

## TITLE PAGE

### Title:

**THE “ROMSÅS IN MOTION” COMMUNITY INTERVENTION: MEDIATING EFFECTS OF PSYCHOSOCIAL FACTORS ON FORWARD TRANSITION IN THE STAGES OF CHANGE IN PHYSICAL ACTIVITY.**

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## **The “Romsås in Motion” Community Intervention: mediating effects of psychosocial factors on forward transition in the stages of change in physical activity.**

### **Abstract**

This study examines whether a community-based physical activity intervention influenced movement in stages of change in physical activity in an adult population, whether any such effect was mediated by psychosocial influences, and whether any such mediations were moderated by socio-demographic or anthropometric factors. The three year long pseudo-experimental intervention (intervention; n= 616, mean age= 49.4 ± 9.9 years, control; n= 565, mean age= 49.1 ± 9.0 years) included physical activity, communication, environmental and participatory components. Stages of change in physical activity and potential psychosocial mediators were assessed by questionnaires. Regression analyses revealed a significant favourable intervention effect on stages of change, partially mediated by enhanced support from family, perceived control, and physical activity identity. No moderation effects by gender, age, ethnicity, education or BMI were observed. Support from family, perceived control, and identity might be important intervention target points for inducing forward movement in the stages of change in physical activity, regardless of socio-demographic and anthropometric background factors.

Key words: intervention, physical activity, psychosocial mediators, socio-demographic and anthropometric moderators

## **Introduction**

Intervention programs aimed at initiating and maintaining physical activity behaviour in adults have produced mixed results (Kahn et al., 2002). Researchers have proposed that interventions may be more effective if they are based on theoretical and empirical research on behaviour change (Sallis & Owen, 1999). Testing the hypothesized mediators of such interventions might improve our understanding of why some interventions are effective and others not, which might further improve theories and interventions (Bauman, Sallis, Dzewaltowski, & Owen, 2002).

The stages of change framework by Prochaska and DiClemente (1983) has successfully been applied in the understanding and prediction of physical activity behaviour (Marcus & Forsyth, 2003). According to the model, individuals move through several stages in their effort to adopt and maintain physical activity: Precontemplation (not intending to change behaviour), Contemplation (intending to change behaviour), Preparation (making small changes in behaviour), Action (actively engaging in the new behaviour), and Maintenance (sustaining the behaviour change over time). Individuals are thought to progress through these stages at varying rates, with some remaining stable for prolonged periods, others progressing and some relapsing to previous stages. Hence, the model emphasizes the dynamic nature of physical activity behaviour, and includes both behavioural change and psychological preparation of behavioural change. Even though some researchers have raised concern about the use of the stages of change construct as a proxy for physical activity change (e.g., Adams & White, 2005), early stage progression has been emphasized as important as it might improve the likelihood of subsequent changes in behaviour (Brug et al., 2005). Thus, it seems useful to include the stages of change construct as a behavioural outcome measure in physical activity promoting interventions.

Several psychosocial variables have been found to relate positively to stages of change in physical activity. Among these are self-efficacy beliefs, social support, attitude, and perceived behavioural control (Courneya, Plotnikoff, Hotz, & Birkett, 2000; Lorentzen et al., in press). Recently, researchers have pointed out that there may be a mutually reinforcing relationship between peoples` role-identity as physically active persons and their physical activity behaviour (Anderson & Cychosz, 1995). It is argued that acting out some aspects of the role as a physically active person (e.g., reading and talking about physical activity, making plans for physical activity, walking the stairs, playing a tennis game) may, through social interaction, reinforce and validate ones` identity related to physical activity. This validation may in turn increase the likelihood of engaging in more physical activity-related activities. Several studies have found a positive relationship between physical activity identity and the stages of change in physical activity (Anderson, 2004; Lorentzen et al., in press), and with self-reports of moderate intensity physical activity (Jackson, Smith, & Conner, 2003). These psychosocial correlates may act as mediators of transition in the stages of change in physical activity (Lewis, Marcus, Pate, & Dunn, 2002). A mediator can be defined as “an intervening causal variable that is necessary to complete a cause-effect pathway between an intervention and physical activity” (Bauman et al., 2002, p. 5). Hence, intervention activities may induce forward movement in the stages by positively influencing these psychosocial variables. Several authors have proposed that hypothesized mediators of interventions should be specified and mediator analyses reported (e.g., Baranowski, Anderson, & Carmack, 1998). To our knowledge, no study so far has examined whether the current set of psychosocial variables mediate transition in stages of change in physical activity in a community-based physical activity intervention. Mediators should also be measured across population subgroups such as age and gender, as these variables may be moderators of intervention-

mediator-outcome relationships (Lewis et al., 2002). For example, social support for physical activity may have a stronger influence on women than men (Sallis & Owen, 1999).

Additionally, most studies on potential physical activity mediators are from programs of relatively short duration (e.g., Miller, Trost, & Brown, 2002), and longer-lasting interventions would increase the possibility of demonstrating mediation in physical activity behaviour change (Baron & Kenny, 1986). Further, multi-strategic programs have been proposed as necessary to increase physical activity behaviour in a population (Sallis & Owen, 1999). Lately, several community-wide campaigns involving many community sectors and broad-based, multiple intervention approaches have been shown effective in increasing physical activity behaviour (Kahn et al., 2002). For instance, a community-based intervention promoting walking among sedentary 50- to 65-year-olds through paid media, public relations, and public health activities (Wheeling Walks) significantly increased the number of walkers and the number of persons meeting the physical activity recommendations, and produced a significant positive change in stages of change in physical activity (Reger et al., 2002). Programs should also involve members of the target group to inform program components and to tailor these to the specific needs and interests of the target groups (Campbell & Jovchelovitch, 2000). Generally, individuals in the early stages may need informational inputs if they are to progress, individuals in the middle stages may need available physical activity arenas/opportunities and behaviour change skills to establish regular habits, while individuals in the highest stages may need to learn cognitive and behavioural techniques to avoid relapses (Marcus & Forsyth, 2003). Indeed, several stage-based interventions have been successful in increasing stages of readiness for exercise (e.g., Marcus et al., 1998). We have already reported favourable significant changes in physical activity and several biological health-related parameters from the community-based intervention from where the current data are drawn (Jenum et al., 2006).

The purposes of the present study were to examine a) whether this three-year-long community-based physical activity intervention influenced transition in stages of change in physical activity in an adult population, b) whether psychosocial influences mediated an eventual transition in stages of change, c) whether socio-demographic and anthropometric factors moderated an intervention effect on stages of change and moderated psychosocial mediating influences, and d) whether current mediation results could be validated by using self-reported strenuous physical activity as the intervention outcome measure.

## **Methods**

### ***Design and procedure***

The “Romsås in Motion” study, set up to implement and evaluate a 3-year-long pseudo-experimental community intervention promoting physical activity in an urban adult population to reduce the burden of type 2-diabetes and cardiovascular disease, provided data for the present study. The study was initiated by the local health authorities, and the control population was selected from a similar neighbouring community without common borders to reduce the potential for contamination between groups. Study design, baseline results, and main outcomes have been published elsewhere (Jenum et al., 2006; Jenum et al., 2003; Lorentzen et al., in press). Pre- and post- intervention surveys in the two suburban communities in Oslo in year 2000 and 2003 included a physical examination encompassing height and weight measurements and the collection of venous blood samples, and one questionnaire (Q1) assessing socio-economic and health status and health-related behaviours, including physical activity participation. Another detailed questionnaire (Q2), which was returned by post and therefore resulted in a lower response rate, included the stages of change construct and psychosocial mediators of change in physical activity. Questionnaire data and Body Mass Index (BMI) were used in current analyses.

## ***Participants***

All individuals between 31 and 67 years in the intervention community (n= 2955) and a representative population sample of similar size, age and gender from the control community (n= 3185) were invited to the baseline health survey. These communities had high mortality rates, poor health status, high physical inactivity rates, low socio-economic status, and a high proportion of non-Western immigrants (Rognerud & Stensvold, 1998). Two thousand nine hundred and fifty (48%; intervention= 50.7%, control= 45.6%) attended the baseline health survey and filled in Q1. Of these, 2336 (79.2%; intervention= 80.4%, control= 77.9%) filled in Q2 providing data on the outcome and potential mediating variables for the present study. Based on registry information of the invited cohort from Statistics Norway, those who attended the baseline health survey had a slightly higher socio-economic status than the non-attendees (Jenum et al., 2003).

Of those who filled in both Q1 and Q2 at baseline, 2113 (intervention= 1089, control= 1024) were alive and still living in the Oslo area in 2003 and were re-invited to follow-up measurements. From this group, 1485 (intervention= 755, control= 730) attended, and 1181 (intervention= 616, control= 565) provided follow-up data from Q2 on outcome variables and were included in the analyses of the present study. This represented an attrition rate from baseline (based on those who were re-invited) of 44.1% (intervention= 43.4%, control= 44.8%).

## ***Intervention***

The intervention aimed at generating a forward transition in stages of change by influencing the following potential psychosocial mediators: social support, self-efficacy, attitudes, perceived control, and identity. The intervention contained four main components:

- 1) *Physical activity programs:* Low-threshold physical activity programs were developed based on suggestions from and in collaboration with the residents of the community (Campbell & Jovchelovitch, 2000). The activities comprised a number of weekly sessions of outdoor walking groups and of indoor aerobic exercise programs conducted by exercise leaders, a dance course, as well as a test of physical fitness twice a year. The programs were all located in the neighbourhood, were free of charge, were of low- to moderate intensity and focused on the enjoyment of physical activity. These activities were expected to promote social support for physical activity, to foster modelling of physical activity by others, to enhance self-efficacy and perceived control over physical activity participation, to generate positive attitudes towards physical activity, and to develop and reinforce people's physical activity identity (Ajzen & Madden, 1986; Anderson & Cychosz, 1995; Bandura, 1986).
- 2) *Communication strategies:* A range of communication efforts were developed and implemented to 1) promote the physical activity programs and 2) communicate information about physical activity and health. Information about health-enhancing physical activity recommendations, weighing the costs and benefits of becoming more active, identifying and overcoming potential barriers to physical activity participation, correcting misconceptions about physical activity and exercise, and encouraging everyday life activities was included. A number of channels and settings were employed; local television, radio, newspapers, posters, stage-based and ordinary brochures, direct mailings, stands, lectures etc. The communication strategies were anticipated to enhance self-efficacy and perceived control over physical activity participation, generate positive attitudes towards physical activity, increase support from family and friends for being physically active, as well as to develop and reinforce physical activity identity (Ajzen & Madden, 1986; Bandura, 1986).



- 3) *Environmental strategies*: In accordance with social-ecological models (Sallis & Owen, 1999), several initiatives were implemented to increase access to physical activity arenas in the local environment and thereby foster self-efficacy and perceived control over physical activity participation: labelling of walking paths in the community and improved street lighting, snow clearing and gritting of pavements and walking paths during the winter season.
- 4) *Participatory strategies*: The intervention was based on participatory approaches (Campbell & Jovchelovitch, 2000), including and integrating local political and lay leaders as well as local health and welfare workers in the planning and implementation of intervention strategies. Furthermore, the project was incorporated in the strategic plans of the community, thereby fostering the councils' commitment to and involvement in the project. These initiatives were expected to foster feelings of empowerment and intervention ownership and strengthen physical activity identity (Anderson & Cychosz, 1995; Campbell & Jovchelovitch, 2000).

The multiple strategy approach was designed to reach individuals at different stages of readiness to adopt and maintain physical activity. In general, communication strategies emphasizing the topic of physical activity and health aimed at enhancing attitudes towards, and thereby motivational readiness for physical activity, among individuals in the first stages of change. The physical activity programs and the environmental strategies targeted people already motivated to increase their physical activity (Marcus & Forsyth, 2003).

In addition to these population-based intervention strategies, individuals with type 2 diabetes or cardiovascular diseases, or who were at high risk for these diseases, identified through the baseline medical examination (n= 78), were offered medical follow-up and individual and group counselling on physical activity, diet and smoking during the

intervention period. Persons with the same risk profile in the control group (n= 50) were remitted to usual care.

## ***Measurement***

### *Stages of change in physical activity*

Stages of change in physical activity were measured using an instrument developed by Prochaska and Marcus (1994). The stages were assessed using a scale of five categories labelled as: 1) “I am currently not physically active and I do not intend to engage in physical activity in the next 6 months” (Precontemplation), 2) “I am currently not physically active, but I am thinking about getting more physically active in the next 6 months” (Contemplation), 3) “I currently do some physical activity, but not regularly” (Preparation), 4) “I am currently regularly physically active, but I have only begun doing so within the last 6 months” (Action), and 5) “I am currently regularly physically active and have done so for more than 6 months” (Maintenance). Respondents were asked to think of all physical activity except work-related activity when choosing a response category. No definitions of physical activity regularity, intensity, and frequency were given. The psychometric properties of the stages of change measure have been reported elsewhere (Lorentzen et al., in press).

### *Psychosocial mediators*

The following potential psychosocial mediators of movement in stages of change in physical activity were measured: social support, self-efficacy, attitude, perceived control, and identity. Measurement descriptions of these variables are summarized in Table 1. All scales were derived or modified from previously developed and validated scales (see Table 1), and additional exploratory factor analyses were performed. Baseline results revealed a two-factor solution for the self-efficacy and attitude scales (Lorentzen et al., in press). To test the

consistency in factor structures, principal components analyses were also performed at follow-up. A similar component structure as at baseline was found for all measures except for social support from friends, where a two-factor solution was found. Because no clear differences in factor contents for this variable were observed, we decided to proceed with the same one-factor solution for friend support as found in the baseline data set. The mean score of all belonging items was computed for each scale/subscale at both time points, including participants with a response rate of 75% or greater on the respective items (Van Sluijs, Van Poppel, Twisk, Brug, & Van, 2005). Higher scores indicated a greater psychosocial readiness for physical activity. Generally, internal consistency properties were found satisfactory (see Table 1).

#### *Socio-demographic and anthropometric variables*

Data on gender, age, and country of origin were available for the invited cohort from Statistics Norway. Subjects born in Western Europe, North America, Australia and New Zealand were categorized as Western. Years of education was self-reported. BMI was calculated from the measured weight in kilograms and height in meters squared ( $\text{kg}/\text{m}^2$ ).

#### *Strenuous physical activity*

A measure assessing self-reported weekly strenuous physical activity (“producing sweating or breathlessness”) in leisure and commute time categorized in the following groups: none, <1 hour, 1-2 hours and  $\geq 3$  hours (Jenum et al., 2006), was included in analyses performed to validate current mediation results.

#### *Statistical analyses*

Independent sample T-tests and chi-square tests were used to assess group differences. Change scores on each potential psychosocial mediator and on stages of change were calculated by subtracting the pre-test score from the post-test score. Accordingly, positive values reflected an increase, and negative values reflected a reduction in the outcome measure. Between 5.8% and 23.4% of the participants were not included in the change score calculations of psychosocial variables as the criteria for being included in the mean score calculations (75% item response rate) were not met at one or both time points.

### *Mediation analyses*

According to Baron and Kenny (1986), four conditions should be met to demonstrate a mediation effect: 1) the intervention affects the outcome, 2) the intervention affects the hypothesized mediator, 3) change in the hypothesized mediator is associated with change in the outcome, and 4) the effect of the intervention on the outcome is attenuated when controlling for change in the hypothesized mediator. The higher the attenuation of the effect, the more potent is the mediator (Lewis et al., 2002).

A series of regression analyses were therefore conducted. First, change in stages in physical activity was regressed on condition to examine the effect of the intervention on the stages of change construct (Regression equation 1). Second, changes in the hypothesized mediators were regressed on condition to test the effect of the intervention on these variables (Regression equations 2). Third, change in stages of change was regressed on both condition and changes in hypothesized mediators (Regression equations 3), exploring a) the relationship between changes in the hypothesized mediators and change in stages and b) the effect of the intervention on stages of change adjusted for change in the hypothesized mediators. Analyses 2 and 3 were performed separately for each psychosocial variable. All analyses were adjusted for baseline differences in education and BMI. When results from Regression equations 1, 2,

and 3a were significant in the predicted direction, and the effect of the intervention on stages of change was attenuated in the third (equation 3b, being controlled for changes in hypothesized mediators) compared to the first equation, the psychosocial variable was regarded to act as a mediator (Baron & Kenny, 1986).

In the additional analyses to validate the mediation results using a measure of self-reported weekly strenuous physical activity, Pearson's correlation coefficient was first calculated for the relationship between change in stages and change (post-test score – pre-test score) in strenuous physical activity. Second, to examine the effect of the intervention on the physical activity measure and the potential psychosocial mediation influences on this effect, the same series of regression analyses were performed with change in strenuous physical activity as the outcome variable, adjusted for baseline BMI and education level.

The significance level was set at  $P < 0.05$ . Although the risk for making a type I error (incorrectly declaring a statistical significance) increases with multiple testing, the significance level was not adjusted for multiple comparisons for reasons outlined by various authors (e.g., Feise, 2002; Perneger, 1998). One of the main arguments forwarded by these authors is that such adjustments imply that a given comparison will be interpreted differently depending on the number of other tests performed, which is not considered appropriate. Moreover, such corrections increase the likelihood of making type II errors (the error of failing to observe a difference when in truth there is one). As there is no consensus on how to deal with the problem of multiplicity, and one do not know if correction will give the correct conclusion, it has been recommended not to adjust for multiple comparisons but to still interpret the results in the light of the increased chance of making a type I error (Feise, 2002; Perneger, 1998).

The number of cases available for each analysis varied between 761 and 1181 due to missing data. All analyses were performed with the Statistical Package for the Social Sciences (SPSS) (version 12.0).

## **Results**

### ***Sample characteristics***

To assess the impact of selection, we compared baseline values on socio-demographic characteristics, the distribution in stages of change in physical activity, and the potential psychosocial mediators for the study cohort with those who were re-invited but did not provide data at the follow-up survey (see Table 2). In the intervention group, those who attended both surveys were fairly representative of the study population at baseline, but were more likely to be older (3.7 years,  $p<0.001$ ), more educated (0.6 years,  $p=0.012$ ), and of Western origin ( $p<0.001$ ). The same was observed in the control group, as well as a slight selection of more people in the higher stages of change ( $p<0.001$ ), expressing more self-efficacy in the face of psychological barriers ( $p<0.001$ ), more positive evaluative attitudes ( $p=0.023$ ), higher perceived control ( $p<0.001$ ), and stronger physical activity identity ( $p=0.004$ ).

Further analyses on those included in the present study revealed that intervention participants were less educated ( $p<0.001$ ), had a higher BMI ( $p=0.049$ ), were more likely to be in the lower stages of change ( $p=0.040$ ), and reported more unfavourable values on support from family ( $p=0.003$ ), on self-efficacy faced with psychological barriers ( $p=0.003$ ), and on self-efficacy faced with practical barriers ( $p=0.046$ ) than control participants. Approximately 60% in both conditions reported to be inactive or irregularly active (Precontemplation, Contemplation, and Preparation stages). Participants in both conditions reported high mean values on evaluative and affective attitudes (see Table 2).

### ***Change in stages of change in physical activity***

In the intervention group, 35.1% progressed one (14.6%) or more (20.4%) stages, 45.9% remained in their initial stage, and 19.0% regressed one (8.0%) or more (11.0%) stages. In the control group, 27.3% advanced one (11.5%) or more stages (15.8%), 53.5% maintained their initial stage, and 19.3% regressed one (8.1%) or more (11.2%) stages. Mean stage change was 0.34 (SD= 1.5) in the intervention group and 0.16 (SD= 1.3) in the control group. Regression analysis (Regression equation 1) revealed a significant favourable intervention effect on stages of change in physical activity ( $\beta= 0.062$ ,  $p= 0.037$ ,  $n= 1156$ ), implying that condition 1 in the mediation analysis procedure was met.

### ***Mediating influences of psychosocial variables***

Simple mean change scores of potential mediators and effect values of the intervention on these variables are shown in Table 3. Analyses (Regression equations 2) revealed that the intervention produced significant increases in three of the potential psychosocial mediators relative to controls; support from family ( $\beta= 0.069$ ,  $p= 0.036$ ), perceived control ( $\beta= 0.065$ ,  $p= 0.031$ ), and identity ( $\beta= 0.099$ ,  $p= 0.001$ ) (see Table 3, column A), implying that condition 2 was met for these factors. No intervention effects considering support from friends, the two self-efficacy variables and the two attitude variables were found.

Changes from baseline to follow-up in all psychosocial variables were significantly and positively related to change in stages in physical activity (from Regression equations 3a, see Table 3, column B), implying that also condition 3 was met for support from family, perceived control and identity. For these three psychosocial variables, condition 4 was also met. More specifically, indications of partial mediation influences were observed as the  $\beta$  weight of the effect of the intervention on stages in physical activity was reduced from 0.062

(from Regression equation 1, beta not shown in Table 3) to 0.055, 0.045, and 0.033, after controlling for changes in support from family, perceived control, and identity, respectively (from Regression equations 3b, see Table 3, column C).

A measure of the extent of mediation, the percent of the total effect that is mediated, was calculated for the three mediators by the following equation:  $(ab/(ab + c))$ , where “a” is the effect of the intervention on the mediator (beta from Table 3, column A), “b” is the relationship between change in mediator and change in stage in physical activity (beta from Table 3, column B), and “c” is the direct effect of the intervention on stages of physical activity change (beta from Regression equation 1). Thus, “ab” represents the indirect effect and “ab + c” the total effect (MacKinnon, 1994). Support from family mediated 18%, perceived control 27%, and identity 34% of the total effect of the intervention on forward stage movement.

### ***Moderators of observed mediation effects***

To examine whether gender, age, ethnicity, education or BMI acted as moderators of the observed partial mediation effects, stepwise hierarchical regression analyses with change score in stages of change as the dependent variable, the baseline level of the moderator variable in step 1, condition in step 2, and the interaction term of condition  $\times$  the baseline moderator variable in step 3 were performed. No interaction effects were found (change in  $R^2$  of step 3 not significant) (data not shown). Since an effect on the outcome variable is necessary for mediation to be established (Baron & Kenny, 1986), no moderating effects on observed mediation could be detected, and further analyses were not conducted.

### ***Strenuous physical activity as outcome measure***



Change in stages in physical activity was significantly related to change in strenuous physical activity ( $r= 0.27$ ,  $p< 0.01$ ,  $n= 984$ ). Regression analysis demonstrated a significant favourable intervention effect on level of strenuous physical activity ( $\beta= 0.075$ ,  $p= 0.020$ ,  $n= 970$ ). Further regression analyses showed that changes in all psychosocial variables, except evaluative attitude, were positively and significantly related to change in strenuous physical activity (see Table 4, column B). Finally, social support from family, perceived control and identity were indicated to be partial mediators of the favourable intervention effect on strenuous physical activity (see Table 4).

## **Discussion**

The present study demonstrated a significant favourable intervention effect on stage movement. The forward transition was partially mediated by positive changes in support from family, perceived control, and identity. Gender, age, ethnicity, education and BMI did not moderate the observed effect of the intervention on stage transition.

### ***Effect of the intervention on stage transition***

The significant positive influence of the intervention on stage transition corresponds well with findings from several other stage-based interventions (e.g., Marcus et al., 1998). However, most of these interventions targeted specific subgroups of the population, and participants received strategies that were individually matched to their current stage of change. In our study, the intervention package comprised strategies aimed at reaching out to community inhabitants at different stages of readiness, while not being individualized. Hence, the significant intervention effect on stage transition seems particularly encouraging.

Concerning other community-based physical activity promoting interventions, a 2-year multi-strategic, uncontrolled intervention, employing a range of similar components as in

the present project, succeeded in reducing the proportion of sedentary women (Wen et al., 2002). Another Norwegian community intervention designed to reduce cardiovascular risk factors among adults through altering lifestyle factors found a favourable intervention effect on physical activity in men (Lupton, Fonnebo, & Sogaard, 2003). However, the Hartslag Limburg's community project, which used a similar intervention as our aimed at preventing cardiovascular diseases by means of changing physical activity, dietetic and smoking behaviour, showed no effect on physical activity levels (Ronda et al., 2004). It is, however, difficult to compare the effects of different community interventions due to different intervention components, lengths of interventions, measurement methods, use of control group, size and characteristics of target groups etc.

A large portion of controls also advanced in stage from baseline. This might have been caused by contamination effects in the control community generated by media coverage of the project, as both communities are located in the same area of Oslo. This would have resulted in an underestimation of the intervention effect. However, due to current international emphasis on physical activity, obesity, and health (Sallis & Owen, 1999), changes in the controls may as well be attributed to secular trends.

### ***Mediating influences of psychosocial variables***

Although the intervention effect on stage movement may be considered low ( $\beta=0.062$ ), such changes might be important from a public health perspective, as even small increases in physical activity could have a considerable impact on population health. The observed favourable effects of the present intervention on several physical activity-related biological measures (Jenum et al., 2006) support this view. Additionally, strong effects of population-based physical activity interventions are rarely observed (Sallis & Owen, 1999). Hence, conducting mediation analyses on the intervention effect was considered important.

*Intervention effects on mediators.* The set of intervention strategies was effective in improving three of the psychosocial variables addressed: support from family, perceived control and physical activity identity, thereby offering some support for the construct validity of the intervention. The lack of effect on the five other psychosocial variables might imply that intervention components targeting these factors were not sufficiently intensive or were not functioning as expected. However, regarding attitude towards physical activity, the insignificant results may also be due to ceiling effects (Lewis et al., 2002), as both groups already had high scores on the attitude variables at baseline.

*Mediation effects on outcome.* The findings showing support from family, perceived control, and identity to be partial mediators of forward movement in the stages in physical activity add support to the mediation paradigm within intervention research (Baranowski et al., 1998). Because early stage progression does not guarantee actual activity adoption and adherence, Adams and White (2005) have argued that physical activity outcomes also should be assessed. Performing the same mediation analyses using a measure of strenuous leisure time physical activity as the outcome variable gave nearly identical results. These findings support the mediating role of these variables in increasing motivational readiness for physical activity as well as levels of physical activity. The significant positive relationship found between changes in stages in physical activity and in the strenuous physical activity measure also supports this finding.

The  $\beta$ -weight for the impact of the intervention on the stage construct was reduced from 0.062 to 0.055 for support from family, to 0.045 for perceived control, and to 0.033 for identity, suggesting that the identity variable contributed the most to the observed forward movement in stages of physical activity change. It has been suggested that identity may be more proximal to physical activity behaviour than other influencing psychosocial factors. For example, in examining the role of sport identity and other psychosocial and socio-

environmental factors on children`s sport participation, Lau and colleagues (2006) found that sport identity was the strongest predictor, and seemed to mediate the effect of sport competence, peer influence, and relative autonomy index on sport participation. Although not investigated in the present data, similar causal pathways may exist in the present case, which might explain the greater mediational contribution of identity relative to social support from family and perceived control. Notwithstanding, the present finding supports previous research which has emphasized the importance of identity in the prediction of physical activity behaviour (Jackson et al., 2003). Thus, it seems important to increase peoples` perception of themselves as physically active persons when attempting to increase motivational readiness for physical activity and actual physical activity behaviour. The results suggest that the intervention components succeeded in that regard, which in turn, seems to have lead to forward movement in the stages of change. Calculations of the extent of mediation indicate that a significant proportion of the intervention effect on stage movement could be explained by changes in the psychosocial factors. The unexplained impact of the intervention may be due to direct effects of intervention strategies or effects mediated by factors not measured in the present study. For example, non-measured environmental factors derived from social-ecological models might have influenced a forward stage transition directly or indirectly (Sallis & Owen, 1999).

Although five of the eight psychosocial factors did not fulfil all four criterions for mediation (Baron & Kenny, 1986), the strong significant positive relationships found between changes in these variables and change in stages in physical activity in the combined intervention and control group still indicate potential mediating properties. These findings also support the range of cross-sectional studies showing positive relationships between these psychosocial factors and various physical activity outcomes (e.g., Courneya & Bobick, 2000).

Thus, more research is needed before firm conclusions can be made about their mediating role.

To our knowledge, only a few studies have applied recommended statistical analyses (Baron & Kenny, 1986) when examining mediators of physical activity behaviour change in adults (e.g., Fahrenwald, Atwood, & Johnson, 2005; Miller et al., 2002). In an intervention aimed at promoting physical activity among mothers of young children, Miller and colleagues (2002) found partner support and self-efficacy to mediate program effects on physical activity behaviour, in line with our findings on social support from family. In congruence with our research, several other studies have failed to identify self-efficacy as a mediator of increases in physical activity (e.g., Fahrenwald et al., 2005). Thus, the present study adds to previous research by examining mediator properties of attitude, perceived control, and identity in forward transition in stages of physical activity change in adults, and by providing support for perceived control and identity as partial mediators of such transitions.

### ***Moderating factors***

Contradictory to what one may expect based on previous physical activity literature (e.g., Sallis & Owen, 1999), gender, age, ethnicity, education, and BMI did not moderate the observed effect of the intervention on stage movement. These results are encouraging and may be attributed to the design of intervention components. For instance, specific efforts were made to reach ethnic minorities. For example, immigrants attending Norwegian classes were offered weekly physical activity groups, adjusted lectures on physical activity and health, and separate arrangements to test their physical fitness. Also, emphasizing socially inclusive physical activities comprising simple exercises in the local environment, free of charge, may have attracted people from different socio-economic backgrounds. These findings add to previous research (Lewis et al., 2002), and indicate that the present strategies aimed at

advancing individuals in the stages of change in physical activity may prove equally effective regardless of variations in backgrounds.

### ***Strengths and limitations***

The strengths of the study include the examination of several theory- and research-based potential psychosocial mediators of physical activity behaviour change (Lewis et al., 2002), the use of recommended statistical analyses (Baron & Kenny, 1986); the examination of potential moderating factors on mediator effects (Lewis et al., 2002); the inclusion of an outcome measure of self-reported physical activity alongside the stages of change measure (Adams & white, 2005); and the use of a long-lasting participatory-based multi-level and multi-component community-based intervention program (Sallis & Owen, 1999) tailored to the specific needs and interests of the target group (Marcus & Forsyth, 2003).

The study, however, has several methodological limitations. Due to resource limitations, we were not able to use a randomized design. Low response rate at baseline (38%) and at follow-up (55.9%) may also have biased the results. The socio-economic status was significantly more favourable among the attendees of the baseline survey compared with the non-attendees (Jenum et al., 2003), although without a pattern differing systematically between conditions. The higher readiness for physical activity behaviour change at baseline in the control group compared to the intervention group, resulting from follow-up selection bias, might have caused an underestimation of intervention effects. The socio-demographic follow-up selection effect seen in both groups suggests that present results may not be generalized to the same extent to non-Western immigrants.

Furthermore, the use of self-reported data challenges reliability and validity (Sallis & Owen, 1999). For example, social desirability may have influenced scores on the different psychosocial and physical activity scales, possibly resulting in response bias. Also, the

assessment of strenuous physical activity is crude. Nevertheless, support for its' validity has been obtained (Kurtze, Rangul, Hustvedt, & Flanders, 2007).

Also, even though Baron and Kenny (1986) recommend regression analyses in the examination of mediators, they still emphasize the possible source of bias by feedback in the mediation chain. They suggest that structural modelling procedures might be useful in illustrating that change in the mediator is not caused by change in the dependent variable.

Finally, as the possibility of having made type I errors in the present findings is increased due to multiple tests, these should be interpreted with caution. For instance, a Bonferroni correction based on the eight candidate mediators would have given a criterion  $p = 0.006$ , which would have influenced the statistical significance of several findings.

### ***Conclusions and implications for practice***

The set of strategies employed in the present community-wide intervention showed promising effects regarding forward transition in stages of self-reported physical activity. The results further indicate that support from family, perceived control, and identity were influenced by the various strategies employed and, in turn, partly contributed to the favourable changes observed in stages in physical activity. These mediators may therefore be important targets for change in interventions promoting physical activity in similar adult population groups. Although no mediating role could be established for support from friends, the self-efficacy variables or the attitude variables, the strong positive significant relationships between changes in these variables and change in stages in the combined intervention and control group still indicate their potential mediating properties. Neither gender, age, ethnicity, education nor BMI moderated the observed effect of the intervention on stage movement, indicating that strategies aimed at influencing psychosocial aspects for advancing individuals

in the stages of physical activity may prove equally effective regardless of these background factors.

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Table 1. Summary of psychosocial variable measurements.

Variable	Number of items / response format	Example of sample items	Definition of physical activity	Original reference source on which items were based	Cronbach's alpha, baseline – post-test
<i>Social support</i>		How often, over the last three months, did...	None	Sallis, Grossman,	
- family	11 / 1 (none) -5 (very often)	... your family / friends, acquaintances, co-workers do physical		Pinski, Patterson, &	0.92 - 0.92
- friends, acquaintances, co-workers	11 / 1 (none) -5 (very often)	activities with you?		Nader, 1987	0.93 - 0.93
<i>Self-efficacy</i>		I am confident I can participate in planned physical activity when...	All physical activity, except work-related physical activity	Fuchs & Schwarzer, 1994	0.92 - 0.92
- psychological barriers	7 / 1 (not at all confident) -7 (extremely confident)	... I am tired			
- practical barriers	5 / 1 (not at all confident) -7 (extremely confident)	... I have a lot of work to do			0.79 - 0.73
<i>Attitude</i>		Being regularly physically active the next month will to me be ...	None	Courneya & Bobick,	
- Evaluative	5 / 1-7	... useless-useful		2000; Norman &	0.91 - 0.91
- Affective	3 / 1-7	... unpleasant-pleasant.		Smith, 1995	0.86 - 0.87
<i>Perceived behavioural control</i>	4 / 1-7	How sure are you that you could be regularly physically active the next month? unsure – sure	All types of physical activities	Norman & Smith, 1995	0.83 - 0.82
<i>Identity</i>	4 / 1 (suits badly) – 5 (suits well)	To what degree do these statements describe you as a person: I view myself as a person who is concerned about physical activity	None	Charng, Piliavin, & Callero, 1988; Jackson et al., 2003; Sparks & Guthrie, 1998	0.92 - 0.92

Table 2. Socio-demographic and physical activity related characteristics of participants at baseline by condition and by inclusion to study.

	Intervention group			Control group			
	Included* n=616 Mean (SD)	Not included n=473 Mean (SD)	p	Included* n=565 Mean (SD)	Not included n=459 Mean (SD)	p	p**
Age (years)	49.4 (9.9)	45.7 (10.2)	<0.001	49.1 (9.0)	47.1 (9.3)	<0.001	0.567
Education (years)	12.0 (3.6)	11.4 (3.8)	0.012	12.9 (3.5)	11.8 (3.8)	<0.001	<0.001
BMI (kg/m <sup>2</sup> )	27.0 (4.7)	27.0 (5.1)	0.921	26.5 (4.3)	26.9 (4.9)	0.187	0.049
Women (%)	57.5	55.8	0.585	55.6	53.8	0.573	0.512
Western (%)	90.6	73.2	<0.001	91.0	75.2	<0.001	0.818
Stage of physical activity (%)			0.857			<0.001	0.040
Precontemplation	17.2	19.0		13.5	21.6		
Contemplation	19.5	19.2		14.7	19.4		
Preparation	25.5	26.8		29.9	27.5		
Action	5.7	5.3		6.5	5.0		
Maintenance	32.1	29.6		35.4	26.6		
Social support, family	2.0 (0.82)	2.1 (0.85)	0.322	2.2 (0.81)	2.1 (0.82)	0.115	0.003
Social support, friends	2.0 (0.80)	2.0 (0.84)	0.250	2.0 (0.82)	2.0 (0.83)	0.359	0.242
Self-efficacy, psychological barriers	4.4 (1.72)	4.4 (1.75)	0.885	4.7 (1.66)	4.3 (1.75)	<0.001	0.003
Self-efficacy, practical barriers	3.6 (1.44)	3.7 (1.43)	0.101	3.8 (1.33)	3.7 (1.42)	0.226	0.046
Attitude, evaluative	6.2 (1.24)	6.2 (1.21)	0.705	6.2 (1.08)	6.1 (1.23)	0.023	0.496
Attitude, affective	5.3 (1.47)	5.3 (1.48)	0.694	5.2 (1.36)	5.1 (1.47)	0.950	0.234
Perceived behavioural control	4.7 (1.61)	4.6 (1.62)	0.450	4.8 (1.53)	4.4 (1.60)	<0.001	0.053
Identity	3.2 (1.25)	3.3 (1.20)	0.871	3.4 (1.17)	3.1 (1.11)	0.004	0.105

\* Providing baseline and follow-up data on outcome variables.

\*\* Differences between included intervention and control group.

BMI, body mass index.

Social support and Identity range from 1 to 5; Self-efficacy, Attitude, and Perceived behavioural control range from 1 to 7. Higher scores indicate a greater psychosocial readiness for physical activity.

Table 3. Mean change (post-test – pre-test) in potential psychosocial mediators for intervention (n = 478-594) and control (n = 446-550) group. Effect of intervention on potential psychosocial mediator (A, from Regression equations 2), relationship of change in potential mediator with change in stages of physical activity (B, from Regression equations 3a), and effect of intervention on stages of physical activity adjusted for change in mediator (C, from Regression equations 3b). All regression analyses (n=887-1156) adjusted for baseline levels of education and BMI.

Potential mediating variable	Intervention	Control	A		B		C	
	M (SD)	M (SD)	$\beta$	p	$\beta$	p	$\beta$	p
Social support, family	0.11 (0.79)	0.01 (0.69)	0.069	0.036	0.200	<0.001	0.055	0.090
Social support, friends	0.07 (0.77)	-0.03 (0.73)	0.062	0.069	0.166	<0.001	0.061	0.067
Self-efficacy, psychological barriers	0.15 (1.55)	-0.03 (1.45)	0.054	0.088	0.250	<0.001	0.038	0.215
Self-efficacy, practical barriers	0.06 (1.45)	0.00 (1.41)	0.031	0.321	0.192	<0.001	0.044	0.156
Attitude, evaluative	0.06 (1.26)	0.01 (1.17)	0.016	0.616	0.148	<0.001	0.068	0.029
Attitude, affective	0.12 (1.56)	0.07 (1.35)	0.016	0.619	0.165	<0.001	0.064	0.044
Perceived behavioural control	0.17 (1.58)	0.00 (1.39)	0.065	0.031	0.361	<0.001	0.045	0.110
Identity	0.20 (0.88)	0.03 (0.84)	0.099	0.001	0.322	<0.001	0.033	0.250



Table 4. Effect of intervention on potential psychosocial mediator (A, from Regression equations 2), relationship of change in potential mediator with change in strenuous physical activity (B, from Regression equations 3a), and effect of intervention on strenuous physical activity adjusted for change in mediator (C, from Regression equations 3b). All analyses (n=761-1092) adjusted for baseline levels of education and BMI.

<b>Potential mediating variable</b>	<b>A</b>		<b>B</b>		<b>C</b>	
	<b>B</b>	<b>p</b>	<b>β</b>	<b>p</b>	<b>β</b>	<b>p</b>
Social support, family	0.069	0.036	0.101	0.004	0.073	0.040
Social support, friends	0.062	0.069	0.080	0.027	0.067	0.066
Self-efficacy, psychological barriers	0.054	0.088	0.167	<0.001	0.049	0.145
Self-efficacy, practical barriers	0.031	0.321	0.134	<0.001	0.055	0.104
Attitude, evaluative	0.016	0.616	0.056	0.095	0.079	0.020
Attitude, affective	0.016	0.619	0.110	0.001	0.077	0.027
Perceived behavioural control	0.065	0.031	0.143	<0.001	0.057	0.084
Identity	0.099	0.001	0.195	<0.001	0.041	0.209