This study evaluates the effectiveness of graded physical exercise on self-efficacy and exercise tolerance among a group of cardiac patients (N = *43). These patients were aged from 41 years to 82 years (mean age = 63.5 years,* SD = *10.0 years). Results of the study show that efficacy of physical activity was significantly associated with exercise tolerance. After a 3-month rehabilitation with graded physical exercise, both efficacy of activity and exercise tolerance were significantly enhanced. The enhancement was relatively independent of patients' gender, age, education, and diagnostic category. Limitations of the study are discussed and future research suggested.*

The Effectiveness of a Cardiac Rehabilitation Program on Self-Efficacy and Exercise Tolerance

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Coronary heart disease is the second leading cause of mortality in Hong Kong. Studies on the etiology of the disease have identified several risk factors that are reversible. These factors include smoking, alcohol consumption, physical inactivity, obesity, a Type-A behavioral pattern, and sedentary lifestyle. Modification of these risk factors has been shown to decelerate the process of atherogenesis in most patients with coronary heart disease (American Heart Association, 1991). Of particular interest is a study conducted by Carson (1989), who reported that a course of progressively increasing physical

CLINICAL NURSING RESEARCH, Vol. 11 No. 1, February 2002 10-21

exercise may decrease mortality in patients with myocardial infarction by 20%. Unfortunately, many coronary heart disease patients and those who have undergone coronary artery bypass surgery fear resuming physical activity even long after it is safe to do so.

A number of rehabilitation programs have been designed to restore the confidence in these patients to resume physical activity. These cardiac rehabilitation programs provide sessions of physical exercise, education, dietary advice, and counseling for the patients. Evaluative studies conducted in the West showed that patients who participated in these rehabilitation programs gained better understanding of heart disease and its associated risk factors (Hickey, 1993). Most importantly, a sense of self-efficacy in physical exercise was also enhanced after participation in such rehabilitation programs (Oldridge & Rogowski, 1991). In view of their effectiveness, cardiac rehabilitation programs were introduced in Hong Kong in 1992.

At present, there are three well-established cardiac rehabilitation centers in Hong Kong providing services for outpatients. Use of these centers is promoted to the public through the mass media and by health professionals. A cardiac rehabilitation convention is also held annually to provide health care personnel with up-to-date information and knowledge and to report on the progress of the cardiac rehabilitation program in Hong Kong. It is believed that the rehabilitation program is beneficial to patients with various forms of heart disease. Nonetheless, to what extent patients in Hong Kong benefit has yet to be empirically ascertained.

This study was conducted at a cardiac rehabilitation center of a regional hospital in Hong Kong. The program organized by the hospital is of 3 months duration, during which the patients attend regular sessions of physical exercise. The exercise sessions are arranged once or twice a week depending on the patient's schedule. The training is graded according to the patient's ability, which is indicated by his or her exercise heart rate zone. The exercise heart rate zone is calculated as patient's rest heart rate plus 50% to 70% of the difference between his or her maximum heart rate and rest heart rate. For patients who were on beta-blocker medication, the exercise heart rate zone is his or her rest heart rate plus 15 to 30 heartbeats.

During the sessions, immediate feedback on physical exercise is provided, and patients are given the opportunity to observe the success of others in performing similar exercises. Information on the risk factors of heart disease and dietary advice is also given in the sessions, and counseling services are provided whenever necessary. The program also comprises a long-term maintenance phase in which the patients continue lifelong attention to risk factor control and rehabilitation. This study was conducted to evaluate the effectiveness of the initial 3-month program using perceived efficacy of physical activity and actual exercise tolerance as outcome measures. Previous researchers (O'Connor et al., 1989) did show that substantial benefits of the self-efficacy of physical exercise could be observed at this phase of the program.

METHOD

SUBJECTS

Forty-three patients (33 men and 10 women) who had not previously participated in any cardiac rehabilitation programs were invited to participate in the present study. These patients were suffering from ischaemic heart disease or recovering from myocardial infarction or percutaneous translumnial coronary angioplasty. The age of these patients ranged from 41 to 82 years old (M = 63.5 years, SD = 10.0).

MEASURES

Self-Efficacy of Activity

The Exercise Tolerance Self-efficacy Expectation Scale (ETSES) developed by Foster et al. (1995) was used to measure self-efficacy of activity. It consists of six subscales that respectively measure self-efficacy of the following activities: walking distance, walking time, hurrying, lifting objects, lifting and carrying, and climbing stairs. The patients were asked to indicate their confidence in performing each activity on a scale that ranged from 0% (*not at all confident*) to 100% (*extremely confident*). A full-scale self-efficacy score, which was the total score of the aforementioned six subscales, was also created. A pilot study on 15 cardiac patients (10 men and 5 women; ages ranging from 49 to 80) was conducted to assess the test-retest reliability of the six subscales. The results confirmed that the test-retest reliabilities of the six subscales over an interval of 10 days were satisfactory (reliability coefficient ranged from .83 to .91). The Cronbach's alpha coefficient of the full-scale score was .95.

Exercise Tolerance

Patients' performance on a treadmill test was used as measure of exercise tolerance. This measure consisted of four indicators, namely, maximum exercise tolerance sustained (METS), maximum heart rate (MHR), exercise time (ET), and percentage of maximum predicted heart rate (MPHR%). METS, MHR, and ET referred to the maximum workload, maximum heart rate, and maximum duration that the patient attained during the treadmill test. MPHR% was the percentage of MHR over the maximum predicted heart rate based on patient's age.

DATA COLLECTION PROCEDURE

The patients were invited to complete a questionnaire that contained the ETSES and items on demographic characteristics. Clinical data on the nature of the patients' problems and medication were obtained from the hospital's records with the consent of the patients. Data on clinical problems were used for presenting a profile of the participants. Information on medication was referred to when determining the level of exercise intensity. As stated previously, the methods for calculating the exercise heart rate zone for patients who were on beta-blocker medication were different from those not on such medication.

After completion of the questionnaire, a treadmill exercise test was conducted. The researcher explained the results of the test to each patient. The same set of data was again obtained at the end of the 3-month rehabilitation program. Of the patients who had completed the questionnaire and the initial treadmill test, 13 did not complete the rehabilitation program for various reasons (e.g., could not spare the time to attend the exercise training, physical complaints, or being diagnosed with carcinoma of the esophagus). Consequently, only 30 patients participated in the rehabilitation program. The 13 patients who

Table 1
Demographic Characteristics and Clinical Problems of Participating and Nonparticipating Patients

	% Participating (n = 30)	Nonparticipating % (n=13)	Chi-Square Value
Sex			
Male	73.3	84.6	
Female	26.7	15.4	0.87
Age			
≥ 59	36.7	23.0	
60 to 69	40.0	30.8	
≥ 70	23.3	46.2	2.28
Education			
No formal education	16.7	15.4	
Primary (≤ Grade 6)	43.3	15.4	
Secondary or above (≥ Grade 7)	40.0	69.2	3.63
Clinical problems			
Post PTCA	40.0	23.0	
Post MI	40.0	46.2	
IHD	30.0	30.8	1.39

NOTE: All chi-square values were statistically insignificant. Post PTCA = post percutaneous transluminal coronary angioplasty; Post MI = post myocardial infarction; IHD = ischaemic heart disease.

did not participate were invited to complete the ETSES 3 months later. Data on these patients were used for evaluating the effectiveness of the cardiac rehabilitation program.

Patients participating in the rehabilitation program were required to attend two exercise sessions a week. Eight patients were unable to take time off from work and attended only one session a week. The mean number of exercise sessions of all the participants was 1.73 (SD = .45). Besides attending the exercise sessions at the clinic, patients were advised to exercise regularly at home for at least a total 60 minutes a week.

RESULTS

DEMOGRAPHIC CHARACTERISTICS AND CLINICAL PROBLEMS

Statistical analysis showed no significant differences in demographic characteristics between the participating and nonparticipating patients (see Table 1). The analysis also

Table 2
Self-Efficacy of Activity Before and After Participation in the Program

	Before		After		
	M	*SD*	*M*	*SD*	*t*-Value
Walking distance	76.2	19.3	86.6	16.1	–4.14***
Walking time	79.1	23.5	91.4	12.5	–3.70**
Hurrying	32.4	37.3	58.6	33.5	–5.11***
Lifting objects	48.6	26.4	63.1	26.6	–4.36***
Lifting and carrying	58.3	29.2	69.8	25.7	–4.91***
Climbing stairs	63.4	23.9	79.7	21.8	–4.23***
Full scale	363.0	135.0	449.1	111.9	–7.77***

**p < .01; ***p < .001.

revealed no significant difference in the pattern of clinical problems between the two groups of patients.

CHANGE OF SELF-EFFICACY AFTER REHABILITATION

The mean self-efficacy scores for each activity obtained before and after the cardiac rehabilitation program are shown in Table 2. Results of t tests for correlated samples confirmed that the patients' self-efficacy of each activity increased significantly after participation in the rehabilitation program. Of all the changes, improvement in perceived efficacy of hurrying had attained the most significant result.

CHANGE OF EXERCISE TOLERANCE AFTER REHABILITATION

Patients also showed improvement in their performance on the treadmill test after participation in the rehabilitation program (see Table 3). Improvement on two of the treadmill scores, namely, MET and ET, attained the statistically significant level. Improvement on the two indicators of heart rate failed to reach a significant level.

REHABILITATION OUTCOME AND PATIENT CHARACTERISTICS

An analysis was performed to examine whether the outcome of rehabilitation was related to demographic characteristics. For the purpose of this analysis, an improvement score (IS) was calculated for each patient. This improvement score was the

Table 3
Exercise Tolerance Before and After Rehabilitation

	Before		After		
	M	*SD*	*M*	*SD*	*t*-Value
Maximum exercise tolerance sustained	6.1	3.0	8.9	3.1	–4.61**
Maximum heart rate	124.5	22.3	129.1	19.1	–1.28
Percentage of maximum predicted heart rate	78.3	12.7	81.5	11.2	–1.40
Exercise time	10.2	3.6	13.3	3.4	–5.70**

**$p < .01$.

difference of the full-scale self-efficacy scores obtained before and after participation of the program. The median of IS was used to divide the patients into two groups of high versus low improvement in self-efficacy. These two groups were then cross-tabulated by sex, age, education, and diagnostic category. Chi-square test was used to examine if the associations between improvement and patients' characteristics were statistically significant. Yates's correction of the chi-square values was made when necessary. None of the chi-square values attained the statistically significant level. Similar analysis also revealed no significant relationship between improvement in treadmill performance and patients' characteristics.

SELF-EFFICACY AND EXERCISE TOLERANCE

Data obtained at the beginning and at the end of the rehabilitation program indicated significant relationships between self-efficacy scores and exercise tolerance as indicated by the treadmill test results (r = .39 to .66, $p < .05$ or less). Improvement in full-scale self-efficacy was also significantly associated with gains in METS ($\chi^2 = 4.80$, $p < .05$), MHR ($\chi^2 = 4.80$, $p < .05$), and MPHR% ($\chi^2 = 4.80$, $p < .05$). Its association with exercise time was marginally significant ($\chi^2 = 3.33$, $p < .10$).

SELF-EFFICACY OF NONPARTICIPATING PATIENTS

Table 4 shows that there was a slight tendency for patients who did not participate in the program to score lower on some

Table 4
Self-Efficacy of Nonparticipating Patients at 3-Month Interval

	First Test		Retest		
	M	*SD*	*M*	*SD*	*t*-Value
Walking distance	69.8	22.7	66.0	26.8	1.51
Walking time	68.6	27.1	63.5	28.5	1.66
Hurrying	22.4	33.0	22.4	34.1	0.00
Lifting objects	41.9	25.1	36.0	16.6	1.73
Lifting and carrying	45.3	23.8	42.7	20.1	0.66
Climbing stairs	53.2	27.0	49.6	24.4	1.18
Full scale	306.2	126.8	280.1	130.0	1.07

Table 5
Self-Efficacy of Activity Between Participating Versus Nonparticipating Patients at the Beginning of the 3-Month Interval

	Participating		Nonparticipating		
	M	*SD*	*M*	*SD*	*t*-Value
Walking distance	76.2	19.3	69.8	22.7	0.83
Walking time	79.1	23.5	68.6	27.1	1.14
Hurrying	32.4	37.3	22.4	33.0	0.83
Lifting objects	48.6	26.4	41.9	25.1	0.75
Lifting and carrying	58.3	29.2	45.3	23.8	1.46
Climbing stairs	68.4	23.9	53.2	27.0	1.65
Full scale	60.5	22.5	51.0	21.1	1.25

of the self-efficacy subscales at the end of the 3-month interval, but the decreasing tendency was not statistically significant (t-value ranged from 0.00 to 1.65, $p > .10$).

The data also showed that at the beginning of the 3-month interval, there were no significant differences in self-efficacy of physical activity between the patients who participated in the program and those who did not, with t-value ranging from .75 to 1.65, $p > .10$ (see Table 5).

When comparison was made at the end of the 3-month interval, the self-efficacy scores on all the six subscales were significantly higher among the patients who participated in the rehabilitation program (see Table 6).

Table 6
Self-Efficacy of Activity Between Participating Versus Nonparticipating Patients at 3-Month Interval

	Participating		Nonparticipating		
	M	*SD*	*M*	*SD*	*t*-Value
Walking distance	86.6	16.1	66.0	26.8	2.39**
Walking time	91.4	12.5	63.5	28.5	3.14**
Hurrying	58.6	33.5	22.4	34.1	3.03**
Lifting objects	63.1	26.6	36.0	16.6	3.88***
Lifting and carrying	69.8	25.7	42.7	20.1	3.54**
Climbing stairs	79.7	21.8	49.6	24.4	3.60**
Full scale	449.1	111.9	280.1	130.0	3.82***

$^{**}p < .01$; $^{***}p < .001$.

DISCUSSION

The results of the present study confirm that the cardiac rehabilitation program with physical exercise was effective in enhancing the self-efficacy of physical activity. Among the six physical activities, hurrying was still the activity that the patients had least confidence in doing at the end of the program. Although the patients showed the greatest improvement in hurrying, the high improvement rate could partly be accounted for by the relatively low base rate of hurrying. Interviews with the patients revealed that 50% of the patients reported no confidence at all in hurrying but had relatively great confidence in walking before joining the rehabilitation program. The improvement rate in walking was nonetheless less than that in hurrying, which was probably due to a ceiling effect.

Improvements in exercise tolerance were also observed after the rehabilitation. Improved performance on MHR and MPHR% (indicator of maximum heart rate) failed to reach the statistically significant level. In reflection, these insignificant findings on heart rate indicators may be attributed to the drug effect experienced by the patients. Evaluative studies conducted in the West asked patients taking beta blockers for controlling arrhythmia or blood pressure to stop the medication 24 to 36 hours before they took the treadmill test. Because this is not the practice in the local setting, patients in the present study did not stop their medication while taking the treadmill test. As a result, the medication could have caused the MHR or MPHR% to be less sensitive in measuring exercise tolerance. To what extent this is true remains to be empirically examined.

The data of the present study confirm that self-efficacy of physical activity was significantly related to actual treadmill test results. In general, gains in self-efficacy were also found to be significantly associated with improvement in treadmill test performance. These findings are consistent with the results reported by Western investigators (Ewart, 1992; Robertson & Keller, 1992) who found that self-efficacy was an important factor that influenced exercise behavior. The findings also confirm the hypothesized correlation between changes in self-efficacy and behavioral change postulated by Bandura (1991). Furthermore, the significant correlation of self-efficacy and actual exercise behavior also provides supportive evidence for the validity of the ETSES. In fact, the present study cross-validates the ETSES with empirical evidence for both its test-retest reliability and construct validity.

Notwithstanding the different rates of improvement in self-efficacy and exercise tolerance, the effectiveness of the rehabilitation program was demonstrated. Four factors were considered by Bandura and his colleagues (Bandura, 1982; Bandura, Adams, Hardy, & Howells, 1980) to be effective in promoting a higher sense of self-efficacy and behavioral change. They are performance accomplishment, verbal persuasion, effective feedback of physiological state, and vicarious experience. Apparently, these four factors had been incorporated in our rehabilitation program. For example, the physical exercise assigned was carefully graded to ensure successful performance. The verbal persuasion and immediate feedback of the patient's physiological state provided by the nurses served to reinforce the self-efficacy resulting from successful performance. Observing the progress and achievements of other patients may also augment one's self-efficacy in engaging in similar exercise. It was believed that the combined effect of these four factors resulted in the enhancement of self-efficacy of activity. Because of limited resources, the separate effects of the four antecedent factors were not examined in the present study. Future study may be conducted to examine the relative contribution of the four factors so that a more effective rehabilitation program may be designed.

A possible limitation of the present study concerns the characteristics of the comparison group. This group was rather small and consisted only of patients who did not have the motivation to complete the program. Admittedly, this was not an ideal group for making comparisons. Because of ethical considerations, however, and lacking a group of patients on a waiting list, patients who did not participate after the first session were expediently used for comparison. Although these patients were willing to fill in the ETSES 3 months later, data on the treadmill test were not available for comparison. More convincing evidence for the effectiveness of the cardiac rehabilitation program may be obtained if the comparison group is better controlled.

On the whole, the findings of the present study did provide supportive evidence for the effectiveness of the rehabilitation program. Such effectiveness was observed regardless of the patient's gender, age, education, and clinical diagnosis. With an enhancement of self-efficacy of activity and exercise tolerance, the risk factor of physical inactivity is expected to be reduced. In view of the relatively small sample of this study, further study with a larger sample to replicate the present findings may be necessary. The effect of improvement of self-efficacy and exercise tolerance on long-term daily functional ability and lifestyle readjustment is also worth pursuing.

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