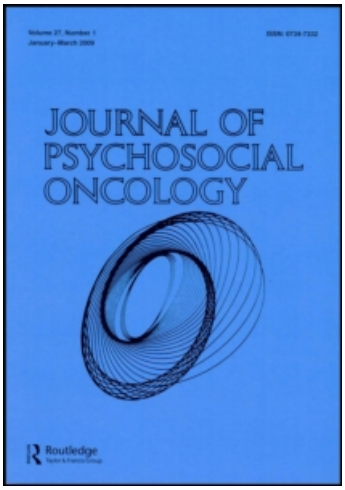

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Cardiorespiratory Fitness and Quality-of-Life Analysis Posttreatment in Breast Cancer Survivors

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Cardiorespiratory Fitness and Quality-of-Life Analysis Posttreatment in Breast Cancer Survivors

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This study compared VO_{2peak}, treatment frequency and dosage, and QOL between 22 post-treated breast cancer survivors (CATotal) and 22 apparently healthy, age-matched women (CO). The CATotal group included 11 with no history of any other co-morbidities (CA) and 11 with controlled hypertension (CA + H). VO_{2peak} was measured using the Bruce Protocol. QOL was measured using the SF-36 survey. Significant differences were observed in VO_{2peak} between CATotal and CO ($p = 0.014$), CA and CA + H ($p = 0.001$), and CA + H and CO ($p = 0.001$). Physical, emotional, and mental health domains of the SF-36 were significantly different between CATotal and CO ($p = 0.006$, 0.001, and 0.05 respectively). These results suggest that breast cancer survivors with controlled hypertension can experience a significant reduction in VO_{2peak} when compared to apparently healthy, age-matched controls. Also, treatment frequency and dosage affected QOL in this group of survivors.

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KEYWORDS oncology, antineoplastic, menopausal status, treated-controlled hypertension, VO_{2peak}, aerobic power

INTRODUCTION

The evolution of surgical techniques and innovations in adjuvant therapy for the treatment of breast cancer has resulted in a substantial increase in life expectancy the past few years (Clarke et al., 2005; Early Breast Cancer Trialists' Group, 2005). However, the acute and chronic side effects commonly observed in patients undergoing breast cancer treatment can cause alterations in the functioning of healthy tissues and overload other physiological systems, which can lead to the possible development of other comorbidities as well as significant reductions in quality of life (QOL) (Fehlauer, Tribius, Mehnert, & Rades, 2005; Janssen-Heijnen et al., 2005; Schou, Ekeberg, Sandvik, Hjermstad, & Ruland, 2005). More specifically, cardiovascular abnormalities caused by the administration of certain chemotherapeutic agents and radiation therapy can cause a significant reduction in the health of patients (Janssen-Heijnen et al., 2005). However, alterations in the functioning of the cardiovascular system are not always solely due to chemotherapy and radiation treatments. Many of the cardiovascular abnormalities that occur post-diagnosis can also be associated with sedentary and harmful lifestyles such as smoking, drinking, and poor diet (Wondergem, Strootman, Frolich, Leer, & Noordijk, 2001). The interrelationship between unhealthy lifestyles and neoplastic treatments designed to eradicate cancer are believed to contribute to the development of fatigue, decrease in physical activity levels, reduction in overall QOL, and reduced chances of long-term survival (Irwin et al., 2008). Therefore, the study of the physical and psychological status of patients posttreatment, as well as the relationship between treatment plans, physical fitness, and different life domains associated with QOL, is paramount.

METHOD

Participants

This cross-sectional study examined a group of 22 sedentary, posttreated Brazilian breast cancer survivors (CATotal) from the Base Hospital of Brasilia (HBDF) and 22 sedentary apparently healthy, age-matched control participants (CO), also from Brasilia-DF, Brazil. All participants were recruited between January 2005 and May 2006. The criteria for participation in the study for the CATotal group included ages between 30 and 68 years; tumor staging between T1N0M0 and T3N2M0 (Stages I–IIIA); had already undergone treatment for breast cancer including mastectomy surgery,

lymphadenectomy, chemotherapy, and radiation; and were undergoing hormonal therapy at the time of the study.

Because this was the first study conducted in Brazil with a cohort of posttreated breast cancer survivors and every patient had to undergo a VO_{2peak} test as part of the study protocol, the physician members of the research team recommended the exclusion of participation of any survivor with history of other comorbidities including diabetes; cardiovascular disease; acute or chronic respiratory disease; acute or chronic bone, joint, muscular abnormalities; mental impairments; or metastatic disease. This was done to ensure the safety of all study participants. However, patients with controlled hypertension were included in the study, because this is a common condition experienced by many posttreated breast cancer patients.

Screening/Recruitment

Potential volunteers were screened and recruited through a medical data base at the HBDF by an authorized medical professional from the HBDF. Before the beginning of the database screening/recruitment process, approval was granted by the Catholic University of Brasilia Internal Review Board (IRB) and from the Government Secretary of Health State of the Federal District of Brasilia. Figure 1 shows a graphic representation of the recruitment of flow.

At the end of the recruitment/screening process, 22 breast cancer survivors (CATotal) (11 with no history of other co-morbidities [CA] and 11 with controlled hypertension [CA + H]) who were within 14 months of diagnosis and completion of major treatment met the criteria for participation in the study. Survivors were then contacted by phone by the primary investigator and invited to take part in the study. A meeting was then scheduled between the primary investigator and interested potential participants. During the meeting, further information regarding the study protocol was given; and after all questions were clarified by the primary investigator and the potential participant agreed to participate in the study, an informed consent form approved by the Catholic University of Brasilia IRB was signed by the participant and primary investigator. Recruitment of apparently healthy control participants (CO) was accomplished by posting fliers around the Catholic University of Brasilia and by word of mouth from members of the research team.

Assessments

During the initial phone call, all participants were instructed to follow preassessment guidelines prior to testing. These included avoiding vigorous physical activity 24 hours prior to testing, avoiding alcohol consumption 48 hours prior to testing, maintaining proper hydration, and wearing clothing appropriate for exercise. Participants reported to the Physical Education and

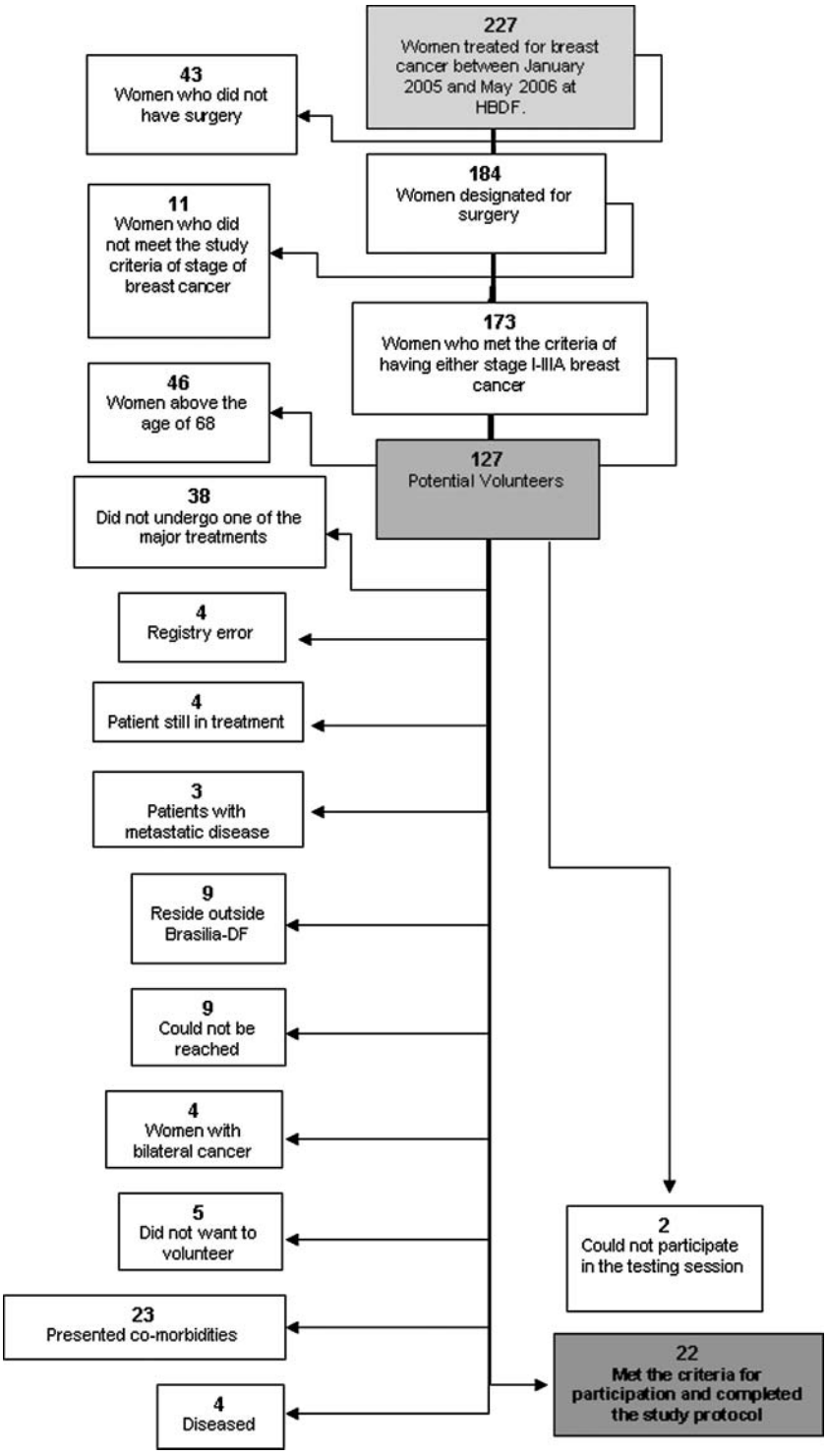

FIGURE 1 Recruitment of flow.

Health Laboratory (LEFES) at the Catholic University of Brasilia for testing. All testing sessions were scheduled to occur in the morning.

Immediately after reporting to the laboratory for testing, survivors and apparently healthy control participants were seated comfortably and demographic information was collected. Participants then received information from a research team member on how to answer the Short Form Health Survey (SF-36) (Ciconelli, Ferraz, & Santos, 1999). After completing the survey, resting vitals including resting heart rate, blood pressure, height, and weight were assessed. A stress test on a treadmill using the Bruce Protocol was then administered by the primary investigator and was assisted by research team members, the LEFES laboratory director, and the cardiologist supervisor of the project.

Instrumentation

Different life domains associated with QOL were assessed through the SF-36 health survey. The SF-36 health survey is a multipurpose survey commonly used for the evaluation of QOL in clinical populations (Ciconelli, Ferraz, & Santos, 1999). It is an instrument comprising 36 items that evaluates physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. A score is given for each of the eight domains (scales) cited above. The higher the scores, the higher the overall QOL is for the patient. Internal consistency and test–retest methods were used to test the reliability of all eight domains (scales) that composed the survey with reliability statistics exceeding the standard 0.70 recommended for measures used in group comparisons among studies.

Cardiorespiratory fitness was assessed using the Bruce Protocol on a computerized treadmill model RT 300 (Moviment, Manaus, Brazil). A metabolic chart model MetaLyzer 3B (Cortex, Frankfurt, Germany) and software Ergo PC Elite for Windows version 3.3.4.3 (Micromed, Brasília, Brazil) were used for oxygen consumption analyses. The criteria used for the determination of VO_{2max} were defined as the maintenance (no change) of oxygen consumption below 50 ml/min or 2.1 ml/kg/min with an increase in workload (Sociedade Brasileira de Cardiologia, 2002). Because these criteria were not met in any participant, VO_{2peak} was used for the analyses. VO_{2peak} was obtained by breath-by-breath analyses using the last 30 seconds of the test and was expressed in relative values (ml/kg/min) and Metabolic Equivalents (METs).

Statistical Analyses

All data were gathered and entered into an electronic database for analysis. All data were analyzed using SPSS version 14 for Windows, a statistical software program. The alpha level was set a priori at 0.05 for all analyses.

Statistical analyses were performed combining all survivors into one group (CATotal) ($n = 22$); survivors separated into two different groups (11 with no history of any other co-morbidity [CA] and 11 with controllable hypertension [CA + H]); and a control group formed by 22 apparently healthy age-matched control participants (CO). Data were analyzed for normality using the Kolmogorov-Smirnov test. Chi-square (χ^2) was used for the analysis of nominal variables including demographics, lifestyle, and clinical information. For the analysis of the SF-36 domains (scales), Mann-Whitney and Kruskall-Wallis statistics were used. For interaction effect analysis between menopausal status and other continuous variables, a two-way ANOVA was used. For the analysis of the possible influence of age on VO_{2peak} between the three groups (CA, CA + H, CO), an ANCOVA was used. A one-way ANOVA and Student *t*-tests were used for the analysis of VO_{2peak} between groups. Homogeneity analysis was performed using the Levene test followed by a Tukey HSD post-hoc for homogeneous variables, while the Dunnett C post-hoc was used for those variables that did not present homogeneous variance. The relationships between the domains of the SF-36, VO_{2peak}, and treatment frequency, dosage, and clinical characteristics of the participants were examined using Spearman correlations.

RESULTS

Demographic characteristics of the study participants are presented in Table 1. No significant difference in age was observed between the CATotal (48.8 ± 8.9) and CO groups (45.5 ± 7.4). However, exploratory analyses performed after splitting the CATotal group into CA and CA + H revealed significant differences in age (42.3 ± 5.7 and 55.3 ± 6.6, $p = 0.001$) between the two groups. Significant differences in menopausal status were observed between the CATotal and CO groups ($p = 0.001$) with a higher number of postmenopausal women occurring in the CATotal group.

Clinical characteristics of the survivors are presented in Table 2. Significant differences in the frequency and amount of radiation therapy received were observed between CA and CA + H groups, with the CA group receiving radiation therapy more frequently and in higher dosages than the CA + H group ($p = 0.028$ and $p = 0.025$, respectively).

The descriptive statistics for the analyses of the domains of the SF-36 QOL health survey and VO_{2peak} are presented in Table 3. The domains role-physical, role-emotional, and mental health were significantly lower in the CATotal group when compared to the CO group ($p = 0.006$, $p = 0.001$, and $p = 0.05$, respectively). No significant differences were observed for any QOL domain when the CATtotal group was divided into the CA group and CA + H group. Exploratory analysis revealed that the QOL domain general health was significantly different between survivors when taking into consideration

TABLE 1 Participant Demographic Information

	Groups					
	CATotal ($n = 22$)		CO ($n = 22$)		All Participants ($N = 44$)	
Characteristics	*n*	%	*n*	%	*n*	%
Marital status						
Single	5	22.7	4	18.2	9	20.5
Living together	1	4.5	3	13.6	4	9.1
Married	10	45.5	11	50	21	47.7
Widowed	2	9.1	1	4.5	3	6.8
Divorced	4	18.2	3	13.6	7	15.9
Total years of education						
0	1	4.5	—	—	1	2.3
1–8 years	10	45.5	9	40.9	19	52.6
More than 9 years	11	50	13	59.1	24	45.1
Number of children						
No children	4	18.2	2	9.1	6	13.6
1–3 children	15		20	90.9	35	79.5
4–6 children	2	9.1	—	—	2	4.5
More than 7 children	1	4.5	—	—	2	4.5
Menopausal status						
Premenopausal	8	38.1%	16	76.2%	24	57.1%
Postmenopausal	13[a]	61.9%	5	23.8%	18	42.8%
Age						
(years, mean ± SD)	48.8 ± 8.9		45.5 ± 7.4		47.1 ± 8.1	
Body weight						
(kg, mean ± SD)	67.9 ± 11.3		62.1 ± 9.1		65 ± 10.2	
BMI						
(kg/m^2, mean ± SD)	26.9 ± 4.1		26.4 ± 4.2		26.6 ± 4.1	

CATotal = breast cancer survivors; CO = control participants; BMI = body mass index.
[a]Significant difference between CATotal and CO groups.

menopausal status ($p = 0.01$). The general state of health according to the SF-36 was higher in premenopausal (59.30 ± 8.7) than in postmenopausal (50.30 ± 10.0) survivors. A significant difference in VO_{2peak} between CATotal and CO was observed ($p = 0.014$). When splitting the CATotal group into CA and CA + H, significant differences in VO_{2peak} were only observed between CA and CA + H ($p = 0.001$) and CA + H and CO ($p = 0.001$). No significant difference was observed in VO_{2peak} between CA and CO groups.

Spearman correlations were performed between VO_{2peak} and the domains of the SF-36 QOL survey, as well as between VO_{2peak} and the number of chemotherapy sessions, chemotherapy treatment plan, number of fractions of radiation treatment received, and total dosage of radiation received in each group (CATotal, CA, CA + H, and CO). The results of the Spearman correlations are presented in Table 4. A significant positive relationship was observed between VO_{2peak} and the domains of physical functioning and general health of the SF-36 in the CA group ($r = 0.764$, $p = 0.006$ and $r = 0.73$, $p = 0.001$, respectively). A significant inverse relationship was observed between VO_{2peak} and the number of radiation therapy fractions received and

TABLE 2 Clinical Characteristics of Breast Cancer Survivors in the Study Cohort

Clinical Characteristics	CA ($n = 11$)		CA + H $n = 11$)		CATotal ($N = 22$)	
	n	%	*n*	%	*n*	%
Pathological diagnostic						
Infiltrating ductal carcinoma	11	100	8	72.7	19	86.4
Infiltrating lobular carcinoma	—	—	2	18.2	2	9.1
Infiltrating pleomorphic lobular carcinoma	—	—	1	9.1	1	4.5
Staging						
IIA	2	18.2	5	18.2	4	18.2
IIB	5	45.5	4	36.4	9	40.9
IIIA	4	36.4	5	45.5	9	40.9
TNM staging classification						
T2N0M0	2	18.2	1	9.1	3	13.6
T2N1M0	3	27.3	3	27.3	6	27.3
T2N2M0	2	18.2	1	9.1	3	13.6
T3N0M0	2	18.2	3	27.3	5	22.7
T3N1M0	2	18.2	1	9.1	3	13.6
T3N2M0	—	—	2	18.2	2	9.1
Number of chemotherapy sessions						
4	2	18.2	3	27.3	5	22.7
6	7	63.6	6	54.5	13	59.1
7	—	—	1	9.1	1	4.5
8	2	18.2	—	—	2	9.1
9	—	—	1	9.1	1	4.5
Chemotherapy treatment plan						
AC	2	18.2	3	27.3	5	22.7
FAC	6	54.5	6	54.5	12	54.5
FEC	3	27.3	1	9.1	4	18.2
FAC + TAXOTERE	—	—	1	9.1	1	4.5
AC + TAXANES	1	9,1	1	9.1	2	9.0
AC + TAXOL + TRASTUZUMAB	1	9,1	—	—	1	4.5
Number of radiation therapy fractions						
25	3*	27.3	7	77.8	10	50
28	8	72.7	2	22.2	10	50
Total dose of radiation therapy						
5000 cGy	2**	18.2	7	77.8	10	45
5040 cGy	9	81.8	2	22.2	10	55
Total	11	100	11	100	22	100

Note: CA = with no history of comorbidities; H = controlled hypertension; CATotal = breast cancer survivors; AC = Adriamycin and Cyclophosphamide; FAC = Fluoracil, Adriamycin, and Cyclophosphamide; FEC = Fluoracil, Epirubicin, and Cyclophosphamide; cGy = Centi-gray.

*Significant difference in number of radiation fractions received between CA and CA + H ($p \leq 0.05$),

**Significant difference in total dose of radiation received between CA and CA + H ($p \leq 0.05$).

total amount of radiation received in the CATotal group ($r = -0.45$, $p = 0.035$ and $r = -0.51$, $p = 0.015$, respectively). No other relationship was observed between VO_{2peak} and any other domain of the SF-36 survey in any of the study groups. Exploratory analysis showed a significant inverse relationship between general health and menopausal status in the CATotal ($r = -0.57$, $p = 0.02$) and CA + H ($r = -0.70$, $p = 0.007$) groups.

TABLE 3 Descriptive Statistics for the Analysis of the Domains of the SF-36 Quality of Life Health Survey and $VO2_{peak}$

	Groups			
SF-36 Health Survey Domains	CA ($n = 11$) M ± SD	CA + H ($n = 11$) M ± SD	CATotal ($n = 22$) M ± SD	CO ($n = 22$) M ± SD
Physical functioning	63.2 ± 25.5	72.2 ± 20.1	67.7 ± 22.2	70.9 ± 22
Role-physical	27.5 ± 26.1	29.5 ± 29.1	28.5 ± 27*	79.5 ± 30.5*
Bodily pain	36 ± 18.5	28.1 ± 21.8	32.1 ± 20.1	30.4 ± 20.1
General health	54 ± 12.4	53.1 ± 7.8	53.6 ± 10.1	51.8 ± 13
Vitality	51.9 ± 19.6	52.7 ± 10.5	52.3 ± 15.4	49.3 ± 12.6
Social functioning	48.7 ± 15.2	56.8 ± 15.1	52.8 ± 15.4	51.1 ± 15
Role-emotional	49.4 ± 34.2	45.4 ± 37.3	47.4 ± 35**	81.8 ± 28.6**
Mental health	52.8 ± 8.3	59.6 ± 11.6	56.2 ± 10.5†	62.3 ± 12.5†
VO_{2peak} (METs)	CA ($n = 11$)	CA + H ($n = 11$)	CATotal ($n = 22$)	CO ($n = 22$)
	6.20 ± 0.35±	4.71 ± 0.96± ¶	5.51 ± 1.10‡	6.37 ± 1.13‡¶

Note: SF-36 =; CA + H = with no history of comorbidities + controlled hypertension; CATotal = breast cancer survivors; CO = control participants; METs = metabolic equivalents.
*$p = 0.006$, **$p = 0.001$, †$p = 0.05$, ‡$p = 0.014$, ±$p = 0.001$, and ¶$p = 0.001$.

DISCUSSION

The current study examined the differences in cardiorespiratory fitness (VO_{2peak}) and QOL between a group of breast cancer survivors and apparently healthy women of similar age. The current study also investigated the relationship between treatment modalities (frequency and dosage) and the domains of the SF-36 health survey in this group of breast cancer survivors.

TABLE 4 Spearman Correlation Coefficients Between VO_{2peak}, the Domains of the SF-36 QOL Survey, Number of Chemotherapy Sessions, Chemotherapy Treatment Plan, Number of Fractions of Radiation Treatment Received, and Total Dosage of Radiation Received

	VO_{2peak}			
SF-36 Domains	CA	CA + H	CATotal	CO
Physical Functioning	0.76[a]	−0.46	−0.01	−0.02
Role-Physical	0.35	−0.28	−0.10	0.16
Bodily Pain	−0.36	0.15	−0.03	0.28
General Health	0.73[b]	−0.41	−0.3	−0.02
Vitality	0.04	−0.02	−0.22	0.18
Social Functioning	−0.17	0.16	0.25	−0.19
Role-Emotional	0.37	−0.16	−0.04	−0.15
Mental Health	0.21	−0.39	0.03	0.10
Clinical Variables				
Number of Chemotherapy Sessions	0.29	−0.29	−0.25	—
Chemotherapy Treatment Plan	0.17	0.14	−0.35	—
Fractions of radiation treatment received	0.21	−0.16	−0.45[c]	—
Total dosage of radiation received	0.21	−0.04	−0.51[d]	—

Level of significance: [a]p = 0.006, [b]p = 0.011, [c]p = 0.035, [d]p = 0.015.

Clinical Characteristics

Twenty two female breast cancer survivors (11 with no other comorbidities [CA] and 11 with controlled hypertension [CA + H]) and 22 apparently healthy women participated in the study. The results of the analyses performed on amount of treatment received by this sample of Brazilian breast cancer patients showed that the women in the CA + H group received less treatment when compared to the CA group. This difference in treatment was due to the amount and frequency of radiation therapy received. It is believed that this difference in radiation therapy treatment dosages between groups could be attributed to the presence of comorbidity (controlled hypertension), which is a very important factor in determining the treatment course of action (Louwman et al., 2005). Another factor that may explain the reduced frequency and amount of radiation therapy in the CA + H group when compared to the CA group could be attributed to age. The women in the CA + H group were significant older than the CA group. According to Janssen-Heinen et al. (2005), age is an important factor to take into consideration when formulating the treatment course of action that is to be administered to a cancer patient. Unfortunately, the inability to provide patients with the appropriate frequency and dosage of treatment due to other comorbidities and age can negatively affect cancer reoccurrence and mortality from all causes (Louwman et al., 2005). Future experiments should continue to explore the impact of the administration of treatment dosage and frequency on overall treatment outcomes and determine if the administration of alternative treatments or the combination of other adjuvant treatment with current standard treatment strategies can improve the chances of better treatment outcomes in older patients or in patients with other comorbidities that may not be able to receive the appropriate dosage of treatment.

Cardiorespiratory Fitness (VO_{2peak})

For proper physiological functioning of vital organs, the minimal oxygen consumption required for a women weighing approximately 55 kg is reported to be approximately 3.5 ml/kg/min or 1 MET (Lucia, Earnest, & Perez, 2003). A significant difference in VO_{2peak} between CATotal and CO was observed. When splitting the CATotal group into CA and CA + H, a significant difference in VO_{2peak} was only observed between CA and CA + H and CA + H and CO groups. No significant difference was observed in VO_{2peak} between CA and CO groups. This is a very important finding because the results of the current study suggest that after 14 months of treatment completion, breast cancer survivors who do not have any other co-morbidities seem to return to levels of cardiorespiratory function similar to healthy age-matched sedentary women who have not had cancer.

In the current study, the average of maximal oxygen consumption, VO_{2peak}, attained during the cardiorespiratory endurance test was 5.81 ± 1.26 METs for all the survivors (CATotal). These results were similar to previous studies (Cheema & Gaul, 2006; Courneya et al., 2003; Fairey et al., 2005; Herrero et al., 2006; L. W. Jones et al., 2007); however, other studies have included survivors with other comorbidities in addition to controlled hypertension (Courneya et al., 2003; L. W. Jones et al., 2007). According to the physical activity compendium, activities of daily living such as sweeping a garage or sidewalk of a house would require a MET of approximately 4 METs (Lucia et al., 2003). Putting this into perspective, for the survivors enrolled in the current study to complete the task of sweeping a garage or sidewalk of a house, an expenditure equal to 75% of the VO_{2peak} would be necessary (Lucia et al., 2003). The decline in functioning of cardiorespiratory and skeletal muscle systems with cancer treatment can last for years posttreatment. As observed in the current study, the decline in cardiorespiratory function of survivors posttreatment contributes to the difficulties in performing simple daily living activities as mentioned by Lucia and colleagues, which helps to explain somewhat the decrease in QOL reported by survivors in this study (Lucia et al., 2003). Therefore, the decline in cardiorespiratory functioning presented in the current study is of significant importance, and if not addressed, can lead to increased mortality and the possibility for the development of other comorbidities including further cardiovascular disease complications (Blair et al., 1996; Crespo et al., 2002; Gulati et al., 2003; Mora et al., 2003).

The CA + H group of survivors presented a lower VO_{2peak} compared to the CA group. According to the American Thoracic Society and the American College of Chest Physicians (2003), a reduction in cardiorespiratory efficiency may be a representation of problems in different levels of biological function such as compromised oxygen transport capability, cardiac debt alterations, pulmonary restrictions, tissue oxygen extraction difficulty, and neuromuscular limitations . The results of the analyses on frequency and dose of treatment received by the group of survivors in the current study are also in agreement with previous studies where decrements in VO_{2peak} were associated with the amount of treatment received (Hooning et al., 2006; Tokatli et al., 2005). However, an intriguing finding in the current study was that even though the CA + H group received a reduced dose of radiation therapy when compared to the CA group, the CA + H group presented a significantly lower cardiorespiratory endurance level. Therefore, it is suggested that the reduced dosage of radiation alone was not totally responsible for the VO_{2peak} difference between groups and that the dosage of chemotherapy received by the CA + H group may have contributed to the lower levels of VO_{2peak}. This hypothesis is supported by previous studies, where the authors documented that individuals being treated for cancer who presented other comorbidities such as hypertension were more susceptible to the

development of chemotherapy-induced cardiotoxicity (Hawfield, Lovato, Covington, & Kimmick, 2006; R. L. Jones & Ewer, 2006). Because in the current study no significant difference in the amount of chemotherapy received between the CA and CA + H groups was observed, it appears that the impact of chemotherapy, even though controlled to meet the standard guidelines for patients with hypertension, may have more aggressively affected the cardiorespiratory system in the CA + H group. According to Meinardi and colleagues (2001), the toxicity of chemotherapeutic agents can last a year after the beginning of treatment which could be the case in the group of survivors that participated in this study.

The differences in VO_{2peak} between the CA + H and other groups could perhaps be also explained by the 13-year age difference between the groups, with the CA + H group comprising older survivors, as well as the type of medications used to control hypertension. As we age, VO_{2max} decreases as a result of decreased muscle mass, maximal heart rate, stroke volume, power output capacity, and arteriovenous oxygen difference (Brooks, Fahey, & Baldwin, 2005). The medications used to control hypertension in patients in the CA + H group included angiotensin converting enzymes (ACE), beta blockers, and diuretics. The main hemodynamic effects of these drugs on the cardiovascular system would involve changes in cardiac debt, total peripheral resistance, and heart rate; with all of these drugs reducing total peripheral resistance, with no impact on cardiac debt or heart rate by ACE or diuretics (Leonetti et al., 1989, 1991; Onder et al., 2002). Therefore, these medications do not seem to have a significant impact on the performance of the CA + H group during the oxygen consumption test. In fact, according to Goodman and Gilman (2002), Brion et al. (2000) and Gordon, Scott, and Duncan (1997), these medications would have provided a beneficiary effect instead. Therefore, the reduced oxygen consumption by the CA + H group was probably not solely affected by the use of these drugs, because some of these drugs would in fact have a positive effect in improving oxygen consumption.

Quality of Life

The analyses performed on the domains of the SF-36 health survey revealed significant reductions on role-physical, role-emotional, and mental health in the group of Brazilian breast cancer survivors who had been diagnosed 14 months prior to enrollment in the study, when compared to a control group of apparently healthy, aged-matched Brazilian women. Similar results have been reported in previous investigations (Bowen et al., 2007; Ganz et al., 2004; Lidgren, Wilking, Jonsson, & Rehnberg, 2007; Robb et al., 2007; Schou et al., 2005). However, it is also reported in the literature that not all breast cancer patients experience a significant reduction in QOL domains (Arndt

et al., 2004; Hurria et al., 2006; Land et al., 2004; Peuckmann et al., 2007). Caution must be taken when analyzing QOL through self-reported questionnaires, since self-reported health related conditions may not represent an accurate or precise description of the condition when compared to physiological parameters (Groenvold et al., 2007; Wong & Fielding, 2007).

A variety of distinct factors can negatively influence the QOL of breast cancer survivors. Many studies have revealed that diagnosis, treatment modality, the toxicity of treatment, and side effects of treatment all compromise QOL via physiological, psychological, and/or social mechanisms (Fehlauer et al., 2005; Ganz et al., 2002; Hopwood, Haviland, Mills, Sumo, & M Bliss, 2007; Robb et al., 2007; Schou et al., 2005; Wong & Fielding, 2007). However, in the current study, no significant association was observed between the domains of QOL assessed through the SF-36, clinical characteristics, or cardiorespiratory fitness in this group of breast cancer survivors. The results of the current study suggest that breast cancer survivors did not present such significant declines in mental health, physical, and role-emotional 14 months postdiagnosis.

These results are in agreement with previous studies where an association between treatment modalities and QOL is not always observed in breast cancer survivors (Arndt et al., 2004; Schultz, Klein, Beck, Stava, & Sellin, 2005; Vacek, Winstead-Fry, Secker-Walker, Hooper, & Plante, 2003). However, the reduced dosage of radiation may have contributed to a nonsignificant decline in QOL in the women who presented controlled hypertension (CA + H). The presence of controlled hypertension did not seem to significantly impact the QOL in the CA + H group, because no significant difference in QOL was observed between the CA and CA + H groups. This finding is supported by previous research by Alonso and colleagues (2004), which reported that within many different chronic disease conditions such as arthritis, pulmonary disease, and congestive heart failure, hypertension was the condition that had the least impact on QOL evaluated using the SF-36 instrument.

Functional capacity, even though not significantly different between the CA and CA + H groups, was significantly associated with VO_{2peak} in the CA group. This association was not surprising, because the functional capacity domain of the SF-36 evaluates subjective aspects intrinsically related to aerobic power. Interestingly, in the same group of patients (CA), the general state of health was inversely associated with aerobic power. This result may bring up the issue of sensitivity of the SF-36 instrument in capturing objective measurements of intense physical effort, followed by the exhaustion sensation; in other words, the indication of a psychological decline related to decrements in physical abilities (Lindholm, Brevinge, Bergh, Korner, & Lundholm, 2003).

The analysis of association conducted between QOL and menopausal status showed that the postmenopausal breast cancer survivors in this

cohort presented an inferior general state of health when compared to premenopausal breast cancer survivors. The results of the current study may be supported by previous studies where premature menopause caused by antineoplastic treatment was associated with reduced QOL and that the symptoms of the condition were considered to play a role in this reduction (Conde et al., 2005; Hopwood et al., 2007; Knobf, 2007). Further research must be conducted for a better understanding of this possible association.

The major limitations of the current study included a relatively small sample size and the inclusion of posttreated breast cancer patients with no other comorbidities besides having controlled hypertension, which precludes the ability for some association analyses as well as generalization of the study results to other populations.

However, the homogeneity of the sample size could also have been a potential strength, due to the absence of other comorbidities, and because all survivors had undergone surgery, chemotherapy, radiation, and hormonal therapy. Therefore, the results of the study should be applicable to breast cancer survivors with similar characteristics. Another strength of the current study is the short timeline for data collection and the use of objective and self-reported methods for the evaluation of physical aspects of the survivors provides a solid foundation for the continuation of research in breast cancer survivors. According to Kuroi, Shimozuma, Ohsumi, Imai, and Ono (2007), the analyses of QOL and its relationship to health is a vital component for the determination of psychological and physiological deficits of patients and is used to make informed decisions on treatment strategies, as well as to monitor the disease process over time. Kuroi et al. also mentioned that the domains of QOL can be interrelated, with no distinct separation between many domains, yet they can be influenced by individual aspects.

In conclusion, the results of the current study show that cardiorespiratory endurance expressed as oxygen consumption (VO_{2peak}) correlated positively with physical function and general health domains of the SF-36 survey evaluating QOL in breast cancer survivors. This means that breast cancer survivors who have similar VO_{2peak} compared to apparently healthy age-matched controls have better physical functioning and overall health when compared to survivors with lower VO_{2peak}, as was the case with the CA + H group. Because the amount and frequency of radiation treatment was negatively associated with QOL and VO_{2peak} in this group of breast cancer survivors, possibly due to the impact of this type of treatment on cardiorespiratory function, the use of an intervention that mitigates the impact of this type of treatment on the cardiorespiratory system should be considered. Therefore, the results of the current study support the use of aerobic exercise as an intervention aimed to promote cardiorespiratory improvements (VO_{2peak}) in posttreated breast cancer patients, which could enable these patients to live a higher QOL.

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