Full Title:

Bandura's exercise self-efficacy scale: validation in an Australian cardiac rehabilitation setting

Short Title:

Exercise self-efficacy

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Abstract

Background: Despite the established benefits of cardiac rehabilitation (CR) in improving health outcomes for people with cardiovascular disease, adherence to regular physical activity at recommended levels remains suboptimal. Self-efficacy has been shown to be an important mediator of health behaviour, including exercise.

Objectives: To assess the psychometric properties of Bandura's exercise self-efficacy (ESE) scale in an Australian CR setting.

Design: Validation study

Setting: Cardiac rehabilitation

Participants: One hundred and ten patients (Mean:60.11 SD:10.57 years)

Methods: Participants completed a six-minute walk test (6MWT) and Bandura's Exercise Self-Efficacy (ESE) scale at enrolment and on completion of a 6-week CR program.

Results: Bandura's ESE scale had a single factor structure with high internal consistency (0.95), and demonstrated no floor or ceiling effects. A comparison of ESE scores by distance walked on 6MWT indicated those who recorded more than 500m at baseline had significantly higher ESE scores (Mean:116.26 SD:32.02 m) than those patients who only achieved up to 400 metres (m) on the 6MWT at baseline (Mean:89.94 SD:29.47 m) (p=0.044). A positive and significant correlation between the change in scores on the ESE scale and the change in the 6MWT distance (r=0.28, p=0.035) was seen.

Conclusions: The ESE scale was a robust measure of exercise self-efficacy over the range of patients attending this outpatient cardiac rehabilitation program.

Interventions to improve self-efficacy may increase CR patient's efficacy for regular physical activity.

Key Words: Australia; cardiac rehabilitation; exercise; physical activity, psychometrics; self-efficacy; six-minute walk test

What is already known about the topic?

- Physical activity is an important strategy in effective secondary prevention
- Participation in cardiac rehabilitation and also adherence to recommendations for physical activity are less than optimal
- Self-efficacy has been shown to be an important mediator of health behaviour, including exercise.

What this paper adds?

- A greater understanding of the role of self-efficacy in the cardiac rehabilitation setting
- Demonstration of the relationship of self-efficacy and performance on a valid and reliable measure of submaximal physical activity
- Demonstration of the potential utility of Bandura's Exercise Self-Efficacy scale in predicting physical activity

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Introduction

Coronary heart disease (CHD), the most common manifestation of cardiovascular disease (CVD), is the leading cause of death both globally (Mathers and Loncar, 2006), and nationally, accounting for 19.5% of all deaths in Australia in 2002, including 10.7% directly from acute myocardial infarction (AMI) (National Heart Foundation of Australia, 2005). Considered a disease of lifestyle, the clinical course of CHD can be favourably altered with interventions for lifestyle changes and modification of risk factors(Giannuzzi et al., 2003). Cardiac rehabilitation (CR) is an internationally-endorsed model of secondary prevention which has been shown to be an effective approach to achieve these changes (Jolliffe et al., 2001, Taylor et al., 2004).

Australia supports a system of universal health care coverage and endorses CR as part of a national policy framework, with these programs predominantly coordinated by nurses (National Heart Foundation of Australia and Australian Cardiac Rehabilitation Association, 2004). Although the benefits of CR programs in reducing both cardiac and all-cause mortality are well-established (Jolliffe et al., 2001, Taylor et al., 2004, Williams et al., 2006), maintaining regular physical activity at recommended levels remains problematic (Arrigo et al., 2008, Blanchard et al., 2007, Zhao et al., 2008). Efficacy expectation, more commonly known as self-efficacy, is the judgement of one's capacity to perform a specific action (Bandura, 1997), and has been found to be an important determinant of adherence to health behaviour change, including physical activity in the CR setting (Luszczynska and Sutton, 2006, Meland et al., 1999, Woodgate and Brawley, 2008). Self-efficacy influences the level of perseverance, commitment and effort exerted to goal achievement (Schwarzer, 1992).

In operationalising the concept of self-efficacy, the most important consideration is that scales must be tailored to the particular domain of functioning that is of interest, and be context-specific (Schwarzer, 1992). In addition, they must assess the multifaceted ways in which efficacy beliefs operate within the selected activity domain (Bandura, 2006). Bandura's exercise self-efficacy scale (Bandura, 2006) has been validated in a Korean sample with chronic disease, with a single factor found to explain 77.5% of the variance (Shin et al., 2001). It has also been shown to be a useful measure of exercise beliefs (Shin et al., 2001), and an influential variable on commitment to a plan for exercise (Shin et al., 2006), making it a potentially useful measure in exercise-based CR programs. However, first it will need to be validated for use in an Australian sample in a CR setting. Therefore, the purpose of this study was to assess the psychometric properties of Bandura's exercise self-efficacy (ESE) scale in a cardiac rehabilitation setting in: a) the distribution of scores including the presence of floor and ceiling effects; b) construct validity; c) internal consistency; and d) the responsiveness to detect change over the 6-week period of the CR program.

Methods

Design and Setting

This validation study assessed the psychometric properties of Bandura's exercise self-efficacy scale which is being used in a larger study assessing risk factor modification in CR attendees. Participants were recruited from three nurse-led, Phase II CR services in the western Sydney region of New South Wales, Australia. In this health service, medical in-patients may commence their CR program pre-discharge (as early as Day 3 post-event), while cardiothoracic patients can commence 21 days post surgical date. An initial 2-hour pre -program assessment of exercise capacity, psychological status, and health-related quality of life, and discussion of risk factor modification, is undertaken prior to program entry. Patients then attend a 6-week individually-tailored, high-intensity exercise program, combined with individual and group education sessions, followed by a post-program assessment.

Eligibility criteria for this study included a diagnosis of an acute coronary syndrome, coronary revascularisation, or coronary artery bypass graft surgery, cleared to participate in an exercise-based 6-week CR program, and willing to give informed consent. Clinical staff made initial contact with potential participants during their pre-assessment interview at each CR setting. At this time, the purpose of the study was explained and an invitation to participate issued. Following expression of interest, potential participants were provided with a Participant Information Sheet and followed up by the research coordinator to confirm willingness to participate in the study, and to organise to meet at their next CR visit.

Ethical approval was obtained from appropriate ethics committees. Participants were informed that participation was voluntary, and they were able to withdraw from the study at any time.

Measures

Bandura's Exercise Self-Efficacy Scale

Exercise self-efficacy is defined as participants' confidence in their ability to exercise regularly (most days of the week). We measured exercise self-efficacy using an 18-item exercise self-efficacy (ESE) scale developed by Bandura (Bandura, 2006), which has been shown to be a useful measure of exercise beliefs in Korean adults with chronic diseases (Shin et al., 2001). Bandura's original statement asked participants to rate how certain they were that they could get themselves to perform their exercise routine regularly (three or more times per week), for a range of conditions. This was modified to reflect current guidelines of physical activity on most days of the week (Briffa et al., 2006, Haskell et al., 2007). A simpler response format that retained the same scale structure, but used single units ranging from 0 to 10, rather than 0 to 100, was also adopted. The statement used in this study read "Please rate how sure you are that you can get yourself to exercise regularly (most days of the week). The scale ranged from 0 (I cannot do this activity at all) to 10 (I am certain that I can do this activity successfully)."

Six-Minute Walk Test (6MWT)

The American Thoracic Society (ATS) 'Guidelines for the Six-Minute walk Test' (Crapo et al., 2002) were used for this study. A 30-metre course in a hospital corridor was marked out, and participants received the ATS standardised instructions and encouragements from the investigator, who was trained in administering the test. A data collection form was designed to record laps walked (using tick marks), a stopwatch with a countdown function used to time the six minutes, and a pedometer used to record additional distance covered in the final partial lap. Prior to commencing the test, participant's blood pressure, heart rate and oxygen saturation were recorded, along with rating of perceived exertion using the Borg Scale (Borg, 1982). These measures were also recorded following completion of the test. All walks were conducted by the same investigator (B.E.) to minimise variability in test administration.

Data collection

Demographic and clinical information were collected from participants at baseline, and 6-weeks later on completion of their CR program. The ESE scale and 6MWT were also administered at these time points.

Statistical Analysis

All data analyses were performed using SPSS 14.0.1. The central tendency and distribution of scores of the 18 items of the ESE scale that were examined were mean, median, standard deviation, skewness, minimum and maximum responses, percent missing, floor and ceiling effects. The normality of distributions of the total ESE scores was tested using Kolmogorov-Smirnov statistic. The presence of floor and ceiling effects, which prevents the detection of an improvement or decline in self-efficacy, was examined using the frequency of highest and lowest possible scores of the 18 items. Floor and ceiling effects of less than 30% were considered acceptable (Kane, 2006). Exploratory factor analysis using principal components with listwise deletion of missing data was used on the 18 items of the ESE scale. Using the scree test criterion by Cattell (Nunnally and Bernstein, 1994), one factor was extracted. Item loadings of greater than 0.4 were used as the cut-off for significant loading on the factor (Tabachnick and Fidell, 2007). The internal consistency of the scale was calculated by Cronbach's alpha. Clinical validity was assessed by comparing the ESE scores with the 6-minute walk distance (6MWD) results, which were categorised into three levels using a similar study sample as a guide (Araujo et al., 2006). Distance walked was rounded to the closest 2 digits of: '*low – 400 metres or less*' '*mid-range – 401 to 500 metres*' & '*high – more than 500 metres*'. It was expected that these 3 groups would differ significantly from one another in the ESE scores when compared using one-way ANOVA. The responsiveness of the scale, the ability to measure a meaningful or clinically important change (Liang, 2000), was assessed using the computation suggested by Meenan *et al.* (Meenan et al., 1984) by correlating the changes in ESE scores with changes in the 6MWD between baseline and the 6-week follow-up.

Results

Sample description

The sample of 110 patients comprised of 79 males and 31 females, with a mean age of 60.11 (SD: 10.57) years. Of the sample, 89 participants completed 6-week follow-up. Baseline clinical and demographic characteristics are presented in Table 1.

Floor and ceiling effects

The mean score of the ESE scale in this CR population was 103.64 (SD: 34.69), with a median of 103.50 and a well-shaped normal distribution with skewness of 0.25 and kurtosis of 0.01. The Kolmogorov-Smirnov test for normality showed normal distribution of the data (p=0.999). Using 30% as cut-off for floor and ceiling effects, none of the 18 items demonstrated any floor or ceiling effects (Table 2).

Factor analysis

The number of factors of the 18 ESE items was subjected to exploratory factor analysis after excluding cases with missing data. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.90 indicating a “marvellous” level of inter-correlation among the items.(Kaiser and Rice, 1974) This result was consistent with Bartlett’s test of sphericity, which showed that the correlations between the items were sufficient to perform factor analysis, approximate Chi-Square of 1374.286, $p<0.001$. The communality values ranged between 0.40 and 0.75. Although two underlying factors had eigenvalues over one, the scree test showed that one factor explained 58% of the variance. All 18 items loaded highly on this single component, with factor loading ranging from 0.63 to 0.87 (Table 3).

Reliability

Coefficient alpha was calculated for the total ESE scale to determine internal consistency of the scale. The internal consistency of the total 18-item ESE scale was 0.95. The item-total scale correlations ranged from 0.59 to 0.84. The inter-item correlation coefficients between *Item 4 (After recovering from an injury that caused me to stop exercising)* and *Item 8 (After recovering from an illness that caused me to stop exercising)* was 0.80, indicating item redundancy. Similarly, high inter-item correlation coefficients (>0.70) were detected among *Item 5 (During or after experiencing personal problems), Item 6 (When I am depressed), and Item 7 (When I am feeling anxious).*

Concurrent validity: Comparison of 6MWT levels by ESE scores

One-way ANOVA test on ESE score at baseline by the three levels of 6MWT distance (Figure 1), indicated that there was a significant difference in mean scores (F=3.313, p=0.041), with Scheffe post hoc tests indicating that those who recorded more than 500 metres in their 6MWT had significantly higher scores on the ESE scale (mean 116.26 ± 32.02) than those participants who only achieved up to 400 metres on the 6MWT at baseline (Mean: 89.94 SD: 29.47m) (p=0.044).

Responsiveness

There was a mean increase in the change in the ESE scale score (Mean:7.28 SD: 29.01); likewise, there was a mean increase in the change of 6MWT distance (Mean:43.53 SD: 50.41m) between baseline and the 6-week follow-up. The result of the correlation analysis showed a positive and significant correlation between the change in scores on the ESE scale and the change in the 6MWD (r=0.28, p=0.035).

Discussion

Based on the results of this psychometric evaluation, the ESE scale was a robust measure of self-efficacy for regular exercise over a range of patients attending outpatient CR. Importantly, the score distributions of the ESE scale in this study showed the sensitivity of this instrument in a CR population. One factor explained 58% of the variance in scores, consistent with the single-factor structure reported by Shin (Shin et al., 2001).

While the absence of any ceiling effects suggest the items represented sufficient gradations of difficulty for this population, with respect to successful performance of regular exercise, a number of high inter-item correlations of above 0.7 indicated possible item redundancy. Of note was a high inter-item correlation of 0.8 between Item 4 *(After recovering from an injury that caused me to stop exercising)* and Item 8 *(After recovering from an illness that caused me to stop exercising)*. It is likely that patients did not differentiate between an *injury* that caused them to stop exercising and an *illness* that caused them to stop exercising, suggesting a single item which uses the more general term *illness* could be used to measure exercise self-efficacy in the presence of challenges to physical health.

Similarly, the high inter-item correlation coefficients (>0.70) detected among Item 5 *(During or after experiencing personal problems)*, Item 6 *(When I am depressed)*, and Item 7 *(When I am feeling anxious)*, suggest these could be replaced by a single item which measures self-efficacy in the face of emotional distress. Although not commented on in the work of Shin and colleagues (Shin et al., 2001), psychometric evaluation of this ESE scale in Korean adults with chronic disease also demonstrated a number of items with high inter-item correlation. Finally, the high frequency of missing data for Item 2 *(When I am feeling under pressure from work)*, was due to a number of retired patients who felt this item was not relevant to their circumstances.

The ESE scale was able to discriminate among different groups of patients defined according to three levels of functional capacity, or clinical severity (distance walked <400m; 401m to 500m; and, >500m). Patients with higher 6MWD at baseline had higher self-efficacy scores for regular exercise, while patients who had lower 6MWD at baseline had lower exercise self-efficacy scores. In addition, the positive and significant correlation between change in scores on the ESE scale and the change in distance walked at baseline and six week follow-up indicate this instrument was sensitive to change over time.

To our knowledge, this is the first time the psychometric properties of a scale that assesses a person's self-efficacy for undertaking regular (most days of the week) exercise has been examined in a CR population and been correlated with an objective measure of functional status (6MWT), and been responsive to change over a six-week period. While these findings support previous research that people's exercise self-efficacy scores increase as they become more active (Marcus and Forsyth, 2003), it is of little clinical value unless the behaviour endures.

Conclusion

The exercise self-efficacy scale used in this study is a reliable and valid measure, and appropriate for use in a CR population. Further testing of this scale with other populations with chronic illness will be needed in assessing not only external validity for different populations, but also the predictive utility of the scale to assess the capacity to initiate and sustain regular physical activity once patients have left the ‘therapeutic microenvironment’ of CR. Use of this scale in future research may provide important insights into the dynamics of self-management of regular physical activity, resulting in improved outcomes for individuals with chronic conditions.

Role of the funding source

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Contributors

Study Design: PD

Data Collection and Analysis: PD; BE; YS

Manuscript Preparation: PD; BE; YS

Conflict of interest

None to declare

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Table 1 Baseline demographic and clinical characteristics of the sample (n=110)

Characteristic	
Age, mean (SD) years	60.11 ± 10.57
Sex, Male %	71.8
Language spoken at home, English only %	79.1
Living with a partner %	77.0
Post secondary schooling %	51.0
Diagnostic eligibility for CR %	
Coronary artery bypass graft surgery	29
Percutaneous coronary intervention	60
Other (stable angina, valve replacement)	11
Six minute walk distance (6MWD),mean (SD) metres	463.15 (89.39)
Exercise self-efficacy score, mean (SD)	103.64 (4.69)

Table 2 Summary data, floor and ceiling effects for Bandura's exercise self-efficacy scale

Item Number	Exercise self-efficacy statement	Mean (SD; range)	Floor effects (% minimum score of 0)	Ceiling effects (% maximum score of 100)
1	When I am feeling tired	5.24 (2.58; 0-10)	3.7	5.5
2	When I am feeling under pressure from work	5.69 (2.78; 0-10)	6.7	10.1
3	During bad weather	5.14 (2.82; 0-10)	4.6	9.2
4	After recovering from an injury that caused me to stop exercising	5.48 (2.44; 0-10)	1.9	4.7
5	During or after experiencing personal problems	6.26 (2.59; 0-10)	3.7	14.7
6	When I am feeling depressed	6.02 (2.75; 0-10)	3.7	11.9
7	When I am feeling anxious	6.17 (2.64; 0-10)	2.8	12.8
8	After recovering from an illness that caused me to stop exercising	5.36 (2.42; 0-10)	2.8	4.6
9	When I feel physical discomfort when I exercise	5.06 (2.26; 0-10)	3.7	2.8
10	After a holiday	7.36 (2.40; 0-10)	1.9	24.1
11	When I have too much work to do at home	6.07 (2.46; 0-10)	0.9	13.0
12	When visitors are present	4.42 (2.88; 0-10)	12.6	7.3
13	When there are other interesting things to do	5.72 (2.54; 0-10)	3.7	9.2
14	If I don't reach my exercise goals	6.50 (2.35; 0-10)	1.8	11.0
15	Without support from my family or friends	6.95 (2.39; 0-10)	0.9	18.5
16	During a holiday	6.60 (2.66; 0-10)	2.8	16.8
17	When I have other time commitments	5.23 (2.40; 0-10)	3.7	4.6
18	After experiencing family problems	5.73 (2.32; 0-10)	0.9	8.3

Table 3 Factor analysis of Bandura's exercise self-efficacy scale

Item Number	Exercise self-efficacy statement	Factor Loading
11	When I have too much work to do at home	0.867
7	When I am feeling anxious	0.855
14	If I don't reach my exercise goals	0.829
6	When I am feeling depressed	0.827
15	Without support from my family or friends	0.819
5	During or after experiencing personal problems	0.798
10	After a holiday	0.789
18	After experiencing family problems	0.787
17	When I have other time commitments	0.761
4	After recovering from an injury that caused me to stop exercising	0.756
1	When I am feeling tired	0.750
8	After recovering from an illness that caused me to stop exercising	0.738
13	When there are other interesting things to do	0.733
9	When I feel physical discomfort when I exercise	0.722
2	When I am feeling under pressure from work	0.710
16	During a holiday	0.646
12	When visitors are present	0.643
3	During bad weather	0.633

Figure 1 Comparison of mean exercise self-efficacy scores with 3 levels of 6MWD at baseline