

Reliability and validity of the Exercise Self-Regulatory Efficacy Scale* for individuals with chronic obstructive pulmonary disease

Amy H. T. Davis, RN, PhD,^a Aurelio José Figueredo, PhD,^b Bonnie F. Fahy, RN, MN,^c and Tassanee Rawiworrakul, RN, PhD^d

BACKGROUND: Exercise has important benefits for individuals with chronic obstructive pulmonary disease (COPD). However, to sustain long-term benefits of exercise, adherence is needed. Adherence requires self-regulation. No scale is available to measure exercise self-regulation in individuals with COPD.

OBJECTIVES: We developed and tested the reliability and validity of an "Exercise Self-Regulatory Efficacy Scale (Ex-SRES)" for individuals with COPD.

METHODS: A convenience sample of 109 subjects with COPD was recruited. Cronbach's alpha was used to assess the internal consistency reliability of the Ex-SRES. Subjects' exercise behaviors and health status were used to assess the validity of the Ex-SRES.

RESULTS: The Ex-SRES demonstrated evidence of reliability (Cronbach's alpha .917) and validity (correlation with minutes of exercise per week [$r = .41$; $P < .0001$] and health status [$r = .37$; $P < .0001$]).

CONCLUSION: The Ex-SRES is a short (16-items) and easy to use questionnaire that may be valuable for assessing patients in clinical settings, as well as for future research studies in behaviors related to exercise. (Heart Lung® 2007;36:205-216.)

Regular exercise operates at every level of health promotion, preventing the development of diseases and reducing the damage done by diseases.^{1,2} Although there is still much debate as to the best type, frequency, and length of exercise individuals need to do on a regular basis,

little doubt remains about the significant beneficial effects of regular exercise for an individual's physical and mental well-being. The majority of available evidence supports the overall tenet that the more we, as health providers, can inspire our patients to exercise regularly, the more benefit they will likely derive from exercising.³ Despite efforts to educate individuals about the benefits of regular exercise and to devise a myriad of exercise routines using various methods and equipment, approximately one third of individuals 18 years and older do not adhere to a regular exercise program. For those individuals who are socially and economically disadvantaged, the rate of nonadherence is closer to 80%.⁴ It is clear that knowledge about the benefits of exercise does not always lead to action, but the factors that influence exercise adherence at large are unclear.

Findings from a number of well-controlled studies provide strong evidence that exercise is also an

From the ^aCollege of Nursing, ^bDepartment of Psychology, University of Arizona, Tucson, Arizona; ^cCardiac/Pulmonary Rehabilitation, St Joseph's Hospital and Medical Center, Phoenix, Arizona; and ^dDepartment of Public Health Nursing, Mahidol University, Bangkok, Thailand.

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*To request a copy of the Ex-SRES instrument, a one-page summary of its psychometrics and scoring syntax, please send a self-addressed envelope with return postage to the corresponding author.

Reprint requests: Amy H. T. Davis, RN, PhD, Assistant Professor, College of Nursing, University of Arizona, 1305 N. Martin, Tucson, AZ 85721-0203.

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effective intervention for individuals with chronic obstructive pulmonary disease (COPD).^{5,6} Because of increasing health care costs and a movement toward active patient participation in their health care, individuals who have COPD, similar to others who have other chronic illnesses, bear a tremendous burden managing their illness and symptoms.^{7,8} COPD is a chronic and progressive illness without a medical cure. However, regular exercise has been shown to reduce the most disabling symptom experienced by individuals with COPD: shortness of breath.^{5,6} These findings supported the short-term benefits of exercise interventions but did not address how these important benefits may be sustained long term.^{5,6} Symptom management is a central concept in the care of individuals with COPD. Because a key benefit of exercise interventions is reduction of shortness of breath, exercise adherence may be viewed as a component of symptom management.⁸ Adherence to exercise interventions serves as the bridge that facilitates sustained benefits derived from exercise interventions.⁸ Plainly, the long-term effectiveness of exercise interventions requires exercise adherence. Nonetheless, as in other populations, adherence to exercise is poor in individuals with COPD.^{4,9} To investigate factors related to exercise adherence in individuals with COPD, it is therefore necessary to further develop the concept of exercise adherence.⁸

Adherence to a regular exercise program depends on one's ability to self-regulate and persist despite potential difficulties or impediments.^{8,10} Individual beliefs in one's ability to self-regulate (self-regulatory efficacy) may vary across health conditions and be dependent on the nature of the potential difficulties. Persisting despite difficulties may be challenging for many individuals. For those with COPD, they may experience severe shortness of breath simply while doing their daily activities. It is not difficult to envision that individuals with COPD may face additional challenges as they attempt to adhere to a regular exercise program. Although prior studies have examined other types of efficacy beliefs in individuals with COPD, such as efficacy to perform physical tasks^{11,12} or manage shortness of breath,¹³ self-regulatory efficacy in individuals with COPD is not well understood. Unlike efficacy beliefs such as in weight lifting, in which an increase in the amount of weight will predictably increase the difficulty of the task, the amount of difficulty each impediment poses on a person's self-regulatory efficacy for exercise is more likely to be individually determined.¹¹ For example, bad weather or experiencing shortness of breath with exercise may pose

more difficulty for some individuals' self-regulatory efficacy for exercise. This will differentially affect their ability to overcome these challenges and adhere to their exercise program. Unfortunately, factors that influence exercise adherence in individuals with COPD are not well defined. Therefore, it is important to understand issues that may pose challenges for individuals with COPD to adhere to exercise, especially their ability to self-regulate and exercise regularly despite these challenges.

SELF-REGULATORY EFFICACY

The ability to self-regulate is a prominent concept in social cognitive theory.¹⁴ The social cognitive perspective emphasizes that, as human beings, we have the capability to interact with the environment, to learn, to regulate our thoughts and behaviors, and to adjust our performance and alter our environment to meet certain standards.¹⁴ To further explain individual behaviors, Bandura¹¹ focused on the role of personal cognitive factors (self-beliefs) within the social cognitive theory and developed the self-efficacy theory. The self-efficacy theory describes the role of individuals' belief in their own capabilities to exercise control over their actions by organizing and executing courses of action necessary to obtain desirable results.^{11,15} Self-efficacy beliefs have been important predictors of behaviors related to physical and mental health.^{16,17} Individuals' belief in their ability to exercise regularly when faced with challenges may be conceptualized as their exercise self-regulatory efficacy. Exercise self-regulatory efficacy describes the ability for one to persist despite challenges, in part, by setting up and managing favorable environments, thinking positive and encouraging thoughts, and identifying and applying consequences for their own actions related to exercising regularly.^{11,15} Improving exercise adherence requires that individuals believe in their ability to exercise regularly even when there are disincentives to exercise, such as bad weather or fatigue.^{11,15}

Past findings have showed that self-regulatory efficacy (belief in one's ability to self-regulate) is a key variable that may influence exercise adherence.^{14,18,19} Accordingly, enhancing self-regulatory efficacy may increase exercise behaviors and exercise adherence, and improvements in exercise adherence may serve to further enhance efficacy beliefs, creating a cycle of positive reinforcements. For example, in an early study of young adults, those who believed that they could resist relapse and make time for exercise, exercised more.²⁰ In another study, adults who adhered to a regular exercise

program believed there were fewer obstacles to exercise than those who did not adhere.¹⁸ Findings from more recent studies also demonstrated that self-regulatory efficacy may be important for exercise adherence. This effect was seen in a study of older adults, in which higher self-regulatory efficacy accounted for 30% of the variance in exercise activity and was significantly related to their physical and mental health status.²¹

In summary, these findings support the contention that it is important to continue to investigate self-regulatory efficacy's relationship to exercise adherence. In the past, several studies have examined efficacy beliefs to perform various exercise-related physical activities in patients with COPD, such as efficacy beliefs to physically walk a certain distance or for a certain length of time.^{13,22,23} None have studied self-regulatory efficacy in individuals with COPD. Other researchers have developed questionnaires that address self-regulatory efficacy to overcome barriers or impediments to exercise in other populations, such as sedentary or older adults.^{21,24,25} A validated measure of self-regulatory efficacy for exercise in subjects with COPD is not available. To further our understanding of exercise self-regulatory efficacy in individuals with COPD, a reliable and valid measure is needed.

EXERCISE SELF-REGULATORY EFFICACY SCALE

Conceptually, the Exercise Self-Regulatory Efficacy Scale (Ex-SRES) is based on social cognitive and self-efficacy theories, and its roots are in symptom management.^{7,8} Individuals with COPD may have particular challenges related to exercise self-regulatory efficacy that are unique to their illness, such as experiencing the symptom of shortness of breath with exertion, which may cause additional anxiety or distress. Therefore, to accurately measure exercise self-regulatory efficacy of individuals with COPD, it is important to elicit input from those with the illness for instrument development (A. Bandura, MD, personal communication, 1999; 2001).

Individuals with COPD may share some characteristics with sedentary adults because of a low exercise rate; they may also resemble older adults because the average age of subjects with COPD is approximately 65 years and would be similar in developmental stage and other preferences. Although individuals with COPD may share some impediments to exercise with other populations such as sedentary and older adults, they are likely to have particular concerns and perspectives specific to

their illness. Therefore, items included on the Ex-SRES were based on prior studies in sedentary and older adults,^{21,24} as well as input from individuals with COPD.

In part of a study that continued prior conceptualizations of exercise adherence, we conducted in-depth one-on-one interviews with 14 individuals with COPD. Subjects were asked to identify what would impede them or keep them from exercising regularly, as well as other questions related to their exercise behaviors. In addition, 45 subjects with COPD participating in a separate study were also asked to identify impediments that may keep them from exercising regularly. Our findings indicated, as anticipated, that individuals with COPD had unique concerns that were different from what has been described in other populations (Fig 1 and 2).^{21,24,25} These unique concerns included experiencing shortness of breath, using oxygen, having bad days and just not feeling like exercising, being ill, and not being able to pay for continuing in monitored rehabilitation programs. In addition, different from studies of sedentary and older adults,^{21,24} individuals with COPD in our samples did not differentiate among being bored, having no interest in the activities, or not liking the activities versus simply not finding exercising fun or enjoyable (Fig 2). It is possible that individuals with COPD perceive exercise as an important intervention rather than recreation or a casual option for health maintenance. These findings suggest that individuals with COPD perceive challenges related to exercise self-regulatory efficacy that are different from other populations.

The Ex-SRES is a user-friendly, 16-item questionnaire that measures the exercise self-regulatory efficacy of individuals with COPD (Fig 1). The questions ask participants to indicate the degree to which they are confident they could continue to exercise regularly (3 times per week for 20 minutes) when faced with various impediments. Participants indicated their confidence level from 0% (not at all confident) to 100% (highly confident) as recommended by Bandura¹¹ for efficacy measures.

PURPOSE

The Ex-SRES was developed with the hypothesis that this scale has a one-factor structure and represents one latent variable: exercise self-regulatory efficacy. The purpose of this article is to examine the reliability and validity of the Ex-SRES in individuals with COPD. In theory, if exercise self-regulatory efficacy is important in individuals with COPD, it will

Please indicate the degree to which you are *confident* or *certain* that you could continue to exercise *regularly* (3 times a week for 20 minutes) when faced with situations listed below. Mark your answer by circling the % that represents your confidence level that you can continue to exercise regularly when faced with situations below.

I believe that I could continue to exercise 3 times a week for 20 minutes:

1. If the weather is bothering me

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

NOT AT ALL

MODERATELY

HIGHLY

CONFIDENT

CONFIDENT

CONFIDENT

2. If I feel aches and pains while exercising

3. If I have to exercise alone

4. If I feel exercising is not fun or enjoyable

5. If I feel self-conscious about my appearance when I exercise

6. If I have no support from other(s)

7. If I am too busy with other activities or are having schedule conflicts

8. If I am on vacation or away from home

9. If I have difficulty getting to the location for exercise

10. If I feel stressed

11. If I feel sick or am ill

12. If I feel short of breath when exercising

13. If I feel tired or fatigued

14. If I am worried about money

15. If I need to use oxygen

16. If I do not feel like it (exercising)

*Note: Each item was listed with the same stem and efficacy scale % for ease of completion.

Fig 1 Exercise Self-Regulatory Efficacy Scale (Ex-SRES).

<u>McAuley, E.</u>	<u>Resnick & Jenkins</u>	<u>Ex-SRES</u>
<u>Sedentary Adults (1992)</u>	<u>Older Adults (2000)</u>	<u>Individuals With COPD (2006)</u>
Weather	Weather	Weather
Bored	Bored	
Vacation		Vacation Or Away From Home
Not Interested		
Pain Or Discomfort	Pain	Aches And Pains
Exercise Alone	Exercise Alone	Exercise Alone
Not Fun Or Enjoyable	Not Enjoy	Not Fun Or Enjoyable
Difficult To Get To Location		Difficult To Get To Location
Don't Like Activity/Program		
Schedule Conflict	Too Busy	Too Busy Or Schedule Conflicts
Self-Conscious		Self-Conscious
No Instructor Encouragement		No Support
Stress	Stressed	Stressed
	Tired	Tired Or Fatigued
	Depressed	
		Short Of Breath
		Need To Use Oxygen
		Do Not Feel Like It
		Sick Or Ill
		Worried About Money

Fig 2 Comparison of items between studies. *Ex-SRES*, Exercise Self-Regulatory Efficacy Scale; *COPD*, chronic obstructive pulmonary disease.

be related to their exercise behaviors. Further, those with better health status will be more apt to believe in their ability to overcome impediments to exercise.²¹ Therefore, to test the validity of the Ex-SRES, we hypothesize that exercise self-regulatory efficacy will be positively correlated to exercise behaviors and health status in individuals with COPD.

SAMPLE AND SETTING

A cross-sectional, correlational study design was used to achieve the purpose of this study. After receiving approval from the University's Human Subjects Committee and appropriate institutional review boards of pulmonary rehabilitation programs, a convenience sample of men and women with mild to severe COPD, based on the American Thoracic Society's²⁶ disease severity criteria, were recruited continuously over 36 months for this study. Subjects were recruited from various sites in two major metropolitan cities and one suburban retirement community 50 miles from one of the metropolitan cities. With permission flyers were placed with physician offices, senior centers, COPD support groups, and four outpatient pulmonary rehabilitation programs to recruit volunteers with permission. Volunteers 21 years of age or older with a diagnosis of COPD were invited to participate. Participants also had to be able to walk unassisted on a flat surface and had no contraindications for exercise. After individuals gave consent to participate in the study, they completed a short cognitive questionnaire (Mini-Mental State Examination [MMSE])²⁷ to confirm their ability to comprehend study materials. Spirometry testing was performed to confirm airway obstruction.²⁶ Participants were excluded if they did not score more than 16 on the MMSE, they had no evidence of airway obstruction, or it was apparent that they could not walk unassisted or had contraindications for exercise.

METHODS

Those individuals who met inclusion criteria were enrolled in the study after providing informed consent. Subjects' mental status, English comprehension, and degree of airflow obstruction were determined. To minimize potential limitations related to data collection, all research personnel were trained by the principle investigator, who is experienced with this population and with study instruments, to ensure consistency of data collection. To be certain that research assistants were able to answer questions appropriately as they arose, the principle investigator was initially available on site during data

collection and thereafter by phone. During data collection, research assistants were present, clarified any questions participants had, and reviewed questionnaires for completeness and accuracy.

OTHER STUDY INSTRUMENTS

Mini-Mental State Examination

The MMSE²⁷ was used to exclude participants with mental status changes or English comprehension difficulties that may impact their ability to provide accurate responses to study questionnaires. Cognitive impairment may be prevalent but not obvious in certain medical conditions and may impact participants' ability to provide accurate information on study questionnaires; consequently, participants' mental status was screened by the MMSE.²⁷ Also, because an interviewer administered the MMSE, it served as a means to assess participants' English comprehension in this study to ensure participants were able to understand study questionnaires. MMSE assesses several areas such as orientation, attention, recall, language, calculation, and visual construction. The MMSE is a longstanding instrument that has been tested in various populations with evidence of reliability and validity in populations, such as geriatric, psychiatric, and neurologic subjects. The MMSE takes approximately 5 to 10 minutes to administer. The total scores may range from 0 to 30 with normal cutoffs from a score of 25 to 30.²⁷ All participants in this sample passed the MMSE.

Medical outcome study's short-form health survey [36 items]

Participants' exercise self-regulatory efficacy was hypothesized to be positively correlated to their health status. To assess the construct validity of the Ex-SRES, health status was assessed with the short-form health survey [36 items] (SF-36), which includes both a physical and a mental health status component.²⁸ The SF-36 is one of the most frequently used self-administered questionnaires to assess individuals' general health status, and it has been extensively administered in a variety of populations including individuals with COPD (Cronbach's alpha .92). The SF-36 has consistently demonstrated good psychometric properties with evidence of reliability and validity.²⁸ The two components of the SF-36 is further grouped into eight subscales of functioning (physical, role-physical, bodily pain, general health, vitality, social, role-emotional, and mental health). Scores for all eight dimensions and two

domains are expressed on a scale of 0 to 100, in which higher scores indicate better health and well-being.²⁸

Exercise behaviors

Participants' exercise self-regulatory efficacy was hypothesized to be positively correlated to their exercise behaviors. To assess criterion validity of the Ex-SRES, participants' exercise behavior (number of minutes participants exercised per week) was determined from participants' detailed descriptions of exercises they are currently doing. For the purpose of this study, participants were asked to indicate what type of exercises they are currently doing, how often, and how much time they spent doing these exercises at each exercise session. The minutes performed for each of these exercises per week were summed and represents their total exercise behavior.

STATISTICAL ANALYSIS

The reliability of the Ex-SRES was determined by individual item analyses and analyses of the entire scale. Item analyses included assessment for floor or ceiling effects, item to total correlations, inter-item correlations, and changes in alpha with item deleted. Cronbach's alpha was used to estimate the entire scale's internal consistency reliability, which estimates the uniformity and cohesiveness of all the items in the scale.^{29,30} Several methods were used to test the validity of the Ex-SRES. Because we are the first to validate this new scale specifically focused on individuals with COPD, we performed a factor analysis to determine whether our hypothesis that this scale has a one-factor structure and represents one latent variable, exercise self-regulatory efficacy, was supportable. Also, the factor procedure permitted us to explore the possibility of multiple factors within this scale. In addition, the Ex-SRES was correlated to a measure of health status (SF-36) and measure of participants' exercise behavior to test its construct validity.

RESULTS

Sample characteristics

A total of 109 subjects with COPD were included for this analysis (mean age 70.8 ± 8.5 years; FEV₁ in liters $1.6 \pm .6$; FEV₁ % predicted 47 ± 19 ; FEV₁/FVC 50.4 ± 18 ; pack/years smoked 43 ± 33). The sample mostly consisted of whites (90%). Gender composition was 59 women (54%) and 50 men (46%). Most participants had some college education (70%). Of

Table I
Additional characteristics of the sample

	n = 109	Frequency	Percent
Use oxygen		67	61.5
Current smoker		2	2
Shortness of breath, constantly		20	18
Shortness of breath, exercise only		53	49
Employed		10	9.2
Unemployed		4	3.7
Retired		91	83.5
On disability		4	3.7
Lives alone		36	33
Lives with spouse/partner		60	55
Lives with other		13	12
Married		53	49
Have health insurance		109	100
Income <\$20,000/y		20	18
Income >\$40,000/y		44	40

these, 18% had graduate education. As for the rest of the participants, 28% had high school and 2% had junior high school education. Additional sample characteristics are provided in Table I.

Reliability testing

For the Ex-SRES as whole, Cronbach's coefficient alpha for internal consistency reliability was .917. By using the principle factor method, a one-factor solution was sought and obtained, which had an eigenvalue of 6.79 and accounted for 77.1% of the cumulative variance in the Ex-SRES. Factor patterns demonstrated that factor loading of items were from .43 (item 11, if I feel sick or ill) to .76 (item 16, if I do not feel like exercising) (Table II). Squared multiple correlations (R^2) using ordinary least squares ranged from .19 to .60 (Table II). All items had a minimum value of 0 and maximum value of 10 except item 7 (too busy), which had a minimum of 1 and maximum of 10. Item to total correlations for the 16 items ranged from .394 to .738. For any one item deleted, the Cronbach coefficient alpha did not increase by more than .05 (Table II). The greatest increase seen was with item 11 (if I feel sick or ill), where Cronbach's alpha increased slightly by .001.

Validity testing

Participants' scores on the Ex-SRES were correlated to their exercise behaviors and health status.

Table II
Exercise Self-Regulatory Efficacy Scale items analyses

Items	Mean \pm SD	(<i>r</i>) to total	(α) Item deleted	Factor loadings	Eigenvalues
Weather	7.08 \pm 3.01	.61	.9119	.6465	6.7943
Aches and pains	6.85 \pm 2.82	.61	.9120	.6355	1.0140
Do alone	7.75 \pm 2.61	.45	.9168	.4664	.5201
Not fun	7.11 \pm 2.81	.65	.9109	.6827	.4392
Self-conscious	8.47 \pm 2.24	.64	.9112	.6616	.3536
No support	7.84 \pm 2.47	.58	.9131	.5999	.2518
Too busy	6.41 \pm 2.67	.66	.9106	.6800	.2194
Away from home	4.77 \pm 3.12	.47	.9162	.5262	.1808
Transportation	6.53 \pm 3.05	.65	.9109	.6682	.0382
Stressed	7.71 \pm 2.57	.73	.9084	.7608	-.0326
Sick	3.25 \pm 2.76	.39	.9184	.4297	-.0750
Short of breath	6.67 \pm 2.92	.73	.9085	.7690	-.0897
Tired	6.52 \pm 2.81	.68	.9100	.7273	-.1349
Money worry	8.32 \pm 2.39	.58	.9130	.6123	-.1762
Need oxygen	7.67 \pm 3.18	.63	.9113	.6672	-.2211
Don't feel like	6.73 \pm 3.09	.74	.9081	.7757	-.2666

SD, Standard deviation. Data represent correlation (*r*) between Ex-SRES and each item within the scale, Cronbach α for the scale if an individual item was deleted from the scale, factor loading of each item on the hypothesized factor (Exercise Self-Regulatory Efficacy), and eigenvalues of each factor.

Participants' scores on the Ex-SRES were significantly related to their exercise behavior (total minutes exercised per week) (mean = 105.36 \pm 109.47; *r* = .41; *P* < .0001). Furthermore, participants' scores on the Ex-SRES were significantly related to the total score on the SF-36 (*r* = .37; *P* < .0001), the SF-36 physical component score (*r* = .21; *P* < .027), and the SF-36 mental component score (*r* = .375; *P* < .0001). Correlations between the Ex-SRES and the eight subscales of SF-36 were from *r* = .15 to *r* = .41 (Table III).

DISCUSSION

Reliability

The Ex-SRES demonstrated evidence of reliability. Internal consistency reliability of the entire scale (Ex-SRES) was supported by a Cronbach's coefficient alpha of .917.³¹ This is consistent with findings of other investigators using similar scales developed for a different population.^{21,24} McAuley²⁴ developed a 13-item barrier self-efficacy scale for use with sedentary adults to assess their efficacy belief in their ability to exercise when faced with some commonly identified barriers to participation (Cronbach's alpha .88) (Fig 2). This scale was later revised into a 9-item scale by Resnick and Jenkins²¹ to

measure older adults' self-efficacy for exercise. The internal consistency reliability Cronbach's alpha was .92. Construct validity was evidenced by older adults' health status (measured by the short-form health survey [12 items]) accounting for a total of 21% of the variance in scores on the scale (mental health 17%; physical health an additional 4%).

The Ex-SRES is theoretically derived and hypothesized to measure one underlying factor, exercise self-regulatory efficacy. The factor pattern of the Ex-SRES had a single factor with a high eigenvalue of 6.79 accounting for a substantial percentage (77%) of the total variance. The scree plot of eigenvalues was used to determine the number of factors. The scree plot was distinct with a large gap between the single factor and other potential factors that are largely indistinguishable from scree (Fig 3). The finding that Ex-SRES represents a single factor is consistent with findings of McAuley²⁴ and Resnick and Jenkins²¹ in sedentary and older adults. Conceptually, it is plausible that individuals with COPD share commonalities with sedentary and older adults as related to exercise self-regulatory efficacy.

The findings of this study differ from that found in a group of patients undergoing cardiac rehabili-

Table III

Relationships between the Exercise Self-Regulatory Efficacy Scale and the short-form healthy survey [36 items]

	Ex-SRES		
	Mean ± SD	<i>r</i>	<i>P</i>
SF-36 total score	46.38 ± 12.02	.37	<.0001†
<i>Physical health</i>	37.72 ± 16.08	.21	<.05*
Physical functioning	45.63 ± 23.17	.23	<.05*
Role-physical	.96 ± .79	.18	.07
Bodily pain	70.81 ± 24.78	.15	.13
General health	47.45 ± 21.29	.19	<.05*
<i>Mental health</i>	54.70 ± 13.62	.38	<.0001†
Vitality	54.89 ± 18.97	.41	<.0001†
Social Functioning	80.34 ± 22.28	.35	<.001†
Role emotional	1.40 ± .79	.27	<.01†
Mental health	54.7 ± 13.6	.33	<.001†

SD, Standard deviation; *Ex-SRES*, Exercise Self-Regulatory Efficacy Scale; *SF-36*, short-form health survey [36 items]. Data represent correlation (*r*) between Ex-SRES and SF-36's total score, physical and mental components, and eight subscales. Significance values were set at alpha less than .05, which would indicate that there is less than 5% probability that the findings are due to chance.

**P* < .05.

†*P* < .01.

tation, in whom three factors were identified.²⁵ However, in that study, the measure was broadly applied to health behavior changes and not specific to the domain of exercise. Also, because the measure was administered by mail, the initial response rate was 48% and decreased to 26% from the second measurement period. Further, the researcher used a different theoretic basis of wellness motivation theory.²⁵ Although it is not uncommon for researchers to use a cutoff eigenvalue of 1.0 to identify the number of factors, a cutoff score is inherently arbitrary and needs to be supported by the scree plot.³⁰ Further, to ensure that scree is not interpreted as a separate factor in a purely exploratory analysis, a more conservative approach with higher eigenvalues of 2.0 to 3.0 may be considered, but most preferential is the identification of factors by a priori theory.³²

Findings from item analyses suggested that the Ex-SRES does not suffer from floor or ceiling effects because all items except item 7 (too busy or schedule conflicts) had a minimum value of 0 and maximum value of 10. Item 7 had a minimum of 1 and maximum of 10, which still represents a wide distribution of scores among the participants. The Ex-SRES also demonstrated evidence of adequate ho-

mogeneity of the items. Correlations between individual items and the total scale were all above the traditionally recommended .20,³³ and the Cronbach coefficient alpha did not increase significantly (by more than .05) when any item was deleted. These results indicate that each item contributed to the reliability of the Ex-SRES scale. Resnick and Jenkins²¹ used a structural equations approach to obtain values of squared multiple correlations as an alternative to the above for estimating reliability.³⁴ However, the advantages of this alternative and a more complex approach for assessing reliability were unclear. All of these findings support the retention of all items as each item seems relevant to the total score, and none of the items negatively affected the internal consistency of the entire Ex-SRES. The rationale is that the reliability of a measure is based on the whole and a test of theory rather than individual items. The elimination of theoretically and clinically important items, such as questions related to oxygen use or illness that are uniquely relevant to individuals with COPD, may compromise the scale's theoretic underpinnings and its replicability in a different sample. In addition, a scale with very few items is less stable and may also be less robust with a greater probability of

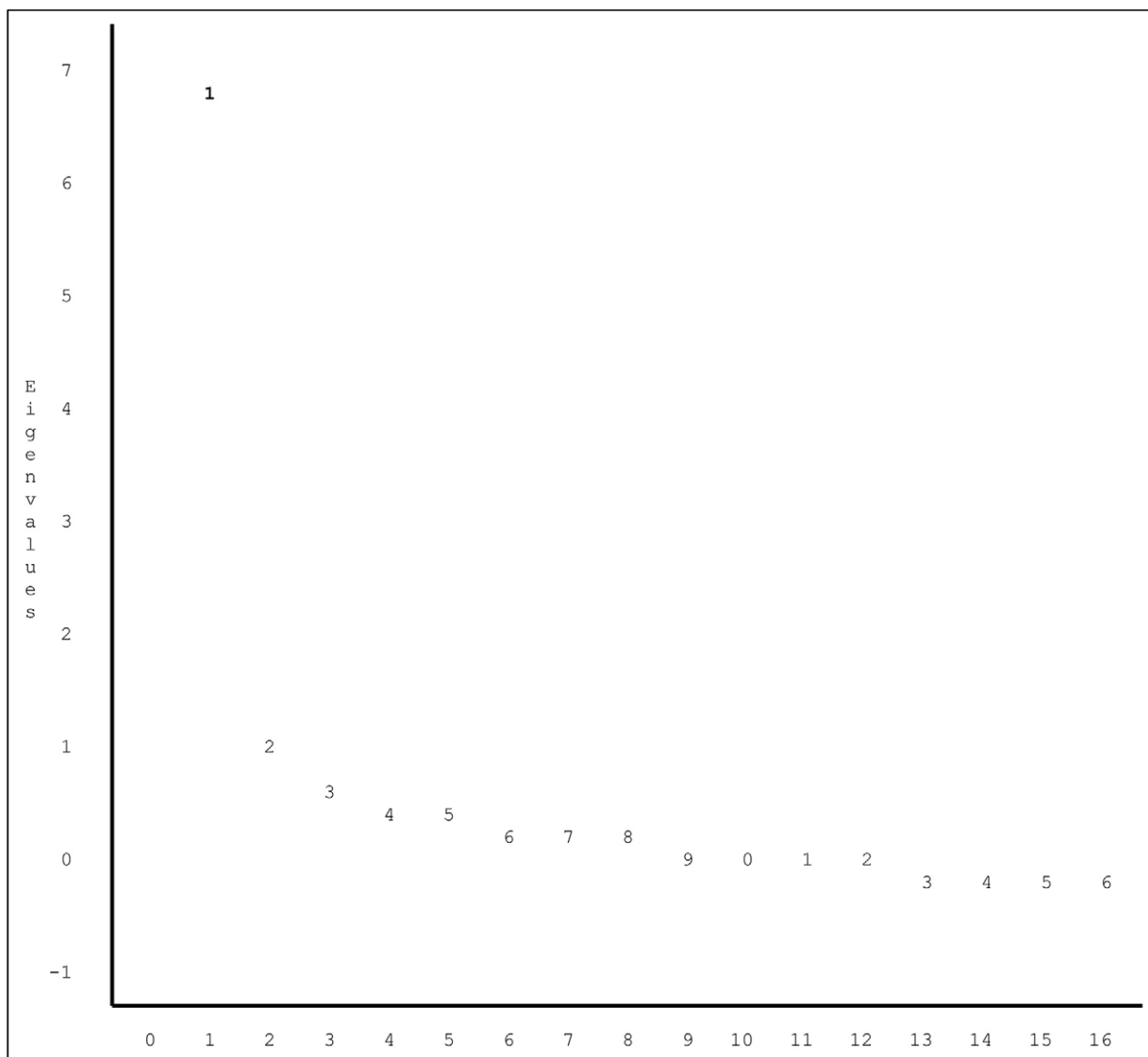


Fig 3 Scree plot of eigenvalues.

error in measurement. Therefore, caution is warranted when considering item reduction based on suggested cutoff points.³¹⁻³³

Validity

The Ex-SRES demonstrated evidence of construct validity. As hypothesized, participants' Ex-SRES scores were significantly correlated with theoretically relevant criterion measures of health status and their exercise behaviors. Consistent with the findings of Resnick and Jenkins,²¹ participants' health status was associated with their exercise self-regulatory efficacy. Participants' scores on the Ex-SRES were significantly related to their total scores

on the SF-36 and indicated that individuals with better health status have higher exercise self-regulatory efficacy. Those with better health status scored higher on both the physical and mental components of the SF-36, also consistent with previous reports in another population.²¹ These findings confirm our hypothesis that those with better health status would be more apt to believe in their ability to overcome impediments to exercise, and therefore their self-regulatory efficacy will be positively correlated to their health status. Participants' exercise self-regulatory efficacy was significantly related to the SF-36's physical health component but not to all its subscales within this component (role-physical

and bodily pain). Role-physical questions related to limitations in work and accomplishments within the last 4 weeks may have not been as applicable to this sample because most of the participants are retired, and none were having an exacerbation at the time of data collection. Similarly, bodily pain may not be as applicable to individuals with COPD because their most prominent symptom is not pain but shortness of breath. These findings support that individuals with COPD may have unique concerns and suggest it may be useful to incorporate measures of shortness of breath and COPD specific physical health status measures for future studies.^{35,36} As hypothesized, participants' scores on the Ex-SRES were significantly related to their exercise behavior (minutes exercised per week) ($r = .41$; $P < .0001$), suggesting that greater exercise self-regulatory efficacy is associated with increased exercise behaviors. This finding provides further support of construct validity for the Ex-SRES. This finding is also consistent with previous findings in a sample of older adults in whom efficacy beliefs were related to exercise behaviors.²¹

LIMITATIONS

Generalizability beyond non-Hispanic whites is a limitation of this study because the sample acquired had a minimum number of minority subjects. Therefore, although the sample size is adequate for initial testing of an instrument using the sample as a whole, the sample size was too small to conduct analyses divided by subgroups, such as race, gender, or age, to gain additional insight into exercise self-regulatory efficacy and exercise adherence in these subgroups of individuals with COPD. Nevertheless, because the recruitment of subjects for clinical studies is challenging, particularly in individuals with COPD, this study represents one of only a few studies that has a sample size of greater than 100 in this population. Obtaining a larger sample with enough power for subgroup analyses would be useful in future studies. Five subjects did not give an answer for their efficacy beliefs related to their ability to continue to exercise if they had to use oxygen. All five subjects were not currently using oxygen and did not think they could answer. Their efficacy beliefs for other items in the Ex-SRES were not different from those of the rest of the sample. In addition, overall exercise self-regulatory efficacy scores were not different between those who are or are not using oxygen. It is possible that these five subjects, who are not using oxygen, cannot imagine

how they might respond if they had to use oxygen, or they may think that if they need oxygen, they may be too ill to exercise. Some individuals may become very ill with an exacerbation that they are physically unable to exercise. Also, individuals with COPD may be advised not to exercise or to exercise less when they are ill; therefore, their response may be influenced by recommendation of health care providers. As a result, it may be more informative to ask individuals with COPD to indicate their efficacy belief in their ability to resume exercising regularly after an illness or worsening of symptoms. Another limitation of the study is the use of self-reported exercise behaviors. Although participants were asked about their current exercise and their report had to detail the type, frequency, and length of exercise performed to minimize recall bias,³⁷ additional measures from logs or accelerometers would provide further validation of participants' exercise behaviors.

CONCLUSION

Exercise self-regulatory efficacy seems important for understanding determinants of exercise adherence in individuals with COPD. Further understanding of exercise self-regulatory efficacy in this population may provide information that could inform the development and implement individualized and targeted interventions to improve exercise adherence in individuals with COPD. In addition, this finding suggests a potential area that may be amenable to the development and implementation of interventions to enhance exercise. Interventions could target and seek to improve exercise self-regulatory efficacy, which may in turn improve exercise adherence in this population. The Ex-SRES could be vital in evaluating success of these types of interventions. An essential step in the further identification of essential components of exercise self-efficacy beliefs is the development of reliable and valid instruments that measure concepts related to identified components of exercise self-efficacy and exercise adherence. The Ex-SRES was developed specifically for individuals with COPD and has demonstrated preliminary evidence of reliability and validity. Further testing of the Ex-SRES in this population is warranted. Accordingly, the Ex-SRES may be a simple and useful tool to assess efficacy beliefs of individuals with COPD. With refinement, the Ex-SRES could provide a basis for tailoring and evaluating clinical interventions designed to enhance exercise adherence in individuals with COPD.

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