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Motivation for physical activity in young adults with physical disabilities during a rehabilitation stay: a longitudinal test of self-determination theory

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Abstract

We tested a self-determination theory (SDT) process model during a 3 week physical activity rehabilitation stay among young adults with a physical disability ($N = 44$, $M_{age} = 24.7$, $SD = 5.1$). As hypothesized, perceived autonomy support positively predicted needs satisfaction at the end of the stay ($r = .38$, $p < .01$). Further, needs satisfaction was positively linked to changes in autonomous motivation for physical activity ($r = .47$, $p < .01$). Both changes in autonomous motivation and self-efficacy were associated with physical activity increases over the stay ($r = .57$, $p < .01$ and $r = .47$, $p < .01$, respectively). Bootstrapping results supported the SDT process model, indicating a support for a development toward more self-determined motivation in rehabilitation.

The present study tested the self-determination theory (SDT) process model (Deci & Ryan, 2000) in the domain of physical activity in a group of young adults with physical disabilities (age 18–35) admitted to a rehabilitation center.

Despite the numerous health benefits of physical activity (Heath & Fentem, 1997; Physical Activity Guidelines Advisory Committee, 2008), several studies indicate that people with physical disabilities are less likely to engage in regular physical activities than nondisabled (Rimmer, Rubin, Braddock, & Hedman, 1999; US Department of Health and Human Services, 2000). This was supported by recent research among young Norwegian adults (age 18–30) that indicated that those with disabilities were less physically active than their able-bodied peers (Saebu & Sorensen, 2010). Using the concepts from the International Classification of Functioning, Disability and Health (WHO, 2001), personal factors explained more of the variance in physical activity than both the environmental factors and factors related to functioning and disability. Similar to research among able-bodied persons, the identity of an active person and the intrinsic motivation were powerful factors for explaining variance in physical activity behavior (Bauman, Sallis, Dzewaltowski, & Owen, 2002). However, results in this domain are not consistent, and studies have reported that other self-determined extrinsic motives like introjected regulation (e.g., Thogersen-Ntoumani & Ntoumanis, 2006) and in particular identified regulation (e.g., Wilson, Rodgers, Fraser, & Murray, 2004) may be as important as intrinsic regulation for explaining the variance in physical activity participation. In addition, Burton, Lydon, D'Alessandro, and Koestner (2006) have demonstrated that controlling motives also can underpin persistence behavior, but acting for this reason may lead to reduced psychological health and well-being for the individual.

Research on motivation for physical activity among people with disabilities is scarce and we need to increase our knowledge about the processes that can enhance healthy behavior, i.e., physical activity. However, some studies exist. Martin (2006) found that enjoyment was a critical personal factor in commitment to disability sport. Another study indicated that health status and lack of money, and the unsuitability of local sports facilities rather than lack of motivation were cited as the main barriers to explain the low participation in sports by young people with disabilities (Finch, Lawton, Williams, & Sloper, 2001). Scelza, Kalpakjian, Zemper, and Tate (2005) reported that lack of motivation, lack of energy, and lack of interest were the most frequently cited barriers to exercise among individuals with spinal cord injury, while another study reported that lack of interest was one of the least frequently perceived barriers to exercise among people with strokes (Rimmer, Wang, & Smith, 2008). Similar results were observed in a study among American African women with disabilities (Rimmer, Rubin, & Braddock, 2000). In summary, the findings thus seem to be contradictory.

In rehabilitation, it has proved to be a challenge to maintain the level of physical activity in everyday life as during rehabilitation (van der Ploeg et al., 2007). This was supported by a study reporting that the increase in the activity level during inpatient rehabilitation did not continue after discharge among people with spinal cord injuries (van den Berg-Emons et al., 2008). Therefore, a stronger focus on motivational aspects in rehabilitation research has been emphasized (Roe, Dalen, Lein, & Bautz-Holter, 2008). Maclean, Pound, Wolfe, and Rudd (2000) found that highly motivated patients were more likely to take responsibility for their own rehabilitation and health outcomes, and that motivation for rehabilitation seems to be influenced by the environment in which the patient is rehabilitated. These findings indicate that factors other than health benefits are important for the motivation for physical activity for persons with disabilities. More knowledge about how motivation for physical activity in everyday life can be improved during rehabilitation is needed.

Theoretical framework

SDT has been strongly recommended as a suitable framework for understanding motivated physical activity behavior (Biddle & Nigg, 2000; Landry & Solmon, 2002). Moreover, SDT has been recently used in physical activity research (Chatzisarantis & Hagger, 2009; Fortier, Sweet, O'Sullivan, & Williams, 2007; Wilson et al., 2004), and over the past 15 years a growing body of work has also applied SDT in studies of health-related behavior change (Patrick & Williams, 2008; Ryan & Deci, 2007; Williams, Freedman, et al., 1998). Further, autonomous functioning and self-determination may be a particular challenge for people with disabilities, since many of them are dependent on help and assistance both in physical activities and daily activities. Limited work has been done in Adapted Physical Activity (APA) using SDT, but we are aware of one study examining the contribution of two different models of psychological needs satisfaction to well-being in a sample of sports athletes with disabilities (Lightheart, Wilson, & Oster, 2010). In our opinion, there is a need for additional research using SDT as a framework in a rehabilitation setting among nonathlete participants. The SDT theory was therefore used as a theoretical framework for identifying and understanding the motivation mediators of physical activity in this study.

Motivation and psychological needs satisfaction

According to SDT, maintenance of behaviors over time requires that patients are autonomously motivated for that behavior (Deci & Ryan, 2000). Autonomous motivation includes intrinsic, integrated, and/or identified forms of behavior regulation. The theory further argues that if health care settings maximize patient's satisfaction of the needs for autonomy, competence, and relatedness, their regulation of health-related behaviors is more likely to be autonomously motivated, and behavior change will be better maintained (Williams, Deci, et al., 1998). Need for autonomy can be satisfied by experiences of choice and volition (e.g., DeCharms, 1968); satisfaction of the need for competence can be a result of behavior that leads to intended outcomes (e.g., White, 1959); and perceptions of being attached to and understood by others can lead to satisfaction of the need for relatedness (e.g., Baumeister & Leary, 1995). These basic needs, according to Ryan and Deci (2000), apply to all people, regardless of gender, group, or culture, and presumably disability.

Although autonomy and competence have been found to be the most powerful influences on autonomous types of motivation, its maintenance, theory, and research suggest that relatedness also plays a role, albeit a more distal one (Deci & Ryan, 2000). The practitioner–patient relationship has been emphasized as an important social context for change. Because patients are vulnerable and often insecure about their own capabilities, individuals are expecting guidance from professionals, and this is especially important in health care. In this process, a sense of being respected and understood is essential to form the experiences of relatedness that nurture internalization (Ryan, Patrick, Deci, & Williams, 2008). At the rehabilitation center in the present study the group setting is considered important, with peer work and exchange of activity experiences among the patients. The patients' feelings of relatedness to the rest of the group may also be important for the outcome of the rehabilitation stay.

In summary, to increase autonomous motivation, the satisfaction of basic psychological needs for autonomy, competence, and relatedness is supposed to be important. The theory argues that all three needs are essential and that if any is thwarted there will be distinct functional costs. Thus, satisfaction of all three needs was included in this study of participants with disabilities because optimal functioning seems to be important for their engagement in physical activities (Jahnsen, Villien, Aamodt, Stanghelle, & Holm, 2003).

Autonomy support, autonomous motivation, and perceived competence

SDT differentiates motivation in terms of the degree to which it has been internalized, suggesting that the more fully it is internalized, the more it will be the basis for autonomously regulated behavior. There are three different autonomous types of regulation: identified (for personally held values such as learning new skills; internally referenced contingency), integrated (behaviors that are fully incorporated into the repertoire of behaviors that satisfy psychological needs), and intrinsic (for enjoyment, pleasure, and fun, without reward or reinforcement). These three types of regulation comprise *autonomous motivation* in research (Williams, Freedman, et al., 1998). Patients who are regularly physically active would be autonomous if they freely choose to exercise because they enjoy being physically active, or are personally committed to improving their health. Practitioners may facilitate autonomous motivation and perceived competence for change by supporting patients as they explore resistances and barriers to change, and helping them identify congruent pathways to health (Ryan et al., 2008). In SDT, such environments are termed autonomy-supportive contexts and defined as: "ones in which significant others offer choice, provide a meaningful rationale, minimize pressure, and acknowledge the target individual's feelings and perspectives" (Williams, Grow, Freedman, Ryan, & Deci, 1996, p. 117). Effective behavior change requires people to be both autonomously motivated and to perceive themselves as competent in doing it (Deci & Ryan, 2000). Competence refers to a felt sense of confidence and effectance in a social context, and it is not an attained skill or capability. The need for competence leads us to seek optimal challenges (Ryan & Deci, 2002). People perceive themselves to be competent when they feel capable of attaining important health outcomes in a social setting, such as meeting a physical activity goal. Autonomy-supportive patient care has been found to enhance autonomous motivation and perceptions of competence, which improved health outcomes (Williams, Freedman, et al., 1998; Williams, McGregor, Zeldman, Freedman, & Deci, 2004).

Along with a sense of autonomy, internalization requires that a person experience the confidence and competence to change. In SDT, support for competence is integrated in the concept of autonomy support defined above and afforded when practitioners provide effectance, relevant inputs, and feedback. This means that the patient is afforded the skills and tools for change, encouraged to choose among them, and is supported when competence or control-related barriers emerge. Patients are not over-challenged, but rather helped to experience mastery in terms of the health behavior change that needs to be engaged (Ryan et al., 2008). Fortier et al. (2007) outlined that the construct of perceived competence is very similar to the self-efficacy concept (Bandura, 1997). It may be discussed if general self-efficacy is more related to issues of social cognition central to Bandura's (1997) model of human agency rather than Deci's (2002) formulation that is based on different theoretical orientations concerned with volitional action. In the present study, items measuring efficacy refer to perceived confidence related to overcoming barriers and challenges in physical activity in general. Thus, the present measure of efficacy may be very similar to measures of perceived competence in SDT (Williams et al., 1996). Efficacy has been found to be one of the strongest predictors of physical activity in adults (Trost, Owen, Bauman, Sallis, & Brown, 2002). Similar results have also been revealed in populations with disabilities (Bean, Bailey, Kiely, & Leveille, 2007; Kroll, Kehn, Ho, & Groah, 2007). The term efficacy has been used in this study.

Recent research has revealed that autonomous motivation and perceived competence for making change were important for involvement in physical activities among able-bodied persons (Bagoien & Halvari, 2005; Chatzisarantis & Hagger, 2009; Chatzisarantis, Hagger, Biddle, & Karageorghis, 2002; Hagger, Chatzisarantis, Barkoukis, Wang, & Baranowski, 2005; Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003). Due to a lack of SDT research on persons with disabilities in rehabilitation settings, we examined some studies of other health-related behaviors as a basis for our hypotheses.

Autonomous motivation and perceived competence were found to be important for better self-management of diabetes behaviors and better glucose control for patients with diabetes (Williams et al., 1998, 2004), active participation in an alcohol treatment program (Ryan, Plant, & Omalley, 1995), adherence to exercise programs and long-term weight management in overweight and obese middle-aged women (Palmeira et al., 2007; Teixeira et al., 2006), and in morbidly obese patients (Williams et al., 1996), smoking cessation (Williams, Gagne, Ryan, & Deci, 2002), and long-term medication adherence (Williams, Rodin, et al., 1998). In summary, it seems as if autonomous motivation and perceived competence may be important for participation in and adherence to various health-related behaviors.

The SDT process model of change

Autonomy-supportive practitioners will facilitate the patients' satisfactions of psychological needs. This is expected to enhance autonomous motivation and perceived competence, which both are expected to yield maintained healthy functioning (Williams et al., 2004). Research has emphasized the importance of autonomy support in several health-care related studies (Halvari & Halvari, 2006; Teixeira et al., 2006; e.g., Williams et al., 2006). However, to our knowledge, the process model has never been applied in the domain of physical activity among young adults with physical disabilities. Thus, we tested a SDT process model in which perceived autonomy support during a 3 week physical activity rehabilitation stay was hypothesized to positively predict psychological needs satisfaction at the end of the stay. This was expected to increase autonomous motivation and self-efficacy for physical activity (motivation variables), which both were expected to be linked to physical activity increases over the stay. We also examined whether autonomy support would be indirectly linked to change in motivation variables through needs satisfaction; and that needs satisfaction would be indirectly associated with changes in physical activity through motivation variables.

According to SDT, satisfaction of basic psychological needs represents essential nutriments for individuals' healthy functioning (Deci & Ryan, 2000), and previous research has demonstrated that satisfaction of the three basic psychological needs is important (Hagger, Chatzisarantis, & Harris, 2006; Wilson, Longley, Muon, Rodgers, & Murray, 2006).

Further, previous studies have observed direct effects of perceived autonomy support on self-reported physical activity, when experiences related to needs satisfaction were not taken into consideration (Chatzisarantis & Hagger, 2009; Hagger et al., 2003, 2005).

Based on this, we tested an alternative basic need theory model and predicted that perceived autonomy support would be positively correlated with satisfaction of basic psychological needs as in the SDT process model outlined above, and that needs satisfaction would be directly positively associated with physical activity (see Figure 1, Model 2).

Method

Participants

During the winter 2009, young adults with disabilities (aged 18–35 years) were invited to one of four similar 3 week rehabilitation stays with up to 14 persons in each group. Sixty-two persons applied for a stay. Of those, nine persons got another rehabilitation offer because they were seriously cognitively challenged. Fifty-three persons were accepted by the admission team, and 48 persons (28 women) accepted the terms of stay and were included in the study. Four of them dropped out during the follow-up period and did not answer the last questionnaire. Thus, 44 persons (27 women) completed the study. Mean age was 24.7 years ($SD = 5.1$; women: $M = 25.3$, $SD = 5.7$; men: $M = 23.9$, $SD = 4.3$). For additional descriptive information, see Table 1.

All the persons who applied for a stay at the national rehabilitation center had the right to treatment over a limited time period. Participants were divided into four groups based on their preferences. Some of the participants were either employed, studying, and/or were dependent on assistance

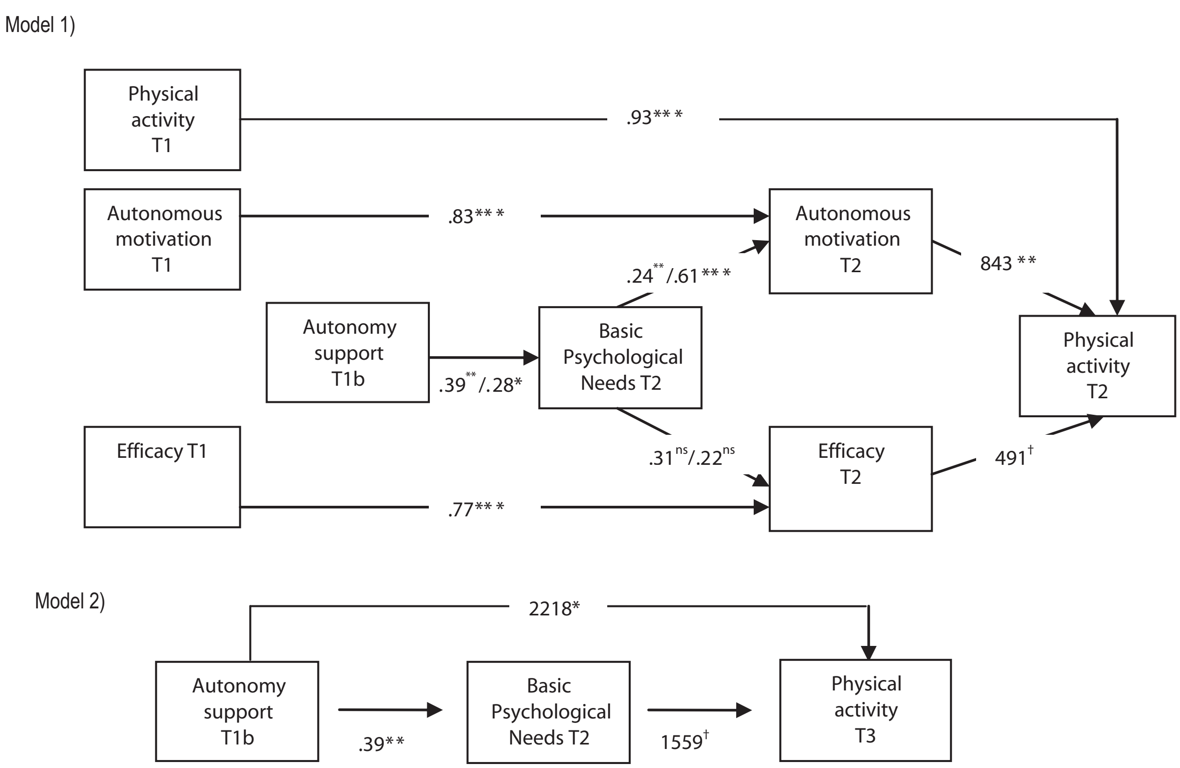

Figure 1 The change model—two different approaches. Bootstrapping models. See text for further information. *Note:* T1 = baseline, T1b = baseline + 1 week, T2 = after 3 weeks intervention, T3 = 12 weeks after intervention. ***$p < .001$. **$p < .01$. *$p < .05$. †$p < .10$.

Table 1 Descriptive Data of the Sample ($N = 44$)

Variables	*n*	%
Engagement		
Student	15	34.1
Employed	14	31.8
Social security	11	25.0
Work-related rehabilitation	12	27.3
Voluntary work	8	18.3
Living		
Living alone	19	43.2
Married/Cohabitants	5	11.4
Living with parents	17	38.6
Living with own children	5	11.4
Activities of daily living		
Personal assistant	5	11.4
Leisure time assistant	6	13.6
Support services	11	25.0
Impairment		
Congenital	28	63.6
Acquired	16	36.4
Mobility limitation	37	84.1
Wheelchair user	24	54.5
Uses crutches/walker	2	4.5
Walk without aids	11	25.0
Visual impairment	6	13.6
Blind	5	11.4

and had to decide the best possible time for the 3 week rehabilitation stay. The study was approved by the Regional Medical Committee for Research Ethics in Norway.

Design

This was a longitudinal study based on repeated measures. Data were collected through an Internet-based questionnaire. Two persons with visual impairments were interviewed by the researcher because they could not complete the questionnaires themselves. The participants filled out the questionnaires three times: at arrival to the rehabilitation center (Time 1 = baseline), at departure from the center (Time 2), and 12 weeks after departure (Time 3). According to Rogasa (1995), three or more observations are preferred to detect individual change and for the estimation of individual growth curves. The period for the intervention was given by the terms of condition for a stay at the rehabilitation center. A third measure and a follow-up period of 12 weeks were considered important because they provided opportunities for the participants to implement a more healthy behavior and physical activity routines in daily life.

Intervention at the rehabilitation center

The rehabilitation program at the rehabilitation center is based on the vision of APA (Hutzler & Sherrill, 2007) by means of physical activities adapted to the specific needs of each individual with a disability. The rehabilitation includes social and cultural activities and extensive use of outdoor natural facilities on a year-round basis. A wide range of services is offered, including adaptation of the environmental factors, technical aids, and individual instruction. The program is intensive with 3–5 hours of physical activity a day, 6 days a week

Before the intervention period, the professional staff at the rehabilitation center was given four lectures on SDT, where the facilitation of autonomy support, possibilities for demonstrating competence, and facilitation for relatedness were especially emphasized. The intervention was based on patient autonomy by providing opportunities for choice and self-initiation during goal setting, priority of activities, and support and surveillance during the rehabilitation stay. Further, extended instruction in the activities was given priority in order to enhance efficacy in activities, and finally, relatedness support in the group of 11–14 participants was emphasized.

Most of the activities were arranged in groups. The group setting is considered important (cf. relatedness), facilitating for the participants to work together, giving feedback to each other, and exchanging activity experiences. During the stay, individuals' schedules are constantly assessed and adjusted when necessary. The range of activities (e.g., traditional ones such as swimming and cross-country skiing and riding, and less traditional activities such as aerobics, alpine skiing, and kayaking) offered by the rehabilitation center provide opportunity to determine the activities best suited to the individual.

Measures

Autonomy support

The Health-Care Climate Questionnaire (HCCQ) concerns support for healthy behavior (Williams et al., 1996). The original HCCQ is a 15-item measure that assesses participants' perceptions of the degree to which they experience their health care providers during the intervention to be autonomy supportive versus controlling in providing the treatment. The short form of the HCCQ that includes 6 of the 15 items was used. Psychometric properties were established in a sample of 1,183 patients in various studies where the measure yielded a one-factor solution with all factor loadings above .74. In another study on persons with diabetes (a sample that has some challenges in common with the sample in the present study), the short version represented good internal consistency ($\alpha = .80$), and correlated .91 with the full version (Williams et al., 1998). A sample item is: "I feel that the staff provided me choices and options." Items were responded to on a 7-point scale ranging from *strongly disagree* (1) to *strongly agree* (7). Scores were calculated by averaging the individual item scores. Autonomy support was measured after 1 week of the rehabilitation stay (baseline + 1 week = Time 1b).

Basic psychological needs

Basic psychological needs were assessed by the Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos & Michailidou, 2006). The BPNES was preferred because it was accessible in a translated version (from the English version to Norwegian, and back-translated to English), it has been developed in Europe, and other researchers have called for more research using this new BPNES (Wilson, Mack, & Grattan, 2008). According to Wilson and Bengoechea (2011), the BPNES is suitable for structured exercise settings and should apply well for the present study. This 12-item scale assesses perceptions of the extent to which the innate needs for autonomy, competence, and relatedness (Deci & Ryan, 2000) are satisfied in the domain of exercise. Sample items are: "The exercise program I follow is highly compatible with my choices and interests" (autonomy); "I feel I have been making huge progress with respect to the end result I pursue" (competence); and "I feel extremely comfortable when together with the other exercise participants" (relatedness). Each item was responded to on a 7-point scale ranging from *strongly disagree* (1) to *strongly agree* (7). Participants completed the scale at the end of the rehabilitation stay (Time 2). Separate scores for autonomy, competence, and relatedness were made by averaging the sum of each four items. A score for total needs satisfaction was also calculated by averaging the sum of the 12 items.

Psychometric properties of the BPNES have been established in a sample of 1,012 persons employed from fitness centers. The results demonstrated an adequate factor structure, internal consistency, generalizability of the factor dimensionality across the calibration and the validation samples, discriminant validity, and predictive validity. In addition, acceptable stability of the BPNES scores over 4 weeks was also presented. The scores of the scale were found to be largely unaffected by socially desirable responding and the tendency to impress management (Vlachopoulos & Michailidou, 2006).

Motivation regulation

Autonomous motivation for physical activity was measured by the Exercise Self-Regulation Questionnaire (SRQ-E) (Ryan & Connell, 1989). The SRQ-E was translated into Norwegian by a bilingual researcher. Back-translation into English by a second bilingual translator was performed to ensure conceptual accuracy. The SRQ-E has demonstrated acceptable validity and reliability in Norway, reflecting the motivational regulations among adolescents and young adults (Ommundsen & Kvalo, 2007). Sample items are: "I try to be physically active on a regular basis because I feel like it's the best way to help myself" (identified regulation) and "I try to be physically active on a regular basis because I enjoy exercising" (intrinsic regulation). The responses were given on a 7-point Likert-type scale ranging from *very true* (7) to *not at all true* (1). Autonomous motivation scores were estimated by averaging the sum of intrinsic and identified regulation items. The SRQ-E also included items for controlled motivation (i.e., introjected and external regulations) which in most cases are found to be unrelated to long-term adherence (Deci & Ryan, 2000). This was also the case in the present study, and controlled motivation is therefore not included in further analyses. The scale was used in a Norwegian study among young adults with disabilities ($N = 327$), and demonstrated good reliability on intrinsic and identified regulations, $\alpha = .80$ and .85, respectively. Factor analysis revealed two factors representing intrinsic and identified regulation. All factor loadings were above .60 (Saebu & Sorensen, 2010).

Efficacy

Exercise self-efficacy was measured by the Exercise Self-Efficacy Scale (ESES). A sample item is: "I am confident that I can overcome barriers and challenges with regard to physical activity and exercise if I try hard enough." Responses were given on a 10-point Likert scale ranging from *not at all true* (1) to *always true* (10). The scale has been tested for validity in a sample with 368 individuals with spinal cord injuries. Preliminary findings indicate that the ESES is a reliable instrument with high internal consistency and scale integrity. Content validity was satisfactory in terms of both face and construct validity (Kroll et al., 2007). In the present study, principal component analysis extracted only one factor, accounting for 62.3% of the variance, with a good internal consistency ($\alpha = .86$).

Physical activity

Physical activity was assessed using an adapted version of the self-administered short form of the International Physical Activity Questionnaire (IPAQ). This measure assesses total time (minutes) in vigorous intensity physical activity, total time (minutes) in moderate intensity physical activity, and total time (minutes) in walking and time spent sitting during the last 7 days. Time spent sitting was excluded in this study because there is no value in asking wheelchair users to report their time spent sitting during the last 7 days. The short form of IPAQ has been developed and tested for use with adults with an age range of 15–69, and has shown acceptable reliability (Spearman's clustered ρ around 0.8) and criterion validity ($\rho = .30$) (Craig et al., 2003). IPAQ had been translated into

Norwegian previously and has been used by the Survey of Living Conditions (Wilhelmsen, 2009).

The examples of vigorous and moderate intensity activities used were not relevant to our sample. The IPAQ protocol allows the use of culturally applicable examples (IPAQ Research Committee, 2005). According to this, "time in fast wheeling/pushing in wheelchair" (vigorous intensity), "time in wheeling/pushing the wheelchair with moderate speed" (moderate intensity), and "time in wheeling/pushing the wheelchair" as an alternative to walking were included (Saebu & Sorensen, 2010). IPAQ provides a continuous variable (metabolic equivalent-minutes/week = MET-minutes/week) that was used as the dependent variable.

Analyses

All data were analyzed using SPSS version 15.0.1 (SPSS Inc., Chicago, IL). Pearson's correlations were performed to detect bivariate associations between the variables. Regression analysis was used to create change scores (standardized residuals) for variables. Residual change scores were used to obtain gain scores that are uncorrelated with the pretest scores, and measure if a person's posttest score is larger or smaller than a predicted value for that person (Waltz, Strickland, & Lenz, 2010). To test the process model and indirect relations, we used bootstrapping. Bootstrapping is a nonparametric resampling procedure, advocated for testing mediation that does not impose the assumption of normality of the sampling distribution. Compared to multiple regression, bootstrapping was used because it is more suitable and recommended for small sample sizes (Preacher & Hayes, 2008). Guidelines for final reporting were used, recommending 5,000 bootstrap samples (Preacher & Hayes, 2008). Repeated measures analysis of variance (ANOVA) was performed to analyze increases or decreases in mean scores of variables from Time 1 (baseline), over Time 2 (end of rehabilitation stay), to Time 3 (12 weeks after the end of the stay).

Results

Descriptive statistics and reliability

Table 2 shows the means, standard deviations, and reliabilities for all variables. The scores for all motivation-related variables are distributed around a high mean (1 *SD* above scale midpoint) at all three times of measurement. The scores for total physical activity are distributed around a high mean, which is comparable to about 4 hours of walking or 3 hours of moderate physical activity daily. Relatively high levels of *SD* emerged in relation to mean scores since there are some participants who are not physically active at all at Time 1 and Time 3.

Correlations for SDT-related variables and physical activity

Bivariate correlations between all measures emerge in Table 2. According to the predicted links in the SDT process model described, autonomy support was significantly positively associated with needs satisfaction, which was significantly linked to both autonomous motivation and efficacy at Time 2. In turn, both autonomous motivation and efficacy at Time 2 predicted positively physical activity at Time 3, but only efficacy is significantly linked to physical activity at Time 2. All predicted associations were significant in the expected direction, except the correlation between autonomous motivation at Time 2 and physical activity at Time 2.

Change scores (standardized residuals) from baseline to the end of the rehabilitation stay of autonomous motivation, efficacy, and physical activity were created by regression of T2 (Time 2) measures onto T1 (Time 1) measures for each variable. The same procedure was applied when creating change scores for motivation and physical activity variables from the end of the rehabilitation stay (T2) to 12 weeks after (T3, Time 3). The correlations among autonomy support, total needs satisfaction, the three needs for autonomy,

Table 2 Mean, *SD*, and Bivariate Correlation (Pearson's) among Independent and Dependent Variables

Measure	*M*	*SD*	α	1	2	3	4	5	6	7	8	9	10
1 Autonomy support T1	6.31	.76	.95										
2 Basic psychological needs T2	6.22	.78	.88	.38**									
3 Autonomous motivation T1	5.82	.94	.80	−.01	.31*								
4 Efficacy T1	7.50	1.68	.86	.25*	.50**	.43**							
5 Physical activity T1	4,672	4,581		.18	.17	.05	.30*						
6 Autonomous motivation T2	5.91	.94	.82	.15	.49**	.90**	.39**	.06					
7 Efficacy T2	7.85	1.74	.89	.31*	.53**	.45**	.83**	.40**	.52**				
8 Physical activity T2	7,251	4,704		.21	.22	.19	.18	.93**	.12	.38**			
9 Autonomous motivation T3	5.89	.97	.84	.08	.41**	.87**	.52**	.06	.82**	.51**	.01		
10 Efficacy T3	7.88	1.60	.86	.27*	.44**	.58**	.87**	.26*	.51**	.78**	.17	.64**	
11 Physical activity T3	5,562	5,080		.33*	.33*	.17	.19	.61**	.27*	.32*	.66**	.11	.25

Note. *$p < .05$. **$p < .01$.

Table 3 Bivariate Correlations (Pearson's) among Independent and Dependent Variables (Residual Change Score)

	Measure	1	2	3	4	5	6	7	8	9	10	11
1	Autonomy support T1											
2	Basic psychological need T2	.38**										
3	Autonomy need T2	.34**	.84**									
4	Competence need T2	.36**	.84**	.82**								
5	Relatedness need T2	.25**	.76**	.35**	.37**							
6	Change in autonomous motivation (T1–T2)	.35**	.47**	.30*	.27*	.52**						
7	Change in efficacy (T1–T2)	.17	.22	.17	.11	.22	.46**					
8	Change in physical activity (T1–T2)	.12	.19	.00	.03	.34*	.57**	.47**				
9	Change in autonomous motivation (T2–T3)	−.08	.00	.26*	.15	−.28*	−.48**	−.26*	−.49**			
10	Change in efficacy (T2–T3)	.05	.03	.28*	.22	−.28*	−.36**	−.51**	−.36**	.43**		
11	Change in physical activity (T2–T3)	.26*	.24.	.17	.25	.18	.13	.03	.01	−.11	.17	
12	Physical activity (T3)	.33*	.33*	.24	.36**	.23	.25*	.30*	.25	−.19	.01	.75**

Note. *$p < .05$. **$p < .01$.

competence, relatedness, and the changes in autonomous motivation, efficacy, and physical activity are presented in Table 3. The correlation between autonomy support and needs satisfaction is the same as presented in Table 2. Further, needs satisfaction was significantly positively associated with change in autonomous motivation (T1–T2) but not with change in efficacy (T1–T2). In turn, change in both these motivation variables (T1–T2) was significantly positively linked to change in physical activity (T1–T2) and to total physical activity at Time 3 (12 weeks after T2). However, changes in motivation variables are not significantly related to change in physical activity from T2 to T3.

Hypotheses testing of relations in the SDT process model

The overall SDT process model suggests that autonomy support would predict needs satisfaction, which would enhance people's efficacy and autonomous motivation, which, in turn, would predict increases in total volume of physical activity. Table 3 shows that autonomy support was positively related to needs satisfaction ($r = .38$, $p < .01$); that needs satisfaction was linked to positive change in autonomous motivation (T1–T2: $r = .47$, $p < .01$) and nonsignificantly related to change in efficacy (T1–T2: $r = .21$, $p > .05$); and that changes in both autonomous motivation (T1–T2: $r = .57$, $p < .01$) and efficacy (T1–T2: $r = .47$, $p < .01$) were related to increased physical activity (T1–T2).

Looking at the single needs (see Table 3), relatedness seems to contribute to a change in autonomous motivation from T1 to T2 ($r = .52$, $p < .01$), which in turn is correlated with the reduction in autonomous motivation from T2 to T3 ($r = -.48$, $p < .01$). Some of the reductions in autonomous motivation from T2 to T3 can also be explained by relatedness ($r = -.28$, $p < .05$). This is not the situation for autonomy and competence. Further, changes in autonomous motivation and efficacy are correlated ($r = .46$, $p < .01$), indicating that relatedness contributes indirectly to the increase in efficacy (T1–T2) through the change in autonomous motivation (T1–T2). This indirect link between the relatedness need and change in efficacy through change in autonomous motivation was significant, path $a \times$ path $b = .20$, $SE = .09$, bias-corrected 95% CI [.06, .45]. Probably because the relatedness need contributes most to the increase in autonomous motivation from T1 to T2, the decrease in the latter variable from T2 to T3 is negatively linked to the same need (relatedness need–change in autonomous motivation from T2 to T3: $r = -.28$, $p < .05$). We also notice that the autonomy need is positively correlated with changes in the autonomous motivation from T2 to T3 ($r = .26$, $p < .05$) and the change in efficacy at the same time ($r = .28$, $p < .05$). The competence need is also positively correlated with changes in autonomous motivation and efficacy, but not significantly.

We tested the SDT process models of physical activity that appears in Figure 1 by bootstrapping. Bootstrapping was applied because it is suitable and recommended for small samples (Preacher & Hayes, 2008). Due to the small sample size, we reduced the number of variables in the analyses by testing two process models separately: (1) a model including autonomy support, needs satisfaction, and changes in autonomous motivation, efficacy, and physical activity from Time 1 to Time 2; and (2) an alternative model including autonomy support, needs satisfaction, and total physical activity at Time 3.

Model 1: autonomy support → needs satisfaction → autonomous motivation and efficacy → physical activity

First, we analyzed the paths among autonomy support at Time 1b (independent variable = IV), needs satisfaction at Time 2 (mediator = M), and autonomous motivation at

Table 4 Test of Indirect Links Emerging in Figure 1

IV		M	DV	PE	*SE*	Bootstrapping BC 95% CI
1	Autonomy support	Needs satisfaction	Autonomous motivation	.10	.04	[.01, .19]
2	Autonomy support	Needs satisfaction	Efficacy	.09	.08	[–.03, .29]
3	Needs satisfaction	Autonomous motivation	Physical activity T2	516.41	206.67	[191.68, 1,062.24]
4	Needs satisfaction	Efficacy	Physical activity T2	110.31	145.08	[–45.56, 537.05]
5	Autonomy support	Needs satisfaction	Physical activity T3	608.81	437.02	[36.91, 1,811.08]

Note. 5,000 bootstrap samples, *a* path IV→ M, *b* path M → DV.
BC = bias corrected; DV = dependent variable; IV = independent variable; M = mediator; PE = point estimate.

Time 2 (dependent variable = DV) using autonomous motivation at Time 1 as a control variable (CV) (see Figure 1, Model 1). The path between autonomy support and needs satisfaction was significant (point estimate, PE, for path $a = .39$, $p < .01$), as was the path between needs satisfaction and autonomous motivation at Time 2 (PE for path $b = .24$, $p < .01$), controlling for autonomous motivation at Time 1 (partial PE of CV on DV = .83, $p < .001$). The indirect link between autonomy support and change in autonomous motivation through needs satisfaction was significant because the bias-corrected confidence intervals (for the bands of products of coefficients after *n* resampling) did not include zero or negatively valued coefficients, path $a \times$ path $b = .10$, $SE = .04$, bias-corrected 95% CI [.01, .19]. See Table 4, row 1.

Second, we analyzed the paths among autonomy support at Time 1b (IV), needs satisfaction at Time 2 (M), and efficacy at Time 2 (DV), controlling for efficacy at Time 1 (CV). The path between autonomy support and needs satisfaction was significant (PE for path $a = .28$, $p < .05$), whereas the path between needs satisfaction and efficacy at Time 2 was nonsignificant (PE for path $b = .31$, $p > .10$), controlling for efficacy at Time 1 (partial PE of CV on DV = .77, $p < .001$). The indirect link between autonomy support and change in efficacy through needs satisfaction was nonsignificant, path $a \times$ path $b = .09$, $SE = .08$, bias-corrected 95% CI [–.03, .29]. See Table 4, row 2.

Third, we analyzed the paths among needs satisfaction at Time 2 (IV), change in autonomous motivation and efficacy from T1 to T2 (M), and physical activity at T2 (DV), controlling for physical activity at Time 1 (CV). The path between needs satisfaction and change in autonomous motivation was significant (PE for path $a^1 = .61$, $p < .001$), but the path between needs satisfaction and change in efficacy was not significant (PE for path $a^2 = .22$, $p > .05$). Analyzing the *b* paths, we revealed that the b^1 path between change in autonomous motivation and change in physical activity was significant (PE for path $b^1 = 843$, $p < .01$), and the b^2 path between change in efficacy and change in physical activity was marginally significant (PE for path $b^2 = 491$, $p = .06$), controlling for physical activity at Time 1 (partial PE of CV on DV = .93, $p < .001$). The indirect link between needs satisfaction and change in physical activity through change in autonomous motivation was significant, path $a \times$ path $b = 516.41$, $SE = 206.67$, bias-corrected 95% CI [191.68, 1,062.24]. See Table 4, row 3. In addition, the indirect link between needs satisfaction and change in physical activity through change in efficacy was not significant, path $a \times$ path $b = 110.31$, $SE = 145.08$, bias-corrected 95% CI [−5.56, 537.05], because it included a negatively valued coefficient. See Table 4, row 4, and the path coefficients illustrated in Figure 1, Model 1.

The correlations between autonomy support and the three needs for autonomy, competence, and relatedness, respectively, were all weaker than the correlation between autonomy support and total needs satisfaction (see Table 3). Partly due to this, no single needs did significantly mediate the links between autonomy support and change in motivational variables. Thus, as shown above, total needs satisfaction including all three needs is the important construct mediating the link between autonomy support and change in autonomous motivation.

Further, the correlation between total needs satisfaction and change in autonomous motivation was relatively strong ($r = .47$, $p < .001$). Regarding single needs, it is only the relatedness need that could match this correlation strength in relation to autonomous motivation ($r = .52$, $p < .001$), whereas this correlation was much lower for the autonomy need ($r = .30$, $p < .05$) and the competence need ($r = .27$, $p < .05$). Consequently, for single needs, only the relatedness need (RN) was significantly indirectly linked to change in physical activity (PA) through change in autonomous motivation (AM), *a* path: RN → AM (.42, $p < .001$); *b* path: AM → PA (939.24, $p < .001$); *c* path: RN → PA (485.13, $p < .05$); *c′* path, RN → PA controlling for the AM mediator: 87.45, $p = .68$. Because the RN → PA path became nonsignificant after controlling for the mediator, a full mediation is supported. This is also indicated by the indirect link, PE = 397.68, $SE = 167.34$, bias-corrected 95% CI [144.93, 804.99]. Regarding the indirect links between single needs and change in physical activity through change in efficacy, none of them were significant. Further, using a similar model, we changed physical activity measured at Time 2 with physical activity measured at Time 3 (12 weeks after the intervention) as the dependent variable, but the model did not demonstrate any strong support to the change model.

An alternative Model 2: autonomy support at Time 1b → needs satisfaction at Time 2 → total physical activity at Time 3

Because autonomy support and needs satisfaction yielded the strongest correlations observed ($r = .33$, $p < .05$) with total physical activity at Time 3 (12 weeks after the end of the rehabilitation stay), we tested an alternative model with these three variables. We analyzed the paths among autonomy support at Time 1b (IV), needs satisfaction at Time 2 (M), and physical activity at Time 3 (DV). The path between autonomy support and needs satisfaction was significant (PE for path $a = .39$, $p < .01$), and the path between needs satisfaction and physical activity was marginally significant (PE for path $b = 1{,}558.85$, $p < .10$). The indirect link between autonomy support at Time 1b and physical activity at Time 3 through needs satisfaction at Time 2 was significant, path $a \times$ path $b = 608.81$, $SE = 437.02$, bias-corrected 95% CI [36.91, 1,811.08]. See Table 4, row 5, and the path coefficients illustrated in Figure 1, Model 2.

In summary, the results supported significantly the indirect relations between autonomy support and change in autonomous motivation through needs satisfaction, and between needs satisfaction and change in physical activity through change in autonomous motivation. We also noticed support for the positive indirect link between autonomy support and total physical activity 12 weeks after the intervention through needs satisfaction.

Increases and decreases in mean scores for motivation and physical activity variables

Repeated measures ANOVA revealed that physical activity (see Table 2) increased significantly from the start of the rehabilitation stay at T1 and until the follow-up (T3) 12 weeks after the intervention, $F(1.26, 54.12) = 12.05$, $p < .001$. (Degrees of freedom were corrected using Greenhouse–Geisser estimates of sphericity.) Further, efficacy increased significantly from T1 to T3, $F(2, 79) = 3.95$, $p = .023$. Finally, the mean for autonomous motivation increased, but not significant, from T1 to T2, and remained relatively high at T3 (see Table 2).

Discussion

The purpose of the present study was to test the SDT process model in the domain of physical activity in a group of young adults with physical disabilities (age 18–35) admitted to a rehabilitation center. The results supported the model and should have some practical implications on how we plan and implement rehabilitation. We have not previously seen the SDT health process model applied in a setting with people with disabilities. As predicted, autonomous motivation was associated with increased total physical activity This provides additional evidence for findings in previous studies among able-bodied persons (Bagoien & Halvari, 2005; Chatzisarantis & Hagger, 2009; Chatzisarantis et al., 2002; Fortier et al., 2007; Hagger et al., 2003, 2005). It also corresponds to other research on people with disabilities (Saebu & Sorensen, 2010). In rehabilitation, the focus has often been on the health imperatives of physical activity, but this study indicates that autonomy support and autonomous motivation play an important role in predicting physical activity for people with disabilities. It further supports the SDT by confirming the relation among autonomy support, basic psychological needs, autonomous motivation, and healthy behavior (Ryan & Deci, 2000; Wilson et al., 2006).

According to Williams et al. (2004), patients are more likely to feel able to control important health outcomes when they are initiating the behaviors themselves. Results from the present study correspond well with Williams et al. who emphasized the importance of clinicians to support patients' self-initiated attempts to master a new technique or skill, and to encourage them to make informed decisions about healthy behavior. Over time, the patients will internalize the regulation of the behavior, and become more autonomous and competent in making healthy behavior changes and then sustaining the changes over time. This should also apply to people with physical disabilities in a rehabilitation setting. Different studies have shown that autonomous motivation has strong connections with positive emotions, interest, and enjoyment of physical activities (Reeve & Deci, 1996; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). In the present study, the strength of correlation between autonomous motivation and total physical activity indicates that this type of motivation is very important for persons with disabilities, too.

Further, perceived efficacy for physical activity was positively associated with total physical activity. It corresponds well with results among able-bodied persons, where efficacy and perceived competence are important correlates of physical activity (Trost et al., 2002) and recent research in populations with disabilities (Bean et al., 2007; Kroll et al., 2007). We noticed that there was no significant positive relation between autonomy support and efficacy, or between needs satisfaction and efficacy, indicating that autonomy support alone is not enough to impact efficacy for physical activity among persons with disabilities in the present study. Similar results have been demonstrated among able-bodied persons by Fortier et al. (2007), which did not reveal any differences in perceived competence in physical activity after an autonomy-supportive intervention. However, this is contrary to other research (Williams et al., 2006), and there is a need for future research in the domain of physical activity and the SDT process model. Results in the present study regarding efficacy may also be explained due to the ceiling effect on the efficacy scale, since the mean scores were high already at Time 1 (see

Table 2). According to Fortier et al., the time frame for assessment is important because it takes time to build feelings of competence. This may explain why the efficacy level also increased from the end of the intervention and up to the follow-up after 12 weeks (see Table 2).

The study revealed three significant indirect effects or mediators. A mediator is on the causal pathway between exposure to the intervention and program effects or outcomes. There may be a single mediator between the intervention and the outcome, or several mediators that intervene and are causally related in sequence, between the program and the outcome (Baron & Kenny, 1986). In the present study, autonomous motivation was a mediator of the relation between changes in basic psychological needs and change in physical activity level. This mediation supported previous research among able-bodied persons (Chatzisarantis & Hagger, 2009; Fortier et al., 2007). Thus, there is a need for additional research to examine other possible mediators between the autonomy-supportive intervention and change in physical activity for people with disabilities.

Further, we also recognize the indirect link between autonomy support and autonomous motivation through needs satisfaction. The results revealed a high level of needs satisfaction (see Table 2), indicating that autonomy, relatedness, and competence together played a role for the direct link to autonomous motivation. This is not surprising, as many of the participants highlighted the autonomy-supportive staff, facilitation for optimal challenges in activity, and the social benefits of being with other people with disabilities during the rehabilitation stay. The link between needs satisfaction and more autonomous physical activity motives has also been demonstrated in previous research (Hagger et al., 2006; Vlachopoulos & Michailidou, 2006; Wilson et al., 2006).

Among the needs, relatedness seems to be the most important one in this study, as it seems to interplay with autonomous motivation through and after the rehabilitation stay, and is indirectly linked to efficacy through autonomous motivation (see Table 3 and the bootstrapping results in the text above). This may be explained by the participant's unique possibility during the rehabilitation stay for sharing experiences with other persons with disabilities in adapted activities, and to be valued by peers with disabilities who have the experience to acknowledge the effort made. For many of the participants, this is quite unusual in their local environment due to a limited amount of persons with disabilities being physically active in small communities. However, the results are not in line with previous research among able-bodied persons, demonstrating that perceived relatedness was linked to controlling regulations for exercise (Peddle, Plotnikoff, Wild, Au, & Courneya, 2008; Wilson, Mack, Muon, & LeBlanc, 2007).

Participants may have felt connected to the staff and the other participants during the stay. Consequently, this may contribute to the changes in autonomous motivation during the stay, and following, indirectly making the participants more vulnerable after the stay, caused by the loss of contact with the rest of the group. We may also speculate in that they gained autonomy and competence during the stay, which is something they internalize, and thus are less vulnerable. The results also indicated that the lack of relatedness after the stay overran the effects of satisfaction of autonomy and competence, and consequently there were zero correlations between total needs satisfaction and the motivational variables (autonomous motivation and efficacy) from the end of the rehabilitation stay and until 12 weeks. The different impact of the needs may also contribute to the lack of predictive variables for the change in physical activity from T2 to T3, with an exception for autonomy support.

The results connected to relatedness may have the implication that there is a need for making the participants in a rehabilitation stay less vulnerable for the lack of their physical activity peers and the staff after the stay. Keywords for such strategies may be local-support groups after a rehabilitation stay, or continued contact with the staff and other participants via e-mail or a Web site.

Although basic psychological needs were included in this study, the study did not have an experimental design, and consequently no causal relations could be drawn. However, the effects of needs satisfaction on behavior may be both directly reflecting automatic processes of influence and indirectly reflecting influences due to deliberative processes.

We also examined an alternative longitudinal model of autonomy support at Time 1, needs satisfaction at Time 2, and physical activity at Time 3 (see Figure 1, Model 2). Previous studies have observed direct effects of perceived autonomy support on self-reported physical activity, when experiences related to needs satisfaction were not taken into consideration (Chatzisarantis & Hagger, 2009; Hagger et al., 2003, 2005). In the present study, needs satisfaction was included in the model, and perceptions of autonomy support demonstrated a direct effect on self-reported physical activity after 12 weeks, indicating a long-term effect for the autonomy-supportive intervention.

The present study demonstrated the effects of a longitudinal intervention program on physical activity behavior, but it is not without limitations. Recruitment of participants among young adults with disabilities in rehabilitation is difficult. Thus, the number of participants is limited and our sample size is small. According to this, the results of the present study may not apply to other people with disabilities with different physical abilities. Future studies might consider replicating results of the present study by conducting a larger scale intervention, if possible. Further, the intensive treatment led to significant change in physical activity during the rehabilitation stay, but we cannot conclude that changes in perceptions of autonomy and efficacy led to the change in physical activity, because changes in the motivation variables were occurring at the same time as the improvements in physical activity. In other words, improvement in physical activity could have produced the change in motivation or efficacy, or the relations could have been bidirectional. Finally, the study did not examine perceptions of structure and involvement that have been forwarded as important components of perceived interpersonal style (Taylor & Ntoumanis, 2007) that could represent effects in this context. Future studies should include perceptions of structure and involvement in rehabilitation settings, and examine if these constructs are divergently valid from satisfied competence and relatedness needs, respectively.

The present study leads to several conclusions. First, the self-determination model for health behavior with autonomy support, needs satisfaction, and changes in autonomous motivation and physical activity was supported. The paths with efficacy included were rejected. Second, the results supported significantly the indirect relations between autonomy support and change in autonomous motivation through needs satisfaction, and between needs satisfaction and change in physical activity through change in autonomous motivation. Finally, an alternative model indicated that autonomy support and needs satisfaction during the rehabilitation stay positively predicted total physical activity scores 12 weeks after the stay.

There is a need for additional research to develop and test self-determination interventions that would enhance patients' autonomous motivations and efficacies for physical activity. We therefore support previous calls for studies to include ways to improve health care practitioner autonomy supportiveness (Williams et al., 2004). According to the results, there is also a need for studies that focus on how patients can take more responsibilities for their health outcomes, and development of efficient techniques and instruments to improve perceived autonomy support. Traditionally, rehabilitation for people with physical disabilities has been directed by the medical expertise, i.e., an externally controlled motivation, with emphasis on the health benefits. However, in the last 10–15 years there has been a development toward more self-determination in rehabilitation (Shakespeare, 2006). The results of the present study support this priority.

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