Effect of High- Versus Low-Frequency Exercise Training in Multidisciplinary Cardiac Rehabilitation on Health-Related Quality of Life

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Background. *The authors examined the importance of the frequency of aerobic exercise training in multidisciplinary rehabilitation in improving health-related quality of life in the short run in patients with documented coronary artery disease.*
Methods. *Patients (114 males and 16 females; age range, 32–70 years) were randomized into either a high-frequency or a low-frequency exercise training program (10 versus 2 sessions per week, respectively) as part of a 6-week multidisciplinary cardiac rehabilitation program. The General Health Questionnaire and the RAND-36 were used to assess changes in psychological distress and subjective health status.*
Results. *After 6 weeks, high-frequency patients reported significantly more positive, change in "psychological distress" ($P < 0.05$), "mental health" ($P = 0.05$), and "health change" ($P < 0.01$), than low-frequency patients. Apart from changes in mean scores, individual effect sizes indicated that a significantly greater percentage of high-frequency patients experienced substantial improvements in "psychological distress" ($P < 0.01$), "physical functioning" ($P < 0.05$), and "health change" ($P < 0.05$), compared with low-frequency patients. In addition, deterioration of quality of life was observed in a considerable number of high-frequency patients (ranging from 1.7% to 25.8% on the various measures).*
Conclusions. *The frequency of aerobic exercise has a positive, independent effect on psychological outcomes after cardiac rehabilitation. However, this benefit after high-frequency rehabilitation appears to be limited to a subgroup of patients. Further investigation is required to identify these patients. Results provide input into recent controversies regarding the role of exercise training in cardiac rehabilitation.*

Key words: cardiac rehabilitation, quality of life, psychological distress, exercise training, exercise frequency, multidisciplinary.

In addition to cardiovascular functional impairments, coronary artery disease often causes decrements in perceived health status and psychological distress.[1] Psychosocial impairments, in turn, adversely affect patients' long-term quality of life,[2] medical outcome,[3] and increase cardiac mortality risk.[4,5] Rehabilitation in coronary patients is therefore not only aimed at improving objective physical status and at reducing risk factors, but also at returning patients to the optimal psychosocial status. This multidimensional aspect of cardiac rehabilitation is increasingly acknowledged,[6-8] and multidisciplinary programs are now applied widely, consisting of a set of components that in addition to exercise training include health education, stress management, relaxation therapy, dietary interventions, and referral to psychotherapy when necessary. These programs recently have shown to effect overall health-related quality of life (HRQoL) positively.[9,10] The improvement in quality of life in multidisciplinary rehabilitation is believed to be based on the complementary effects of the various components, but the cornerstone in most programs is still aerobic exercise training. The frequency of exercise sessions, however, varies considerably.

A higher exercise frequency accompanies higher costs of a program and requires more time and effort of the patient to complete rehabilitation. From this perspective, it is important to gain understanding about the effect of exercise frequency on patients' recovery. To date, a systematic evaluation of whether different frequencies of aerobic exercise sessions produce different rehabilitation outcomes has not been described. Using existing models of cardiac rehabilitation in the Netherlands, we had the unique opportunity to evalu-

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ate high-frequency exercise training (10 per week) compared with that more commonly used in the United States (2 per week). The purpose of the present study was to examine whether the frequency of exercise training does improve patients' perception of their HRQoL.

Methods

Study Design and Patients

Data were derived from a clinical trial in which patients are randomized into either a high-frequency or a low-frequency exercise training program as part of a 6-week outpatient (phase II) multidisciplinary cardiac rehabilitation program. All patients who entered the Beatrixoord Rehabilitation Center for cardiac rehabilitation between June 1993 and November 1995 were screened for eligibility. Participation in the study required manifest coronary artery disease (myocardial infarction documented by electrocardiogram and blood enzyme activity, coronary surgery, percutaneous transluminal coronary angioplasty, angina pectoris with documented stenosis in at least one major coronary artery), and 30 to 70 years of age. Exclusion criteria were uncompensated heart failure; unstable arrhythmias; unstable angina; contraindications for exercise training; exercise training limiting concurrent condition (e.g., chronic obstructive pulmonary disease, skeletal or muscular disorders); inability to complete questionnaires; candidate for inpatient cardiac rehabilitation. Patients who met the eligibility criteria were informed about the study and asked to participate during a 3-day screening period. After they gave their written informed consent to participation in the study, patients completed self-administered questionnaires (T1) and subsequently were randomized into either type of program by an external institute. Patients received the next available study number with the associated random allocation to either the high-frequency or low-frequency program. Six weeks later (T2; end of rehabilitation program) patients again completed the same questionnaires to assess changes in HRQoL. The study protocol was approved by the institutional review board.

Rehabilitation Programs

The two programs being evaluated are each a 6-week outpatient cardiac rehabilitation program with a multidisciplinary approach offering the same set of components. The programs basically differ only in the frequency of aerobic exercise training per week, whereas other components are equal for all study patients. Patients randomized into the high-frequency program attended the rehabilitation center 5 full days per week for 6 consecutive weeks. Exercise sessions were held twice a day. Patients enrolled in the low-frequency exercise program attended the rehabilitation center 2 half-days per week for 6 consecutive weeks. Exercise sessions were held twice a week.

One exercise training session included 30 minutes of training on a stationary bicycle with continuous electrocardiographic monitoring in a group of 3 to 6 patients, and 60 minutes of sports (e.g., ball sports, calisthenics, swimming) in a group of 6 to 12 patients. The intensity of cycling was determined individually from the initial exercise test, where the training target heart rate was calculated as 60% to 70% of the heart rate reserve plus the resting heart rate (Karvonen method). Exercise sessions of both programs were conducted by the same staff, in the same building, but at different times.

Components other than exercise training included: group relaxation therapy offered once a week with separate sessions for both programs; individual psychological and dietetic counseling (when necessary) scheduled around exercise sessions; education and information about various topics addressed in separate classes. These classes were covered in 2 full-day sessions offered on a rotating weekly basis. Patients of both programs possibly were enrolled in the same education sessions. Regarding the individual counseling, explicit efforts were made by the rehabilitation staff to accommodate low-frequency patients' schedules, ensuring that the programs differ only in exercise frequency.

Questionnaires

Because this study evaluated a brief rehabilitation process, we selected two extensively used and well-validated instruments that are sensitive to detect changes over a short period of time. Moreover, to ensure sensitivity in outcome assessment,[11] the selected instruments together capture dimensions of quality of life that match the theoretically prescribed effects of our cardiac rehabilitation program (i.e., improving subjective health and reducing psychological distress). General Health Questionnaire (GHQ)[12,13] was used as a measure of psychological distress. The scores on this 12-item scale run from 0 to 36. The higher the score, the more patients presented psychological distress compared with "normal." Internal consistency of this scale in this study was high and highly similar to estimates in previous research:[13] Cronbach's = 0.87. The RAND-36,[14,15] which is a Dutch version of the MOS SF-36,[16] was used as a measure of subjective health. Seven subscales were used addressing perceptions of mental health, vitality, physical functioning, bodily pain, social functioning, general health, and perceptions of changes in general health since the cardiac event. The scores on each subscale run from 0 to 100. A higher score denotes a better functioning or more positive health change. Internal consistency of the various subscales in this study were satisfactorily and highly similar to estimates in previous research:[16] Cronbach's ranged from 0.72 to 0.88.

Statistical Analysis

To identify any difference between groups at baseline, clinical and psychosocial characteristics of both groups were compared with a Student's t test in case of variables of interval level, and with a chi-square analysis in case of variables of nominal or ordinal level. Pairwise t test was used to identify significant average changes in the quality of life measures, for both programs separately. To test differential effects between programs, analysis of covariance was used for each quality of life measure separately, using the baseline score as the covariate. This procedure statistically controlled for any initial differences among patients in psychosocial status at baseline. Effect sizes were used to classify patients into the subgroups "improvement," "no-change," or "deterioration." They were calculated by taking the difference between the entry score and end score and dividing it by the pooled standard deviation from both groups at the baseline.[17] Following Cohen,[17] Denollet and Brutsaert,[9] and Uniken Venema-van Uden et al.,[18] significant improvement and deterioration were defined respectively as effect size ≥ 0.5 and ≤ −0.5. Chi-square analyses were used to examine if the percentage of patients who showed improvement, no-change, or deterioration was significantly different between both programs.

Results

Baseline Characteristics

A total group of 186 patients met the eligibility criteria. Of these 186 patients, 30% (n = 56) were not included for different reasons: patients refused to fill out questionnaires (n = 9); did not agree with randomization due to a strong preference for one of the programs; physiological data could not be obtained (n = 11). Thus, 130 patients were admitted to the study (87.7% male and 12.3% female). Among all study patients, 89.2% were married or had a stable relationship. Group characteristics regarding clinical and demographic features are outlined in Table 1 and demonstrate no differences between groups. However, some differences in psychosocial status were identified. Independent Student's t test showed small but significant differences on social functioning (P = 0.04), mental health (P = 0.03), and vitality (P = 0.05), indicating that patients assigned to the low-frequency program were doing somewhat better on these dimensions.

Table 1. *Comparison (n [%]) of Group Characteristics After Randomization*

	High-frequency Program (n = 63)	*Low-frequency Program (n = 67)*	*P*
Age (years)*	52.0 (9.3)	52.9 (9.5)	NS
Gender			NS
Male	52 (82.5)	62 (92.5)	
Female	11 (17.5)	5 (7.5)	
Married	56 (88.9)	60 (89.6)	NS
Exercise capacity*			NS
Peak-VO_2 (mL/min/kg)	26.4 (6.4)	22.9 (5.8)	
LV ejection fraction*	0.48 (0.11)	0.46 (0.10)	NS
Coronary diagnosis			NS
Myocardial infarction	47 (74.6)	51 (76.1)	
Angina	4 (6.4)	9 (13.4)	
Cardiac bypass surgery	6 (9.5)	2 (3.0)	
PTCA	6 (9.5)	5 (7.5)	
Medication			NS
β-blocker	49 (77.8)	55 (82.1)	
ACE-inhibitor	19 (28.3)	17 (25.3)	

*Mean and standard deviation.
NS: difference not statistically significant; PTCA: percutaneous transluminal coronary angioplasty; LV: left ventricular.

Only 4 patients (all from the low-frequency program) withdrew their consent for various non medical reasons and stopped with rehabilitation. Ten patients were excluded from follow-up analyses for various other reasons; 5 from the high-frequency and 5 from the low-frequency program (e.g., bypass or percutaneous transluminal coronary angioplasty during rehabilitation, not willing to complete repeated questionnaires). Finally, **116** patients were included to report effects on health-related quality of life; 58 in the high-frequency program and 58 in the low-frequency program.

Changes in Mean Scores

After 6 weeks of rehabilitation (Table 2), the group of patients in the high-frequency program reported significant improvements in all dimensions, with exception for "bodily pain." Patients in the low-frequency program reported significant improvements in "psychological distress," "vitality," "physical functioning," and "social functioning." Comparing the changes between both programs, some differences in favor of the high-frequency patients were observed by completion of the 6-week rehabilitation program. High-frequency patients experienced significantly greater decline in distress scores (F = 5.41, $P < 0.05$), more improvement in "mental health" (F = 3.64, $P = 0.05$), and more positive "health change" (F = 9.47, $P < 0.01$) than low-frequency patients. The same consistent but nonsignificant trend was observed for "general health," "vitality," "physical functioning," and "social functioning."

Improvement and Deterioration

Results of individual effects sizes scores are outlined in Table 3 and demonstrate that a significantly greater percentage of high-frequency patients experienced substantial improvement in "psychological distress" (70.6% versus 37.9%) and "health change" (51.7% versus 27.5%), and a significantly smaller percentage of high-frequency patients had deteriorated in these measures (3.4 versus 6.9% and 12.1 versus 17.2),

Table 2. *Mean Scores Before and After 6 Weeks of Rehabilitation for the High-frequency (n = 58) and Low-frequency (n = 58) Group*

Outcome Measure		*Before Rehabilitation*	*After 6 weeks Rehabilitation*	*Change*	*P*
GHQ					
Psychological distress*	High-frequency	17.2 (7.2)	9.6 (5.2)	-7.6	< 0.001‡
	Low-frequency	14.8 (6.2)	10.6 (4.4)	-4.2	< 0.001
RAND-36†					
General Health	High-frequency	58.3 (16.2)	62.3 (14.8)	+4.0	< 0.05
	Low-frequency	61.7 (18.1)	61.5 (19.2)	+0.2	NS
Vitality	High-frequency	50.2 (19.5)	59.5 (15.9)	+9.3	< 0.001
	Low-frequency	58.9 (19.7)	64.3 (18.0)	+5.4	< 0.05
Physical functioning	High-frequency	70.7 (19.3)	80.3 (19.9)	+9.6	< 0.001
	Low-frequency	77.8 (18.8)	83.5 (17.0)	+5.7	< 0.01
Mental health	High-frequency	59.0 (22.1)	70.2 (17.9)	+11.2	< 0.001‡
	Low-frequency	68.2 (17.1)	71.1 (16.3)	+ 2.8	NS
Health change	High-frequency	56.4 (25.7)	73.3 (18.4)	+16.9	< 0.001‡
	Low-frequency	66.6 (21.7)	69.7 (24.4)	+3.1	NS
Social functioning	High-frequency	56.4 (22.4)	70.7 (20.5)	+14.3	< 0.001
	Low-frequency	66.6 (23.3)	80.8 (20.4)	+14.2	< 0.001
Bodily pain	High-frequency	89.6 (30.7)	93.3 (25.6)	+3.7	NS
	Low-frequency	92.8 (25.7)	96.4 (18.5)	+3.6	NS

Standard deviation appears in parentheses.
*Higher score signifies more distress.
†Higher score signifies a more favorable functioning.
‡Change was significantly different between high-frequency and low-frequency group.
GHQ: General Health Questionnaire; NS: change not statistically significant.

Table 3. *Number (n[%]) of Patients in the High-frequency (n = 58) and Low-frequency (n = 58) Program Who Showed Improvement, Deterioration, or No-change, After 6 Weeks of Rehabilitation*

Outcome Measure		*Improvement**	*Deterioration**	*No change*	*P†*
GHQ					
Psychological distress	High-frequency	41 (70.6)	2 (3.4)	15 (26.0)	< 0.01
	Low-frequency	22 (37.9)	4 (6.9)	32 (55.2)	
RAND-36					
General Health	High-frequency	24 (41.4)	9 (15.5)	25 (43.1)	NS
	Low-frequency	14 (24.1)	5 (25.8)	29 (50.1)	
Vitality	High-frequency	30 (51.7)	8 (13.7)	20 (34.6)	NS
	Low-frequency	25 (43.1)	12 (20.7)	21 (36.2)	
Physical functioning	High-frequency	23 (39.7)	5 (8.6)	30 (51.7)	< 0.05
	Low-frequency	11 (18.9)	2 (3.4)	45 (15.5)	
Mental health	High-frequency	28 (48.2)	6 (10.3)	24 (41.5)	NS
	Low-frequency	19 (32.7)	9 (15.5)	30 (51.8)	
Health change	High-frequency	30 (51.7)	7 (12.1)	21 (36.2)	0.05
	Low-frequency	16 (27.5)	10 (17.2)	32 (55.3)	
Social functioning	High-frequency	34 (58.6)	10 (17.2)	14 (24.1)	NS
	Low-frequency	36 (62.1)	7 (12.1)	15 (25.8)	
Bodily pain	High-frequency	6 (10.3)	4 (6.8)	48 (82.9)	NS
	Low-frequency	3 (5.1)	1 (1.7)	54 (93.2)	

GHQ: General Health Questionnaire; NS: difference not statistically significant.
*Improvement and detoriation are respectively defined as an effect size of ≥0.5 and ≤–0.5.
†Chi-square test significance for crosstabulation of percentage improvement, deterioration, and no change by type of program.

when compared with low-frequency patients. This trend, though not significant, also was noted in "general health," "vitality," and "mental health." Regarding physical functioning, on the other hand, a significantly greater percentage of high-frequency patients improved (39.7% versus 18.9.%), but a greater percentage of high-frequency patients reported deterioration (8.6% versus 3.4%) when compared with low-frequency patients. Again, this latter trend, though not significant, was observed in "social functioning" and "bodily pain." Hence, individual scores indicate that apart from changes in mean scores, also more high-frequency patients than low-frequency patients actually improved.

Discussion

This study is the first that has systematically evaluated whether the frequency of aerobic exercise training during outpatient multidisciplinary cardiac rehabilitation plays a decisive role in improving patients' HRQol. Over a short 6-week multidisciplinary program, high-frequency exercise training resulted in greater improvements than low-frequency exercise training; high-frequency patients reported significantly more reduction in their psychological distress, significantly more improvement in their mental health status, and significantly more positive change in their health since the cardiac event, than the low-frequency exercise group. Improvements in other quality of life measures (social and physical functioning, vitality, and bodily pain) were consistently greater in high-frequency patients, although not statistically significant.

It is evident among most practitioners that exercise training positively influences convalescence after a major cardiac event. However, with few exceptions, investigators have found small, or no psychological changes associated with exercise itself and claimed that, to enhance subjective health and well-being, it would be more meaningful to integrate exercise in a multidisciplinary rehabilitation program.[19,20] This program therefore offered exercise training in conjunction with psychosocial, nutritional, and educational interventions and demonstrates that, given that other components are equal in both programs, differences in psychological effects appear to be a function of the frequency of exercise. Several possible mechanisms may contribute jointly to the greater psychological improvement found in high-frequency patients. First, patients may learn that exercise is associated with better health. By actually exercising daily, patients think they are doing all they can to recover, which might enhance their feelings of personal control. Secondly, the confrontation with physical exertion every day in a safe environment likely boosts their physical self-confidence.[21] Patients realize that it is still possible to be physically active all day and to resume daily life activities even if they have cardiac disease. For instance, enhanced self-confidence[22] and personal control[23] have been found to reduce distress in cardiac patients. In addition to these mechanisms that are associated with the exercise training per se, some nonspecific treatment effects (e.g., therapist attention, social interactions with fellow patients, or change of daily routine) also may contribute to the observed different effects which deserve further examination.

Significant improvements in "general health" and "mental health" were not found in the low-frequency group. A plausible explanation is that, given the low frequency, the duration of the low-frequency program is too short, resulting in inadequate treatment strength. Other investigators have documented significant improvements in quality of life dimensions after a multidisciplinary rehabilitation program using comparable low frequency visits per week, but for extended duration (8 weeks to 3 months).[9,10]

In addition to changes in mean scores, we also examined the individual effect size scores of which two observations are noteworthy. First, regarding most outcome measures, more high-frequency patients showed a substantial improvement than did low-frequency patients. These results support the findings based on average outcomes that high-frequency exercise training appears to be more favorable than low-frequency exercise training. Secondly, while in both programs changes in average scores may show significant improvements, the additional individual scores display a negative outcome in a number of patients. These results concur with an earlier statement by VanDixhoorn et al.[24] and Denollet and Brutsaert,[9] that average outcomes mask the fact that some patients clearly benefit from a particular program, whereas others do not benefit or may deteriorate. Why is it that a number of patients have deteriorated? It is possible that those who showed deterioration in the high-frequency program might have shown benefit from low-frequency rehabilitation or vice versa. As for the present study, additional analysis showed that patients who deteriorated did not differ from patients who actually improved their health-related quality of life in terms of demographic characteristics, cardiac diagnosis, and baseline exercise capacity and left ventricular ejection fraction. Which other patient characteristics, or perhaps environmental conditions, are responsible for the effect of a program? Answering such questions will require further investigation. By using individual scores, studies generate research questions that may contribute to the development of individually tailored programs which is a major challenge in cardiac rehabilitation research today. That is, cardiac rehabilitation practitioners are increasingly called upon to use a patient-oriented approach which offers the patient a rehabilitation program that addresses his or her specific needs.[25,26]

Study Limitations

It should be noted that the study group might not be representative for all patients with coronary artery disease. Our center is known for its multidisciplinary rehabilitative approach, which most often results in referral of patients with relatively serious psychosocial impairments. It therefore is likely that the findings reflect the needs of this subgroup of patients given their psychological impairments. Another limitation that warrants mentioning concerns the potential "response shift," that accompanies research using subjective measurements of effect.[27] The results of individual effects in particular must be interpreted with caution. A negative outcome such as "deterioration" suggests an increased negative impact of health condition on a particular domain of function. However, such an outcome also may be due to a shift in standards of patients used to judge their situation. Furthermore, the results may not be fully generalizable to other institutions because of differences in the program implementation such as atmosphere or staff.

The applicability of an intensive program with a high-frequency exercise training differs among cardiac rehabilitation institutes within and between countries. Finally, the authors are aware that this study only included short-term effects of cardiac rehabilitation, and that the long-term effects are unknown. However, recall that psychosocial impairments, as measured up to 3 weeks after the cardiac event, predicts mortality risk and adversely affect patients' ability to comply with risk factor modification. These facts support the critical importance of ensuring a rapidly improved overall quality of life soon after the cardiac event. In that respect, it is of paramount interest to observe that the frequency of exercise training in cardiac rehabilitation plays a decisive role. However, it is important to recognize that the findings and implications of this report pertain to the improvement of quality of life and that other important benefits of exercise training are not considered.

Implications

Our results provide insights in the recent controversies regarding the role of exercise training in cardiac rehabilitation[28,29] in two profound ways. First, the findings underscore the importance of exercise training in a multidisciplinary rehabilitation program, not only with respect to improving patients' exercise tolerance, but also HRQoL. Secondly, as evidenced by the individual effects, there is no set number of exercise sessions beneficial to all patients. Cardiac rehabilitation programs that routinely prescribe patients a set number of exercise sessions disregard individual patient needs. In this case, although there was some benefit of a 2 half-day per week cardiac rehabilitation model, an intense 5-day per week model generated a greater therapeutic effect on HRQoL. However, this finding can be attributed to generous improvements in a subgroup of patients, yet to be identified.

In summary, within a randomized clinical trial, we observed that high-frequency exercise training generally elicited a greater effect in the improvement of HRQoL in coronary patients during 6 weeks of multidisciplinary rehabilitation compared with low-frequency exercise training. Findings suggest a positive independent effect of the frequency of exercise training on psychological outcomes after cardiac rehabilitation. This benefit provided by a high-frequency exercise training program, however, does not apply to every patient. Further investigation is warranted to address the question of *which* patients need added days of exercise training.

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