

Cardiorespiratory Fitness and Quality of Life at Different Exercise Intensities after Myocardial Infarction

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Abstract

Background: Studies relating physical exercises and health have contributed to elucidate the influence of sedentary habits on the incidence of cardiovascular diseases.

Objective: To compare the effect of different intensities of aerobic exercises on patients' functional capacity (VO_{2peak}) and quality of life after acute myocardial infarction.

Methods: Eighty-seven men (57.7 ± 6.1 years old) were enrolled in this prospective study and assigned to one of three groups: a) high-intensity physical training ($n=29$) at 85% maximum heart rate for 12 weeks; b) moderate-intensity training ($n=29$) at 75% maximum heart rate for 12 weeks; and c) control group ($n=29$), who were followed. The training groups did aerobic exercises five times a week in 45-minute sessions, besides muscular strengthening and stretching exercises. Maximum VO_2 was measured through a cardiopulmonary test, and quality of life was assessed through the MacNew Questionnaire.

Results: Two-way ANOVA revealed a significant increase in VO_{2peak} ($p<0.05$) in the high-intensity training group (from 29.9 ± 2.2 ml/kg.min to 41.6 ± 3.9 ml/kg.min) compared with the moderate-intensity training group (from 32.0 ± 5.3 ml/kg.min to 37.1 ± 3.9 ml/kg.min). Additionally, both training groups showed a significant increase in this parameter compared with the control group (from 31.6 ± 3.9 ml/kg.min to 29.2 ± 4.1 ml/kg.min). Quality of life improved significantly ($p<0.05$) in the high-intensity training group (from 5.66 to 6.80) and in the moderate-intensity training group (from 5.38 to 6.72), but not in the control group (from 5.30 to 5.15).

Conclusion: Exercises of greater intensity resulted in an increase in functional capacity and quality of life in patients after myocardial infarction. (Arq Bras Cardiol 2010; 95(3): 399-404)

Key words: Exercise; physical fitness; quality of life; myocardial infarction.

Introduction

Individuals who suffered acute myocardial infarction (AMI) usually have impaired physiological, social, and labor conditions, with poor quality of life (QOL)^{1,2}. QOL assessment has been emphasized as an important variable in clinical practice, since it brings medical knowledge that can result in healthcare changes and in the consolidation of new paradigms for the health-disease process³.

Cardiac rehabilitation (CR) is a series of prophylactic and therapeutic measures aimed at reducing the physical and psychosocial impacts caused by the individual's limiting conditions. Its goal is to improve the functional capacity, QOL, and prognosis⁴ and, if possible, to reverse the progression of coronary artery disease (CAD) as well^{5,6}. CR can reduce general

mortality by 20% and heart-related mortality by 26% in 2-5 years after the cardiac event⁷.

Apparently, there is an inverse correlation between the level of physical fitness and the occurrence of CAD manifestations⁸. In this context, the individual's lifestyle, including physical activity, has an impact on the treatment of AMI, even as a potential factor for disease regression^{5,9,10}.

Aerobic exercises are an important tool in CR because they are cost-effective, reduce risk factors for CAD, and consequently improve the individual's QOL and cardiorespiratory fitness^{6,11-13}, which is one of the most important cardiovascular parameters in the prognosis of coronary pathologies^{11,13}. Both the functional capacity (VO_{2peak}) and QOL assessment proved to be important for the strategic treatment and prognosis of CAD¹⁴.

However, there are few studies involving infarcted patients undergoing a CR program. We do not yet know whether exercise intensity should be considered a critical factor and what this intensity should be^{15,16}. We also lack well-defined guidance on the intensity required to reach the benefits of aerobic exercises on VO_{2peak} and QOL.

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Therefore, the objective of this study was to compare the effect of different aerobic exercise intensities on VO_{2peak} and QOL of post-AMI patients.

Methods

Sample

In this prospective study, patients from the Greater Florianópolis region who had suffered an AMI in the previous 12 months were assessed. Exclusion criteria were: female gender; age under 18 years; heart failure; poorly controlled diabetes; chronic obstructive pulmonary disease; systolic and diastolic arterial pressure higher than 160 mmHg and 95 mmHg, respectively; smokers; and those who had not been sedentary for at least 12 months. Of the 153 patients initially assessed, 55 did not meet these criteria and therefore were excluded. All subjects underwent the tests at least 60 days after the infarction date.

Ninety-eight patients met the following inclusion criteria: adult (18 years old or older), male gender, sedentary life for 12 months or more, and AMI in the previous 12 months, and were randomly assigned to one of three groups. Of the 98 patients who started the training program, 11 did not conclude the trial: one patient moved to another city; two patients had unstable angina episodes and were referred to medical reassessment; one patient had joint problems; one patient was advised to leave the program by a second medical opinion; one patient underwent another percutaneous transluminal angioplasty; and one patient did not like the program.

The 87 patients who concluded the trial joined a 12-week intervention program; their mean age was 57 ± 6.1 years. All subjects agreed to participate in this clinical trial by signing an Informed Consent Form according to the Brazilian Health Council Resolution No.196/96. This study was approved by the Research Ethics Committee of the State University of Santa Catarina, under Protocol No. 62/2007.

Measurement instruments

All subjects underwent a cardiopulmonary test on an ATL 15000 Embramed treadmill equipped with a Micromed Elite ErgoPC 13 computerized system (Brasília, Brazil) and a Cortex ergospirometry system (Germany, 2005) with breath-by-breath gas analyzer. A multistage, multiple-workload Ellestad protocol, indicated for diagnostic tests and functional assessments, was used. It consists of six stages, starting at 1.7 mph and a 10% slope for 3 minutes, increasing the workload by two metabolic equivalents (METs) per stage until reaching 6.0 mph at a 15% slope.

The anthropometric measurements used were: height (cm), measured by a SANNY stadiometer (accuracy 0.1cm), and weight (kg), measured by a Filizola™ scale (resolution 100g), for Body Mass Index (BMI) calculation (kg/cm^2); waist and hip circumference (cm); and waist-to-hip ratio (WHR)¹⁷.

The heart rate was measured at all exercise sessions using a Polar™ SF1 heart rate monitor. QOL was assessed using the MacNew Quality of Life after Myocardial Infarction Questionnaire (MacNew QLMI), developed by Oldridge

et al¹⁸ and validated in Portuguese by Benetti et al¹⁹. This questionnaire quantitatively assesses QOL perception, and the recommended score involves emotional, physical, and social domains. It contains questions on humor, self-esteem, stress, disposition, independence, sexuality, confidence regarding the heart problem, chest pains, physical capacity, etc.

Exercise training program

The individuals were assigned to a high-intensity (HI) aerobic exercise program ($n=29$), a moderate-intensity (MI) aerobic exercise program ($n=29$), or a control group (C) ($n=29$). For the HI aerobic exercise program, patients exercised at around 85% of their maximum heart rate (HR) achieved in the stress test, whereas for the MI program, patients exercised at a approximately 75% of their HR_{max} . Both groups did aerobic exercises five times a week during 45 minutes, followed by stretching and muscular strengthening exercises for 15 minutes. Patients in the control group did not do any exercises. The three groups were instructed to maintain their usual diet.

Statistical analysis

Descriptive statistics (mean and standard deviation) were used to describe the sample. All data were evaluated through Analysis of Variance (Two-way ANOVA) and the Tukey's post-hoc test when necessary. The level of significance used was 0.05.

Results

Subject characteristics

Table 1 shows the characteristics of the study subjects. There were no significant differences among the groups for the parameters analyzed ($p < 0.05$). Concerning the anthropometric characteristics, subjects in groups MI and C were overweight ($BMI > 24.9 \text{ kg}/\text{cm}^2$) and subjects in the HI group were obese ($BMI > 30 \text{ kg}/\text{cm}^2$), according to the WHO classification¹⁷. The waist-to-hip ratio (WHR) was higher than the reference values (0.95 for men), indicating that the sample was within the risk range¹⁷. Table 1 also shows that high-density lipoprotein cholesterol (HDL-c) levels were lower than those recommended (40 mg/dl) in the three groups¹⁹.

Cardiorespiratory fitness

Figure 1 shows VO_{2peak} results for the three groups. It can be observed that VO_{2peak} improved significantly in both aerobic training groups (HI and MI) after a 12-week intervention. Also, there was a significant statistical difference between the training groups and the control group after the intervention period. Finally, the HI group achieved a significant improvement compared with the MI group ($p < 0.05$).

Quality of life

Table 2 shows the results related to QOL scores. The group analysis before and after intervention demonstrated that the practice of physical exercises, regardless of their intensity,

improved QOL perception compared with the control group. However, the comparison between HI and MI training groups revealed that exercise intensity had a significant impact on QOL improvement ($p < 0.05$).

Discussion

Studies relating physical exercises and health have contributed to elucidate the influence of sedentary habits on the incidence of cardiovascular diseases^{4,20-22}. A clinical trial conducted with heart disease patients demonstrated that the capacity to exercise is a strong predictor of death risk¹³. Therefore, non-pharmacological interventions, such as physical exercise programs, are recommended as primary and

secondary measures for preventing these diseases²³. However, the anti-atherogenic mechanisms associated with exercise have not yet been fully explained.

This study demonstrated that patients who do HI aerobic exercises attain better cardiorespiratory fitness and QOL than those who do MI exercises and those who are sedentary. Apparently, for healthy subjects and patients with CAD, the greater the capacity to exercise, the greater the protection against death even in the presence of other risk factors¹³. Hagberg et al²⁴ demonstrated that patients with CAD improved their myocardial oxygenation and left ventricular ejection fraction by undergoing high-intensity training (70-90% VO_{2max}) for 12 months, in 1-hour sessions, five times a week. Those findings corroborate ours. Additionally, patients improved their glucose intolerance, insulin sensitivity, and lipid profile.

A study with 62 patients with stable angina randomized to regular physical exercise ($n=29$) or clinical follow-up for 12 months revealed that the practice of physical exercises increases VO_{2max} significantly in patients with symptomatic CAD. To get this benefit, patients should burn around 1,400 kcal/week through some form of physical activity, which corresponds to three or four hours of aerobic resistance training⁶.

High-intensity aerobic exercises apparently improve coronary endothelial function and circulation associated with non-stenotic coronary atherosclerosis, probably due to the recruitment of collateral vessels and blood flow increase in the ischemic areas of the myocardium. In that study, ten patients underwent a physical exercise program and nine made up the control group. The four-week exercise program consisted of 10-minute supervised sessions at 80% HR_{max} six days a week. The findings revealed a 54% reduction in paradoxical coronary vasoconstriction in response to the acetylcholine infusion in the exercise group compared with the control group. Physical

Table 1 - Subject characteristics

	HI	MI	C
AMI time (months)	7±3.32	9±2.50	9±2.71
PTCA (subjects)	10	12	15
CABG (subjects)	11	14	9
BMI (kg/cm ²)	30.03 ± 4.09	29.80 ± 3.97	29.67 ± 4.1
WHR	1.05 ± 0.04	1.03 ± 0.05	1.06 ± 0.05
HDL-c (mg/dl)	34 ± 6	31 ± 5	36 ± 8
LDL-c (mg/dl)	125 ± 17	129 ± 17	119 ± 21
TAG (mg/dl)	141 ± 26	138 ± 30	149 ± 23

HI - high intensity; MI - moderate intensity; C - control group; AMI - acute myocardial infarction; PTCA - percutaneous transluminal coronary angioplasty; CABG - coronary artery bypass graft; BMI - body mass index; WHR - waist-to-hip ratio; HDL-c - high-density lipoprotein cholesterol; LDL-c - low-density protein cholesterol; TAG - triglycerides; $p < 0.05$.

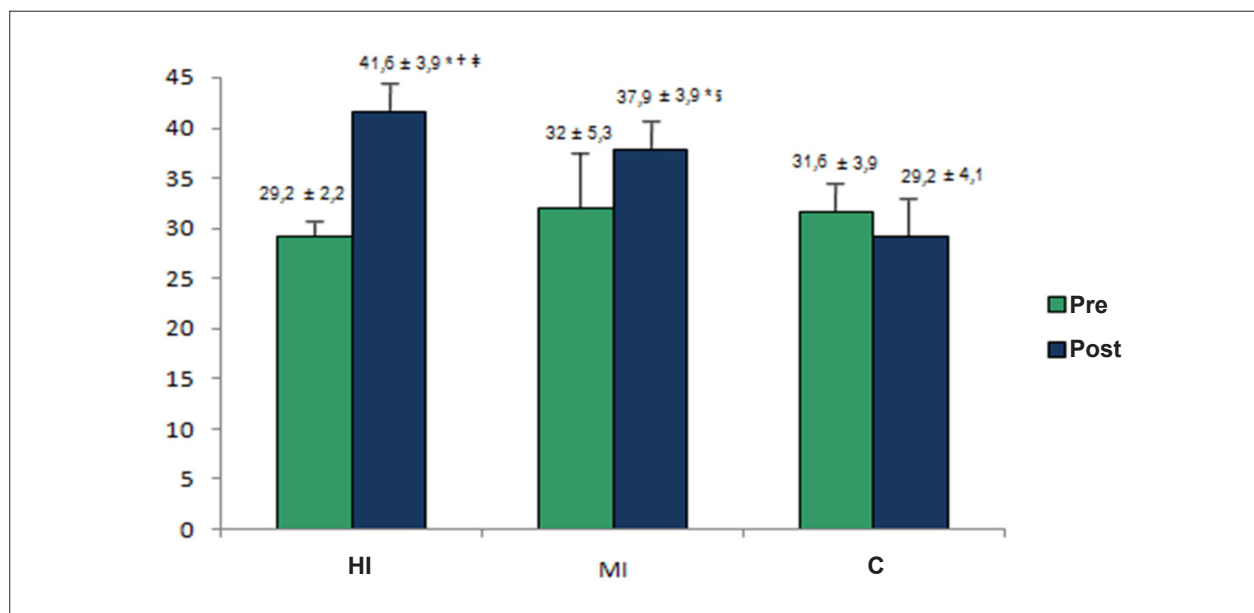


Figure 1 - VO_{2peak} comparison among the groups pre- and post-intervention; HI - high intensity; MI - moderate intensity; C - control group; * significant difference between pre- and post-intervention periods; † significant difference between HI and MI after intervention; ‡ significant difference between HI and C after intervention; § significant difference between MI and C; $p < 0.05$.

Table 2 - Comparison of quality of life scores before and after intervention

	General		Emotional		Physical		Social	
	Pre-	Post	Pre-	Post	Pre-	Post	Pre-	Post
HI	5.66	6.80*‡	5.20	6.71*‡	4.90	6.9*‡‡	5.30	6.7*‡
MI	5.38	6.72*§	5.00	6.91*§	5.21	6.18*§	5.00	6.6*§
C	5.30	5.15	5.40	5.80	5.55	5.12	4.40	4.90

HI – high intensity; MI – moderate intensity; C – control group; * significant difference between pre- and post-intervention periods; † significant difference between HI and MI after intervention; ‡ significant difference between HI and C after intervention; § significant difference between MI and C; $p < 0.05$.

exercises also improved coronary reserve and flow-dependent coronary vasodilatation ($p < 0.01$), against no changes in the control group. Thus, aerobic physical exercises proved to improve the endothelial function of coronary arteries in patients with known CAD and endothelial dysfunction²⁵.

The effect of high intensity (90-95% HR_{max}) and moderate intensity (70-85% HR_{max}) exercises on VO_{2max} was studied in 40 healthy, physically active and non-smoking subjects. The subjects exercised three times a week for eight weeks. At the end of the intervention period, a significant increase in VO_{2max} was observed in the individuals who did high-intensity physical exercises compared with those of moderate and low intensities²⁶. This increase in functional capacity may be considered a modifiable protection factor, since each 1-MET increment in cardiorespiratory fitness was associated with a 12% reduction in cardiovascular mortality¹³.

Another study demonstrated that the practice of physical exercises, even if moderate, at 60% VO_{2max} can increase by 30% the myocardial perfusion observed with thallium in patients with CAD. The coronary angiography revealed also a significant increase in collateral circulation, which, at least in part, accounts for the improvement in myocardial perfusion²⁷. Another study of patients with progressive stenotic injuries reported a reduction in myocardial ischemia, suggesting, through conventional angiography, that collateral circulation is in part responsible for the increase in myocardial perfusion²⁸.

A recently published study assessed 4,940 men after AMI and/or coronary artery bypass graft that underwent a CR program and were followed for nine years. In this CR program, patients walked three miles in 45 minutes, five times a week. It was concluded that the improvement in walking distance is a strong predictor of CAD prognosis compared with the increase in VO_{2max} . The practice of moderate-intensity exercises proved efficient in heart disease patients, even without significant increase in VO_{2max} ²⁹.

Although several articles have shown that the practice of exercises improves primary cardiac risk factors, the effect of a regular exercise program on health-related QOL remains unknown. Quality of life is currently defined as “the individuals’ perceptions of their position in life in the context of the culture and value systems where they live and in relation to their goals, expectations, standards and concerns”³⁰.

It is understandable that daily problems and other intervening events resulting from the chronic disease need to be addressed in the context of the individual’s interaction and adaptation to the disease and the environment, aiming

for a better QOL. Besides the physiological benefits on CAD, physical exercise interventions provided good social integration and easy access to information and education on the disease, which might have improved QOL perception in patients undergoing CR³¹.

After an eight-week program of aerobic exercises two times a week at 65% HR_{max} , patients returned to productive life, improved their emotional status, reduced their anxiety, and increased their tolerance to exercise compared with the control group³². The 201 individuals enrolled in the study suffered from moderate depression or anxiety. Another trial demonstrated that an eight-week program of physical exercises at 70%-85% HR_{max} , performed either at home or in the hospital, improved the subjective QOL perception and tolerance to exercise among post-AMI patients of all age groups, but particularly in patients up to 75 years of age³³.

As for the VO_{2peak} results, a significant difference in physical perception was observed between groups HI and MI, suggesting that such physiological improvement was reflected in QOL. However, exercise intensity apparently does not affect the emotional and social aspects of QOL perception. These results could possibly be explained by the fact that both training groups stayed in closer contact with the multidisciplinary team, receiving information and education, which tend to result in better compliance with healthy life habits and a better understanding of the disease³⁴.

Conclusions

The improvement in functional capacity and quality of life is more significant when higher intensity exercises are prescribed. The practice of exercises, regardless of their intensity, improves the perceived quality of life.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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There were no external funding sources for this study.

Study Association

This study is not associated with any post-graduation program.

References

1. Gonçalves FDP, Marinho PEM, Maciel MA, Galindo Filho VC, Dornelas AA. Avaliação da qualidade de vida pós-cirurgia cardíaca na fase I da reabilitação através do questionário SF-36. *Rev Bras Fisioter.* 2006; 10 (1): 121-6.
2. Thompson DR, Jenkinson C, Roebuck A, Lewin RJ, Boyle RM, Chandola T. development and validation of a short measure of health status for individuals with acute myocardial infarction: the myocardial infarction dimensional assessment scale (MIDAS). *Qual Life Res.* 2002; 11 (6): 535-43.
3. Seidl EMF, Zannon CMLC. Qualidade de vida e saúde: aspectos conceituais e metodológicos. *Cad saúde pública.* 2004; 20 (2): 580-8.
4. Taylor RS, Brown A, Ebrahim S, Jolliffe J, Noorani H, Rees K, et al. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials. *Am J Med.* 2004; 116 (10): 682-92.
5. Ornish D, Brown SE, Scherwitz LW, Billings JH, Armstrong WT, Ports TA, et al. Can lifestyle changes reverse coronary heart disease? The lifestyle heart trial. *Lancet.* 1990; 336 (8708): 129-33.
6. Hambrecht R, Niebauer J, Marburger C, Grunze M, Kalberer B, Hauer K, et al. Various intensities of leisure time physical activity in patients with coronary artery disease: effects on cardiorespiratory fitness in progression of coronary atherosclerotic lesions. *J Am Coll Cardiol.* 1993; 22 (2): 468-77.
7. Bethell HJN. Exercise-based cardiac rehabilitation. *Medicine.* 2006; 34 (5): 195-6.
8. Sui X, LaMonte MJ, Blair SN. Cardiorespiratory fitness and risk of nonfatal cardiovascular disease in women and men with hypertension. *Am J Hypertens.* 2007; 20 (6): 608-15.
9. Niebauer J, Hambrecht R, Schlierf G, Marburger C, Kälberer B, Kübler W, et al. Five years of physical exercise and low fat diet: effects on progression of coronary artery disease. *J Cardiopulm Rehabil.* 1995; 15 (1): 47-64.
10. Zornoff LA, Paiva SA, Assalim VM, Pola PM, Becker LE, Okoshi MP, et al. Clinical profile, predictors of mortality, and treatment of patients after myocardial infarction, in an academic medical center hospital. *Arq Bras Cardiol.* 2002; 78 (4): 396-405.
11. Lazzoli JK. Doença arterial coronariana e atividade física. *Revista SOCERJ.* 2000; 13 (4): 31-3.
12. Sociedade Brasileira de Cardiologia. Diretriz de reabilitação cardiopulmonar e metabólica: aspectos práticos e responsabilidades. *Arq Bras Cardiol.* 2006; 86 (1): 74-82.
13. Myers J, Prakash M, Froelicher V, Do D, Partington, S, Atwood JD. Exercise capacity and mortality among men referred for exercise testing. *N Engl J Med.* 2002; 346 (11): 793-801.
14. Mayou R, Bryant B. Quality of life in cardiovascular disease. *BMJ.* 1993; 69 (5): 460-6.
15. Delp MD, Mcallister RM, Laughlin MH. Exercise training alters endothelium-dependent vasoreactivity of rat abdominal aorta. *J Appl Physiol.* 1993; 75 (3): 1354-63.
16. Green DJ, Cable NT, Fox C, Rankin JM, Taylor RR. Modification of forearm resistance vessels by exercise training in young men. *J Appl Physiol.* 1994; 77 (4): 1829-33.
17. World Health Organization. Obesity: preventing and managing the global epidemic – Report of a WHO consultation on obesity. Geneva; 2000.
18. Oldridge N, Gottlieb M, Guyatt G, Jones N, Streiner D, Feeny D. Predictors of health-related quality of life with cardiac rehabilitation after acute myocardial infarction. *J Cardiopulm Rehabil.* 1998; 18 (2): 95-103.
19. Benetti M, Nahas MV, Barros MVG. Reproducibility and validity of a brazilian version of the MacNew quality of life after myocardial infarction (MacNew QLM) questionnaire. *Med Sci Sports Exerc.* 2001; 33: 62.
20. Sociedade Brasileira de Cardiologia. IV Diretriz brasileira sobre dislipidemias e prevenção da aterosclerose. *Arq Bras Cardiol.* 2007; 88 (supl. I): 1-18.
21. Paffenbarger RS Jr. Contributions of epidemiology to exercise science and cardiovascular health *Med Sci Sports Exerc.* 1988; 20 (5): 426-38.
22. Blair SN, Kampert JB, Kohl HW 3rd, Barlow CE, Macera CA, Paffenbarger RS Jr, et al. Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *JAMA.* 1996; 276 (3): 205-10.
23. Harris SS, Caspersen CJ, DeFries GH, Estes EH Jr. Physical activity counseling for healthy adults as a primary preventive intervention in the clinical setting. report for the us preventive services task force. *JAMA.* 1989; 261 (24): 3588-98.
24. Hagberg JM. Physiologic adaptations to prolonged high-intensity exercise training in patients with coronary artery disease. *Med Sci Sports Exerc.* 1991; 23 (6): 661-7.
25. Hambrecht R, Wolf A, Gielen S, Linke A, Hofer J, Erbs S, et al. Effect of exercise on coronary endothelial function in patients with coronary artery disease. *N Engl J Med.* 2000; 342 (7): 454-60.
26. Helgerud J, Hoydal K, Wang E, Karlsen T, Berg P, Byerjaas M, et al. Aerobic high-intensity intervals improve $\dot{V}O_{2\max}$ more than moderate training. *Med Sci Sports Exerc.* 2007; 39 (4): 665-71.
27. Belardinelli RA, Georgiou D, Ginzton L, Clanci G, Purcaro A. Effects of moderate exercise training on thallium uptake and contractile response to low-dose dobutamine of dysfunctional myocardium in patients with ischemic cardiomyopathy. *Circulation.* 1998; 97 (6): 553-61.
28. Schuler G, Hambrecht R, Schlierf G, Niebauer J, Hauer K, Neumann J, et al. Regular physical exercise and low-fat diet: effects on progression of coronary artery disease. *Circulation.* 1992; 86 (1): 1-11.
29. Kavanagh T, Hamm L, Beyene J, Mertens DJ, Kennedy I, Campbell R, et al. Usefulness of improvement in walking distance versus peak oxygen uptake in predicting prognosis after myocardial infarction and/or coronary artery bypass grafting in men. *Am J Cardiol.* 2008; 101 (10): 1423-7.
30. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. *Social Sci Med.* 1995; 41 (10): 1403-9.
31. Cade NV. Terapia de grupo para pacientes com hipertensão arterial. *Rev Psiq Clin.* 2001; 28: 300-4.
32. Oldridge, NB, Guyatt G, Jones N, Crowe J, Singer J, Feeny D, et al. Effects on quality of life with comprehensive rehabilitation after acute myocardial infarction. *Am J Cardiol.* 1991; 67 (13): 1084-9.
33. Marchionni N, Fattiroli F, Fumagalli S, Oldridge N, Del Lungo F, Morosi L, et al. Improved exercise tolerance and quality of life with cardiac rehabilitation of older patients after myocardial infarction. *Circulation.* 2003; 107 (17): 2201-06.
34. Cavalcante MA, Bombig MT, Luna Filho B, Carvalho AC, Paola AA, Povoá R. Qualidade de vida de pacientes hipertensos em tratamento ambulatorial. *Arq Bras Cardiol.* 2007; 89 (4): 245-50.