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Promoting physical activity through a psychological group intervention in cardiac rehabilitation: a randomized controlled trial

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Abstract We examined the long-term effectiveness of a group-based psychological intervention ("MoVo-LISA") to promote physical activity in patients with coronary heart disease. In this randomized controlled trial, $N = 202$ inactive patients with coronary heart disease were assigned to the control group ($n = 102$; treatment as usual) or the intervention group ($n = 100$; treatment as usual plus MoVo-LISA). Physical activity was assessed at baseline, 6 weeks (post-treatment), 6 months, and 12 months after discharge. ANCOVA for repeated measures revealed a significant interaction effect [$p < .001$; $\eta_p^2 = .214$] indicating a large effect [$d = 1.03$] of the intervention on behavior change post-treatment. At 12-month follow-up, the level of physical activity in the intervention group was still 94 min per week higher than in the control group ($p < .001$; $d = 0.57$). Results of this RCT indicate that the MoVo-LISA intervention substantially improves the level of physical activity among initially inactive patients with coronary heart disease up to 1 year after the intervention.

Keywords Physical exercise · Long-term effects · Rehabilitation · MoVo-concept · Coronary heart disease

Introduction

It is well established that an adequate level of physical activity leads to a mentally and physically healthier life (Warburton, & Bredin 2017). Physically active people reduce their risk of cardiovascular diseases (Karjalainen et al., 2015; Murtagh et al., 2015), diabetes (Boniol et al., 2017), obesity (Conn et al., 2014) as well as mental disorders (Conn, 2010; Rimer et al., 2012). Physical activity does not only play an important role in the primary prevention of chronic diseases. Especially in the rehabilitation of coronary heart disease, patients enormously benefit from the positive effects of physical activity on cardiovascular mortality (Booth et al., 2014; Gielen et al., 2015). The American Heart Association (AHA), the U.S. Department for Health and Human Services, as well as the World Health Organization (WHO) recommend that adults aged 18–64 years should perform at least either 150 min per week of moderate-intensity aerobic physical activity or 75 min per week of vigorous-intensity aerobic physical activity or an equivalent combination of both to maintain their health (Arnett et al., 2019; Piercy et al., 2018; World Health Organization, 2010). These guidelines are also recommended for most patients with coronary heart disease (Fihn et al., 2012). During rehabilitation, the participation in physical activity is recommended to be supervised (Fihn et al., 2012). However, only 46% of patients with coronary heart disease follow these guidelines 1 year after cardiac hospitalization (Reid et al., 2006). Therefore, effective intervention programs are necessary to encourage regular physical activity initiation and maintenance after cardiac rehabilitation.

In order to change the physical activity habits of patients with chronic diseases, numerous individual or group-based interventions have been developed and evaluated. In a

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meta-analysis by Conn et al. (2008), the post-intervention effects of 163 reports of physical activity among chronically ill patients (e.g. cardiac diseases, diabetes, cancer) after an educational intervention were evaluated. They found that after treatment, patients in the intervention groups were more active for 48 min per week than those in control groups (d = .45). These positive effects of health-educational interventions on exercise behavior in secondary care are also found in patients with coronary heart disease (Cole et al., 2010; Ghisi et al., 2014). A meta-analysis of 28 studies provided evidence that subjects receiving a social cognitive-based intervention exercised more than those in the usual care groups immediately after the intervention (SMD = .69) and in follow-up (6–12 months; SMD = .25) (Zhu et al., 2013). More recent randomized controlled trials used various behavior change techniques (e.g. information about health behavior, goal-setting, self-monitoring, feedback) to improve physical activity habits among patients with coronary heart disease (Alsaleh et al., 2016; Sudeck, & Hoener 2011; Ter Hoeve et al., 2018). Alsaleh et al. (2016) compared the effects of a behavior change intervention consisting of one face-to-face group meeting and six telephone calls over 6 months to a usual care group. The intervention was based on Social Cognitive Theory and Self-Efficacy Theory (Bandura, 1977, 2004) and promoted goal-setting, self-monitoring and feedback through motivational interviewing. The results showed a significant difference in moderate physical activity of 129 min per week post-intervention between the intervention group and the control group receiving treatment as usual (238 vs. 109 min per week; $p < .05$). Furthermore, 88% of the intervention group followed the recommendations of the WHO (150 min/week of moderate physical activity) compared to 24% of the control condition ($p < .05$; Alsaleh et al., 2016). In contrast, however, Ter Hoeve et al. (2018) did not find any difference between the usual care group and both intervention groups (three face-to-face group sessions or six telephone coaching sessions) regarding physical activity. The interventions in their study consisted of behavior change techniques such as information about health behavior, self-monitoring, goal setting, feedback, barrier identification, and relapse prevention (Ter Hoeve et al., 2018). These recent incongruent results on the efficacy of motivational and volitional interventions in patients with coronary heart disease point out the need for further research to improve physical activity behavior in cardiac rehabilitation with a theory-based and standardized intervention that integrates the most relevant motivational and volitional techniques to change someone's behavior.

The present study investigates the effects of an intervention that integrates both motivational and volitional aspects of behavior change, the psychological group program "MoVo-LISA", based on the **Mo**tivation-**Vo**lition process model to promote **L**ifestyle-**I**ntegrated **S**port **A**ctivity (Fuchs et al., 2011). The MoVo process model summarizes the most relevant findings from social cognition models (Ajzen, 1991; Bandura, 2001) and action control theories (Kuhl, 2000; Schwarzer, 2008) and is described in detail in the Method section. Based on this model, MoVo-LISA provides motivational and volitional strategies for participants to develop a physically active lifestyle. The *motivational strategies* aim at forming a strong and self-concordant goal intention, whereas the *volitional strategies* support participants to develop implementation competencies as well as action control abilities. The detailed manual of the MoVo-LISA group intervention is described in Goehner and Fuchs (2007). MoVo-LISA was first introduced internationally in publications by Goehner, Seelig and Fuchs (2009) as well as Fuchs et al. (2011). Several publications on specific aspects of the program followed since then (Fuchs et al., 2012, 2017; Gerber et al., 2010; Goehner et al., 2009, 2015). The effects of the MoVo-LISA program on physical activity have been investigated in two non-randomized clinical studies (Fuchs et al., 2011; Gerber et al., 2010). One study investigated the effects of the intervention among individuals with overweight and obesity and found a significant increase of 101 min per week regarding exercise duration from pre-intervention to the 4-month follow up ($p < .001$, Gerber et al., 2010). The second study investigated the effects of MoVo-LISA provided in an orthopedic in-patient rehabilitation in a quasi-experimental design with a follow-up of 12 months (Fuchs et al., 2011). Results of this study showed that 12 months after discharge, the MoVo-LISA group was more active than the usual care group by 28.5 min per week (p = .05). Mediation analyses of the psychological mechanisms underlying the observed behavior change suggest that action planning was critical in particular at the initiation stage of regular physical activity ($p < .01$), whereas barrier management strategies were important at the maintenance stage of the newly acquired behavior ($p < .01$) (Fuchs et al., 2012). However, these results are based only on quasi-experimental (non-randomized) data. The current study is the first to provide evidence from a randomized controlled design with a long-term follow-up of 12 months in patients with coronary heart disease.

Research question

The aim of the current study was to examine the effects of MoVo-LISA provided in cardiac in-patient rehabilitation in a randomized controlled trial with a long-term follow-up of 12 months. We hypothesized that the intervention group would show a substantially higher level of physical activity 12 months after discharge than the control group who

received usual care. Furthermore, we hypothesized that during the 12 months following discharge, participants who received MoVo-LISA would be more compliant to the WHO recommendations of 75 min per week of vigorous-intensity aerobic physical activity compared to the control group.

Method

The study procedures were approved by the research ethics board of The University of Applied Sciences Idstein and the reporting of this study adheres to the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Schulz et al., 2010).

Study design and procedure

This study is a randomized controlled trial with an intervention group receiving MoVo-LISA and treatment as usual and a control group receiving only treatment as usual. The treatment consisted of the standard rehabilitation program of a cardiac rehabilitation clinic in Southern Germany. This rehabilitation program followed the national guidelines of best-practice care for people with coronary heart disease and consisted of medical examinations and therapy, exercise and physical therapy, educational sessions to enhance the knowledge of a healthy lifestyle as well as recommendations to participate in an aftercare program (e.g., cardiac exercise groups).

Assessments consisting of self-report questionnaires took place at five time points (Fig. 1: study design): At clinic admission (T1), at clinic discharge (T2), as well as 6 weeks (T3; post-intervention), 6 months (T4), and 12 months after discharge (T5). The questionnaires of T1 and T2 were distributed and collected within the clinic; all further questionnaires were sent to participants' home addresses by postal mail. Participants did not receive any incentives for taking part in this study.

Participants

The sample consisted of patients who were registered for a 3-week in-patient cardiac rehabilitation program in a clinic in Southern Germany. At admission, patients underwent a medical examination and were asked to participate in the study. Inclusion criteria were (a) 18–75 years of age, (b) physically inactive [< 30 min/week] for the last 3 months and (c) coronary heart disease, diagnosed by a physician. Exclusion criteria were: (d) chronic cardiac insufficiency, (e) cardiac valve surgery, (f) myocarditis; ejection fraction < 40%, (g) cardiac pacemaker, and (h) diagnosis of a mental disorder. These criteria were checked by a physician to guarantee that only patients who were able to be physically active were included in this study. Eligible patients were invited to sign the informed consent and take part in the first assessment (T1).

Sample flow and sample description

Figure 2 shows the participant flow of this study from enrollment to analysis. The recruitment started in January 2014 and ended in September 2015. After answering questions about their diagnosis, their physical activity level, their general willingness to behavior change and their psychological health, a total of $N = 323$ patients with coronary heart disease were assessed for eligibility for the study. Of these persons, $n = 53$ did not meet the inclusion criteria.

Furthermore, $n = 11$ patients dropped out from the in-patient rehabilitation in the first week because they had to be returned to acute care. Of the 259 eligible patients, 57

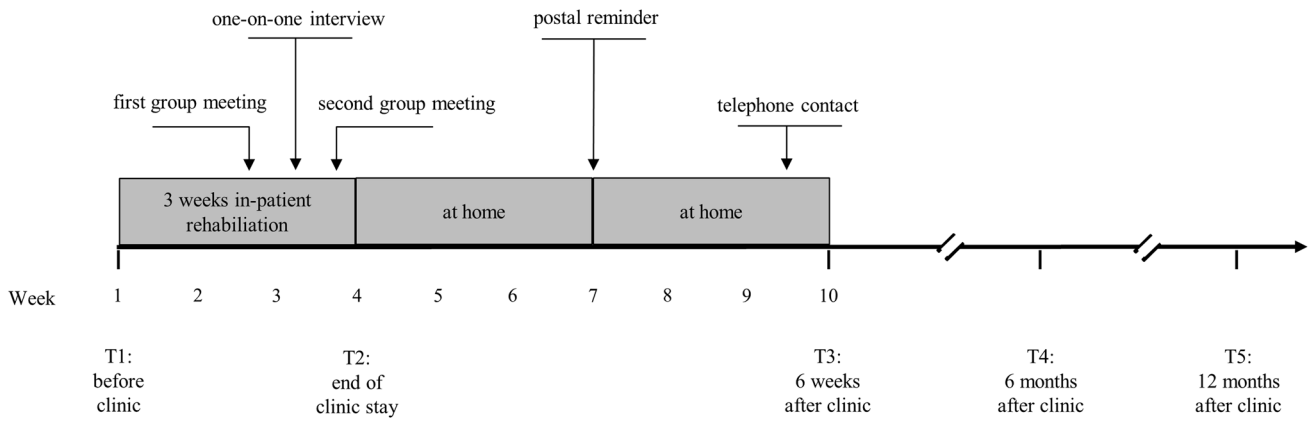
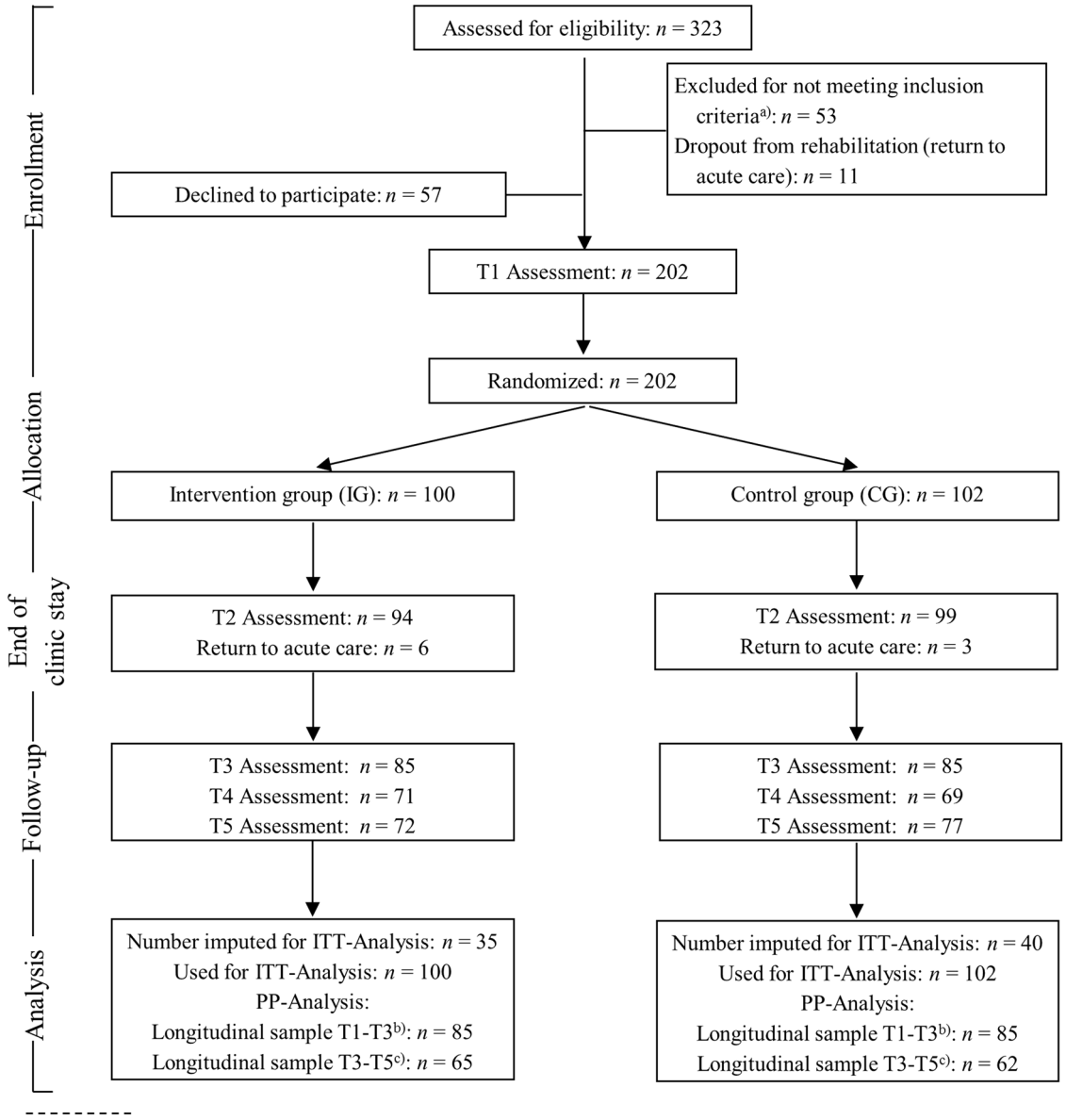


Fig. 1 Study design: Intervention design (above arrow) and measurement design (below arrow)



[a] inclusion criteria: age: 18 - 75 years, physically inactive (< 30 min/week), no chronic cardiac insufficiency, no cardiac valve surgery, no myocarditis, ejection fraction > 40%, no cardiac pacemaker

[b] Sample T1-T3 comprises all participants with complete data sets for T1, T2 and T3 (PP-Analysis)

[c] Sample T3-T5 comprises all participants with complete data sets for T3, T4 and T5 (PP-Analysis)

Fig. 2 Participant flow from enrollment to analysis

declined to participate in this study so that 202 patients were eligible for the study and were included and randomized (intervention group: $n = 100$; control group: $n = 102$). Six persons of the intervention group and three persons of the control group could not take part in the T2 assessment due to return to acute care. Study drop-out was at 4.5% (intervention group: $n = 94$; control group: $n = 99$) at T2, 15.8% (intervention group: $n = 85$; control group: $n = 85$) at T3, 30.7% (intervention group: $n = 71$; control group: $n = 69$) at T4, and 26.2% (intervention group: $n = 72$; control group: $n = 77$) at T5.

The sociodemographic characteristics of the sample ($N = 202$) are shown in Table 1. With regard to these characteristics, there were no significant differences between the intervention group and the control group except for age (intervention group: $M_{age} = 57$ years,

Table 1 Demographic characteristics of the sample at baseline (T1)

Characteristics	Intervention group (n = 100)	Control group (n = 102)	Difference between groups
Age [years; mean (SD)]	57 (8.2)	60 (8.9)	p = .01
Body mass index [kg/m^2; mean (SD)]	28.3 (4.5)	29.4 (5.5)	p = .11
Sex [n; (% of group)]			
Male	79 (79.0)	75 (73.5)	p = .36
Partnership [n; (% of group)]			
Alone living	24 (24.0)	25 (24.5)	
With partner	76 (76.0)	77 (75.5)	p = .93
Education [n; (% of group)]			
No degree	1 (1.0)	0 (0.0)	
Hauptschule[a]	41 (41.0)	44 (43.1)	
Realschule[b]	24 (24.0)	21 (20.6)	
Abitur[c]	35 (35.0)	30 (29.4)	
Other	1 (1.0)	5 (4.9)	p = .47
Employment status [n; (% of group)]			
Full-time work	60 (67.4)	58 (65.2)	
Part-time work	10 (11.2)	10 (11.2)	
Currently unemployed	19 (21.4)	21 (23.6)	p = .93
Rehab history [n; (% of group)]			
In-patient treatment before	16 (16.0)	19 (18.6)	p = .62
Smoking status [n; (% of group)]			
Smokers	25 (25.0)	20 (19.6)	p = .36

SD standard deviation; *n* number of cases

[a]Basic secondary school

[b]Middle-level secondary school

[c]General qualification for university entrance

SD = 8.2; control group: M_{age} = 60 years, *SD* = 8.9; p = .01).

MoVo process model

The MoVo process model postulates that five motivational-volitional factors influence health behaviors, such as physical activity: strength of goal intention, self-concordance of this goal intention, action planning, barrier management and outcome experiences (in detail: Fuchs et al., 2012, 2017).

Goal intention is the central motivational construct of the MoVo process model. Goal intentions are the results of motivational processes of weighing up the cost and benefits of the behavior (outcome expectations), and appraising one's own ability to perform it successfully (self-efficacy). There are two parts of this central motivational construct: strength of goal intention, which explains the degree of firmness a person expresses towards an intended action, as well as the self-concordance of this goal intention. Self-concordance refers to the extent to which a specific goal intention is congruent with the basic needs, interests and values of the person (Sheldon, 2014). To translate goal intentions into real actions, they need an exact action planning in which a person specifies the when, where, and how of an intended action (Gollwitzer, 1999). For instance: "I intend to participate at the Pilates course on Wednesday 8 a.m. at the City Health Centre." The likelihood of initiating and continuing regular physical activity is significantly enhanced by carefully elaborated action plans (de Vet et al., 2011). However, despite a careful action planning internal (e.g. lethargy) and external (e.g. unexpected appointments at work) barriers put the intended actions at risk on a daily basis. Therefore, volitional strategies of barrier management such as mood management, stimulus control, cognitive restructuring, or attention control (Kuhl, 2000) can help to keep the intended actions on target. After their physical activity, people evaluate the newly performed behavior and compare their experiences with their own expectations (Goehner et al., 2009). Depending on the outcome experiences people make during and after physical activity, they confirm or change their outcome expec-

tations. Based on these outcome expectations, they maintain or modify their future goal intentions [cf., Rothman's (2000) concept of 'perceived satisfaction with received outcomes'; Fuchs et al., 2017].

Intervention

MoVo-LISA is a standardized and published intervention for different settings and target groups (Goehner, & Fuchs 2007) and consists of five modules (Fig. 1: intervention design). Licensed sports therapists and physiotherapists were trained to conduct the intervention during a two-day seminar and received information about the theoretical background and the implementation of the program in order to increase the level of standardization. These therapists were also part of the team that conducted the usual care program. The size of MoVo-LISA groups differed between three and six persons during the recruitment period.

First group session

The first group session was scheduled for 60 min at the end of the second week of the 3-week clinic stay. This session aimed at clarifying personal health goals and collecting activity ideas. Patients were asked to find structured exercise activities, e.g. Nordic walking or gym exercises, or lifestyle physical activities, e.g., taking the bike or walking to work, that they enjoy and would be ready to engage in to achieve their personal health goals. Then, patients chose the one activity that fitted best into their daily routines and could be implemented in the long term. This activity was translated into a concrete exercise plan that had to be personalized (referring to self-concordance), practical (work within daily activities), precise with regard to time, place, sport-partner, and occasion (referring to implementation intentions), and effective with regard to the individual health problem (Goehner et al., 2009).

One-on-one session

Three days after the first session, participants were scheduled for a 10-min one-on-one session. In this personal meeting the individual plans were discussed in detail with the therapist who helped each patient to find the best fitting exercise plan and made sure that it could be implemented in the daily routines.

Second group session

At the end of the clinic stay, the second group session took place, scheduled for 90 min. The second group session introduced anticipation of internal and external barriers (i.e., being tired, not having enough time). Participants were also taught how to manage barriers by applying volitional strategies of barrier management. This group meeting was scheduled on the very last day of the clinic stay in order to facilitate the transition into everyday life after discharge.

Aftercare modules

To support patients in their commitment during the first 6 weeks after discharge, which is supposed to be a crucial time point in implementing physical activity, the last two components of MoVo-LISA were placed. A postal reminder was sent out 3 weeks after the in-patient rehabilitation and 6 weeks after discharge, the participants received a 10-min telephone to discuss how well they implemented their activity plans in their daily routine by then (Goehner et al., 2009).

During their clinic stay, all patients of both intervention and control groups frequently had contact to the therapists as part of the usual care. Besides the intervention participants of both groups had personal contact to the study staff twice during their clinic stay to fill out the questionnaires.

Randomization

A randomization list was created by a researcher (SK) before trial begin using Excel 2007 (Microsoft, Redmond, WA, USA) with a 1:1 allocation. At the end of every week during recruitment, an independent member of the clinical staff not involved in the intervention or study accessed the randomization list and conducted the allocation for the included participants.

Measures

Participants filled out five identical questionnaires consisting of all psychological constructs of the MoVo process model including physical activity as behavior outcome. In this publication we only report on physical activity as the intervention effects on the mediators are very complex and go beyond the scope of this paper. Physical activity was measured with the BSA-questionnaire (Bewegungs- und Sportaktivität Fragebogen), a validated German self-report instrument to measure the level of physical activity, exercise and sports participation in minutes per week (Fuchs et al., 2015). The participants named a maximum of three exercise or sports activities they had regularly engaged in within the last 4 weeks and indicate the frequency and duration in minutes for each activity episode. If the named activity did not involve larger groups of skeletal muscles

and lead to maintenance of or increases in endurance, power, coordination, or flexibility, this activity would be classified as invalid. In total, six activities named by the subjects (walking a dog, breathing exercises, gardening, bowling, forestry work, taking a walk) were classified as invalid and excluded from further calculations. For each valid activity, an activity amount in "minutes per week" was computed by multiplying frequency by duration and—since the subjects reported the frequency within the last 4 weeks—dividing it by four. To adjust the amount of very long-lasting exercise or sports activities typically containing a lot of rest periods (e.g., downhill skiing, hiking), the single amounts of those activities were truncated to 120 min per week. Then, all single amounts of the named exercise activities were added up to obtain the individual's score on the *Physical Activity Index*. Physical activity was assessed at the time points T1 (at clinic admission), T3 (6 weeks after discharge), T4 (6 months after discharge) and T5 (12 months after discharge) (Fig. 1). As all participants received the standard rehabilitation program of the cardiac clinic, the amount of physical activity did not differ between subjects at clinic discharge (T2). Also, the specific exercise therapy provided at the clinic was not comparable with normal daily PA before and after the clinic. Therefore, there was no assessment of physical activity at T2.

Statistical analyses

Intention-to-treat (ITT) analyses and additional per-protocol (PP) analyses of the physical activity index (mean) as well as the percentage of those who exercise for at least 75 min per week were conducted to address the problem of attrition bias. 37.1% of the participants displayed missing data over all assessment points (Fig. 2). Missing values analyses were performed and data missing completely at random (MCAR) was assumed since there were no significant differences between background variables for subjects with complete versus incomplete data, and Little's test for MCAR was not significant (χ^2 [16, $N = 149$] = 15.015, $p = .524$) (Little, 1988). Missing values were then imputed using the expectation maximization algorithm within Missing Values Analysis (SPSS 24). We conducted repeated measures analyses of covariance (ANCOVA) with age and sex as covariates and group (intervention and control group) as treatment factor. All statistical analyses were separated in the analysis of the intervention effect (T1–T3) and the analysis of the maintenance of the intervention effect (T3–T5). This separation of the ANCOVA better reflects the post-treatment and sustainability effects as it is expected that both intervention and control group improve their physical activity level until the end of the intervention/control-condition (interaction effect group-by-time) and after that try to sustain their physical activity level, which is best represented by the main effect "group". As a result of the listwise exclusion of missing data in the PP analyses, the sample sizes differ between the first longitudinal sample T1–T3 (IG: $n = 85$; CG: $n = 85$) and the second longitudinal sample T3–T5 (IG: $n = 65$; CG: $n = 62$). Independent-samples t-Tests with Bonferroni-Holm-correction were conducted at every time point to compare both groups. Generally, the level of significance was set at $p < .05$ for all analyses. All data were analyzed using SPSS Statistics 24.

Results

Intention-to-treat analysis

Means on the physical activity index

Means on the physical activity index of the intervention group and control group are shown in Fig. 3a. Table 2 also displays means and standard deviations as well as the results of all ANCOVAs for repeated measures. Post-treatment (T3), both groups increased their level of physical activity from initially 0 min per week (T1; inclusion criteria) to an average of 308 min per week (intervention group), respectively 133 min per week (control group), suggesting a significant between-group difference 6 weeks after discharge ($p < .001$; Table 2). At the 6-month follow-up (T4), both groups reduced their level of physical activity, but the intervention group remained significantly more active than the participants of the control condition ($p = .003$). Finally, 12 months after discharge, the physical activity level of the intervention group remained almost stable with 198 min per week on average and was substantially higher than of the control group with 104 min per week on average ($p < .001$; Table 2).

An ANCOVA for repeated measures (T1–T3) with two factors (group [2], time [4]) as well as sex and age as covariates revealed a significant interaction term group-by-time ($p < .001$) indicating a large effect of the MoVo-LISA intervention on behavior change after the intervention (T3) [$d = 1.03$]. A second analysis of covariance for repeated measures (T3–T5) was conducted to estimate the maintenance of the intervention effect (main effect "group") and yielded a significant main effect group ($p < .001$; Table 2).

Percentages on the physical activity index

Figure 4a shows the percentage of participants who exercise for at least 75 min per week. The reference point at 75 min per week was set because many participants in this

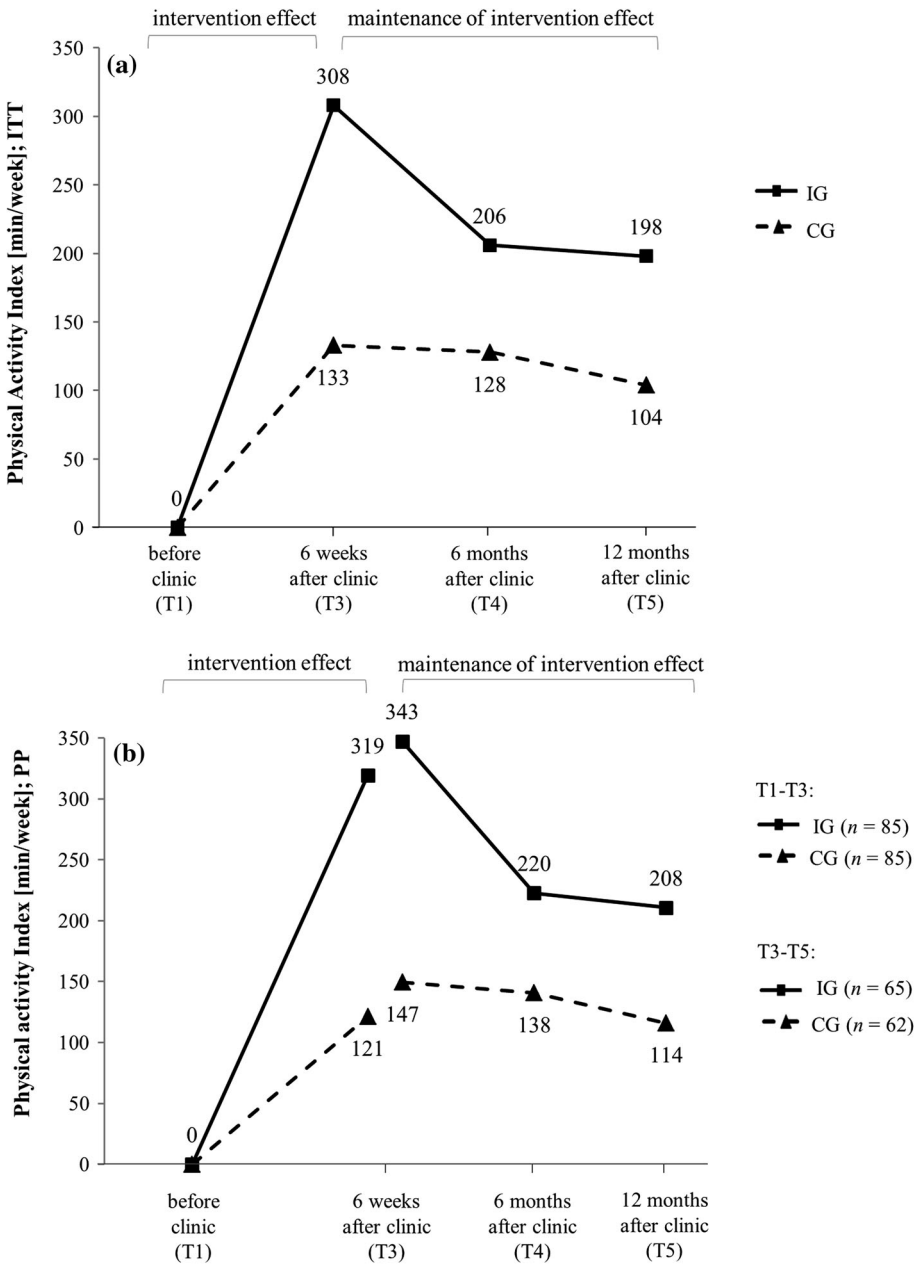


Fig. 3 *a* + *b*, Means of physical activity index [min/week]; **a** ITT analysis; **b** PP analysis. *IG* intervention group, *CG* control group

study did not only engage in moderate-intensity physical activities such as Nordic walking or hiking but also in vigorous activities (e.g., running, fitness training). Thus, the recommendation of the WHO (2010) for vigorous-intensity activities was chosen as an appropriate reference point for all participants (including those who are mainly moderate-intensively active).

As both groups were physically inactive at T1, the percentage at the first time point was 0%. After the intervention (T3), 92% of the intervention group and 59% of the control group were more than 75 min per week physically active which is a significant group difference ($p < .001$). Six months after discharge at T4, both groups' percentages were reduced to 70% in the intervention and 46% in the control condition (group difference: $p = .001$). At the 12-month follow-up (T5), the percentage of active participants who exercised for at least 75 min per week was 27% higher in the intervention than in the control group and the between-group difference was also significant ($p < .001$; Table 2).

Per-protocol analysis

The PP analyses comprised all participants with complete data sets for T1 and T3 (intervention effect; intervention group: $n = 85$; control group: $n = 85$), respectively with complete data sets for T3, T4 and T5 (maintenance of intervention effect; intervention group: $n = 65$; control group: $n = 62$; Fig. 2).

Table 2 Means and standard deviations of PA index and percentage of PA for IG and CG (ITT- and PP-analyses). Intervention and group effects (ANCOVA)

ITT-analysis		Means (M) and standard deviations (SD)				Intervention effect (interaction effect "group × time" with data from T1 to T3)				Maintenance of intervention effect (main effect "group" with data from T3 to T5)			
Variable		*T1* M (SD)	*T3* M (SD)	*T4* M (SD)	*T5* M (SD)	*F* (group by time)	*df*	*p*	η_p^2	*F* (group)	*df*	*p*	η_p^2
PA Index means [min/week]	IG	0 (0)	308 (199)	206 (211)	198 (191)	54.062	1, 198	< .001	0.214	31.335	1, 198	< .001	0.137
	CG	0 (0)	133 (136)	128 (161)	104 (133)								
Test of significance[a]			< .001	.003	< .001								
Effect size (Cohen's d)			1.03	0.42	0.57								
Percentage of PA [≥ 75 min/week]	IG	0 (0)	92.0 (27.3)	70.0 (46.1)	74.0 (44.1)	30.886	1, 198	< .001	0.135	23.949	1, 198	< .001	0.108
	CG	0 (0)	58.8 (49.5)	46.1 (50.1)	47.1 (50.2)								
Test of significance[a]			< .001	.001	< .001								
Effect size (Cohen's d)			0.83	0.50	0.57								
PP-analysis		Sample 1[b]		Sample 2[c]									
		T1	*T3*	*T3*	*T4*	*T5*							
PA Index means [min/week]	IG	0 (0)	319 (202)	343 (213)	220 (240)	208 (194)	52.674	1, 166	< .001	0.241	19.556	1, 123	< .001	0.137
	CG	0 (0)	121 (143)	147 (154)	138 (188)	114 (158)							
Test of significance[a]			< .001	< .001	.036	.006							
Effect size (Cohen's d)			1.13	1.10	0.38	0.53							
Percentage of PA [≥ 75 min/week]	IG	0 (0)	90.6 (29.4)	90.8 (29.2)	63.1 (48.6)	69.2 (46.5)	36.189	1, 166	< .001	0.179	14.320	1, 123	< .001	0.104
	CG	0 (0)	50.6 (50.3)	58.1 (49.7)	43.6 (50.0)	46.8 (50.3)							
Test of significance[a]			< .001	< .001	.027	.020							
Effect size (Cohen's d)			0.97	0.81	0.40	0.46							

PA physical activity, *IG* intervention group; *CG* control group, *ITT* intention-to-treat, *PP* per-protocol

[a]Between groups at the given time point (B-H-adj. *p*-level)

[b]PP-analysis: Sample 1: IG (n = 85), CG (n = 85)

[c]PP-analysis: Sample 2: IG (n = 65), CG (n = 62)

Means on the physical activity index

Means on the physical activity index of the intervention and control group for the PP analysis are shown in Fig. 4a. ANCOVA for repeated measures yielded a significant interaction term group-by-time for the intervention effect from T1 to T3 ($p < .001$) as well as a significant main effect group from T3 to T5 ($p < .001$; Table 2) which reflects the sustainability of the intervention effect. Between group comparisons revealed significant differences post-intervention (T3; $p < .001$), 6 months after discharge (T4; $p = .036$) and at the 12-month follow-up (T5: $p = .003$; Table 2).

Percentages on the physical activity index

Figure 4b displays the percentage of participants with complete data who exercise for at least 75 min per week. Congruent to the between group comparison of the physical activity index, the analyses yielded significant differences after the intervention (T3; $p < .001$), at the 6-month

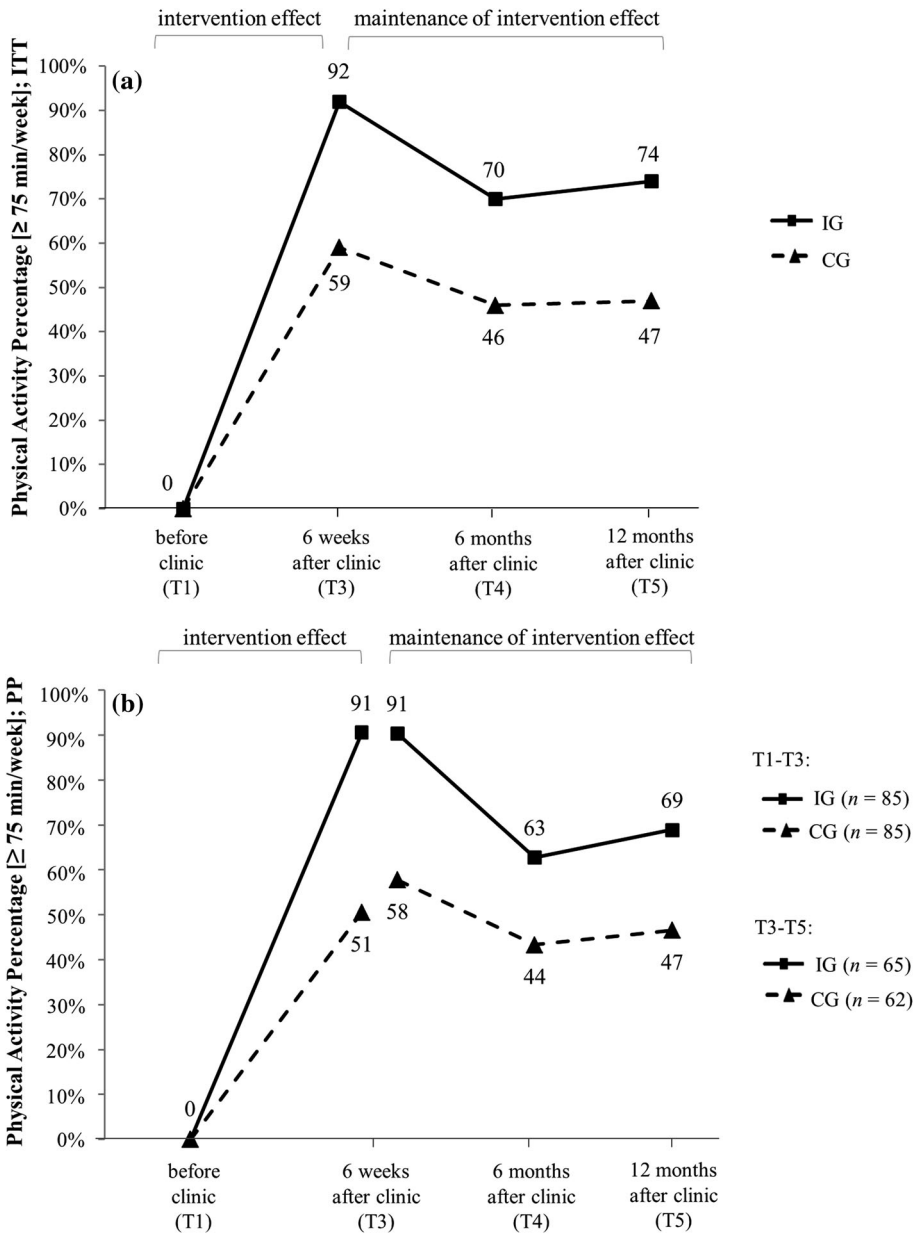


Fig. 4 *a* + *b*. Percentage of participants who exercised for at least 75 min per week; **a** ITT analysis; **b** PP analysis. *IG* intervention group, *CG* control group

follow-up (T4; $p = .027$), and finally 12 months after discharge (T5; $p = .010$).

Discussion

This is the first study that investigated the long-term effects of MoVo-LISA on the basis of a randomized controlled design in patients with coronary heart disease. Results of both ITT and PP analyses indicated that MoVo-LISA substantially improves the level of physical activity among initially inactive patients with coronary heart disease up to 1 year after the intervention. After the intervention (T3), patients who received MoVo-LISA were significantly more active in terms of minutes per week ($M = 175$ min per week) compared to those patients who did not participate in this intervention ($d = 1.03$, ITT). At the 12-month follow-up, participants in the intervention group were still exercising an average of 94 min per week more than those in the control group which equals a medium effect ($d = .57$, ITT). Likewise, 12 months after discharge, the percentage of those who were exercising at least 75 min per week (WHO recommendation) was 27% (ITT) higher in the intervention group than in the control group. Again, this effect is of medium size ($d = .57$). Both ITT and PP analyses showed similar result patterns (by looking at means and percentages) with slightly higher scores of physical activity in the PP analysis. These higher scores may be due to the fact that in the PP analysis only adherent participants were considered whereas the ITT analysis also

included the dropouts who were more likely not to exercise. It is noteworthy that the control group also showed substantial improvements in the level of physical activity pointing to the high motivational quality of the usual care program of the clinic. However, MoVo-LISA added a substantial behavior change effect over and above the standard rehabilitation. It is also important to note that the intervention and control groups did not differ regarding their chosen physical activities as the most frequently performed activities in both groups were walking/Nordic Walking, cycling and fitness exercises over all time points.

The general picture of these findings is in accordance with earlier evaluations of the MoVo-LISA program. In the investigation by Fuchs et al. (2011), the MoVo-LISA group was still exercising 28.5 min per week on average more than the usual care group 12 months after discharge (96.1 vs. 67.6 min per week; $p = .05$). In the present study, the difference between both groups at the 12-month follow-up was substantially higher with an average of 94 min per week between the intervention and control group. A possible explanation for these diverging findings could lie in the different target samples in orthopedic patients (Fuchs et al., 2011) and in patients with coronary heart disease (present study). As the recommendations of the therapists regarding physical activity are specific to the diagnosis, patients with musculoskeletal conditions may be more likely to choose strengthening exercises whereas coronary heart disease patients are recommended to do long lasting endurance training such as walking or hiking. Similar to the present study, Sudeck and Hoener (2011) also focused on cardiac inpatients in a rehabilitation facility and found higher levels of physical activity supporting the previous explanation. 12 months after discharge, participants receiving a psychological group program to promote physical activity were more active for 30 min per week than the usual care group (145 vs. 115 min per week; $p < .05$; SMD = 0.22; Sudeck and Hoener 2011). The present findings are supported by Alsaleh et al. (2016) who also reported high levels of physical activity 6 months after a behavioral intervention in patients with coronary heart disease (238 [intervention] vs. 109 [control] minutes per week; $p < .05$). Furthermore, in Alsaleh's study 88% of the intervention group met the recommendations of the WHO 6 months after the intervention compared to only 24% of the usual care group which is also close to the results of the current study (ITT: 70% vs. 46%).

Taken together the available evidence from non-randomized previous studies (Fuchs et al., 2011; Gerber et al., 2010) and from the randomized controlled trial reported in this paper, MoVo-LISA has shown to be a successful intervention program to help people with chronic diseases, especially coronary heart disease, sustainably improve their physical activity behavior. We attribute the success of this program to the systematic translation of theoretical concepts (MoVo process model) into a concretely written curriculum (Goehner, & Fuchs, 2007) with which the therapists were trained to become group leaders of MoVo-LISA. The theory-based and standardized content of this intervention may be an important factor for the success of this program and also distinguishes the present study from past publications in the field of physical activity promotion in cardiac rehabilitation.

Limitations

Some methodological limitations of the study have to be discussed. External validity is limited by a sampling bias as the study was conducted in only one clinic. Threatening the internal validity, the attrition rate between T1 and T5 was at 37%. Furthermore, there was a significant difference between participants and dropouts regarding age ($p = .005$). Younger participants were more likely to quit their participation in the study. However, there were no differences with regard to sex, BMI, family status, or education between participants and dropouts. As no objective measures of physical activity were applied, there is a risk that this measurement has been biased by socially desired response tendencies. It might also be hypothesized that these response tendencies are more pronounced in the intervention group because of the enhanced commitment and awareness of the importance of physical activity in this study.

Furthermore, patients participating in this study might also have been more confident in beginning to exercise than patients who refused to take part in the study. Thus, it is possible that MoVo-LISA especially reaches patients who feel more comfortable engaging in regular physical activity. This could also be an explanation why the intervention and control groups have higher levels of physical activity than other cardiac rehabilitation studies (Alsaleh et al., 2016; Sudeck, & Hoener, 2011).

In this paper, we did not address the underlying psychological mechanisms that led to the enhanced physical activity levels in the intervention group as the mediation effects are very complex and go beyond the scope of this paper. Thus, we cannot draw direct conclusions about the effects of the intervention on motivational and volitional factors.

Practical and future implications

MoVo-LISA is a short and standardized program that enables rehabilitation patients to become physically active on a regular basis after clinic discharge. It can be realized as part of the standard rehabilitation care and, thus, reach

sedentary patients who want to change their physical activity behavior but would otherwise not receive sufficient guidance from the usual rehabilitation programs to transform their intention into concrete actions. Even outside the rehabilitation setting, this program has the potential to substantially improve physical activity behavior and therefore reduce the risk of chronical diseases. Results reported in this study suggest that with MoVo-LISA, almost every participant exercised for at least 75 min per week after the intervention (92%; control group: 58%) indicating a strong intervention effect on physical activity. At the 12-month follow-up, the rate of those who exercised for at least 75 min per week reduced to 74% (CG: 47%) revealing that the perpetuation of the reached activity level is in need of improvement to further support the rehabilitation aftercare. One way to sustain physical activity could be to use new technologies such as mobile applications to support participants in maintaining the acquired strategies from MoVo-LISA and, thus, stabilizing their physical activity level. This combination of a face-to-face counselling and mobile application (blended intervention) should have great potential to help participants maintaining their newly acquired physical activity behavior.

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Compliance with ethical standards

Conflicts of interest Ramona Wurst, Stephan Kinkel, Jiaxi Lin, Wiebke Göhner, Reinhard Fuchs declare that they have no conflict of interest.

Human and animal rights and Informed consent All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all individual participants included in the study.

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