The effects of a lifestyle physical activity counseling program with feedback of a pedometer during pulmonary rehabilitation in patients with COPD: A pilot study

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Abstract

Objective: To study the effects of a lifestyle physical activity counseling program with feedback of a pedometer during pulmonary rehabilitation.
Methods: Twenty-one chronic obstructive pulmonary disease (COPD) patients were randomized to an experimental group that followed a regular rehabilitation program plus the counseling intervention or to a control group that only followed rehabilitation. The primary outcome was daily physical activity assessed by pedometers. Secondary outcomes were physical fitness, health-related quality of life, activities of daily living, depression and self-efficacy.
Results: The experimental group showed an increase of 1430 steps/day (+69% from baseline), whereas the control group showed an increase of 455 steps/day (+19%) ($p = 0.11$ for group × time interaction). The secondary outcomes showed no differences.
Conclusion and practice implications: This study showed that the use of the pedometer, in combination with exercise counseling and the stimulation of lifestyle physical activity, is a feasible addition to pulmonary rehabilitation which may improve outcome and maintenance of rehabilitation results.
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Keywords: Exercise counseling; Pedometer; Lifestyle physical activity; COPD

1. Introduction

A major symptom experienced by patients with chronic obstructive pulmonary disease (COPD) is dyspnea during exertion. This symptom often leads to lower physical activity levels, which in turn may lead to deconditioning and a reduction in health-related quality of life.

Pulmonary rehabilitation has proved to being able to reverse this process, and the effects are well documented [1–3]. However, long-term effects are less clearly defined. Studies that have followed patients for a longer period show that benefits diminish after about 1 year [4,5]. Ries et al. [5] hypothesized that due to the unstable nature of their disease,

COPD patients may easily return to the spiral of inactivity and deconditioning when an intensive maintenance strategy is absent after the rehabilitation. Interestingly, home-based pulmonary rehabilitation programs have proven to provide long lasting effects, even after 5 years. One important feature of these programs was the use of normal life style activities [6–8].

We hypothesize that a physically active lifestyle of patients with COPD is essential for maintaining the benefits after rehabilitation. This can be achieved through lifestyle physical activities like walking, cycling, stair-climbing and gardening. By incorporating these activities during pulmonary rehabilitation, daily physical activity levels may remain higher after rehabilitation and the benefits of rehabilitation may last longer. The Dutch Norms for Healthy Physical Activity (DNHPA), which is derived from the

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norms of the American College of Sports Medicine (ACSM) [9–11], serve as reference for the effects of lifestyle physical activities on health.

In this study, we tried to enhance daily physical activity in patients with COPD by using a lifestyle physical activity counseling program with feedback of a pedometer. Such a program might be relevant for these patients because lifestyle physical activity programs turn out to be very effective in improving physical activity in healthy adults [12–14]. Because intensity and duration are interchangeable concerning energy expenditure in physical activity [15], lifestyle physical activities of moderate intensity with longer duration can replace high intensive physical activities of shorter duration. Low to moderate intensity activities are more appropriate for patients with COPD because of their low exercise tolerance, which is due to ventilator limitation and oxygen-uptake problems [16]. Furthermore, exercise counseling interventions have shown to be effective in increasing physical activity [17,18] and are of interest in maintaining physical activity [19], because they can be tailored to the needs and circumstances of the individual [17,19]. Finally, pedometers have proved to accurately detect steps taken, as an indication of volume of physical activity [20–22], and the feedback of the pedometer can be an important resource in increasing physical activity behaviors [23]. Pedometers offer new perspectives in changing physical activity behavior because patients can monitor themselves and can set concrete goals for increasing physical activity. Up to now, several studies have shown that pedometers are successful in increasing physical activity in healthy adults [24,25] and in various patient groups [26–30]. Schönhofer et al. [31] demonstrated that pedometers are feasible to assess the level of physical activity in patients with COPD.

Consequently, a lifestyle physical activity counseling program with continuous monitoring and feedback from a pedometer may be a suitable strategy for increasing and maintaining physical activity in patients with COPD. Until now, no intervention studies have been carried out that used a lifestyle physical activity counseling program with feedback of a pedometer in patients with COPD. Before long-term effects of this method can be measured, first the short-term effects must be mapped out. Therefore, the purpose of this study was to investigate the short-term effects of a lifestyle physical activity counseling program with feedback of a pedometer during a standard pulmonary rehabilitation on daily physical activity. Secondary effects on physical fitness, health-related quality of life, activities of daily living, depression and self-efficacy were also measured.

2. Methods

2.1. Study design

Patients who were referred for pulmonary rehabilitation were randomly assigned to an experimental or a control group. Patients in the experimental group followed a lifestyle physical activity counseling program with feedback of a pedometer next to a regular pulmonary rehabilitation program. The control group participated only in a regular pulmonary rehabilitation program. Patients in both groups were examined prior to the pulmonary rehabilitation (pretest) and after 9 weeks of rehabilitation (posttest). Descriptive characteristics and pulmonary function at baseline were assessed during a standard intake investigation prior to rehabilitation, and were carried out by the clinical staff, who was blinded for group assignment.

In the control group, patients wore the pedometer 1 week prior to the rehabilitation and 1 week during week 9 of their rehabilitation. Patients in the experimental group wore the pedometer for 10 weeks (1 week prior to rehabilitation and 9 weeks during rehabilitation). Patients were instructed to wear the pedometer over the course of the entire day until going to bed, and to record daily step counts in a diary. Patients also recorded in their diary at which time they put the pedometer on and at which time they put the pedometer off.

2.2. Patients

Thirty patients entering pulmonary rehabilitation at the Groningen University Center for Rehabilitation were eligible. Twenty-nine patients agreed to take part in this pilot study and signed a written informed consent. Criteria for inclusion were diagnosis of COPD (Stages I–IV) [33], aged between 40 and 85 years, and being able to read and write in Dutch. Patients were excluded if they used a wheelchair, if they had significant co-morbidity interfering with rehabilitation, and if they were assigned to rehabilitation modules other than the physical modules.

2.3. Intervention

Patients in both the experimental and control groups followed a regular pulmonary rehabilitation program according to evidence-based guidelines from the American College of Chest Physicians and the American Association of Cardiovascular and Pulmonary Rehabilitation [2]. The rehabilitation program contained exercise training, dietary intervention and psycho-educational modules.

The experimental group followed a lifestyle physical activity counseling program with feedback of a pedometer next to the regular pulmonary rehabilitation program. The aim of this intervention was to stimulate patients to increase their daily physical activity level by incorporating lifestyle physical activities into daily life. Patients received exercise counseling in order to motivate them to enhance physical activity in daily life and wore a pedometer in order to monitor changes in physical activity behavior. The pedometer was used as a motivational and feedback tool [29,30]. Lifestyle physical activities are physical activities that belong to the daily activity pattern (e.g. walking,

cycling, stair-climbing and gardening). Physical therapists carried out the exercise counseling after being trained. The counselors followed the principles of motivational interview technique [34,35]. Four individually exercise counseling sessions were carried out during the course of the study. Each session took approximately 30 min. The first counseling session was carried out 2 weeks prior to rehabilitation and dealt with motivation for increasing physical activity. In this session, the pedometer with user instructions were given to the patient. The second counseling session was carried out in week 1 of the rehabilitation and dealt with goal-setting. The third counseling session was carried out in week 5 of the rehabilitation and dealt with shifting boundaries. Mean steps/day were evaluated and patients were asked to set a goal for seeking their maximal physical activity limit once (measured in numbers of steps). The fourth counseling session was carried out in week 7 of the rehabilitation and dealt with consolidation of physical activity behavior. Patients were asked to set a goal for their personal physical activity norm, which should be between their mean steps/day until then and their maximal number of steps.

2.4. Outcome measures

The primary outcome measure was daily physical activity and was measured by the Yamax Digi-Walker SW-200 (Tokyo, Japan). In controlled laboratory settings, the Yamax SW series pedometers have consistently been shown to be among the most accurate. The SW-701 (which has the same step count mechanism as the SW-200) consistently gave values within 3% of actual steps taken during a self-paced walk, on an individual basis (Cronbach's α 0.99) [21]. Subsequently, the SW-200 pedometer was found to be 1 of the 4 models (among 13) that accurately measures steps taken during free-living physical activity [22]. Finally, the SW-200 pedometer was found to have similar accuracy in normal-weight, overweight and moderately obese individuals [36]. The SW-200 pedometer is easy to use. It is worn on the belt or waistband and responds to vertical accelerations of the hip during gait cycles.

Secondary outcome measures were physical fitness, health-related quality of life, activities of daily living, depression and self-efficacy. Physical fitness was measured by the 'chair stand test' (reliability: test–retest correlation r 0.80), 'the arm curl test' (reliability: r 0.81), the '8-foot up-and-go test' (reliability: r 0.95) and the '2-min step test' (reliability: r 0.90) [37,38]. The 2-min step test is an alternative for the 6-min walk test, which is more space- and time-consuming. The rate of perceived exertion (RPE) during the 2-min step test is comparable to the RPE during the 6-min walk test, 13.9 and 13.6, respectively, suggesting that the exercise intensity of these two aerobic endurance tests is similar [38].

Two instruments were used to measure health-related quality of life, namely the St. George's Respiratory Questionnaire (SGRQ) [39], a disease-specific health status questionnaire, and the RAND-36 [40], a generic health status questionnaire. The SGRQ consists of 76 items that measure 3 components: 'symptoms' (problems caused by specific respiratory symptoms), 'activity' (restriction of activities by dyspnea) and 'impacts' (impact on everyday life caused by the disease) (reliability: test–retest correlation r 0.92) [39]. The RAND-36, which is a Dutch translation of the MOS 36-item Short-Form Health Survey [41], consists of nine subscales. In this study, five subscales were used: physical functioning (reliability: Cronbach's α 0.92), vitality (Cronbach's α 0.82), bodily pain (Cronbach's α 0.88), general health perceptions (Cronbach's α 0.81) and change in health status (an one item subscale: no α available) [40].

Two instruments were used to measure activities of daily living. Independent functioning in daily living was measured by the Groningen Activity Restriction Scale (GARS) and consists of 18 items about personal hygiene and household activities of daily living (reliability: reported Cronbach's α range from 0.82 to 0.94) [42]. The Dutch Exertion Fatigue Scale (DEFS) measured exertion fatigue in the spheres of household, personal hygiene and social life. Exertion fatigue is defined as fatigue that is directly related to activity. A low score relates to less exertion fatigue in activities of daily living (reliability: Cronbach's α 0.91) [43].

Manifestations of depression were measured by the Beck Depression Inventory (BDI) [44]. The BDI is a self-administered 21-item self-report scale. The total score of the BDI indicates levels of depression, 0–4: possible denial of depression, 5–9: normal, 10–18: mild to moderate depression, 19–29: moderate to severe depression and 30–63: severe depression (reliability: Cronbach's α 0.81 for non-psychiatric populations) [45].

Self-efficacy in physical abilities was measured by the LIVAS [46], which is a Dutch version of the Perceived Physical Ability Subscale of the Physical Self-Efficacy Scale [47] (reliability: Cronbach's α 0.70) [46].

Fat-free mass was measured by a bio-electrical impedance meter (Bodystat 1500). Fat-free mass index (FFMI) was calculated by dividing fat-free mass (in kg) by the square of height (in m^2). Pulmonary function tests were performed following accepted standards [48], using a spirometer (Jaeger MS-IOS) and bodybox (Masterlab version 4.52i).

2.5. Statistical analysis

Means and standard deviations (S.D.) were calculated for most descriptive characteristics at baseline. The Mann–Whitney test was used for interval and ratio data, the Chi-square test for nominal and ordinal data to test for significant differences between experimental and control groups at baseline.

The primary outcome measure of daily physical activity was mean steps/day for 7 days (a complete week) including rehabilitation activity (7Rplus). Patients attended our clinic

3 days a week. The days of the week vary depending on the module that the patients follow; (a) Monday, Wednesday and Friday; (b) Monday, Wednesday and Thursday; (c) Tuesday, Thursday and Friday. The remaining 4 days without rehabilitation, including 1 weekend, formed the second step-count variable: 4Rmin. The third step variable was calculated by computing the weekend before pretest and posttest to 4Rmin. This variable thus consists of mean steps/day for 6 days without rehabilitation, including 2 weekends (6Rmin).

Means and S.D.s as well as 95% confidence intervals (CI) were calculated for most outcome measures. To facilitate the interpretation of results, effect sizes (d), calculated according to the method of Cohen [49], are also reported. An effect size of 0.2 is regarded as a small effect, 0.5 as a medium-sized effect, and 0.8 as a large effect [49].

Repeated measures analysis of variance was used to test for significant group × time interactions between the experimental group and the control group, i.e. the effect of the counseling intervention. Besides, the power was calculated. This indicates the change to find a significant result, when there is an effect in the population indeed.

Assumption of normality was tested with the Shapiro–Wilk test. Assumption of equality of covariance matrices was tested with the Box's test. Statistical analysis was performed with the Scientific Package of Social Sciences (SPSS) version 11.5. A p-value < 0.05 (two-sided) was considered statistically significant.

3. Results

Twenty-nine patients agreed to participate in this pilot study. Eight patients did not meet the inclusion criteria: five patients were excluded because they had no COPD and three patients because of the assignment to a rehabilitation module other than the physical modules. So, 21 patients were randomized to either the experimental or the control group. Five patients dropped out during the 9 weeks. Complete data sets were obtained from 16 patients (Fig. 1, flow chart).

Descriptive characteristics at baseline are shown in Table 1. There were no significant differences in descriptive characteristics between both groups at baseline.

3.1. Compliance and wearing time of the pedometer

The compliance of recording daily step counts in the dairy turned out to be very high; 91.7% during pretest and posttest in experimental and control group and 95.5% during the 10 weeks that the experimental group wore the pedometer. There were no significant differences in the mean time of wearing the pedometer during the day between experimental group (13.1 h/day) and control group (13.8 h/day).

3.2. Primary outcome measure

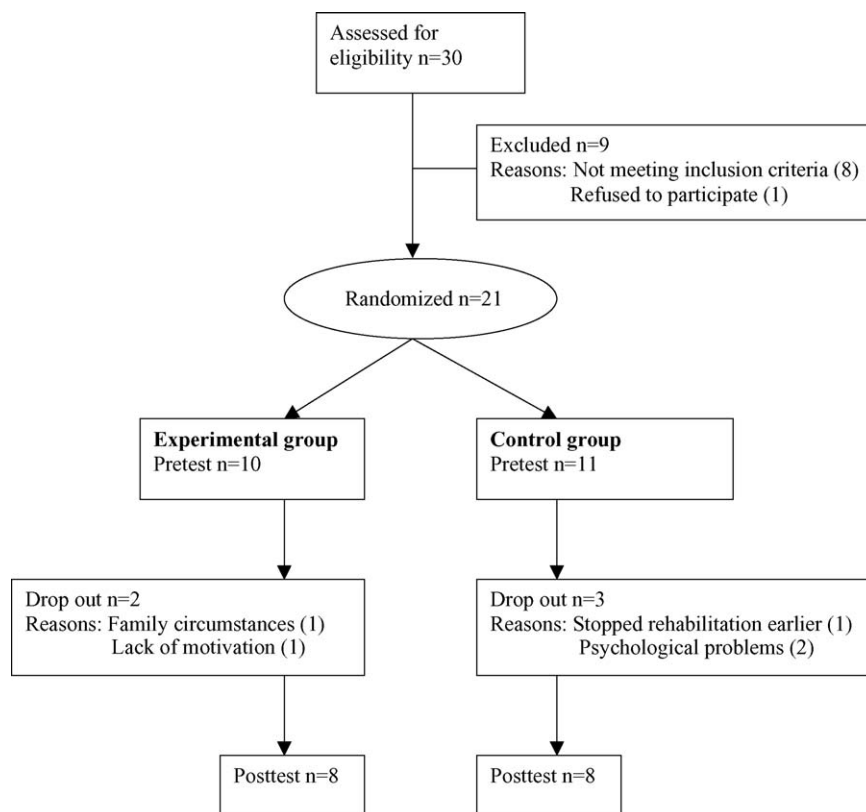As shown in Table 2, the experimental group increased their mean steps/day by 1787 steps/day (+84% from

Fig. 1. Flow chart of the study.

Table 1
Descriptive characteristics at baseline

Variables	Experimental group	Control group
Patients, n	10	11
Male/female gender, n	5/5	4/7
Age, year	65.7 ± 10.4	62.5 ± 12.3
BMI, kg/m^2	29.3 ± 8.4	28.2 ± 6.6
FFMI, kg/m^2	18.2 ± 3.1	17.3 ± 2.7
FEV$_1$, L	1.44 ± 0.80	1.24 ± 0.62
FEV$_1$, % predicted	52 ± 22	43 ± 13
FEV$_1$, % VC	48 ± 21	44 ± 16
TLC, % predicted	109 ± 25	111 ± 24
RV, % predicted	164 ± 51	180 ± 61
ITGV, % predicted	145 ± 51	143 ± 45
GOLD, n		
Stage I (mild)	1	0
Stage II (moderate)	3	5
Stage III (severe)	5	3
Stage IV (very severe)	1	3

Data are presented as mean $\pm$ S.D. unless otherwise indicated; BMI: body mass index; FFMI: fat-free mass index; FEV$_1$: forced expiratory volume in 1 s; % VC: tiffeneau index; TLC: total lung capacity; RV: residual volume; ITGV: intra thoracic gas volume; GOLD: global initiative for chronic obstructive lung disease; Stage I: FEV$_1 \geq 80\%$ predicted; Stage II: $50 \leq$ FEV$_1 < 80\%$ predicted; Stage III: $30 \leq$ FEV$_1 < 50\%$ predicted; Stage IV: FEV$_1 < 30\%$ predicted.

baseline) for 7 days including rehabilitation (7Rplus) and by 1430 steps/day (+69%) for 6 days without rehabilitation (6Rmin). This in contrast with the control group, in which mean steps/day were increased by 1220 steps/day (+52%) for 7Rplus and by 455 steps/day (+19%) for 6Rmin. Effect sizes within the groups were large (>0.80) in the experimental group for 7Rplus, 4Rmin and 6Rmin and were smaller in the control group, especially for 4Rmin and 6Rmin. The effect of the lifestyle physical activity counseling program with feedback of a pedometer was not statistically significant, but the between-groups effect size was large (>0.80) for 6Rmin. The power was 37%.

3.3. Secondary outcome measures

Table 2 showed that there was a significant effect of the intervention for the '8-foot up-and-go test', but assumptions were violated. The effect of the intervention was borderline significant for the '2-min step test' with a large between-groups effect size (>0.80). No significant effects of the intervention were found for the two other items of physical fitness or for health-related quality of life (HRQoL), activities of daily living (ADL), depression and self-efficacy. Most effect sizes were small to medium.

4. Discussion and conclusion

4.1. Discussion

This study examined the effects of a lifestyle physical activity counseling program with feedback of a pedometer

during 9 weeks of pulmonary rehabilitation. The experimental group increased their mean steps/day by 1430 steps/day (+69%) for 6 days without rehabilitation (6Rmin), whereas the control group showed an increase of 455 steps/day (+19%). The difference in pretest and posttest between the experimental and control groups was clinically relevant, with an effect size >0.80. However, this was not statistically significant.

According to Tudor-Locke and Myers [50], older adults and those living with chronic diseases typically walk between 3500 and 5500 steps/day and would be classified as sedentary (<5000 steps/day) according to the preliminary classification of pedometer-determined physical activity in healthy adults [23]. It is also noticed that this classification might not be sustainable for older adults and those living with chronic diseases. There are a few studies that measured daily physical activity in patients with COPD with an accelerometer [51–53] and with a pedometer [31]. Patients in the latter study took approximately 3700 steps/day. In our study, patients took approximately 2200 steps/day at baseline and approximately 3400 steps/day at posttest. This is far less than Tudor-Locke and Myers [50] found in older adults and individuals with a chronic disease. It is also less than Schönhofer et al. [31] found for patients with COPD. The included patients in that study were on average younger (56 ± 12 years) but had approximately the same lung function (FEV$_1$ $47 \pm 9\%$ predicted) than the patients in our study. This suggests that a reason for the low step count in our study is the higher age of our patients. In this respect, it has already been known that older adults take less steps/day [23]. Another reason for the lower steps/day score can be seasonal influences on daily physical activity. Energy expenditure in daily physical activity and leisure-time physical activity is significantly higher in spring and summer [54–56]. Schönhofer et al. [31] do not describe in which season they carried out their study. Our study was carried out in autumn and winter.

No study has been carried out yet that uses a pedometer as a motivational and feedback tool together with exercise counseling in order to increase daily physical activity in patients with COPD. In two studies, healthy adults significantly increase their daily steps from 8565 at baseline to 10,538 (+23%) after an 8-week pedometer-based lifestyle physical activity intervention [25], and from 4753 at baseline to 7949 (+67%) after an 8-week pedometer-based physical activity program [24]. The relative increases in number of steps/day in our study were more pronounced. This can be explained by the lower baseline score in our study: it is easier to gain a relative increase from a low starting-point than a high starting-point. But it could also be explained by the additional value of exercise counseling.

Pedometer-based interventions are already successfully used to increase physical activity in various other patient groups as well [26–28]. The First Step Program (FSP) of Tudor-Locke et al. [29,30] for individuals with type-II diabetes is a pedometer-based lifestyle physical activity

Table 2

Summary of daily physical activity (DPA) measured by a pedometer, physical fitness (PF), health-related quality of life (HRQoL), activities of daily living (ADL), depression and self-efficacy for experimental group and control group

Variables	Experimental group ($n = 8$)					Control group ($n = 8$)					Repeated measures analysis of variance			
	Pretest		Posttest		d-Within	Pretest		Posttest		d-Within	Group × time interaction[a]			Power (%)
	Mean	95% CI	Mean	95% CI		Mean	95% CI	Mean	95% CI		F	p	d-Between	
DPA														
7Rplus	2140	1201–3079	3927	2114–5741	1.03	2334	1446–3242	3554	2155–4954	0.87	0.82	0.38	0.52	13
4Rmin	2059	1118–3000	3594	1937–5251	0.95	2312	1396–3227	2985[b]	1255–4716	0.48	1.52	0.24	0.78	21
6Rmin	2082	1139–3025	3512	1797–5227	0.89	2377	1370–3384	2832[b]	1530–4133	0.33	3.01	0.11	0.84	37
PF														
Chair stand, n	7.3	3.9–10.6	9.1	4.5–13.8	0.37	8.4[b]	6.7–10.0	9.1	7.6–10.6	0.37	1.26	0.28	0.35	18
Arm curl, n	11.4	6.7–16.1	15.4	10.2–20.6	0.68	12.0	7.7–16.3	13.5	9.4–17.6	0.30	1.58	0.23	0.47	22
8-foot up-and-go, s[e]	9.7[b]	5.1–14.3	7.7[b]	4.9–10.6	−0.44	7.3	5.3–9.3	7.5	5.1–9.9	0.08	5.56[c]	0.03	−0.52	59
2-min step, n	36.6	19.0–54.3	57.4	31.6–83.1	0.79	49.3	35.8–62.7	55.1	36.7–73.5	0.30	4.14	0.06	0.80	47
HRQoL														
SGRQ														
Symptoms[e]	76.1	68.3–83.8	81.4[b]	74.2–88.6	0.59	68.5	55.7–81.4	64.3	48.5–80.0	−0.24	1.93	0.19	0.75	25
Activity[e]	74.5	61.8–87.3	72.8	60.2–85.5	−0.11	66.1	56.3–75.9	61.5	42.3–80.6	−0.25	0.22	0.65	0.21	7
Impacts[e]	45.0	35.6–54.3	38.9	24.5–53.2	−0.42	36.4	26.5–46.4	29.0	14.8–43.2	−0.50	0.04	0.85	0.11	5
Total[e]	59.1	51.3–66.8	56.3[b]	45.1–67.4	−0.24	50.8	43.4–58.2	44.7	30.4–58.9	−0.45	0.38	0.55	0.36	9
RAND-36														
R-PF	16.3	6.6–25.9	28.8	12.5–45.0	0.78	32.1	13.2–50.9	34.4	15.1–53.7	0.10	2.37	0.14	0.57	30
R-V	38.1	25.3–51.0	54.4	41.3–67.5	1.05	38.8	27.4–50.1	51.3	38.5–64.0	0.86	0.15	0.70	0.26	7
R-BP	64.0	36.7–91.4	74.0	51.5–96.5	0.33	73.7	51.8–95.6	72.5[b]	47.2–97.7	−0.04	1.25	0.28	0.38	18
R-GHP[d]	23.8	13.8–33.7	25.6	18.1–33.2	0.17	46.4	31.4–61.5	39.3	28.1–50.4	−0.49	1.39	0.26	0.62	19
R-HC	34.4	2.9–65.9	68.7[b]	37.7–99.9	0.92	25.0	9.2–40.8	65.6	40.8–90.5	1.63	0.14	0.72	−0.21	6
ADL														
GARS[e]	41.3	34.8–47.7	39.5	32.0–47.0	−0.21	33.1	24.6–41.7	34.1	25.1–43.2	0.09	1.71	0.21	−0.31	23
DEFS[e]	6.8	5.0–8.5	6.1	4.4–7.8	−0.34	6.5	3.9–9.1	7.1	4.9–9.4	0.21	1.42	0.25	−0.49	19
Depression														
BDI[e]	12.6	7.5–17.7	12.3	6.3–18.2	−0.04	12.9[b]	8.5–17.2	11.5	6.1–16.9	−0.24	0.07	0.79	0.19	6
Self-efficacy														
LIVAS	25.3	19.7–30.8	28.5	24.1–33.0	0.53	27.0	21.7–32.3	26.6	19.2–34.1	−0.05	1.10	0.31	0.56	17

7Rplus: steps/day for 7 days including rehabilitation; 4Rmin: steps/day for 4 days without rehabilitation; 6Rmin: steps/day for 6 days without rehabilitation; R-PF: physical functioning; R-V: vitality; R-BP: bodily pain; R-GHP: general health perception; R-HC: health change.

[a] Estimates the effect of the counseling intervention.

[b] Assumption of normality violated.

[c] Assumption of equality of covariance matrices violated.

[d] Significant difference in pretest between experimental and control group.

[e] Hypothesis pretest > posttest.

intervention that corresponds largely with our lifestyle physical activity counseling program with feedback of a pedometer. A controlled outcome evaluation of the FSP showed that individuals with type-II diabetes in the experimental group increased their physical activity pattern, relative to the control group, with >3000 steps/day [30].

There were a number of factors in this study that caused methodological bias. The sample size of the study was small and the S.D.s of steps/day were large which resulted in a low power. In the same line, the low power probably accounts for the non-significant results on the secondary outcome measures. Five patients dropped out during the study. An intention to treat analysis was not performed, because of the drop-out reasons. Finally, one disadvantage of using pedometers is that they are not sensitive to non-ambulatory activities (e.g. cycling, swimming, weight-training). Nevertheless, walking is one of the most common forms of activity, and aggregate evidence provides abundant support for using pedometers to assess physical activity [57]. For future research, it would be helpful to develop step equivalents for the non-ambulatory activities, so that these activities can be taken into account.

4.2. Conclusion

In summary, this study showed that the number of steps/day increase after 9 weeks of rehabilitation. The additional lifestyle physical activity counseling program with feedback of a pedometer showed a clinically relevant increase in steps/day, although not statistically significant, on top of the rehabilitation effect. We expect that this method is in particular of benefit in maintaining the results of rehabilitation. A trial on long-term effects would therefore be desirable. However, further studies with larger patient groups and longer follow-up periods are needed to establish these preliminary results.

4.3. Practice implications

The pedometer is a device that has become very popular in daily use as well as in science. They are simple in use, affordable, the output (e.g. steps take, steps/day) is extremely user-friendly [23] and accurately detects steps taken, as an indication of volume of physical activity [20–22]. This pilot study showed that the use of the pedometer, in combination with exercise counseling and the stimulation of lifestyle physical activity, is a feasible addition to the present-day pulmonary rehabilitation. The costs of implementation and carrying out this program are minimal. Moreover, this program can easily be adopted in different settings. The patients who followed this lifestyle physical activity counseling program with feedback of a pedometer were very positive about this method and would recommend it to other patients. Also the physiotherapist who carried out the counseling sessions were enthusiast about this program. In sequel to this pilot study, a trial on long-term effects

would be desirable. We think that this lifestyle physical activity counseling program with feedback of a pedometer is of use in chronic patients such as COPD in adopting a more physical active lifestyle.

References

[1] Lacasse Y, Wong E, Guyatt GH, King D, Cook DJ, Goldstein RS. Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease. Lancet 1996;348:1115–9.

[2] ACCP/AACVPR Pulmonary Rehabilitation Guidelines Panel. Pulmonary rehabilitation: joint ACCP/AACVPR evidence-based guidelines. Chest 1997;112:1363–96.

[3] American Thoracic Society. Pulmonary rehabilitation—1999. Am J Respir Crit Care Med 1999;159:1666–82.

[4] Cambach W, Wagenaar RC, Koelman TW, van Keimpema T, Kemper HCG. The long-term effects of pulmonary rehabilitation on patients with asthma and chronic obstructive pulmonary disease: a research synthesis. Arch Phys Med Rehabil 1999;80:103–11.

[5] Ries AL, Kaplan RM, Myers R, Prewitt LM. Maintenance after pulmonary rehabilitation in chronic lung disease; a randomised trial. Am J Respir Crit Care Med 2003;167:880–8.

[6] Strijbos JH, Postema DS, van Altena R, Gimeno F, Koëter GH. A comparison between an outpatient hospital-based pulmonary rehabilitation program and a home-care pulmonary rehabilitation program in patients with COPD. A follow-up of 18 months. Chest 1996;109:366–72.

[7] Wijkstra PJ, ten Vergert EM, van Altena R, Otten V, Kraan J, Postema DS, Koëter GH. Long-term benefits of rehabilitation at home on quality of life and exercise tolerance in patients with chronic obstructive pulmonary disease. Thorax 1995;50:824–8.

[8] Wijkstra PJ, ten Hacken N, Wempe JB, Koëter GH. What is the role of rehabilitation in COPD? In: Pearson M, Wedzicha W, editors. Chronic obstructive pulmonary disease. Critical debates. Massachusetts: Blackwell Science; 2003. p. 147–67.

[9] American College of Sports Medicine Position Stand (ACSMPS). In: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exerc 1998;6:975–91.

[10] Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC, Kriska A, Leon AS, Marcus BH, Morris J, Pafferibarger RS, Patrick K, Pollock ML, Rippe JM, Sallis J, Wilmore JH. Physical activity and public health, a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 1995;273:402–7.

[11] American College of Sports Medicine Position Stand (ACSMPS). Exercise and physical activity for older adults. Med Sci Sports Exerc 1998;30:992–1008.

[12] Dunn AL, Marcus BH, Kampert BJ, Garcia ME, Kohl HW, Blair SN. Comparison of lifestyle and structured inventions to increase physical activity and cardiorespiratory fitness. A randomized trial. JAMA 1999;281:327–34.

[13] Andersen RE, Wadden TA, Bartlett SJ, Zemel B, Verde TJ, Franckowiak SC. Effects of lifestyle activity vs. structured aerobic exercise in obese woman. A randomized trial. JAMA 1999;281:335–40.

[14] Kahn EB, Ramsey LT, Brownson RC, Heath GW, Howze EH, Powell KE, Stone EJ, Rajab MW, Corso P. The effectiveness of interventions to increase physical activity. A systematic review. Am J Prev Med 2002;22:73–107.

[15] Westerterp KR. Pattern and intensity of physical activity. Nature 2001;410:539.

[16] Dressendorfer RH, Haykowsky MJ, Eves N. Exercise for patients with COPD. American College of Sports Medicine (ACSM); 2002, http://www.acsm.org/.

[17] Calfas KJ, Long BJ, Sallis JF, Wooten WJ, Pratt M, Patrick K. A controlled trial of physician counseling to promote the adoption of physical activity. Prev Med 1996;25:225–33.

[18] Bij AK, van der Laurant MG, Wensing M. Effectiveness of physical activity interventions for older adults: a review. Am J Prev Med 2002;22:120–33.

[19] Simons-Morton DG, Calfas KJ, Oldenburg B, Burton NW. Effects of interventions in health care settings on physical activity or cardiorespiratory fitness. Am J Prev Med 1998;15:413–30.

[20] Crouter SE, Schneider PL, Karabulut M, Bassett DR. Validity of ten electronic pedometers for measuring steps, distance, and energy costs. Med Sci Sports Exerc 2003;35:1018–23.

[21] Schneider PL, Crouter SE, Lukajic O, Bassett DR. Accuracy and reliability of ten pedometers for measuring steps over a 400-m walk. Med Sci Sports Exerc 2003;35:1779–84.

[22] Schneider PL, Crouter SE, Bassett DR. Pedometer measures of free-living physical activity: comparison of 13 models. Med Sci Sports Exerc 2004;36:331–5.

[23] Tudor-Locke C, Bassett DR. How many steps/day are enough? Preliminary pedometer indices for public health. Sports Med 2004;34:1–8.

[24] Lindberg R. Active living: On the road with the 10,000 steps program. J Am Diet Assoc 2000;100:878–9.

[25] Croteau KA. A preliminary study on the impact of a pedometer-based intervention on daily steps. Am J Health Promot 2004;18:217–20.

[26] Yamanouchi K, Shinozaki T, Chikada K, Nishikawa T, Ito K, Shimizu S, Ozawa N, Suzuli Y, Maeno H, Kato K, Oshida Y, Sato Y. Daily walking combined with diet therapy is a useful means for obese NIDDM patient not only to reduce body weight but also to improve insulin sensitivity. Diab Care 1995;18:775–8.

[27] Moreau KL, Degarmo R, Langley J, McMahon C, Howley ET, Bassett DR, Thompson DL. Increasing daily walking lowers blood pressure in postmenopausal women. Med Sci Sports Exerc 2001;33:1825–31.

[28] Swartz AM, Strath SJ, Bassett DR, Moore JB, Redwine BA, Groër M, Thompson DL. Increasing daily walking improves glucose tolerance in overweight women. Prev Med 2003;37:356–62.

[29] Tudor-Locke CE, Myers AM, Bell RC, Harris SB, Rodger NW. Preliminary outcome evaluation of the First Step Program: a daily physical activity intervention for individuals with type 2 diabetes. Patient Educ Couns 2002;47:23–8.

[30] Tudor-Locke CE, Bell RC, Myers AM, Harris SB, Ecclstone NA, Lauzon N, Rodger NW. Controlled outcome evaluation of the First Step Program: a daily physical activity intervention for individuals with type 2 diabetes. Int J Obes Metab Disord 2004;28:113–9.

[31] Schönhofer B, Ardes P, Geibel M, Köhler D, Jones PW. Evaluation of a movement detector to measure daily activity in patients with chronic lung disease. Eur Respir J 1997;10:2814–9.

[33] Global initiative for chronic obstructive long disease (GOLD). Pocket guide to COPD diagnosis, management and prevention; updated July 2003, www.goldcopd.com.

[34] Miller WR, Rollnick S. Motivational interviewing. Preparing people to change addictive behavior. New York, London: The Guildford Press; 1991.

[35] Terry A. Motivational interviewing. In: Memon A, Bull R, editors. Handbook of the psychology of interviewing. Chichester: Wiley; 1999. p. 55–69.

[36] Swartz AM, Bassett DR, Moore JB, Thompson DL, Strath SJ. Effect of body mass index on the accuracy of an electronic pedometer. Int J Sports Med 2003;24:588–92.

[37] Rikli RE, Jones CJ. Development and validation of a functional fitness test for community-residing older adults. J Aging Phys Activ 1999;7:129–59.

[38] Rikli RE, Jones CJ. Senior fitness test manual. Champaign: Human Kinetics; 2001.

[39] Jones PW, Quirk FH, Baveystock CM, Littlejohns P. A self-complete measure for chronic airflow limitation—the St. George's Respiratory Questionnaire. Am Rev Respir Dis 1992;145:1321–7.

[40] van der Zee KI, Sanderman R. Het meten van de algemene gezondheidstoestand met de RAND-36: een handleiding. Groningen: Noordelijk Centrum voor Gezondheidsvraagstukken; 1993.

[41] Ware EW, Sherbourne CD. The MOS 36-item Short-Form Health Survey (SF-36). Med Care 1992;30:473–83.

[42] Kempen GI, Miedema I, Ormel J, Molenaar W. The assessment of disability with the Groningen Activity Restriction Scale. Conceptual framework and psychometric properties. Soc Sci Med 1996;43:1601–10.

[43] Tiesinga LJ, Dassen TWN, Halfsen RJG. DUFS and DEFS: development, reliability and validity of the Dutch Fatigue Scale and the Dutch Exertion Fatigue Scale. Int J Nurs Stud 1998;35:115–23.

[44] Beck AT, Ward CH, Mendelson M, Mock J, Erbuagh J. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561–71.

[45] Beck AT, Steer RA, Garbin MG. Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. Clin Psychol Rev 1988;8:77–100.

[46] Bosscher RJ, Laurijssen L, de Boer E. Measuring physical self-efficacy in old age. Percept Mot Skills 1993;77:470.

[47] Ryckman RM, Robbins MA, Thornton B, Contrell P. Development and validation of a physical self-efficacy scale. J Pers Soc Psychol 1982;42:891–900.

[48] Quanjer PH, Tammeling GJ, Cotes JE, Pedersen OF, Peslin R, Yernault JC. Lung volumes and forced ventilatory flows. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. Eur Respir J 1993;16:5–40.

[49] Cohen J. Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Erlbaum; 1988.

[50] Tudor-Locke C, Myers AM. Methodological considerations for researchers and practitioners using pedometers to measure physical (ambulatory) activity. Res Q Exerc Sport 2001;72:1–12.

[51] Coronado M, Janssens JP, de Murlat B, Terrier P, Schutz Y, Fitting JW. Walking activity by accelerometry during respiratory rehabilitation. J Cardiopulm Rehabil 2003;23:357–64.

[52] Belza B, Steele BG, Hunziker J, Lakshminaryan S, Holt L, Buchner DM. Correlates of physical activity in chronic obstructive pulmonary disease. Nurs Res 2001;50:195–202.

[53] Steele BG, Holt L, Belza B, Ferris S, Lakshminaryan S, Buchner DM. Quantitating physical activity in COPD using a triaxial accelerometer. Chest 2000;117:1359–67.

[54] Pivarnik JM, Reeves MJ, Rafferty AP. Seasonal variation in adult leisure-time physical activity. Med Sci Sports Exerc 2003;35:1004–8.

[55] Matthews CE, Hebert JR, Freedson PS, Stanek EJ, Merrian PA, Ebbeling CB, Ockene IS. Sources of variance in daily physical activity levels in seasonal variation of blood cholesterol study. Am J Epidemiol 2001;135:987–95.

[56] Uitenbroek DG. Seasonal variation in leisure time physical activity. Med Sci Sports Exerc 1993;25:755–60.

[57] Tudor-Locke C, Williams JE, Reis JP, Pluto D. Utility of pedometers for assessing physical activity: convergent validity. Sports Med 2002;32:795–808.