect, and large ES is set to the same distance over medium as small was below it (Cohen, 1992). We examined total and specific indirect relationships of X on Y by multiple mediation using bootstrapping. In this process we used the macro INDIRECT (Preacher & Hayes, 2008). The results were presented as path models (figure 3 & 4). Missing data were replaced using mean substitution combining main effects of items and subject (Roth, Switzer, & Switzer, 1999). The formula we used for imputation was: (the subject's mean of responded items in the same scale + mean of the particular missing item across individuals) / 2. Subjects responding to less than 50% of the items in each scale were omitted from analyses involving that variable.

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