Official Journal of the Asian Pacific Society of Respirology
Respirology

ORIGINAL ARTICLE

Effect on health-related quality of life of ongoing feedback during a 12-month maintenance walking programme in patients with COPD: a randomized controlled trial

SALLY L. WOOTTON,[1,2] ZOE MCKEOUGH,[1] CINDY L.W. NG,[3,10] SUE JENKINS,[3,4,5] KYLIE HILL,[3,5] PETER R. EASTWOOD,[3,6,7] DAVID HILLMAN,[6] CHRISTINE JENKINS,[8] NOLA CECINS,[5] LISSA SPENCER[9] AND JENNIFER ALISON[1,9]

[1]*Discipline of Physiotherapy, The University of Sydney, Sydney, NSW;* [2]*Chronic Disease Community Rehabilitation Service, Northern Sydney Local Health District, Sydney, NSW;* [3]*School of Physiotherapy and Exercise Science, Faculty of Health Sciences, Curtin University, Perth, WA;* [4]*Physiotherapy Department, Sir Charles Gairdner Hospital, Perth, WA;* [5]*Institute for Respiratory Health, Perth, WA;* [6]*Department of Pulmonary Physiology and Sleep Medicine, Sir Charles Gairdner Hospital, Perth, WA;* [7]*Centre for Sleep Science, School of Anatomy, Physiology and Human Biology, University of Western Australia, Perth, WA;* [8]*Department of Thoracic Medicine, Concord Hospital, Sydney, NSW;* [9]*Physiotherapy Department, Royal Prince Alfred Hospital, Sydney, NSW, Australia;* [10]*Physiotherapy Department, Singapore General Hospital, Singapore*

ABSTRACT

Background and objective: **In patients with COPD, this study evaluated the effect on health-related quality of life (HRQoL) of adding ongoing feedback to a 12-month unsupervised maintenance walking programme.**

Methods: **Participants were randomized to either an intervention group (IG) or control group (CG). Both groups completed the same 2-month supervised, walking training programme followed by a 12-month unsupervised maintenance walking programme. During the maintenance programme, the IG received ongoing feedback (telephone calls, biofeedback and progressive goal setting) and the CG received no feedback.**

Results: **A total of 75 participants completed the study (mean (SD): age 69 (8) years; forced expiratory volume in 1 s (FEV_1) 43 (15) % predicted). There was no between-group differences in the magnitude of change in HRQoL when data collected on completion of the 12-month maintenance programme were compared with that collected either before the 2-month supervised programme (mean between-group difference (MD) in total St George's Respiratory Questionnaire change scores: 1 point, 95% CI: −9 to 7) or on completion of the 2-month supervised programme (MD: 4 points, 95% CI −2 to 10).**

Conclusion: **Following a 2-month supervised walking training programme, ongoing feedback was no more effective than no feedback in maintaining HRQoL during a 12-month unsupervised walking programme.**

SUMMARY AT A GLANCE

Ongoing feedback (telephone calls and biofeedback) was no more effective than no feedback during a 12-month unsupervised walking programme that followed a short-term supervised walking programme. Based on these findings, further research is needed to investigate the optimal design of unsupervised maintenance programmes in patients with COPD.

Clinical trial registration: ACTRN 12609000472279 at www.anzctr.org.au/

Key words: chronic obstructive pulmonary disease, exercise, health-related quality of life, maintenance, pulmonary rehabilitation.

Abbreviations: 6MWD, 6-min walk distance; 6MWT, 6-min walk test; CG, control group; CRQ, Chronic Respiratory Disease Questionnaire; DL_{CO}, single-breath diffusing capacity of the lung for carbon monoxide; ESWT, endurance shuttle walk test; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; HADS, Hospital Anxiety and Depression Scale; HRQoL, health-related quality of life; IG, intervention group; ISWT, incremental shuttle walk test; LMM, linear mixed model; MD, mean between-group difference; PR, pulmonary rehabilitation; RCT, randomized controlled trial; RV, residual volume; SGRQ, St George's Respiratory Questionnaire; TLC, total lung capacity.

INTRODUCTION

In patients with chronic obstructive pulmonary disease (COPD), health-related quality of life (HRQoL) is significantly reduced compared with healthy individuals[1] and better HRQoL has been related to reduced hospital admissions.[2] Pulmonary rehabilitation (PR) has been shown to

Correspondence: Sally L. Wootton, Chronic Disease Community Rehabilitation Service, Northern Sydney Local Health District, The Lodge, Building 37, Macquarie Hospital, Cnr Twin and Badajoz Roads, North Ryde, Sydney, NSW 2113, Australia. Email: sally.wootton@health.nsw.gov.au

Received 15 March 2017; invited to revise 5 April 2017; revised 24 May 2017; accepted 7 June 2017 (Associate Editor: Melissa J. Benton).

improve HRQoL[3] as well as improve exercise capacity and reduce hospital admissions in patients with COPD.[4–6] Following completion of short-term (6–12 weeks) PR programmes, the positive effects on HRQoL and exercise capacity[3] have been shown to decline within 1–2 years.[7–9] Maintenance exercise programmes aim to encourage long-term adherence to exercise in order to preserve the benefits achieved during short-term programmes. While a recent systematic review concluded that maintenance programmes with supervised exercise sessions, conducted at least once per week can maintain exercise capacity for up to 6 months in patients with COPD,[10] many PR programmes lack the capacity to offer long-term supervised maintenance exercise programmes.[11–13]

Randomized controlled trials (RCT) investigating unsupervised maintenance programmes have shown little effect on maintaining HRQoL and exercise capacity, despite using strategies to encourage adherence such as telephone support with or without monthly supervised exercise sessions.[7,14,15] When biofeedback strategies have been added to telephone support, maintenance of effects has been shown.[16,17] However, these previous findings should be interpreted with caution due to limitations arising from very small sample size[17] and short durations of follow-up.[16,17] As such, the effectiveness of telephone support combined with biofeedback to maintain HRQoL and exercise capacity during an unsupervised maintenance walking programme over a longer time period remains unknown.

The primary aim of this study was to evaluate, in patients with COPD, the effect on HRQoL of adding ongoing feedback (telephone calls, biofeedback via pedometer and progressive goal setting) compared with no feedback during a 12-month unsupervised maintenance walking programme, which followed a supervised walking training programme. The hypothesis was that, at study completion, participants who received the ongoing feedback would have better HRQoL compared with those who did not receive the ongoing feedback. The secondary aim of the study was to evaluate the effects of the ongoing feedback on exercise capacity and adherence to the maintenance walking programme.

METHODS

The study was a long-term, prospective, assessor-blinded, multicentre (five sites), RCT with concealed allocation. Participants were randomized prior to commencing a 2-month supervised walking training programme (i.e. baseline) via an independent telephone randomization service using computerized random number generator sequencing into two groups: an intervention group (IG) and a control group (CG). Before commencing the 12-month maintenance programme, both groups received the same 2-month intervention of a supervised, walking training programme, two to three times per week. The findings of the 2-month study have been previously reported, comparing the effects of supervised walking training (combined IG and CG) to a group who received usual medical care and did not participate in any exercise training.[18] The intervention for participants in the IG and CG only differed once they entered the 12-month maintenance phase. Randomization was stratified according to lung function (forced expiratory volume in 1 s (FEV_1) < or ≥40% predicted), HRQoL measures using the St George's Respiratory Questionnaire (SGRQ) (total score < or ≥45), exercise capacity (6-min walk distance (6MWD) < or ≥70% predicted) and trial centre.

Participants were recruited from outpatient PR programmes in two cities within Australia between May 2009 and June 2012. Inclusion and exclusion criteria have been previously described.[18] Written informed consent was obtained from all participants. The study was approved by the ethics committees of Sydney South West Area Health Service (Sydney, Australia), The University of Sydney (Sydney, Australia), Curtin University (Perth, Australia), Sir Charles Gairdner Hospital (Nedlands, Australia) and Bentley Hospital (Perth, Australia).

Following completion of the short-term supervised programme, both the IG and CG were instructed to perform unsupervised maintenance walking exercise, 3 days a week for 12 months starting at the same duration achieved in the final week of supervised training and at a pace which elicited a dyspnoea score of three to four on a modified 0–10 point category-ratio dyspnoea scale.[19] In addition, the IG received telephone calls, biofeedback provided via a pedometer (G-Sensor accelerometer, Pedometers Australia, Cannington, Australia) and progressive goal setting (based on pedometer data). Diaries were provided for participants in both groups to record details of completed walking sessions. Further details of the intervention and the telephone script can be found in Appendices S1 and S2 (Supplementary Information).

Assessment protocol and measurements

Participants were assessed on four occasions over a 14-month period as follows: (i) prior to commencing the 2-month supervised walking training programme (baseline assessment), (ii) at the end of the 2-month supervised walking training programme which marked the commencement of the maintenance phase (2-month assessment), (iii) after 6 months of maintenance (8-month assessment) and (iv) after 12 months of maintenance (14-month assessment). During the baseline assessment, age, height, weight, gender, co-morbid conditions and medication use were recorded. Levels of anxiety and depression were measured by the Hospital Anxiety and Depression Scale (HADS).[20] At all four assessment time points, participants completed measures of HRQoL, exercise capacity and spirometric lung function over two visits within a 7-day period. FEV_1 and forced vital capacity (FVC) were collected using a calibrated portable spirometer (EasyOne spirometer, ndd Medical Technologies Inc., Andover, MA, USA) according to standard procedures. Lung volumes (body plethysmography) and single-breath diffusing capacity of the lung for carbon monoxide (DL_{CO}) were measured at baseline only, according to standard protocols. Measures obtained were compared with normative data.[21–23] Disease severity was classified according to the Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease (GOLD) spirometric criteria.[24]

Health-related quality of life

The primary outcome was HRQoL measured by the SGRQ.[25] The interviewer-administered Chronic Respiratory Disease Questionnaire (CRQ), with the individualized dyspnoea domain, was also completed.[26]

Exercise capacity

Functional exercise capacity was measured by the 6-min walk test (6MWT), peak exercise capacity by the incremental shuttle walk test (ISWT) and endurance exercise capacity by the endurance shuttle walk test (ESWT).[27] Procedures for the walk tests have been previously described.[18]

Adherence to unsupervised maintenance walking programme

Adherence in both groups was determined using data from diaries and also, for the IG, by reviewing telephone transcripts. At the 8-month and 14-month assessments, the number of returned diaries in both groups was recorded, as well as the number of completed telephone transcripts in the IG.

Sample size and data analysis

The sample size was based on detection of a clinical meaningful difference in total SGRQ score between the IG and CG at the 14-month assessment. Eighty-six participants were sufficient to provide 80% power to detect a between-group difference in SGRQ total score of at least 7.7 points, which is greater than the minimum clinically important difference ($\alpha = 0.05$, two-sided).[28] This assumed an SD of 12.7 points in total SGRQ score as previously reported.[29] To allow for a 10% dropout, 95 participants were required. Data were analysed using SPSS software (Version 20 for Windows, IBM Inc, Armonk, NY, USA). Intention to treat analysis was conducted with no imputation of missing data. Descriptive statistics are presented as raw mean values and SD unless otherwise stated. Linear mixed models (LMM) were used to determine significance between groups across all time points using the sample that was available at each time point. An estimate of the within-group effect on three comparisons, baseline to 2 months; baseline to 14 months; and 2 to 14 months, was determined for each group using the least significant difference (pairwise comparison) and is reported as mean differences and 95% CI from the predicted values of the LMM. To evaluate the between-group treatment

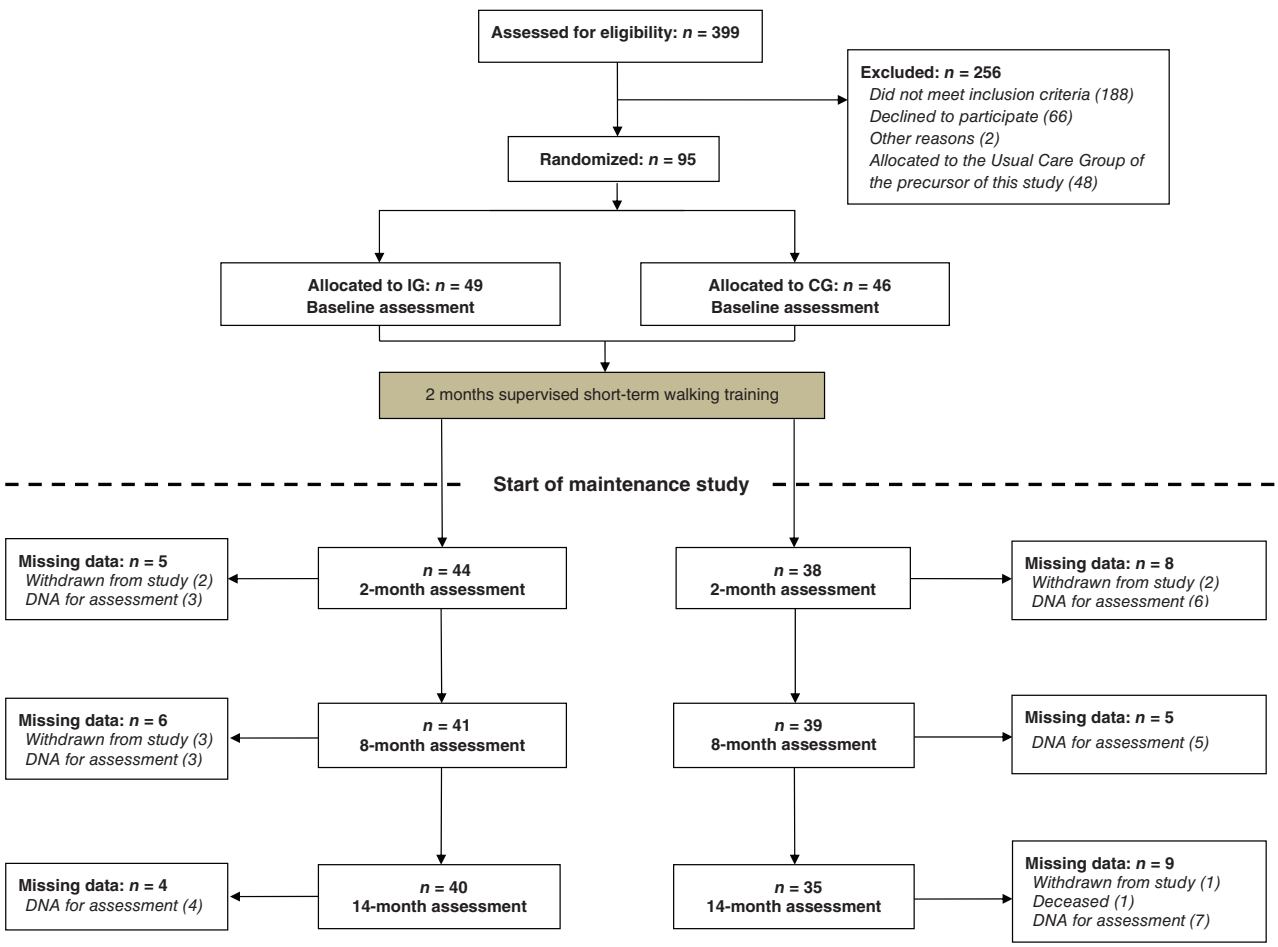

Figure 1 Participant flow. Numbers at each time point are based on those that entered the maintenance phase of the study. In some instances, participants may not have attended the 2- or 8-month assessment but attended the 14-month assessment. CG, control group; IG, intervention group.

effect on these three comparisons, change scores were determined by simple subtraction of the within-group effect and differences in the change scores were compared using independent t-tests.

RESULTS

Participant flow is presented in Figure 1. Baseline characteristics of participants were similar between groups (Table 1). Participants had moderate to severe COPD (FEV_1: 45 (15) % predicted),[24] reduced HRQoL (SGRQ total score: 46 (17)), reduced exercise capacity (6MWD: 74 (13) % predicted) and symptoms of anxiety and depression that were within normal range (0–7 points on HADS[20]). Participants completed an average of 17 (7) out of a possible 24 supervised walking training sessions prior to commencement of the maintenance programme. Of the 95 participants who commenced the 2-month supervised walking training programme, 20 participants (21%) did not complete any of the 14-month outcome measures. No adverse events were reported during the study.

Health-related quality of life

The SGRQ outcomes are presented in Tables 2–4 and Figure 2A. Both the IG and CG significantly improved SGRQ total score at the end of the 2-month supervised walking training programme. Between-group analyses demonstrated no significant differences in the change in SGRQ from baseline to 14 months or from 2 to 14 months (Fig. 2A). The results from the CRQ are presented in Tables S1–S3 (Supplementary Information).

Exercise capacity

The exercise capacity outcomes are presented in Tables 2–4 and Figure 2B. Both the IG and CG significantly improved exercise capacity measured by the ESWT with the IG also significantly improving on the ISWT and 6MWT at the end of the 2-month supervised walking programme. Between-group analyses demonstrated no significant differences in change in exercise capacity from baseline to 14 months or from 2 to 14 months.

Adherence to unsupervised maintenance walking programme

Reported levels of adherence to unsupervised maintenance walking exercise sessions are presented in Table S4 (Supplementary Information). Between-group analyses of adherence levels were not possible due to lack of data in the CG.

DISCUSSION

This large, multicentre, RCT was designed to determine the effects on HRQoL of adding ongoing feedback to a 12-month unsupervised maintenance walking programme that followed a 2-month, supervised, walking training programme in patients with COPD. Although the supervised programme produced significant improvements in HRQoL in both groups, when all assessment time points were considered, there were no significant between-group differences in the magnitude of change in HRQoL or in any of the secondary outcomes between baseline and 14 months or between 2 and 14 months.

Our finding of no between-group differences in HRQoL is consistent with a previous RCT that showed

Table 1 Participant characteristics

Variable	IG $n = 49$	CG $n = 46$
Age (years)	70 (7)	69 (9)
Gender, male/female	25/24	30/16
Height (m)	1.7 (0.1)	1.7 (0.1)
Weight (kg)	69 (16)	74 (14)
BMI (kg/m^2)	24 (5)	26 (5)
Current smokers, *n* (%)	9 (18)	6 (13)
Anxiety, HADS score	6 (4)	7 (4)
Depression, HADS score	5 (4)	5 (3)
Pulmonary function		
FEV_1 (L)	1.08 (0.37)	1.18 (0.46)
FEV_1 (% predicted)	43 (15)	43 (15)
FVC (L)	2.60 (0.72)	2.82 (0.95)
FVC (% predicted)	75 (16)	76 (19)
FEV_1/FVC (%)	43 (13)	43 (14)
TLC (% predicted)	114 (33)	110 (17)
FRC (% predicted)	148 (60)	139 (34)
RV (% predicted)	157 (76)	142 (40)
RV/TLC (%)	53 (9)	50 (10)
DL_{CO} (% predicted)	43 (16)	45 (17)
GOLD grade		
II, *n* (%)	23 (47)	17 (37)
III, *n* (%)	18 (37)	24 (52)
IV, *n* (%)	8 (16)	5 (11)
Respiratory medication		
Short-acting bronchodilator, *n* (%)	28 (57)	27 (59)
Long-acting bronchodilator, *n* (%)	31 (63)	30 (65)
Inhaled corticosteroid, *n* (%)	2 (4)	3 (7)
Combination therapy, *n* (%)	31 (63)	31 (67)
Oral corticosteroid, *n* (%)	6 (12)	8 (17)
Co-morbidity		
Hypertension, *n* (%)	22 (45)	18 (39)
Cardiac (including previous surgery), *n* (%)	19 (39)	17 (37)
Diabetes, *n* (%)	1 (2)	3 (7)
Asthma, *n* (%)	7 (14)	6 (13)
Bronchiectasis, *n* (%)	1 (2)	0 (0)
Other respiratory history, *n* (%)	4 (8)	5 (11)
Cancer, *n* (%)	3 (6)	4 (9)
Non-cardiac surgery, *n* (%)	5 (10)	5 (11)
Neurological, *n* (%)	0 (0)	1 (2)
Psychological, *n* (%)	7 (14)	8 (17)
Increased cholesterol, *n* (%)	9 (18)	10 (22)
Musculoskeletal, *n* (%)	21 (43)	18 (39)
Other, *n* (%)	29 (59)	34 (74

Data presented as mean (SD) unless stated otherwise.

CG, control group; DL_{CO}, single-breath diffusing capacity of the lung for carbon monoxide; FEV_1, forced expiratory volume in 1 s; FRC, functional residual capacity; FVC, forced vital capacity; GOLD, Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease; HADS, Hospital Anxiety and Depression Scale; IG, intervention group; *n*, number; RV, residual volume; TLC, total lung capacity.

Table 2 Health-related quality of life and exercise capacity at baseline, 2-, 8- and 14-month assessment

	Baseline assessment		2-Month assessment		8-Month assessment		14-Month assessment		LMM *P*-value
	IG	CG	IG	CG	IG	CG	IG	CG	Time × group
SGRQ, *n*	49	46	43	37	41	38	38	33	
Total score	46 (18)	47 (16)	40 (12)	42 (16)	40 (15)	45 (18)	40 (17)	47 (17)	0.71
Symptoms	57 (22)	55 (22)	49 (22)	52 (25)	48 (22)	54 (27)	48 (24)	52 (24)	0.66
Activity	62 (20)	66 (19)	57 (18)	61 (19)	61 (19)	63 (20)	60 (22)	66 (19)	0.53
Impacts	32 (17)	35 (19)	27 (13)	28 (16)	25 (15)	32 (18)	26 (16)	35 (19)	0.29
6MWT, *n*	49	46	42	35	38	36	35	27	
Distance (m)	458 (87)	467 (80)	479 (86)	468 (100)	464 (105)	453 (93)	469 (98)	432 (121)	0.11
ISWT, *n*	49	46	41	33	37	36	28	35	
Distance (m)	315 (107)	317 (112)	361 (125)	323 (140)	346 (123)	328 (134)	338 (135)	324 (143)	0.25
ESWT, *n*	49	46	43	35	37	36	29	35	
Time (s)	304 (210)	317 (186)	584 (388)	561 (395)	529 (387)	443 (360)	495 (383)	405 (377)	0.41

Data presented as raw mean (SD).

6MWT, 6-min walk test; CG, control group; ESWT, endurance shuttle walk test; IG, intervention group; ISWT, incremental shuttle walk test; LMM, linear mixed model; *n*, number of participants analysed; SGRQ, St George's Respiratory Questionnaire.

Table 3 Health-related quality of life and exercise capacity within-group differences

		Mean difference 2 months – baseline		Mean difference 14 months – baseline		Mean difference 14 months – 2 months	
		IG	CG	IG	CG	IG	CG
	n	49	46	49	46	49	46
SGRQ							
	Total score	–6 (–10, –2)*	–6 (–10, –2)*	–5 (–9, –1)*	–2 (–6, 2)	1 (–2, 5)	4 (0.1, 8)*
	Symptoms	–8 (–14, –1)*	–3 (–10, 4)	–7 (–15, 1)	–4 (–12, 4)	0 (–7, 8)	–1 (–9, 8)
	Activity	–4 (–8, 0)	–5 (–10, –1)*	0 (–4, 5)	0 (–4, 5)	4 (–1, 9)	6 (1, 11)*
	Impacts	–5 (–9, –1)*	–7 (–12, –3)*	–5 (–10, –1)*	–3 (–7, 2)	–0.5 (–4, 3)	4 (1, 8)*
6MWT	Distance (m)	17 (4, 30)*	–1 (15, –13)	–6 (–26, 13)	–40 (–61, –18)	–23 (–41, –5)*	–39 (–59, –18)*
ISWT	Distance (m)	36 (17, 55)*	8 (–14, 29)	–1 (–20, 17)	–1 (–21, 20)	–37 (–60, –14)*	–8 (–34, 17)
ESWT	Time (s)	256 (161, 351)*	214 (110, 318)*	146 (43, 249)*	46 (–67, 159)	–110 (–232, 12)	–168 (–303, –33)*

*$P < 0.05$.

Data presented as predicted between-time mean (95% CI) differences by group.

6MWT, 6-min walk test; CG, control group; ESWT, endurance shuttle walk test; IG, intervention group; ISWT, incremental shuttle walk test; *n*, number of participants analysed; SGRQ, St George's Respiratory Questionnaire.

no difference between groups in the SGRQ during a 12-month unsupervised maintenance exercise programme despite the IG receiving monthly supervised sessions.[7] However, some evidence of the effectiveness of the ongoing feedback in the IG was demonstrated by SGRQ total score being maintained from 2 to 14 months and remaining significantly better than baseline in the IG by the end of the study. In contrast, in the CG, there was a significant decline in SGRQ total score from 2 to 14 months and this had returned to baseline levels by the end of the study.

The ESWT is an outcome which represents endurance walking capacity and is particularly sensitive to the effects of short-term training in COPD.[27] Both groups had significant improvements in ESWT time following the short-term training. In the IG, there was a non-significant decline in ESWT time from 2 to 14 months which remained significantly better at 14 months compared with baseline. In contrast, the CG had a significant decline in ESWT time from 2 to 14 months and this had returned to baseline levels by the end of the study, demonstrating no maintenance of endurance walking capacity in this group. There were, however, no between-group differences in ESWT time when changes from baseline to 14 months or 2 to 14 months were compared. This finding is in contrast to previous RCTs or studies that demonstrated maintenance of functional exercise capacity during unsupervised maintenance walking programmes that investigated a similar combination of telephone support with biofeedback.[16,17] However, these previous studies were limited by lack of blinded assessment,[16] small sample size[17] and short follow-up periods of 3[16] and 6[17] months. In addition, participants in these previous studies[16,17] were randomized following completion of short-term PR whereas in our study, randomization occurred at commencement of the supervised walking training. Participants who complete PR may be more

Table 4 Health-related quality of life and exercise capacity between-group differences

		Between-group difference in change scores	
		Between baseline and 14-month assessment (95%CI)	Between 2-month and 14-month assessment (95%CI)
SGRQ	*n*	*71*	*68*
	Total score	2 (–4, 8)	4 (–2, 9)
	Symptoms	2 (–10, 14)	–0.9 (–13, 11)
	Activity	–1 (–8, 5)	3 (–4, 10)
	Impacts	1 (–6, 7)	6 (0.4, 12)
6MWT	*n*	*62*	*60*
	Distance (m)	–37 (–69,–4)	–16 (–46, 15)
ISWT	*n*	*63*	*59*
	Distance (m)	2 (–27, 32)	23 (–13, 60)
ESWT	*n*	*64*	62
	Time (s)	–96 (–253, 61)	–54 (–245, 137)

Data was determined from the predicted means from Linear Mixed Model (LMM). ESWT: endurance shuttle walk test; ISWT: incremental shuttle walk test; m: metres; *n*: number of participants analysed; s: seconds; SGRQ: St George's Respiratory Questionnaire; 6MWT: six-minute walk test

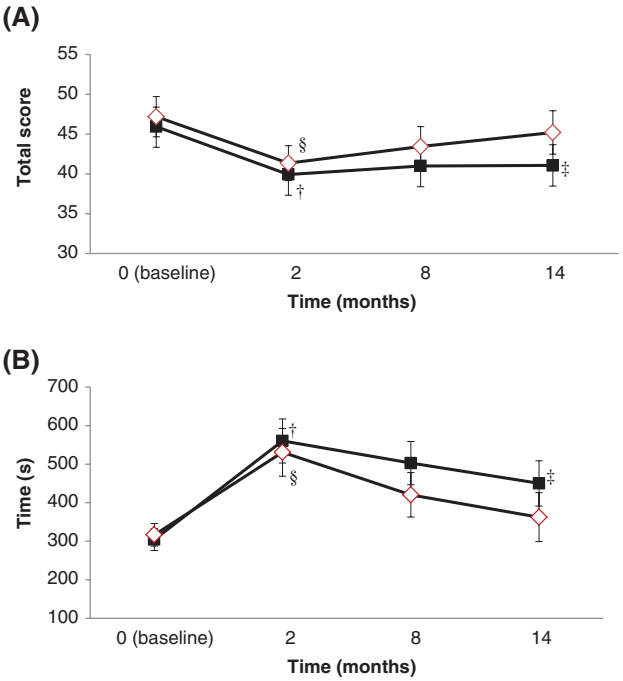

Figure 2 (A) St George's Respiratory Questionnaire total score. Data are presented as predicted mean values from linear mixed models (LMM) with error bars representing SE. (B) Endurance shuttle walk test (ESWT). Data are presented as adjusted mean values from LMM with error bars representing SE. (A and B) ■, intervention group (IG); ◇, control group (CG); †IG significant improvement from baseline to 2 months; ‡IG significant improvement from baseline to 14 months; §CG significant improvement from baseline to 2 months.

compliant with exercise and be more motivated to participate in long-term exercise training, which could have contributed to the positive effects on exercise capacity.[16,17] We chose to randomize participants prior to commencing a short-term PR programme as this is more representative of the patient population and patient journey.

While HRQoL and ESWT were maintained in the IG, this did not translate into between-group differences which may have been a consequence of a number of factors, in particular, that the changes were small in relation to the variability in measurements. The small effect of the intervention may have resulted from the relatively poor adherence to the unsupervised walking programme, which was somewhat surprising as we hypothesized that the regular feedback and ongoing support using health coaching principles[30] would have resulted in improved adherence during the maintenance phase. It appears from our findings that this level of support was not sufficient or appropriately targeted to change exercise behaviour and encourage adherence in patients with COPD in order to maintain a significantly greater HRQoL and exercise capacity than those not receiving such interventions. Adherence remains difficult to objectively measure and hence self-reported diaries are often used; however, our results demonstrated limited engagement in the use of diaries. While adherence levels in the CG appeared to be higher than in the IG, this only reflected the low number of diaries returned in the CG rather than greater adherence. A greater amount of data was available on the level of adherence in the IG due to information collected during the regular telephone calls. The IG adherence of 52% to the prescribed walking exercise frequency during the maintenance phase was similar to that reported in other studies[7,31,32] and may be a more accurate reflection of adherence levels in patients with COPD than that collected via diaries. A further explanation for the lack of between-group difference may be that both groups were instructed to do walking exercise during the maintenance programme, thus potentially reducing the between-group differences. This contrasts with a previous maintenance study[17] in which the comparison group did not do maintenance exercise and the use of telephone calls and pedometers was effective at producing between-group differences in HRQoL at 6 months following completion of the initial training programme, mainly due to a decline in HRQoL in the CG.[17]

A limitation of the study was the relatively large loss to follow-up (21%) during the maintenance phase which meant that the target of 86 participants completing the study was not reached. This dropout rate is consistent with other maintenance studies in COPD.[7,15,17,33] A larger sample size would have been unlikely to change the between-group differences as the *P*-values were not close to being significant and the magnitude of the differences were less than the minimum clinically important differences so unlikely to be important. A second limitation of the study was that a

per-protocol analysis was not possible as there were insufficient data to determine accurate adherence to the maintenance walking programme, due to the inadequacies of diary use. In future studies, more objective measures of adherence would help inform clinicians about the true effect of unsupervised maintenance interventions in adherent participants. Despite these limitations, the strength of this study was the robust methodological design using intention-to-treat analysis with participants recruited prior to short-term supervised exercise training, thus reflecting real-life clinical practice.

In conclusion, this study investigated the effects on HRQoL of adding ongoing feedback to a 12-month unsupervised maintenance walking programme that followed a 2-month supervised walking training programme in patients with COPD. There were no between-group differences in the magnitude of change in HRQoL from baseline to 14 months or from 2 to 14 months. Based on these findings, ongoing feedback was no more effective than no feedback in maintaining the gains of short-term supervised walking programme. As long-term supervised maintenance exercise programmes are not always an option following PR, further research is needed to investigate the optimal design of unsupervised maintenance programmes in patients with COPD.

Acknowledgements

The authors would like to thank the staff at Royal Prince Alfred Hospital, Concord Repatriation General Hospital, Prince of Wales Hospital, Manly Hospital, Hornsby Ku-ring-gai Hospital, Bentley Hospital and Sir Charles Gairdner Hospital for their assistance and support, and also thank the patients who participated in the study and Professor Jennifer Peat for statistical support. The study was funded by an Australian National Health and Medical Research Council project grant: 570814. P.R.E. was funded by a National Health and Medical Research Council of Australia (NHMRC) Senior Research Fellowship (1042341).

Disclosure statement

This study was previously presented at the Australian Physiotherapy Association Cardiorespiratory Physiotherapy Australia 14th Biennial Scientific Conference in 2015 and the TSANZSRS Annual Scientific Meeting in 2017.

REFERENCES

1 Ilgin D, Ozalevli S, Kilinc O, Sevinc C, Cimrin AH, Ucan ES. Gait speed as a functional capacity indicator in patients with chronic obstructive pulmonary disease. *Ann. Thorac. Med.* 2011; **6**: 141–6.
2 Osman LM, Godden DJ, Friend JAR, Legge JS, Douglas JG. Quality of life and hospital re-admission in patients with chronic obstructive pulmonary disease. *Thorax* 1997; **52**: 67–71.
3 Spruit MA, Singh SJ, Garvey C, ZuWallack R, Nici L, Rochester C, Hill K, Holland AE, Lareau SC, Man WDC *et al.* An Official American Thoracic Society / European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. *Am. J. Respir. Crit. Care Med.* 2013; **188**: e13–64.
4 Cecins N, Geelhoed E, Jenkins S. Reduction in hospitalisations following pulmonary rehabilitation in patient with COPD. *Aust. Health Rev.* 2008; **32**: 415–22.
5 Griffiths TL, Phillips CJ, Davies S, Burr ML, Campbell IA. Cost effectiveness of an outpatient mulitdisciplinary pulmonary rehabilitation programme. *Thorax* 2001; **56**: 779–84.
6 Rubí MD, Renom F, Ramis F, Medinas M, Centeno MJ, Górriz M, Crespí E, Martín B, Soriano JB. Effectiveness of pulmonary rehabilitation in reducing health resources use in chronic obstructive pulmonary disease. *Arch. Phys. Med. Rehabil.* 2010; **91**: 364–8.
7 Brooks D, Krip B, Mangovski-Alzamora S, Goldstein RS. The effect of postrehabilitation programmes among individuals with chronic obstructive pulmonary disease. *Eur. Respir. J.* 2002; **20**: 20–9.
8 Foglio K, Binachi L, Bruletti G, Battista L, Pagani M, Ambrosino N. Long-term effectiveness of pulmonary rehabilitation in patient with chronic airway obstruction. *Eur. Respir. J.* 1999; **13**: 125–32.
9 Troosters T, Gosselink R, Decramer M. Short- and long-term effects of outpatient rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial. *Am. J. Med.* 2000; **109**: 207–12.
10 Beauchamp MK, Evans R, Janaudis-Ferreira T, Goldstein RS, Brooks D. Systematic review of supervised exercise programs after pulmonary rehabilitation in individuals with COPD. *Chest* 2013; **144**: 1124–33.
11 Steiner M, Holzhauer-Barrie J, Lowe D, Searle L, Skipper E, Welham S, Roberts CM. Pulmonary rehabilitation: time to breath better. National Chronic Obstructive Pulmonary Disease (COPD) Audit Programme: Resources and organisation of Pulmonary Rehabilitation services in England and Wales, 2015. Accessed [12 Dec 2015.] Available from URL: http://www.hqip.org.uk/resources/copd-audit-organisational-report-2015/
12 Camp PG, Hernandez P, Bourbeau J, Kirkham A, Debigare R, Stickland MK, Goodridge D, Marciniuk DD, Road JD, Bhutani M *et al.* Pulmonary rehabilitation in Canada: a report from the Canadian Thoracic Society COPD Clinical Assembly. *Can. Respir. J.* 2015; **22**: 147–52.
13 Australian Institute of Health and Welfare. Monitoring pulmonary rehabilitation and long-term oxygen therapy for people with chronic obstructive pulmonary disease (COPD), 2013. [Accessed 18 Nov 2014.] Available from URL: www.aihw.gov.au
14 Ries AL, Kaplan RM, Myers R, Prewitt LM. Maintenance after pulmonary rehabilitation in chronic lung disease. *Am. J. Respir. Crit. Care Med.* 2003; **167**: 880–8.
15 Waterhouse JC, Walters SJ, Oluboyede Y, Lawson RA. A randomised 2X2 trial of community versus hospital pulmonary rehabilitation, followed by telephone or conventional follow-up. *Health Technol. Assess.* 2010; **14**: 1–140.
16 Steele BG, Belza B, Cain KC, Coppersmith J, Lakshminarayan S, Howard J, Haselkorn JK. A randomized clinical trial of an activity and exercise adherence intervention in chronic pulmonary disease. *Arch. Phys. Med. Rehabil.* 2008; **89**: 404–12.
17 Du Moulin M, Taube K, Wegscheider K, Behnke M, van den Bussche H. Home-based exercise training as maintenance after outpatient pulmonary rehabilitation. *Respiration* 2009; **77**: 139–45.
18 Wootton SL, Ng C, McKeough ZJ, Jenkins S, Hill K, Eastwood PR, Hillman DR, Cecins N, Spencer LM, Jenkins C *et al.* Ground based walking training improves quality of life and exercise capacity in COPD. *Eur. Respir. J.* 2014; **44**: 885–94.
19 Borg G. Psychophysical bases of perceived exertion. *Med. Sci. Sports Exerc.* 1982; **14**: 377–81.
20 Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr. Scand.* 1983; **67**: 361–70.
21 Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general US population. *Am. J. Respir. Crit. Care Med.* 1999; **159**: 179–87.
22 Stocks J, Quanjer P. Reference values for residual volume, functional residual capacity and total lung capacity. *Eur. Respir. J.* 1995; **8**: 492–506.
23 Crapo RO, Morris AH. Standardised single breath normal values for carbon monoxide diffusing capacity. *Am. Rev. Resp. Dis.* 1981; **123**: 185–9.
24 Vogelmeier CF, Criner GJ, Martinez FJ, Anzueto A, Barnes PJ, Bourbeau J, Celli BR, Chen R, Decramer M, Fabbri LM *et al.* Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease 2017 Report: GOLD Executive Summary. *Arch. Bronconeumol.* 2017; **53**: 128–49.

25 Jones PW, Quirk FH, Baveystock CM. The St George's Respiratory Questionnaire (SGRQ). *Respir. Med.* 1991; **85**: 25–31.
26 Guyatt GH, Berman LB, Townsend M, Pugsley SO, Chambers LW. A measure of quality of life for clinical trials in chronic lung disease. *Thorax* 1987; **42**: 773–8.
27 Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, McCormack MC, Carlin BW, Sciurba FC, Pitta F *et al.* An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur. Respir. J.* 2014; **44**: 1429–46.
28 Jones PW. Interpreting thresholds for a clinically significant change in health status in asthma and COPD. *Eur. Respir. J.* 2002; **19**: 398–404.
29 Griffiths TL, Burr ML, Campbell IA, Lewis-Jenkins V, Mullins J, Shiels K, Tunbridge J, Turner-Lawlor PJ, Payne N, Newcombe RG *et al.* Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: a randomised controlled trial. *Lancet* 2000; **355**: 362–8.
30 HealthChange Australia. Model of Health Change. [Accessed 20 Jan 2016.] Available from URL: www.healthchangeassociates.com
31 Carrieri-Kohlman V, Nguyen HQ, Donesky-Cuenco D, Demir-Deviren S, Neuhaus J, Stulbarg MS. Impact of brief or extended exercise training on the benefit of a dyspnea self-management program in COPD. *J. Cardiopulm. Rehabil.* 2005; **25**: 275–84.
32 Heppner PS, Morgan C, Kaplan RM, Ries AL. Regular walking and long-term maintenance of outcomes after pulmonary rehabilitation. *J. Cardiopulm. Rehabil.* 2006; **26**: 44–53.
33 Spencer L, Alison J, McKeough Z. Maintaining benefits following pulmonary rehabilitation: a randomised controlled trial. *Eur. Respir. J.* 2010; **35**: 571–7.

Supplementary Information

Additional supplementary information can be accessed via the *html* version of this article at the publisher's website.

Appendix S1 Further details of intervention: intervention group.
Appendix S2 Telephone script.
Table S1 Chronic Respiratory Disease Questionnaire at baseline, 2-, 8- and 14-month assessment.
Table S2 Chronic Respiratory Disease Questionnaire difference within groups.
Table S3 Chronic Respiratory Disease Questionnaire between-group differences.
Table S4 Reported adherence to walking training during the 12-month maintenance walking programme.

