Clinical and Economic Outcome of a Cardiopulmonary and Metabolic Rehabilitation Program

Fabiana Pereira Vecchio Rebelo, Aline dos Santos Garcia, Dalton Francisco de Andrade, Cláudio Ribeiro Werner, Tales de Carvalho

Universidade do Estado de Santa Catarina – UDESC - Florianópolis, SC - Brazil

Summary

Objective: **To evaluate the clinical and economic outcome of a Cardiopulmonary and Metabolic Rehabilitation Program (CPMR) created by an HMO.**

Methods: **The sample was comprised of 96 clients, divided into two groups of 48 individuals (treatment group – TG, individuals who participated in the CPMR program, and control group – CG, individuals who did not participate in the program) of both genders, with age ranging between 54 and 79 years. Training time of the TG was 22 (±3) months. To assess the clinical outcome before and after CPMR, exercise tolerance, plasma lipoprotein profile (TC, LDL-C, HDL-C, TC/HDL-C and triglycerides), resting blood pressure (BP), and body composition (Body mass index – BMI and Waist-to-hip ratio – W/HR) were determined.**

Results: **The TG presented the following results in the pre and post CPMR assessment, respectively: TC (mg/dL) 242,5 (±48,32) and 189.47(±39.83); LDL–C (mg/dL) 162(±37.72) and 116,3(±33,28); HDL-C (mg/dL) 46,5(±8,59) and 57.8(±10.36); Tg (mg/dL) 165.15(±90.24) and 113.29(±54,92); TC/HDL-C 5.42 (±1.10) and 3.35 (±0.81); VO2 peak (mL/Kg/min) 26.92 ± 7 and 32.64 ± 5.92; BMI 29.35 (±3.93) and 28.12 (±3.55) for women and 29.17 (±5.14) and 27.88 (±4.83) for men; W/HR 0.93(±0.05) and 0.94(±0.04) for women and 0.93(±0.07) and 0.92(±0.06) for men; BP (mmHg) 151(±13.89) and 132(±9.56); DBP (mmHg) 83(±8.07) and 77(±5.92); monthly expenses CG (R$) 8,840.05 (±5,656.58) and 8,978.32 (±5,500.78); monthly expenses TG (R$) 2,016.98 (±2,861.69) and 1,470.73 (±1,333.25).**

Conclusions: **In the group undergoing the CPMR Program, favorable clinical changes were observed in relation to the plasma lipoprotein profile, blood pressure, and exercise tolerance, with no relation to changes in medications.**

Key words: **Breathing exercises; rehabilitation; treatment outcome; exercise; cardiovascular diseases; metabolic disease; health programmes and projects.**

Introduction

It is estimated that cardiovascular diseases will account for more than 20 million deaths/year by the year 2020; in 2030, the number of deaths will be over 24 million/year[1]. Among cardiovascular diseases, ischemic heart disease is considered the most frequent in some of the most highly populated States and large cities in Brazil[2]. Cardiovascular diseases account for approximately 500,000 deaths in Brazil every year, and are among the major causes of expenses with medical assistance[3].

The influence of lifestyle on the development and progression of heart diseases is undeniable. Cardiopulmonary and Metabolic Rehabilitation is characterized by being a multidisciplinary treatment process to develop and maintain the levels of physical, social and psychological activities after the onset of multifactorial diseases. Formal Cardiac Rehabilitation programs effectively improve functional capacity, quality of life and symptoms related to ischemia; reduce stress, cardiovascular mortality, and the risk of subsequent coronary events;, and promote reversion of atherosclerosis[3].

Back in 1993, the World Health Organization (WHO) already recommended that all individuals with cardiovascular diseases, not only those with coronary artery diseases and hypertension, but also those with chronic rheumatic heart disease, congenital cardiac defects, heart failure of different etiologies, and others, should be necessarily referred to Rehabilitation programs to be considered satisfactorily treated. These programs could and should also be implemented in places far from the major centers, which lack human resources and materials[4]. This means that a treatment based only on drugs is considered incomplete, as frequently occurs with high blood pressure (HBP) and coronary artery diseases (CAD), for which the causal factors, notably the sedentary lifestyle, are not removed[5]. Unfortunately, the utilization of structured rehabilitation programs has been seldom considered mandatory for a clinical treatment to be deemed complete. This may be verified by the lack of such programs worldwide, especially in undeveloped and developing countries such as Brazil, where, consequently, studies reporting experiences with CPMR are rare[5,6].

As one of the leading causes of death and physical, social, psychological and work disability, cardiovascular diseases have

Mailing address: Fabiana Pereira Vecchio Rebelo •
Av. Trompowsky, 181/201
88015-300 – Florianópolis, SC - Brazil
E-mail: fabirebelo@newsite.com.br
Manuscript received February 08, 2006; revised manuscript received August 15, 2006; accepted August 17, 2006

demanded the allocation of substantial financial resources which, almost always, are not sufficient to meet the global needs for the performance of complete diagnostic laboratory tests and of some therapeutic procedures, whether invasive or not[7]. In the United States, the expenses with cardiovascular diseases are estimated at more than US$ 128 billion/year, mainly on account of myocardial revascularization procedures. Heart failure affects more than two million Americans, and approximately 400,000 new cases are diagnosed each year, representing a direct cost of more than US$ 10 billion dollars a year. Approximately 75% of this cost corresponds to hospitalizations[8].

It is necessary to recognize that money resources for health are limited, both in the public and private systems. Additionally, providing the optimal treatment for a certain disease does not necessarily mean using more financial and technological resources. Cost analysis should relate financial expense of the medical care to the effect observed on health, such as improvement in life expectancy and reduction in mortality. Cost-effectiveness ratio is one of the three methods for comparison of treatments[9]. In Cardiology, the assessment in terms of cost-effectiveness has been used to compare different therapeutic modalities, considering the cost necessary to save one life in one year. Investments lower than US$ 20,000 that save one life per year are considered optimal situations in terms of cost-effectiveness. Investments between US$ 20,000 and US$ 40,000 are considered acceptable for usual interventions. When the investment to save only one life per year is above US$ 40,000, the therapeutic modality is considered unacceptable in terms of cost-effectiveness[10]. Throughout the years, Cardiovascular Rehabilitation has demonstrated beneficial changes in risk factors and reductions in cardiovascular morbidity and mortality in a setting considered excellent in terms of therapeutic cost-effectiveness of CAD and Heart Failure (HF). The Rehabilitation Program in HF, in addition to promoting a reduction in the rate of rehospitalization because of decompensation (three-fold lower), is also able to increase life expectancy by approximately two years[9]. The cost-effectiveness of rehabilitation in the treatment of coronary patients is only higher than that of the strategies to reduce cholesterol and of smoking cessation programs, aspects which are, in fact, part of a structured Cardiac Rehabilitation program[11]. The excellent cost-effectiveness ratio of Cardiovascular Rehabilitation programs renders the insignificant number of these programs in Brazil illogical, particularly in the public network. Even in the United States the rate of patients in Cardiac Rehabilitation is small, reaching less than 60% of phase 1 post-MI patients. Elderly people and women are referred in even lower proportions. The economic impact of this modality has not been studied in the programs implemented in Brazil, where this type of information is unavailable[7,9]. Based on these aspects, we sought to study the economic impact of the Cardiopulmonary and Metabolic Rehabilitation Program, in addition to the clinical benefit provided by this intervention.

Methods

This is a retrospective investigation conducted by means of two types of study: 1) Case-series study (to assess the clinical outcome), and 2) Case-control study (to assess the economic outcome)[12].

Characteristics of the population studied - The study sample consisted of 96 individuals enrolled in the health plan of the Unimed Litoral de Itajaí Health Maintenance Organization, divided into two groups (control and treatment). Both groups were formed by 48 subjects, of which 27 were males (56.25%) and 21 were females (43.75%). The clinical characteristics of the population studied are shown in Tables 1 and 2.

Inclusion criteria - The sample was purposefully included in the study for presenting the following criteria: a) Having been referred to the Program by medical and/or economic indication (having placed heavy burdens on the HMO); b) being previously sedentary; c) having participated in the program for at least 18 months, with 75% of attendance to the exercise sessions, and d) presenting all data necessary for the study properly recorded in reports and medical charts. Based on the characteristics of the treatment group (TG), 48 individuals were selected in a retrospective survey of medical and economic charts. Matching criteria wereage, gender, profession and diagnosis. All individuals selected for the control group (CG) presented the characteristics necessary for inclusion in the Unisaúde Program (medical and/or economic indication). However, they did not participate in the program.

Program characteristics - The Unisaúde Cardiopulmonary and Metabolic Rehabilitation Program, from which the patients of this study were selected, is aimed at assisting individuals who are in the second, third or fourth phase of the Rehabilitation process. The mean time of attendance to the program of TG participants was 22 (±3) months.

This program consists of the practice of supervised physical exercises, with a frequency of five times a week, and duration of 60 minutes. Three times a week, the individuals performed 45 minutes of aerobic exercises in a cycle ergometer, treadmill, or outdoor walking on a track, at 70-80% of the maximum heart rate (reached in exercise test under usual medication), followed by 15 minutes of stretching and relaxation exercises. In the other two days of the week, the individuals performed aerobic exercises for 30 minutes, and resistance exercises for 30 minutes (muscle resistance), followed by stretching and relaxation. Resistance exercises are performed for the main muscle groups with the help of dumbbells and ankle weights. Two series of 20 repetitions are performed for each muscle group. Patient monitoring and control of exercise intensity is made by measuring blood pressure and heart rate before, during and after the exercises. Additionally, the Borg's rating of perceived exertion is also used, and levels between 11 and 13 are considered optimal. Before start of these procedures, all patients are evaluated by the physician responsible for the program. They perform an exercise test (under usual medication), and their anthropometric measurements are taken (weight, height, waist and hip circumference). After three months, on average, they are reassessed and a new exercise prescription is made. Patients are also given additional orientation on quality of life, stress control techniques, healthy food, and others, by means of lectures monthly delivered by a multidisciplinary team.

Measurement instruments - 1) systematic non-participant observation: The events observed were documented in a

Table 1 - Descriptive clinical characteristic of the sample studied (control group – CG, and treatment group – TG) according to age

Age	N	Minimum	Median	Maximum	Mean	Standard deviation
TG	48	53.00	66.00	78.00	65.65	6.46
CG	48	53.00	67.00	78.00	65.73	6.54

Table 2 - Descriptive clinical characteristics of the treatment (TG) and control (CG) groups as regards gender, profession and diagnosis

	TG		CG	
Variables	n	%	n	%
Males	27	56.25	27	56.25
Females	21	43.75	21	43.75
Retirement	30	62.5	30	62.5
Coronary artery disease (CAD)	21	43.75	21	43.75
Myocardial infarction (MI)	1	2.08	1	2.08
Myocardial revascularization (MR)	1	2.08	2	4.16
Coronary angioplasty (TCA)	1	2.08	0	0
High blood pressure (HBP)	27	56.25	29	60.41
Diabetes mellitus (DM)	9	18.75	7	14.58
Obesity	16	33.33	16	33.33
Dyslipidemia	34	70.83	34	70.83

field diary where data regarding the program characteristics were recorded (physical structure, methodology applied, professionals involved), and others; and 2) document analysis: medical reports, medical charts, administrative and economic reports, and additional information deemed important by the authors were analyzed. These data were noted in an individual data collection chart. The variables present in the document analysis were obtained by consulting data collection protocols adopted by the Unisaúde Program.

Exercise tolerance - Peak oxygen consumption ($VO_{2\ peak}$) was measured indirectly, using a maximum treadmill exercise test, according to the Bruce Protocol[13], which proposes progressive increases of speed and incline at every 3-minute stage. In the initial stage, the incline is 10% and the speed is 2.732 km/h. At each stage a load corresponding to 1.367 km/h and 2% incline is added, until the maximal exertion is reached. The equation used to estimate the $VO_{2\ peak}$ for men was: VO_2 = (2.9 x time in minutes) + 8.33; and for women: VO_2 = (2.74 x time in minutes) +8.03 [13]. The result is expressed in ml.kg^1.min^1.

CAD risk factors - Biochemical tests: Total cholesterol, LDL-cholesterol, HDL-cholesterol, total cholesterol/HDL ratio, and triglyceride tests were performed using enzyme colorimetric assay. Recommendations for collection procedure were previously explained to the subjects and duly followed (laboratory recommendations).

Blood pressure - Blood pressure data were collected using the auscultation method, with a mercury column sphygmomanometer and defining Korotkoff phases I and VI. Resting blood pressure was measured prior to the performance of the pre and post-intervention exercise test.

Body composition - Body composition data were obtained using the body mass index (BMI) and fat ratio between waist and hip perimeters (WHR).

BMI - The first step to obtain the BMI was the measurement of body mass (in Kg), and then height (in meters). BMI was calculated using the equation: body (Kg) / height^2 (m). This assessment was made by Physical Education teachers responsible for physical exercise sessions of the Unisaúde program, and the instruments used were a scale with a precision of 100g (duly calibrated by INMETRO) and a stadiometer with a resolution of 1mm.

WHR - This ratio was obtained by measuring the waist (abdominal) circumference in centimeters right below the navel, and the hip circumference at the larger diameter of the gluteus region[14]. These measurements were also taken by physical education teachers responsible for the physical exercise sessions of the Unisaúde program, and the instrument used was a flexible metal tape (non stretchable), with a precision of 1 mm.

Economic analysis - This analysis was performed by observing the monthly expenses spreadsheet that UNIMED Litoral Health Maintenance Organization obtained from the subjects of the study. These expenses included medical visits, hospitalizations, procedures and tests performed during the pre and post-implantation periods of the Unisaúde program. We should point out that values concerning additional expenses of the Program (purchase and maintenance of exercise equipment, professionals and trainees' wages, cleaning, water, energy, telephone, security, management fees, and others) were added to the calculation of Unisaúde program post-implantation expenses in the treatment group (TG). These expenses were also obtained using expense spreadsheets from the financial department.

The statistical analysis consisted of a descriptive part[15] and of an inferential part. The paired t test and t test were performed. All tests were performed at a significance level of 0.05 (α=5%).

Results

Use of medication - Only six (12.5%) of the TG patients were under treatment with hypoglycemic agents; one (2.08%) of them used insulin and the others (10.4%) used oral hypoglycemic agents. Medication remained unchanged in the pre and post-program implementation periods. The use of lipid lowering agents was observed in 11 (22.9%) individuals; in two (4.1%) of them the use was restricted to the pre-Unisaúde program phase. Antihypertensive medication used by 9 (18.75%) individuals also remained unchanged in both periods. Twelve (25%) individuals used betablockers and only one (2.08%) of them discontinued the medication in the post-intervention period. We can say, therefore, that medication changes in the treatment group were not significant (Table 3).

Clinical variables - For each patient participating in the CPMR program (Unisaúde), that is, the treatment group (TG), two measurements were taken – one pre and one post-implementation of the Unisaúde program. Of note, no changes in the medication used by the participants of TG were observed in the period before and after the assessments. Since no medical charts or reports containing information from the control group (which did not participate in the Unisaúde program) were available, these data could not be presented for this group.

Most of the clinical variables studied (BMI, TC/HDL, TRIG, GLY, $VO_{2\ peak}$, DBP and SBP) showed significant changes ($p<0.05$), when the pre and post-intervention periods were compared, as shown in Table 4. Only the W/HR variable presented a significant difference solely in the male group.

Expense variable - In each group of 48 patients (TC and CG), two measurements were also taken – one during the pre-implantation period of the CPMR program and the other during the post-implantation period. Measurements taken in the patients, which will be used in the comparison, are shown in the following chart (Chart 1),

The differences between the pre and post-implementation periods were analyzed in the treatment and control groups. Difference variables are preceded by the Greek letter Δ (delta). In the calculation of the Expense Post variable, R$ 270.00/per year were added for each patient of the treatment group, regarding additional expenses previously explained in measurement instruments.

The descriptive statistics of the expenses of patients of the control and treatment groups in the pre and post CPMR program periods, as well as the expense variation (Δ) are shown in Table 5.

Estimates of means and standard errors presented in this part of the study were obtained by applying statistical models. Results of the t test performed in the difference variables described to verify the occurrence of statistically significant differences between the two groups are shown in Table 6. Given that the relation between the standard deviations of the difference variables of the expenses between the groups was higher than 4 (Table 5), the estimates of variances were determined separately for each group in the t test. The test was performed at a significance level of 0.05 (α=5%).

No statistically significant difference was verified between the mean differences of expenses in the pre and post- CPMR program implantation period for the treatment and control groups, with p=0.2048 and p=0.1302, respectively.

No statistically significant difference (p=0.1211) was observed between the mean differences of expenses in the two periods (pre and post CPMR) between the treatment (TG) and control (CG) groups, as shown in Table 7. Although no significant difference occurred between the expenses of TG and CG, we can observe a decrease in the expenses in TG (negative variation of 548.25), and an increase of these expenses in CG (positive variation of 138.27).

Discussion

In relation to the clinical outcomes pre and post-assessment, a significant difference was observed in the majority of the variables studied (TC, HDL-C, TC/HDL, TG, BMI, $VO_{2\ peak}$, DBP and SBP), in both genders, except in the waist-to-hip ratio (W/HR), for which a significant difference was found only in the male group, in relation to the initial assessment.

Table 3 - Use of medication by participants in the treatment group – TG (n=48) in the pre and post-Cardiopulmonary and Metabolic Rehabilitation Program (CPMR) period

	PRE		POST	
Medication used	n	%	n	%
Oral hypoglycemic agent	5	10.4	5	10.4
Insulin	1	2.08	1	2.08
Hypolipemic agent	11	22.9	9	18.75
Antihypertensive agent	9	18.75	9	18.75
Beta-blocker	12	25	11	22 .9

According to the III Guideline on Prevention of Atherosclerosis of the Department of Atherosclerosis of the Brazilian Society of Cardiology[16], the mean values obtained for the TC, LDL-C, and triglyceride variables (242.5 mg/dL ±48.32; 162mg/dL ±37.72; 46.5 mg/dL ±8.59 and 165.15 ±90.24 mg/dL, respectively) in the first assessment performed, classified the sample in the categories of high TC and LDL-C, low HDL-C, and borderline TG; the value of the TC/HDL-C ratio was 5.42 (±1.10), considered a high risk[17]. These values demonstrate that the lipid profile of individuals in the pre-Unisaúde program period was not favorable. Data from the second assessment demonstrated values (mean in mg/dL) of 189.47 (±39.83); 116.3(±33.28); 57.8(±10.36) and 113.29 (±54.92), respectively, and TC/HDL-C 3.35 (±0.81), thus classifying the TC and TG as optimal, HDL-C as high, LDL-C

Table 4 - Mean clinical variables (lipoprotein profile, oxygen consumption, systolic and diastolic blood pressure, body mass index, wait-to-hip ratio, and waist circumference) of patients in the treatment group – TG (n=48) in the pre and post-CPMR implantation period

	PRE		POST		
Variable	Mean	SD	Mean	SD	P
TC	242.5	±48.32	189.47	±39.83	< 0.001
LDL-C	162	±37.72	116.3	±33.28	< 0.001
HDL-C	46.5	±8.59	57.8	±10.36	< 0.001
TC/HDL	5.42	±1.10	3.35	±0.81	< 0.001
TRIG	165.15	±90.24	113.29	±54.91	< 0.001
$VO_{2\ peak}$	26.92	±7.00	32.64	±5.92	< 0.001
SBP	151.15	±13.89	132.71	±9.56	< 0.001
DBP	83.44	±8.07	77.60	±5.92	< 0.001
BMI male	29.17	±5.14	27.88	±4.83	< 0.001
BMI female	29.35	±3.93	28.12	±3.55	< 0.001
W/HR male	0.93	±0.05	0.92	±0.06	0.0337
W/HR female	0.93	±0.05	0.940	±0.04	0.3944
WC male	94.85	±8.41	91.48	±7.77	< 0.001
WC female	91.9	±9.23	89.48	±8.56	< 0.001

Chart 1 - Measurements taken in mean annual expenses of the control group (CG) and treatment group (TG) in the pre and post-CPMR implantation periods

Measurement	Description
Pre expense CG	mean annual expenses from 01/01/98 to 10/01/99 in the control group (CG)
Post expense CG	mean annual expenses from 01/01/03 to 10/01/04 in the control group (CG)
Pre expense TG	mean annual expenses from the beginning of the plan up to the inclusion in the CPMR in the treatment group (TG)
Post expense TG	mean annual expenses from the beginning of the CPMR up to 11/30/04 in the treatment group (TG)

Table 5 - Descriptive statistics of the expenses in the control group – CG (n=48) and in the treatment group – TG (n=48)

Variable	Minimum	Median	Maximum	Mean	Standard Deviation
Pre exp CG	2,577.66	6,987.96	24,987.09	8,840.05	5,656.58
Post exp CG	2,604.69	7,119.91	24,704.62	8,978.32	5,500.78
Δ Exp CG	-1,956.89	131.98	2,029.41	138.27	621.98
Pre exp TG	66.91	1,076.43	16,158.09	2,016.98	2,861.69
Post exp TG	301.22	1,162.60	7,567.06	1,470.73	1,333.25
Δ Exp TG	-15,698.55	197.66	5,719.90	-546.25	2,943.39

as desirable, and TC/HDL-C as low risk. It is important to note that no relevant change occurred in the use of medication during the period between the first and second assessments; thus, there was no medication influence in the comparison of the results obtained. These results corroborated those of other studies found in the literature, in which beneficial changes were also observed in the lipid profile of individuals with CAD or risk factors for CAD, undergoing CPMR with performance of physical exercises[18,19,20].

The increase in functional capacity may be demonstrated by the increase in maximum oxygen consumption ($VO_{2\ peak}$). After physical training, the $VO_{2\ peak}$ in relation to body weight (mL/Kg/min) may increase, and increases of 4 to 93% have been reported, with the majority of the authors reporting variations from 10 to 40%[21]. According to the variation in the mean results of $VO_{2\ peak}$ (in mL/Kg/min) obtained indirectly according to the performance in exercise tests (performed with Bruce protocol) of the present study (26.92 ± 7, in the

Table 6 - Results of paired t tests performed for the expense variation in the treatment group – TG and in the control group – CG between the pre and post-CPMR periods

Difference	Mean	Standard Deviation	t	P
Δ Exp TG	-546.30	424.84	-1.29	0.2048
Δ Exp CG	138.27	89.78	1.54	0.1302

Table 7 - Result of the t test performed between the mean expense variations between the pre and post CPMR period in the control group – CG and treatment group - TG

Comparison	Mean TG	Mean CG	t	P
Δ Expenses TG x Δ Expenses CG	-546.25	138.27	-1.576	0.1211

pre-program period, and 32.64 ± 5.92 in the post-program), we can verify an increase by 17.5% in the values. Hambrecht et al (2004)[22] also verified an improvement by 16% in the $VO_{2\,peak}$ of the group undergoing 12 months of physical training. The increase in the capacity of physical work results in the use of a lower percentage of oxygen consumption during daily activities, with subsequent reduction in the intensity of symptoms such as dyspnea, tiredness, and perceived exertion[23-25]. This is very important for the improvement of quality of life of patients, especially those more limited, such as those with angina or heart failure.

There is a correlation between the increase in body mass and the risk of cardiovascular diseases. Excess weight would predispose to these diseases due to lipid and glucose metabolism and blood pressure abnormalities. To assess body composition in the present study, the Body Mass Index (BMI) was used. Although this index takes only weight and height into consideration and gives a similar classification to weightlifters and obese individuals, it has been widely used in clinical studies relating obesity to CAD risk[26]. The values of BMI obtained in the pre and post-program assessments were 29.35 (±3.93) and 28.12 (±3.55) for women and 29.17 (±5.14) and 27.88 (±4.83) for men, respectively. These changes were significant for both genders, although no nutritional control had been made during CPMR; only speeches on healthy life habits were delivered by a multidisciplinary team (including a nutritionist). According to the current literature, controversy still exists on the occurrence of a threshold value of BMI from which an increase in total mortality would be verified[24]. However, in a meta-analysis of 600 thousand people followed up for 15-30 years, mortality from all causes was lower in BMI ranges of 23-28 Kg/m^2 [27]. According to the United States National Heart, Lung and Blood Institute's recommendations[26,28], all adult individuals with a BMI higher than 25 Kg/m^2 are at a higher risk. Following this classification, the sample would continue at a higher risk even after the intervention. However, when the classification of obesity (BMI>30 Kg/m^2) is considered, we can verify that the mean values of the sample studied are lower. In addition to BMI, the W/HR was also assessed. Data obtained did not demonstrate significant changes in this variable (change from 0.93±0.06 to 0.93±0.05), except for males, among whom the change was from 0.93(±0.05) to 0.92(±0.06). Although the data collected referred to W/HR (obtained from the medical charts), the recent literature recommends only the abdominal circumference to differentiate the two distinct types of obesity (android and gynecoid)[29]. From this comparison, abdominal circumference values > 94 in men, and > 80 in women are identified as risk markers, and values higher than 102 in men and 88 in women identify a high risk of development of HBP, dyslipidemia, DM and CAD[30,31]. In the present study, the values of abdominal circumference decreased from 94.85 (±8.41) cm to 91.48 (±7.77) cm in men (decreased risk classification) and from 91.9 (±9.23) cm to 89.48 (±8.56) cm in women (maintenance of classification of risk for the development of the diseases previously mentioned).

High blood pressure (HBP), whether systolic or diastolic, increasing at rest or on exertion, in any age or gender, is a factor which strongly contributes to the development of CAD. Hypertensive individuals develop cardiovascular diseases in a proportion three times higher than normotensive individuals. In terms of absolute risk, CAD is the most frequent sequela of HBP and contributes to the development of each clinical manifestation of coronary artery disease, including MI, sudden death, and angina pectoris[21,32]. Mean values of blood pressure of the subjects in this study were 151(±13.89)/83(±8.07) mmHg in the pre-Unisaúde period and 132(±9.56)/77(±5.92) mmHg in the post-Unisaúde period. According to the IV Brazilian Guidelines on Hypertension[33], the individuals moved from the classification of isolated systolic hypertension to normal blood pressure. As previously mentioned, no relevant changes in anti-hypertensive medication occurred between the two periods, thus suggesting that the decrease in the values of blood pressure (BP) resulted from the hypotensive effect of physical exercises. Similar results, with decrease in blood pressure after CPMR, were also found by other authors, such as Paffenbeger et al[34], Negrão et al[35], Cortez[36], and Rebelo et al[37]. However, for BP values to remain normal, it is necessary that the individuals keep continuously engaged in physical conditioning programs. In the case of training discontinuation or irregular practice, pressure levels fail to be regularly controlled[36].

Regarding economic aspects, pre and post-Unisaúde monthly expenses were, respectively: control group (R$) 8,840.05 (±5,656.58) and 8,978.32 (±5,500.78); treatment group (R$) 2,016.98 (±2,861.69) and 1,470.73 (±1,333.25). Although a tendency of reduction in expenses (-546.39) was observed in the treatment group (TG), and of increase (138.27) in the control group (CG), the differences between expenses in the pre and post program periods were not statistically significant ($p<0.05$) because of the high variability in expenses (high standard deviation), which ranged from -15,698.55 to +5,719.90 in the TG, and from -1,956.89 to +2,029.41 in the CG. This means that, while an individual in the TG failed to spend R$ 15,698.55, on average, another individual added R$ 5,719.90 to his monthly expenses. In the CG, in turn, just like an individual failed to spend R$ 1,956.89 monthly, another individual increased his monthy expenses by R$ 2,028.41. Probably, for this difference to be considered significant, a greater number of participants (greater n) would be necessary for the study. The same comment can be made in the comparison between the mean differences of expenses in the two periods between the two groups, where there occurred a tendency of decrease in expenses in the TG, and of increase in the CG. This means that, the expenses decreased with Unisaúde implantation, and they increased without the Unisaúde program. This makes us believe that without the Unisaúde, the expenses in the TG would also have increased. The fact that the mean age of participants was 65,65 (±6,46) years contributed to this hypothesis of increase in the expenses without the Unisaúde, since, according to statistical analyses performed by UNIMED, visits to physicians, as well as the performance of tests and procedures, tend to increase at this age. The difference between pre and post-Unisaúde expenses was not significant, also because of the great variability of the data found. Once again, we believe that a sample with a greater number of individuals would probably demonstrate this difference statistically. Data from the literature report that CPMR is effective from an economic standpoint, and could reduce health system costs, particularly when patients maintain the levels of exercise prescribed in the long term[20]. Studies conducted by Olridge et al[38], Ades, Pashkow, Nestor[39]; Lowensteiyn et al[40], Jeffrey, Probstfield[41], and Hambrecht, et al[22] established a favorable cost-effectiveness relation to the application of physical exercises in the primary and secondary prevention of CAD, mainly when there is adequate compliance to the program.

Considering the study limitations previously exposed, further studies with the same objectives are necessary for a proper assessment of the economic aspects of CPMR in Brazil.

Conclusions

In the group undergoing a Cardiopulmonary and Metabolic Rehabilitation program, favorable clinical changes were observed in relation to plasma lipoprotein profile, systemic blood pressure, and tolerance to exercise, with no relation with changes in medications.

A reduction in the expenses of the HMO was observed only in the group that participated in the rehabilitation program, since the expenses increased in the control group.

References

1. Mackay J, Mensah G. Atlas of heart disease and stroke, Geneva: WHO; 2004.
2. Lotufo, PA Premature mortality from heart diseases in Brazil: a comparison with other countries Arq Bras Cardiol. 1998; 70 (5): 321-5.
3. Lessa I. Medical care and death due to coronary artery disease in Brazil, 1980-1999. Arq Bras Cardiol. 2003; 81 (4): 329-35.
4. World Health Organization. Rehabilitation after cardiovascular diseases, with special emphasis on developing countries. Geneva: WHO; 1993. (Report of a WHO Expert Committee).
5. Carvalho T. Reabilitação cardíaca em portadores de cardiopatia isquêmica com obstruções coronárias possíveis de tratamento intervencionista. [tese de doutorado] São Paulo: Faculdade de Medicina da Universidade de São Paulo; 2001.
6. Carvalho T, Mansur AJ, Hallal AL, De Bonna E. Cardiac rehabilitation of ischemic cardiopathy patients with indication for invasive treatment of coronary obstructions. J Am Coll Cardiol. 2002; 39 (9 Suppl): 206.
7. Serra S. Excelência na relação custo-efetividade: razão para indicação da reabilitação cardíaca. Jornal do Departamento de Ergometria e Reabilitação Cardíaca. 2003; 27: 14-5.
8. Pamley WW. Cost-effective management of heart failure. Clin Cardiol. 1996; 19: 240-2.
9. Moreira PBB. Custo-efetividade de programas de reabilitação cardiovascular. Jornal do Departamento de Ergometria e Reabilitação Cardíaca. 2004; 27: 14-6.
10. Georgiou D, Chen Y, Appadoo S, Belardinelli R, Greene R, Parides MK, et al. Cost-effectiveness analysis at long-term moderate exercise training in chronic heart failure. Am J Cardiol. 2001; 87: 984-8.
11. Jolliffe JA, Rees K, Taylor RS, Thompson D, Oldridge N, Ebrahim S. Exercise-based rehabilitation for coronary heart disease. Cochrane Database Syst Rev. 2001; 1: CD001800.
12. Avezum A. Tratamento das doenças cardiovasculares baseado em evidências. In: Porto, CC. Doenças do coração: prevenção e tratamento. Rio de Janeiro: Guanabara Koogan; 2005.
13. II Diretrizes da Sociedade Brasileira de Cardiologia sobre teste ergométrico. Arq Bras Cardiol. 2002; 78 (supl. 2): 1-17.
14. Fernandes Fº J. A prática da avaliação física: testes, medidas e avaliação física em escolares, atletas e academias de ginástica. 2a ed. Rio de Janeiro: Shape; 2003.
15. Bussab WO, Moretin PA. Estatística básica. 5a ed. São Paulo: Saraiva; 2002.
16. III Diretrizes da Sociedade Brasileira de Cardiologia sobre Dislipidemias e Diretriz de Prevenção da Aterosclerose do Departamento de Aterosclerose da Sociedade Brasileira de Cardiologia. Arq Bras Cardiol. 2001; 77 (supl. 3): 1-48.
17. Pollock M, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, et al. Resistance exercise in individuals with and without cardiovascular disease. Circulation. 2000; 101: 828-30.
18. Serra S, Loos L. Programa de reabilitação cardíaca aplicado a pacientes com doença coronária crônica. Rev SOCERJ. 1993; 6: 120-5.
19. Grover AS, Paquet S, Levinton C, Coupal, L, Zowall H. Estimatting the benefits of modifying cardiovascular risk factors: a comparison a primary versus secondary prevention. Arch Intern Med. 1998; 158: 655-62.
20. Brown A, Taylor R, Noorani H, Stone J, Skidmore B. Exercise-based cardiac rehabilitation programs for coronary artery disease: a systematic clinical and economic review. Otawa: Canadian Coordinating Office for Health Technology Assessment (CCOHTA); 2003.
21. Duarte GM, Alfieri RG. Exercício e coração. 2a ed. São Paulo: Cultura Médica; 1993.
22. Hambrecht R, Walther C, Mobius-Winkler S, Gielen S, Linke A, Conradi K, et al. Percutaneous coronary angioplasty compared with exercise training in patients with stable coronary artery disease: a randomized trial. Circulation.

2004; 109: 1371-8.

23. Squires RW, Gau GT, Miller TD, Allison TG, Lavie CJ. Cardiovascular rehabilitation: status 1990. Mayo Clin Proc. 1990; 65: 731-55.

24. Miller NH, Haskell WL, Berra K, DeBrusk RF. Home versus group exercise training for increasing functional capacity after myocardial infarction. Circulation. 1984; 70: 645-9.

25. Bjarnason-Wehrens B, Predel HG, Graf C, Gunther D, Rost R. Improvement of physical performance and aerobic capacity mediated by a novel 4-week ambulatory cardiac rehabilitation program. Z Cardiol. 1999; 88: 113-22.

26. Diretrizes para Cardiologistas sobre Excesso de Peso e Doença Cardiovascular dos Departamentos de Aterosclerose, Cardiologia Clínica e Funcor da Sociedade Brasileira de Cardiologia. Arq Bras Cardiol. 2002; 78 (supl 1): 1-13.

27. Troiano RP, Frongillo EA Jr, Sobal J, Levitsky DA. The relationship between body weight and mortality: a quantitative analysis of combined information from existing studies. Int J Obes Metabol Dis. 1996; 20: 63-75.

28. Associação Brasileira de Estudos sobre Obesidade e Síndrome metabólica. Documento sobre 1º Consenso Latino Americano de Obesidade. Rio de Janeiro; 1998 (on line). Citado em 2004 abril 15. Disponível em: http://www.abeso.org.br/pdf/consenso.pdf.

29. Arner P. Not all fat is alike. Lancet. 1998; 351: 1301-2.

30. Bouchard C, Bray GA, Hubbard VS. Basic and clinical aspects of regional fat distribution. Am J Clin Nutr. 1990; 52: 946-50.

31. Han TS, van Leer EM, Seidell JC, Lean ME. Waist circunference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. BMJ. 1995; 311 (7017): 1401-5.

32. Astrand P. Physical activity and fitness. Am J Clin Nutr. 1992; 55: 1231-6.

33. IV Diretrizes Brasileiras de Hipertensão Arterial. Arq Bras Cardiol. 2004; 82 (supl 4): 1-14.

34. Paffenbarger Jr RS, Hyde RT, Wing AL, Lee IM, Jung DL, Kampert JB. The association of changes in physical activity level and othes lifestyle characteristics with mortality among men. N Engl J Med. 1993; 328: 538-45.

35. Negrão CE, Forjaz CLM, Brum PC. Exercício físico e hipertensão arterial. Hiperativo. 1994;. 1: 18-22.

36. Marino Jr G, Cortez JAA, Kiss MAPDM, Carazzato JG. Análise das alterações verificadas em diversas variáveis estudadas durante o teste ergométrico, em pacientes coronariopatas pós-infarto e hipertensos, submetidos a programa de reabilitação e condicionamento físico. Rev Bras Med Esporte. 1995; 1 (2): 36-47.

37. Rebelo FPV, Benetti M, Lemos LS, Carvalho T. Efeito agudo do exercício físico aeróbio sobre a pressão arterial de indivíduos hipertensos controlados submetidos a diferentes volumes de treinamento. Revista Brasileira de Atividade Física e Saúde. 2001; 6: 28-38.

38. Oldridge NB, Furlong W, Feeny D, Torrance G, Guyatt G, Crowne J, et al. Economic evaluation of cardiac rehabilitation soon after acute myocardial infarction. Am J Cardiol. 1993; 72: 154-61.

39. Ades PA, Pashkow FJ, Nestor JR. Cost-effectiveness of cardiac rehabilitation after myocardial infarction. J Cardiopulm Rehabil. 1997; 17: 222-31.

40. Lowensteyn I, Coupal L, Zowall H, Grover SA. The cost-effectiveness of exercise training for the primary and secondary prevention of cardiovascular disease. J Cardiopulm Rehabil. 2000; 20: 147-55.

41. Jeffrey L, Probstfield. How cost-effective are new preventive strategies for cardiovascular disease? Am J Cardiol. 2003; 91: 22-7.