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# The Pulmonary Rehabilitation Adapted Index of Self-Efficacy (PRAISE) tool predicts reduction in sedentary time following pulmonary rehabilitation in people with chronic obstructive pulmonary disease (COPD)☆

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## Abstract

**Objectives** To examine the predictive validity, minimal important difference (MID) and responsiveness of the PRAISE tool.
**Design** Retrospective data analysis from HomeBase trial of home vs centre-based pulmonary rehabilitation.
**Setting** Tertiary health service.
**Participants** One hundred and sixty-six participants with COPD (100 men) with mean age 69 (SD 9) years, $FEV_1$% predicted 50% (19).
**Interventions** Eight-week pulmonary rehabilitation program, conducted at the hospital or at home.
**Main outcome measures** The 15-item PRAISE tool comprising 10 general and five pulmonary rehabilitation-specific self-efficacy questions. Predictive validity was examined by exploring the relationship between baseline PRAISE score and objective change in physical activity following pulmonary rehabilitation using the SenseWear Armband. The MID was evaluated using anchor-based and distribution-based methods. Responsiveness was assessed with effect sizes.
**Results** A higher baseline PRAISE score (indicating better self-efficacy) was an independent predictor of reduced sedentary time following pulmonary rehabilitation ($P = 0.03$). A one point increase in PRAISE was associated with a decrease in sedentary time of 4 minutes/day (95% confidence interval −7.8 to −0.4 minutes/day). Anchor-based estimates of the MID were 0.5 to 1.5 points; however sensitivity and specificity were modest (area under the curve <0.70). Change in PRAISE score following pulmonary rehabilitation had an effect size of 0.21.
**Conclusions** The PRAISE tool has predictive validity and may be useful to identify those with high self-efficacy who are more likely to achieve important health behaviour changes with pulmonary rehabilitation. The small effect size suggests that the PRAISE tool was not responsive to changes following pulmonary rehabilitation.

**Trial registration number** NCT01423227, clinicaltrials.gov.


*Keywords:* Physical activity; Pulmonary disease, chronic obstructive; Self-efficacy; Health behaviour

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## Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of death [1] and is characterised by dyspnoea, reduced exercise capacity, poor quality of life [2] and physical inactivity [3]. Physical inactivity is associated with more acute exacerbations [4] and increased mortality risk [5] for people with COPD. Pulmonary rehabilitation programmes aim to enhance physical activity [6] through exercise training and self-management education [7]. Optimising physical activity involves increasing moderate to vigorous physical activity time [8] and reducing sedentary behaviour [6]. Pulmonary rehabilitation significantly improves physical activity in people with COPD, particularly if it is combined with physical activity counselling [9].

Self-efficacy COPD has been identified as an important factor which affects behaviour change in COPD [10] General self-efficacy describes a positive self-belief system and those with high self-efficacy have confidence in performing tasks and coping with adversity [11]. Task specific self-efficacy describes self-belief in completing specific health behaviours [12]. Self-efficacy is a particularly important predictor of physical activity behaviours in the early adoption stage of exercise programs [13]. This is relevant to pulmonary rehabilitation, where those with higher self-efficacy may be more likely to adopt the desired physical activity behaviours during the initial 8-week program.

The Pulmonary Rehabilitation Adapted Index of Self-Efficacy (PRAISE) tool was developed to measure self-efficacy in pulmonary rehabilitation [10]. It incorporates the General Self-Efficacy scale (GSES) which is highly valid and reliable [14]. Five pulmonary rehabilitation specific questions are also included [10]. The PRAISE tool has good reliability and internal validity, however its relationship with objective changes in behaviour has not been explored, nor has an estimate for the minimal important difference (MID) been proposed [10]. It is not known whether the additional five questions improve the performance of the original GSES questionnaire [15].

The aims of this study were: to examine the relationship between PRAISE scores at commencement of pulmonary rehabilitation and objective changes in physical activity using accelerometer data; to examine the minimal important difference using anchor based and distribution based methods; and to compare the responsiveness of the 15-item PRAISE tool with the responsiveness of the two domains of general and task specific self-efficacy.

## Methods

### *Design*

This study used existing data from the HomeBase trial, a blinded randomised controlled study, powered for equivalence of clinical outcomes, with subjects recruited from two tertiary hospital sites [16].

### *Participants*

The trial recruited 166 participants who met the inclusion criteria (age over 40 years, diagnosis of COPD ($FEV_1$/FVC <70%) and smoking history ≥10 pack years [16]). Participants were excluded if they had asthma, had attended pulmonary rehabilitation in the preceding 2 years, an acute exacerbation within 4 weeks or other co-morbidities which prevented exercise participation.

### *Interventions*

Participants were randomly allocated to either a hospital-based or a home-based rehabilitation programme for eight weeks [16]. The interventions, both of which involved exercise training, self management training and promotion of daily physical activity, have previously been described [17]. Equivalence of the home and centre-based programs was established [17]. As a result we have combined data across the two groups for most statistical analyses in this study.

### *Measurements and outcomes*

Participants completed the PRAISE tool at baseline and eight weeks. The PRAISE tool [10] consists of 15 statements scored from 1 to 4, with higher levels indicating greater self-efficacy. Scores for general self-efficacy and the task-specific domains were calculated separately. Objective measures of physical activity were obtained in a subgroup of consecutively recruited participants using the SenseWear MF Armband (SWA, Bodymedia, Pittsburgh, USA). The SWA is a validated method to measure physical activity in COPD [18,19]. The armband was worn for seven days on the left upper arm. Physical activity variables of interest were time spent in moderate to vigorous physical activity; sedentary time; sleep time; energy expenditure; and number of steps. The first and last days of data were excluded from analysis. A day of data was included if there were at least 10 hours of data within the 24 hour period. A minimum of four valid days were required, inclusive of at least one weekend day [20]. The intensity of physical activity is described according to metabolic equivalents (1 MET = 1 kcal/kg/hour), with sedentary ≤1.5 METs [21], and moderate and vigorous physical activity (MVPA) ≥3 METs [22]. Bouts of time spent in each classification of physical activity were extracted, defined as activity lasting at least 10 minutes [22]. Bouts were measured in waking hours from 07.00 to 19.00 [20].

Health-related quality of life was assessed using the Chronic Respiratory Disease Questionnaire (CRQ) [23] which has domains of dyspnoea, fatigue, mastery and emotional function. Dyspnoea was rated using the Modified Medical Research Council (MMRC) scale [24]. Presence of a mood disorder was evaluated with the Hospital Anxiety

and Depression Scale (HADS) [25]. The Global Rating of Change Scale (GRCS) provided an overall rating of perceived changes in health status following pulmonary rehabilitation, a recommended component of MID calculations [26]. The COPD-specific Comorbidity Test (COTE) Index [27] was used to document comorbidities [27]. Completion of pulmonary rehabilitation was defined as attending a minimum of 70% of assigned sessions [28].

### *Statistical analysis*

All data were analysed using Statistical Package for the Social Sciences Version 24 (IBM Corp., Armonk, NY,USA). As this was a retrospective study no power calculation was performed. A $P$-value <0.05 was considered statistically significant.

### *Predictive validity*

Predictive validity was determined by examining the relationship between baseline PRAISE scores and changes in physical activity following pulmonary rehabilitation, using Pearson's Correlation coefficient for normally distributed variables and Spearman's rho for non-parametric variables. Results of the univariate analysis determined the variables included in a multivariate regression analysis, to assess the independent contribution of PRAISE scores to physical activity changes. Potential predictors of change in physical activity (respiratory function, age, HADS, MMRC, CRQ domains, COTE index, Body Mass Index (BMI), gender, programme completion and group allocation) were included in the model if $P < 0.10$ on univariate analysis. Due to the small number of participants ranked Grade 0 and 4 on the MMRC, Grades 0 and 1 and Grades 3 and 4 were combined for analysis. Results were presented as the total percentage of variance that could be explained by the regression model ($R^2$), and beta with 95% confidence intervals.

### *Minimal important difference*

*Anchor based methods* involve comparing a patient's change score to other measures of clinical change. These methods acknowledge the individual's perspective of their changed status. Two established measures were utilised:

(1) The GRCS assesses participants' self-rating of change on a scale of −7 to +7 (Table S1). For analysis, scores of "−1, 0 and +1" were classified as "no change", "2 to 3" classified as "small positive change" and "−2 to −3" as a "small negative change". A score of "4 to 7" and "−4 to −7" was considered a "substantial positive change" or "substantial negative change" [29]. These classifications for the GRCS have been utilised in other respiratory populations [30]. The changes in PRAISE score associated with "substantial positive change", "small positive change" and "no change" rated by the GCRS were compared using analysis of variance.

(2) The CRQ Mastery domain measures "a feeling of control of the disease" [31], a construct similar to self-efficacy. The MID for CRQ mastery is well established [26].Those who achieved a change in CRQ mastery of greater or equal to the MID of 0.5 (total change of score of ≥2 for the four mastery questions) were considered "changed" and a lesser score was considered "unchanged". Those with a reduction in score of two or more were categorized as "negatively changed". The sensitivity and specificity for change in PRAISE score to discriminate between individuals who were classified as "changed" and "unchanged" according to their GRCS or CRQ Mastery was calculated and Receiver Operating Characteristic (ROC) curves were obtained. An estimate of the MID was obtained using the data point closest to the upper left corner of the curve, representing the best balance of sensitivity and specificity. The area under the curve (AUC) represents the probability that scores will correctly discriminate between improved and unimproved patients with an area of 0.7 to 0.8 considered acceptable and 0.8 to 0.9 considered excellent [32].

*Distribution based measures* use psychometric and statistical properties of the measurement to estimate the MID by calculating:

(1) 0.5 times the SD of the change scores [33,34] which gives the values for a small effect of change
(2) The Standard Error of Measurement, defined as $\sigma_1 \sqrt{(1 - r)}$, where $\sigma_1$ is the baseline SD and r is the test-retest reliability. The test-retest reliability for PRAISE is r = 0.99 ($P \leq 0.001$) [10]. One SEM is a small effect and may be used to estimate the MID [35].

### *Responsiveness*

Responsiveness is the ability of a tool to measure clinically significant change [33]. Responsiveness of the PRAISE was evaluated by calculating the effect size (ES) which quantifies the difference between two means on a unit-less scale and is calculated as $ES = (\mu 1 - \mu 2)/\sigma_1$, where $\mu 1$ is the mean at baseline and $\mu 2$ is the mean at completion and $\sigma_1$ the baseline SD of the tool. An effect size of 0.2 is considered small, 0.5 moderate and 0.8 large [36]. A moderate effect size is considered a clinically important effect.

## Results

### *Demographics*

The demographic and baseline characteristics of the 166 study participants are summarized in Table 1. The majority were male ($n = 100$, 60%) with a mean age of 69 (SD 9.4) years and $FEV_1$% predicted of 50% (SD 19). Forty-two of the 86 participants allocated to the centre-based rehabilitation completed the programme (49%) and for the home based participants, 73 (91%) completed. Eight participants used long

Table 1
Baseline characteristics of participants.

| Characteristic | $n = 166$ |
|---|---|
| Age (yr), mean (SD) | 69 (9) |
| Gender, *n* male (%) | 100 (60) |
| 6 minute walk distance (m), mean (SD) | 403 (114) |
| $FEV_1$ (% predicted), mean (SD) | 50 (19) |
| BMI ($kg/m^2$), mean (SD) | 28.3 (6.4) |
| Centre-based pulmonary rehabilitation, *n* (%) | 86 (52) |
| MMRC dyspnoea, *n* (%) | |
| Grade 0 | 2 (1) |
| Grade 1 | 69(42) |
| Grade 2 | 50(30) |
| Grade 3 | 40(24) |
| Grade 4 | 5 (3) |
| PRAISE score, mean (SD) | |
| Baseline | 47.06 (7.01) |
| Male participants ($n = 98$) | 48.04 (6.62) |
| Female ($n = 66$) | 45.61 (7.36) |
| Change following pulmonary rehabilitation ($n = 144$) | 1.27 (7.25) |
| Pack years (*n*), median [IQR] | 43 [30–58] |
| Smoking status, *n* (%) | |
| Ex-smoker | 137 (82) |
| Current smoker | 28 (17) |
| Baseline daily physical activity variables | $n = 56$ |
| MVPA measures | |
| Total time in MVPA (minutes/day), median [IQR] | 69 [24–134] |
| Duration of MVPA in bouts (minutes/day), mean (SD) | 10 (0–39) |
| Number of MVPA bouts (*n*), median [IQR] | 0.7 [0–2.5] |
| Sedentary measures | |
| Total sedentary time (minutes/day), mean (SD) | 1077 (178) |
| Duration of sedentary in bouts (minutes/day), mean (SD) | 486 (117) |
| Number of sedentary bouts *(n)*, mean (SD) | 5 (1.5) |
| Sleep time (minutes/day) | |
| Total sleep time, mean (SD) | 396 (146) |
| Sleep 7am to 7pm, median [IQR] | 39 [17–81] |
| Sleep 7pm to 7am, mean (SD) | 336 (120) |
| Energy expenditure (kj) | 9612 (2751) |
| Number of steps (*n*) | 3852 (2653) |

BMI = body mass index; PRAISE = Pulmonary Rehabilitation Adapted Index of Self-Efficacy; MMRC = Modified Medical Research Council dyspnoea scale; MVPA = moderate and vigorous physical activity.

term oxygen therapy. Physical activity data ($n = 56$) showed that activity levels were low (Table 1).

### *Predictive validity*

#### *Univariate relationships*

Data from 56 participants were available for analysis (29 in home group and 37 in centre-based group). Those with a higher baseline PRAISE score tended to have a greater reduction in sedentary time following pulmonary rehabilitation, but the relationship was weak ($r = -0.26$, $P = 0.05$, Fig. 1). Those with higher baseline PRAISE scores had a greater reduction in the average time spent sedentary in bouts of at least 10 minutes of sedentary behaviour following pulmonary rehabilitation ($r = -0.269$, $P = 0.04$, Fig. 2). There were no other significant relationships between baseline PRAISE and change in physical activity variables (Table S2). There was a significant difference in baseline PRAISE scores favouring males (mean difference = 2.44, $P = 0.03$). Participants

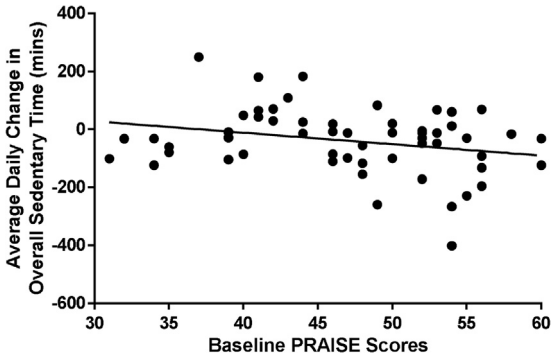


Fig. 1. Relationship between baseline PRAISE (Pulmonary Rehabilitation Adapted Index of Self-Efficacy) scores and change in average daily sedentary time over 24 hours ($r = -0.26$, $P = 0.05$).

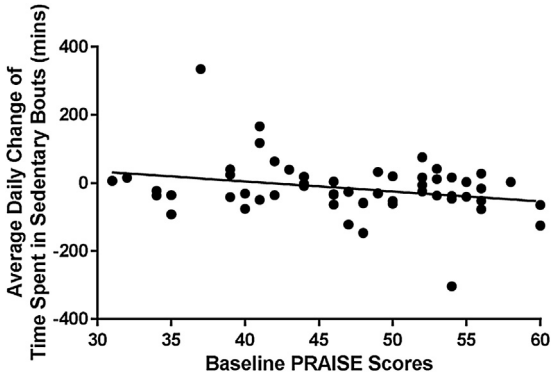


Fig. 2. Relationship between baseline PRAISE (Pulmonary Rehabilitation Adapted Index of Self-Efficacy) scores and change in average time spent in sedentary bouts during waking hours 07:00 to 19:00 ($r = -0.269$, $P = 0.04$).

assigned to each group (home-based vs centre-based) did not demonstrate significant differences in their baseline PRAISE scores. The baseline PRAISE scores did not differ between "completers" and "non-completers".

#### *Multiple linear regression analysis*

Change in total sedentary time: Univariate relationships of potential predictors with change in sedentary time are shown in Table S3. A linear regression model that included baseline PRAISE score, the COTE index and pack years (Table 2) explained 20% of the variance of change in sedentary time. Both the COTE index and baseline PRAISE were independent predictors, with the COTE index being the greater contributor. A one point increase in PRAISE was associated with a decrease in sedentary time of 4 minutes/day (95% confidence interval −7.8 to −0.4 minutes/day). Group allocation did not contribute to the model.

Change in time spent in sedentary bouts: Continuous factors entered in the model are in Table S4. A model which explains 16% of the variance included baseline PRAISE and MMRC dyspnoea scores (Table 2). Both the MMRC and baseline PRAISE were independent contributors to the model; however the baseline PRAISE score was the greater contributor. A one point increase in PRAISE was associated

Table 2
Stepwise multiple linear regression model for change in daily sedentary time.

| | Unstandardised coefficients (B) | 95% confidence interval for B | *P*-value | Standardised coefficient (Beta) |
|---|---|---|---|---|
| Change in daily sedentary time | | | | |
| Constant | 221.616 | 32.539 to 410.694 | 0.022 | |
| PRAISE score at baseline | −4.101 | −7.847 to −0.354 | 0.033 | −0.273 |
| COTE index | −12.277 | −23.059 to −1.496 | 0.026 | −0.284 |
| Pack years | −1.073 | −2.305 to 0.159 | 0.086 | −0.217 |
| Change in daily bouts of sedentary time | | | | |
| Constant | 220.773 | 62.46 to 379.09 | 0.007 | |
| PRAISE score at baseline | −3.844 | −6.761 to −0.928 | 0.011 | −0.349 |
| MMRC Revised | −32.415 | −58.941 to −5.888 | 0.018 | −0.324 |

PRAISE = Pulmonary Rehabilitation Adapted Index of Self-Efficacy; COTE index = COPD-specific Comorbidity Test; MMRC Revised, Modified Medical Research council dyspnoea scale combining Grades 0 to 1 and Grades 3 to 4.

with a decrease in sedentary time of 4 minutes/day (95% confidence interval −7 to −1 minutes/day). Group allocation, HADS depression and CRQ fatigue scores did not contribute to the model.

### *Minimal important difference*

#### *Anchor based measures*

Data for 141 participants were available. The changes in PRAISE scores according to GRCS are represented in Fig. 3.

Those who reported substantial and small improvements on GRCS had a significantly larger improvement in PRAISE than those who reported "no change" (mean 2.98 (95% confidence interval 1.66 to 2.49) vs −1.2 (−3.1 to 0.70), $P = 0.001$). Similarly, those who reported clinically significant improvements on the CRQ Mastery domain had larger improvements in PRAISE than those who did not (mean 3 (1.42 to 4.56) vs −0.49 (−2.52 to 1.55), $P = 0.012$). Using the ROC method, estimates for the MID using GRCS were 0.5 points with AUC of 0.688, sensitivity 0.705 and specificity 0.400. Using CRQ Mastery, the threshold was 1.5 points with AUC of 0.681, sensitivity 0.646 and specificity 0.343 (see Figs. S1 and S2).

#### *Distribution based measures*

The half SD method revealed an MID of 3.608 and standard error of measurement MID was 0.7.

### *Responsiveness*

Data for 144 participants were available. Following pulmonary rehabilitation there was a significant improvement in PRAISE score (mean 1.27 points, 95% CI 0.08 to 2.46) with no difference between groups. The effect size for change in PRAISE following pulmonary rehabilitation was 0.21. Similar effect sizes were evident when considering only the GSES items (effect size 0.18), or the five pulmonary rehabilitation specific items (effect size 0.22).

## Discussion

This study is the first to demonstrate predictive validity of the PRAISE tool. Baseline PRAISE score was an independent predictor of changes in sedentary behaviour following pulmonary rehabilitation. The MID estimates for the PRAISE varied from 0.5 to 1.5 units; however low sensitivity and specificity suggests these may not be useful in clinical practice. The small effect size of the PRAISE tool and of its two domains indicates low responsiveness following pulmonary rehabilitation.

Inactivity in the COPD population is profound when compared to healthy subjects [37] and contributes to many adverse outcomes. Improving physical activity involves increasing MVPA [8], but also reducing the duration of sedentary time [38]. People with COPD may not make substantial improvements in MVPA post pulmonary rehabilitation [17]. However there is growing understanding that targeting sedentary behaviour [4,39] may have health benefits, even in the absence of improvement in MVPA. It is unclear what factors may assist in reducing sedentary behaviour in COPD and more research is required [38]. This study has demonstrated that baseline self-efficacy of an individual could be one factor contributing to changes in sedentary behaviour. However, the regression models explained only a small percentage of changes in sedentary behaviour (16 to 20%), suggesting other, unmeasured factors are also important. This is not surprising as physical activity is a complex behaviour with multiple physiological, behavioural, cognitive and environmental determinants [13].

Our study proposed an estimate for the MID, however the anchor-based thresholds of 0.5 and 1.5 point change may not be sensitive. For this reason, the MID proposed from our study cannot be used with confidence. Other more established outcome measures, such as the CRQ mastery domain, could be utilized to detect clinically relevant change in self-efficacy [23]. Previous studies have shown a significant correlation between change in CRQ mastery and change in PRAISE scores [10], which was confirmed by our results. In addition, the CRQ has an established MID [23].

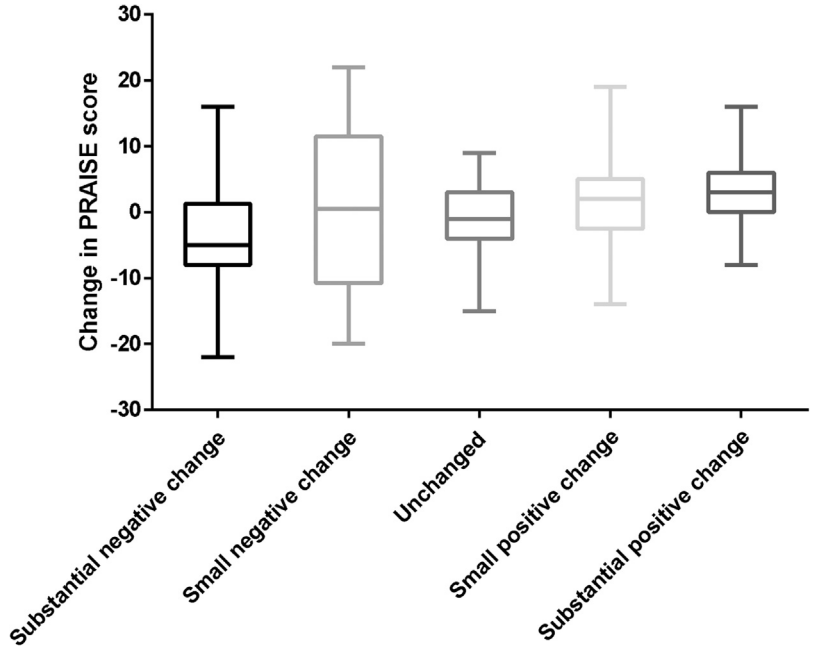


Fig. 3. Relationship between change in PRAISE (Pulmonary Rehabilitation Adapted Index of Self-Efficacy) score and self-reported overall global rating of change. The top and bottom of the boxes represent the interquartile range and the middle line represents the median. Whiskers represent minimum and maximum values.

At completion of pulmonary rehabilitation, the change in PRAISE score from our study (1.27 [95% CI, 0.08 to 2.46], $P < 0.001$) was smaller in magnitude than that reported by the developers of the PRAISE tool in a similar population (3.59 [95% CI, 2.24 to 4.73]) [10]. The previous study included participants with lower PRAISE scores at baseline (male PRAISE scores mean 40.65 vs 48.04 in our current study). Higher PRAISE scores at baseline in our study may also explain the smaller change in the PRAISE post pulmonary rehabilitation.

As the baseline PRAISE score was predictive of changes in sedentary time, this could be utilised as a screening tool to identify those with higher self-efficacy who are more likely to achieve physical activity benefits from pulmonary rehabilitation. More importantly, it could also be used to identify those who may benefit from adjunctive interventions to enhance self-efficacy in order to attain full benefits from pulmonary rehabilitation. The literature includes many recommendations on how self-efficacy can be enhanced through pulmonary rehabilitation in patients with COPD [40]. Further research would be required to ascertain which approaches are likely to be most effective.

There were several factors which may have limited our results. Although we had a large number of participants with PRAISE score changes ($n = 144$), PRAISE scores at baseline were moderately high with no participants scoring below 30 (lowest score possible was 15). Those who consented to participate in the study were aware they would undertake an exercise programme, which may have attracted participants with higher self-efficacy and contributed to selection bias. The small effect size for PRAISE could have reflected a small effect of pulmonary rehabilitation, rather than a lack of responsiveness for the PRAISE, however participants achieved clinically important gains in CRQ mastery, which makes this less likely [17]. Participants were recruited from two tertiary health services which may affect generalisability. We had a comparatively small subset of 56 participants for whom both PRAISE and objective physical activity data were available. No power calculation was performed, as this was a retrospective study using data from a previous clinical trial. With this sample however, we were able to demonstrate statistically significant relationships between baseline PRAISE and changes in sedentary time.

## Conclusion

This is the first study to identify the relationship between self-efficacy measured at baseline with PRAISE and objective changes in behaviour targeted by pulmonary rehabilitation. We have also demonstrated that the baseline PRAISE score is an independent predictor of reduction in sedentary behaviour. The small effect size of the PRAISE tool may indicate that it is not responsive to changes in self-efficacy following pulmonary rehabilitation; further investigation is indicated to establish its utility as an outcome measure. The PRAISE is a useful screening tool to identify those who require additional interventions to improve

their self-efficacy and attain the full benefits of pulmonary rehabilitation.

**Key messages**

- Higher combined general and task-specific efficacy measured on the PRAISE tool prior to pulmonary rehabilitation was associated with greater reductions in sedentary time following intervention, demonstrating predictive validity of this tool.
- The MID estimates for PRAISE ranged from 0.5 to 1.5, however the modest area under the receiver operating curve (ROC) suggest that these thresholds may not be clinically useful
- The small effect size suggests that the PRAISE tool was not responsive to changes in self-efficacy following pulmonary rehabilitation and further investigation is warranted to establish its usefulness as an outcome measure.

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*Conflict of interest*: None declared.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.physio.2018.07.009.

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