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ORIGINAL ARTICLE

Metabolic Syndrome and Risk of Cardiovascular Diseases in Female Breast Cancer Survivors

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Abstract

Background: The implementation of intensive therapy protocols increases the probability of adverse events in patients with breast cancer (BC). Components of metabolic syndrome (MS) are among these events.

Objective: To verify the prevalence of MS and cardiovascular disease (CVD) risk in female BC survivors.

Materials and Methods: This is a descriptive, observational, cross-sectional study. Our sample comprised 60 women without BC (G1) and 60 women who had survived BC (G2). We collected sociodemographic, anthropometric, tumor, and clinical data. After variable analysis, the participants received positive or negative MS diagnoses and a 10-year CVD risk stratification. The significance level adopted for the analyses was 5% ($p < 0.05$) and the confidence interval (CI) was 95%. For comparing categorical data, we used the chi-squared, Fisher's exact, or G tests; for comparing continuous data, we used the parametric Student's t-test and the non-parametric Mann-Whitney test.

Results: Both groups presented overweight and an increased waist-to-hip ratio. Weight, body mass index, abdominal circumference, hip circumference, and low-density cholesterol were variables that presented statistically significant differences between groups. MS was diagnosed in 32% of women in G1 and 45% of those in G2. Regarding the 10-year risk for CVD, most women were in the low-risk stratum: the mean total risk of CVD occurrences was 7.48% in G1 and 7.70% in G2.

Conclusion: We observed a higher prevalence of MS among women who survived BC, possibly due to overweight, as well as a low 10-year risk for CVD after cancer treatment. Although we did not observe a statistically significant difference, we suggest the adoption of a healthy lifestyle and rigorous control of cardiometabolic risk factors.

Keywords: Metabolic Syndrome; Heart Diseases; Breast Neoplasms.

Introduction

Cancer represents the second main cause of death worldwide, behind only cardiovascular diseases (CVD).[1] Projections for 2030 expect around 24 million cases of cancer and 14.6 million deaths.[2] This disease represents a global health challenge that has been increasing in low-and middle-income countries with the globalization of the economy and lifestyles.[3] Among various neoplasm types, breast cancer (BC) is the one that affects women the most each year, being responsible for 23% (1 380 000) of all new cancer cases and 14% (458 400) of all deaths due to cancer.[4]

The number of long-term cancer survivors is increasing. A better organization of cancer care, more effective treatment options, and evidence-based tumor-specific protocols are factors that have contributed to this increase.[5-7] However, 2 out of 3 cancer survivors are prone to suffering from complications in the long term.[8] A wide spectrum of late adverse effects such as CVD, diabetes, dyslipidemia, arterial hypertension, osteoporosis, and metabolic syndrome (MS) components are likely to develop among cancer survivors. For this reason, it is important to design appropriate health management strategies for these patients.[7,9-10]

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Studies show a high prevalence of MS in the Brazilian population. One of these population studies found a MS prevalence of 29.8% in adults (95% confidence interval [CI]).[4] In a study performed with 50 women with BC aged between 40 and 80 years and 50 age-matched controls, the prevalence of MS was 40.0% among patients with BC and 18.0% in the control group (P = 0.02). A positive independent association was observed between MS and risk of BC (odds ratio [OR] = 3.037; 95% CI 1.214–7.597).[11]

In MS, adipocytes and adipokines derived from the perivascular adipose tissue such as leptin, resistin, IL-6, and tumor necrosis factor-α are potent pro-inflammatory molecules that may promote oxidative stress in the endothelium and affect endothelial function,[12] leading to a predisposition to CVD.[13,14] In this context, a new subspecialty has emerged within the cardiology field: cardio-oncology, where cardiologists participate in a multidisciplinary team dedicated to cancer treatment. Before initiating treatment, it is important to identify patients at increased risk for cardiac toxicity so that alternative, less cardiotoxic treatment options can be considered.[15,16]

The aim of the present study was to verify the prevalence of MS and CVD risk in female BC survivors (BCS).

Materials and Methods

Study Type and Site

This research was characterized as a descriptive, observational, cross-sectional study. Sample selection occurred at a philanthropic hospital located in São Luís, state of Maranhão (MA), which is a high-complexity oncology referral center.

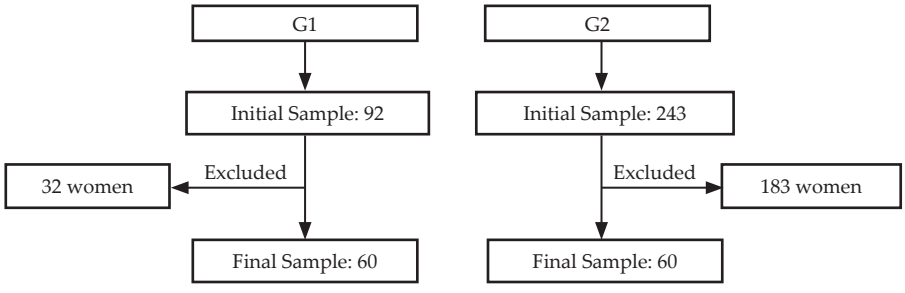
Ethical Aspects

This study was based on ethical principles that rule research with human beings and followed Resolution No. 466/12 of the National Health Council. The project was approved by the Ethics and Research Committee (CEP) of *Universidade Federal do Maranhão* according to opinion No. 2 386 296. Participants signed a free and informed consent form (FICF) and received information on the main aspects of the study such as the procedure, objective, and possible contributions; they were free to withdraw their participation at any moment of the study and at no penalty or charge.

Sample

The sample consisted of 120 female patients and was divided into 2 groups: G1, 60 women with no BC diagnosis, and G2, 60 female BCS (Flow Diagram 1). These corresponded to the required sample size according to previous sample size calculations which used the formula for the proportion of 2 samples, since we aimed to investigate data on the prevalence of MS in 2 distinct groups, for comparison purposes. The study used as reference for this calculation was performed by Ortiz et al. (2014).[17]

Out of a sample of 92 women selected from the general population, after applying inclusion and exclusion criteria, we obtained a selection of 60 women for the G1 group. Meanwhile, out of 243 women with BC (G2), we selected 60 women according to the selected inclusion and exclusion criteria. The selection of participants for G2 was performed by the recruitment of patients registered at the Hospital Cancer Registry (HCR) of the aforementioned hospital.



Flow Diagram 1 – The study's patient selection process.

Inclusion and Exclusion Criteria

We selected women aged between 35 and 60 years for this study. In G1, BC-free women as per medical confirmations performed in the previous 2 months. In G2, female BCS according to a medical certificate, with staging levels I, II, or III, positive pathology examination of the sentinel lymph node, who were treated at the study hospital and who accepted to participate in the study by signing the FICF. BCS who had had a complete axillary dissection were excluded from the study. We also excluded, from both groups, patients who were pregnant or who had ascites due to the difficulty in identifying abdominal obesity; patients who had any type of heart disease of any etiology, according to their clinical history and physical examination; those who had a clinical manifestation of atherosclerosis or genetically proven dyslipidemias; those who had infectious diseases or kidney and/or liver diseases; patients who presented physical, psychic, cognitive, and sensorial alterations that prevented the execution of the study tests; and those who refused to participate in any of the study's stages.

Data Collection

The study began after the selected patients received information regarding the ethical aspects of the research and signed the FICF, as determined by Resolution No. 466/12 of the National Bioethics Commission of Brazil (CONEP). We collected sociodemographic data, as well as information on date of diagnosis, staging level, treatment modalities, and other data from the HCR.

Participants selected for both groups were then invited to the Clinical Research Center of Hospital Universitário da Universidade Federal do Maranhão (CEPEC- HUUFMA), where blood collections and other measurements were performed. Initially, we requested a 12-hour fast before blood collection; then, women answered questionnaires on their age, sociodemographic information, the occurrence of other comorbidities or menopause, use of medications, and smoking and drinking habits.

For obtaining arterial pressure (AP) values, patients were seated, with feet on the ground, and the measurement was performed after 5 minutes of rest. Measurements were performed using the non-operated arm (as was the blood collection). We performed 3 consecutive readings for each participant, with a 3-minute interval. The first reading was discarded, and the mean value between the 2 other measurements was used. We also investigated weight (kg) using an electronic scale and height (m) with a wall-mounted stadiometer, as well as abdominal circumference/waist (AC) and hip circumference (HC) with a tape measure, which allowed us to determine the waist-to-hip ratio (WHR). The body mass index (BMI) was calculated by dividing weight (in kg) by height (in m) squared.

Subsequently, blood collection was performed at the hospital's laboratory. The biochemical investigation included total cholesterol and triglycerides (TG) measured by the endpoint colorimetric method and high-density lipoprotein (HDL-cholesterol) measured by the selective precipitation method coupled with the endpoint colorimetric method. Low-density lipoprotein (LDL-cholesterol) and very low-density lipoprotein (VLDL) were obtained through the Friedewald formula: LDL cholesterol (mg/dL) = total cholesterol - HDL-cholesterol - (triglycerides/5); this formula was valid for TG values of up to 400 mg/dL.

Glycemia, in turn, was quantified by the glucose oxidase enzymatic method. Serum insulin concentrations were also determined. Insulin resistance diagnoses were established according to the Homeostasis Model Assessment for Insulin Resistance (HOMA-IR) index, which is the product of fasting insulin (mUI/mL) and fasting glycemia (mmol/L) divided by 22.5. Insulin resistance was defined when values were higher than 3.16. After analyzing all collected data, participants received a positive or negative MS diagnosis.

MS diagnoses were established according to criteria by the National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III), being positive when 3 or more of the following parameters were present: 1) abdominal fat: an AC of more than 88 cm; 2) low HDL-cholesterol levels (less than 50 mg/dL); 3) elevated TG levels (150 mg/dL or more); 4) elevated AP (135/85 mmHg or more); 5) elevated glycemic levels (110 mg/dL or more). For analyzing cardiovascular risk, we used the Framingham risk score.

According to this score, each variable has value ranges with specific positive or negative scores. The total score considers the following variables: sex, age, smoking habits, diabetes mellitus, HDL-cholesterol, total cholesterol, systolic arterial pressure, and diastolic arterial pressure. The final score corresponds to the possibility (in %) of occurrence of a cardiovascular disease in the next 10 years. Therefore, individuals are classified into the following categories: low risk (with a 10-year cardiovascular risk of less than 10%), intermediate risk (between 10% and 20%), and high risk (more than 20%).

Data Analyses

The collected data were stored and analyzed using SPSS, version 2. The significance level adopted for our analyses was 5% ($p < 0.05$) and a 95% CI. Continuous variables with normal distribution were described as means ± standard deviations, and those that did not present normal distributions were described as median values and interquartile ranges. Firstly, the Kolmogorov-Smirnov test was applied for testing the hypothesis that data followed a normal distribution and helping in the choice between parametric and non-parametric tests through which the significance of data between groups was verified. Therefore, for comparing categorical data we used the chi-squared, Fisher's exact, or G tests, and for comparing continuous data we used the parametric independent samples Student's t-test and the non-parametric Mann-Whitney test.

We used logistic regression models for estimating OR and 95% CI and verifying which variables influenced the occurrence of MS in female BCS. The models included an isolated analysis of variables that presented a statistically significant difference when compared with the control group regarding MS.

Results

Mixed-race participants and those with secondary education were the most prevalent in both groups. Considering family income, we observed that participants of this study had a low socioeconomic status, since 40% of the control group had a family income of ½ to 1 minimum wage and the same percentage earned 1 to 2 times the minimum wage in the BCS group. Most women reported not practicing regular physical exercise or having a family history of cancer, as well as not smoking or drinking; this last variable presented a statistical difference from the control group, as did the presence of menopause (Table 1).

Regarding the characteristics of tumors and the performed treatment (Table 2), the right breast had been affected in 60% of female BCS. Considering staging levels, the most prevalent was stage II (43.3%). As for treatment, 86.6% underwent a complete protocol (surgery, chemotherapy, and radiotherapy), with varying orders according to clinical characteristics and the tumor's anatomopathological aspects. The mean follow-up time, representing the end of treatment and follow-up, was 4 years.

When comparing anthropometric parameters and metabolic risk factors among female BCS and the control group (Table 3), we observed that both groups presented overweight (mean BMI of 26.08 kg/m^2 in the control group and 29.27 kg/m^2 in the female BCS group). The WHR in both groups was over 0.86, which is the threshold for identifying high cardiovascular risk. Cholesterol levels were above normal values for women, with mean values of 200.46 mg/dL and 213.98 mg/dL in the control and BCS groups, respectively. Some variables presented statistically significant differences between groups, such as weight, BMI, AC, HC, and LDL-cholesterol.

Variables that presented statistically significant differences between groups were analyzed by a logistic regression model. Through this model, we identified that isolated variables did not increase the OR for MS, except for HC (Table 4).

The identification of MS in both groups, according to NCEP-ATP III criteria, is demonstrated in Graph 1. In this graph, we observe a higher occurrence of MS in the BCS group, with 27 women (45%), in contrast to 19 (32%) in the control group. When comparing groups, we did not observe a statistically significant difference.

In the 10-year CVD risk stratification according to Framingham scores (Table 5), we obtained a high prevalence of low cardiovascular risk in both groups (73% in the control group and 72% in female BCS), with no statistically significant differences between groups according to Student's t- and Mann-Whitney testing of the obtained scores.

For assessing the mean cardiovascular risk in both groups (Graph 2), we obtained a 10-year risk for developing CVD of 7.48% in the control group and 7.70% among female BCS. When comparing groups, we did not observe a statistically significant difference ($p > 0.05$).

Discussion

Women in both groups presented similar socioeconomic and clinical characteristics, such as low schooling levels and low socioeconomic status (Table 1). These factors influence the level of knowledge on diseases in general and the adoption of healthy lifestyles,[5] which could explain the low prevalence of regular physical activity among women in this study. This fact directly impacts MS and CVD risk factors.[1] However, female BCS had less damaging life habits, such as lower levels of smoking and drinking, when compared to the control

Table 1 – Socioeconomic and clinical characteristics of female breast cancer survivors and the control group. São Luís-MA, 2021

Characteristics	Control group (n = 60)	BCS group (n = 60)	*p*
Race			
White	10 (17%)	10 (17%)	
Black	16 (27%)	19 (32%)	0.849[b]
Mixed-race	33 (55%)	29 (48%)	
Asian	1 (2%)	2 (3%)	
Schooling			
Incomplete primary/lower secondary education	8 (13%)	3 (5%)	
Primary/lower secondary education	5 (8%)	4 (7%)	
Incomplete secondary education	5 (8%)	6 (10%)	0.543[b]
Secondary education	33 (55%)	34 (57%)	
Incomplete tertiary education	3 (5%)	2 (3%)	
Tertiary education	6 (10%)	11 (18%)	
Family income			
< ½ MW	3 (5%)	6 (10%)	
½ to 1 MW	24 (40%)	14 (23%)	
1 to 2 MW	22 (37%)	24 (40%)	0.222[b]
2 to 5 MW	10 (17%)	16 (27%)	
> 5 MW	1 (2%)	0 (0%)	
Physical activity			
Yes	47 (78%)	42 (70%)	0.297[a]
No	13 (22%)	18 (30%)	
FH of cancer			
No	40 (67%)	36 (60%)	0.448[a]
Yes	20 (33%)	24 (40%)	
Menopause			
No	29 (48%)	9 (15%)	**<0.0001[a]**
Yes	31 (52%)	51 (85%)	
Smoking			
No	55 (92%)	58 (97%)	0.439[c]
Yes	5 (8%)	2 (3%)	
Drinking			
No	38 (63%)	56 (93%)	**0.0001[c]**
Yes	22 (37%)	4 (7%)	

BCS: breast cancer survivors; MW: times the minimum wage; FH: family history; a: chi-squared test; b: G test; c: Fisher's exact test.

Table 2 – Characteristics of tumors and treatments underwent by the female breast cancer survivor group. São Luís- MA, 2021

Characteristics	n	%
Tumor location		
Right breast	36	60.0
Left breast	24	40.0
Staging		
I	11	18.3
II	26	43.3
III	23	38.3
Treatment		
C + S + R	21	35.0
C + S + R	25	41.6
C + R + S	5	8.3
C + R + S	1	1.7
C + S	5	8.3
C + R	1	1.7
C + S	1	1.7
S	1	1.7
Follow-up time (years)	4 ± 2.44	

C: chemotherapy, S: surgery, R: radiotherapy

group. The higher prevalence of menopause among BCS may be related to chemotherapy treatment, which favors its early development.[7]

The anthropometric parameters and metabolic risk factors directly related to obesity (weight, BMI, AC, HC, and LDL-cholesterol) were elevated in female BCS, with statistically significant differences when considering the control group (Table 3). Results of a controlled and well-designed study with some of these variables demonstrated that cancer survivors were more dyslipidemic than the control population.[16] The increase in BMI among post-menopausal women mainly results from an associated increase in estrogens.[18] In addition, the pain, fatigue, and weakness associated with chemotherapy may cause physical inactivity, leading to abdominal obesity. Moreover, an unhealthy diet and lack of exercise increase visceral fat, leading to MS and chronic diseases such as obesity, hypertension, and diabetes.[19]

A prospective study performed in Denmark with women with BC revealed that those who had a BMI of 30 kg/m^2 or higher presented more advanced disease at diagnosis when compared to those who had a BMI of less than 25 kg/m.[24] Another study performed in the United States observed that, in women who gained weight after a BC diagnosis, each 5-kg gain was associated with a 13% increase in specific mortality, concluding that an elevated BMI was associated to higher mortality rates due to BC.[18] The presence of visceral adipose tissue can lead to MS due to its hyperlipolytic state and contribution of free fatty acids to the increase in insulin resistance.[16] Therefore, it is extremely important to routinely assess the nutritional status of women with BC with easily obtainable anthropometric measures such as BMI and AC.[4]

Female BCS face approximately twice the risk of death due to CVD and other chronic diseases than age-matched

Table 3 – Comparison between anthropometric parameters and metabolic risk factors between female breast cancer survivors and the control group. São Luís-MA, 2021

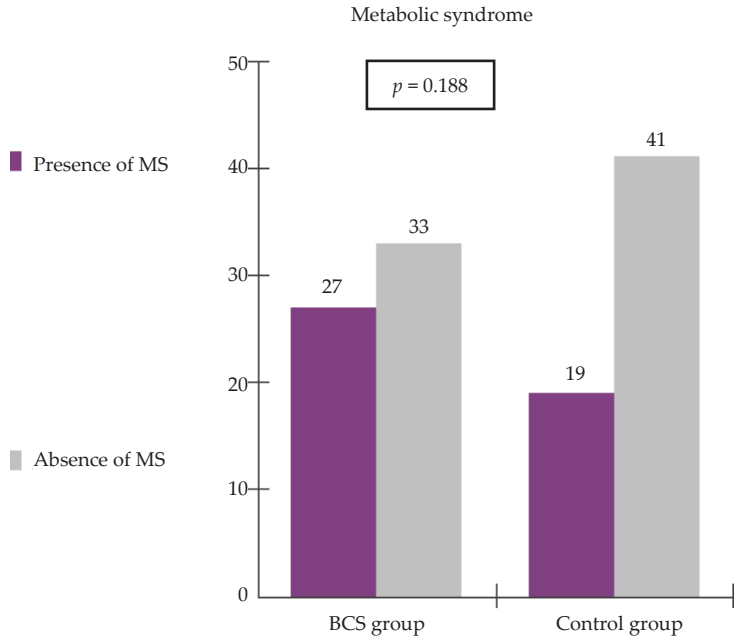
Variables	Control group (mean ± SD)	BCS group (mean ± SD)	p
Age (years)	49.06 ± 6.22	48.86 ± 7.23	0.871[a]
DAP (mmHg)	86.08 ± 14.11	83.5 ± 14.24	0.320[a]
Weight (Kg)	62.15 ± 11.45	69.36 ± 13.01	**0.002**[a]
Height (m)	1.54 ± 0.05	1.53 ± 0.05	0.703[a]
BMI (Kg/m²)	26.08 ± 4.40	29.27 ± 5.18	**0.0004**[a]
AC (cm)	86.18 ± 15.33	92.08 ± 13.56	**0.021**[a]
HC (cm)	93.63 ± 9.33	99.89 ± 11.49	**0.001**[a]
HDL (mg/dL)	49.73 ± 14.9	49.43 ± 13.02	0.907[a]
LDL (mg/dL)	118.87 ± 35.54	132.5 ± 30.20	**0.020**[a]
VLDL (mg/dL)	32.10 ± 12.53	28.86 ± 10.90	0.134[a]
Triglycerides (mg/dL)	159.83 ± 59.07	143.25 ± 61.98	0.136[a]
	Median / IQR (25–75)	**Median / IQR (25–75)**	
SAP (mmHg)	120 110–132.5	120 110–130	0.636[b]
Cholesterol (mg/dL)	202 181–238.3	197.5 178.5–221.5	0.271[b]
WHR	0.92 0.84–0.95	0.93 0.89–0.97	0.207[b]
Glycemia (mg/dL)	95.5 89–104.5	90.5 85–102.25	0.096[b]
Insulin (μUI/mL)	5.79 3.50–12.3	6.81 3.40–1.03	0.603[b]
HOMAR- IR	1.42 0.84–2.93	1.65 0.74–2.71	0.437[b]

SD: standard deviation; IQR: interquartile range; BCS: breast cancer survivors; SAP: systolic arterial pressure; DAP: diastolic arterial pressure; BMI: body mass index; AC: abdominal circumference; HC: hip circumference; WHR: waist:to-hip ratio; HDL: high-density lipoprotein; LDL: low-density lipoprotein; VLDL: very low-density lipoprotein; HOMAR-IR: Homeostasis Model Assessment for Insulin Resistance; a: Student's t-test; b: Mann-Whitney test. p < 0.05 (significance).

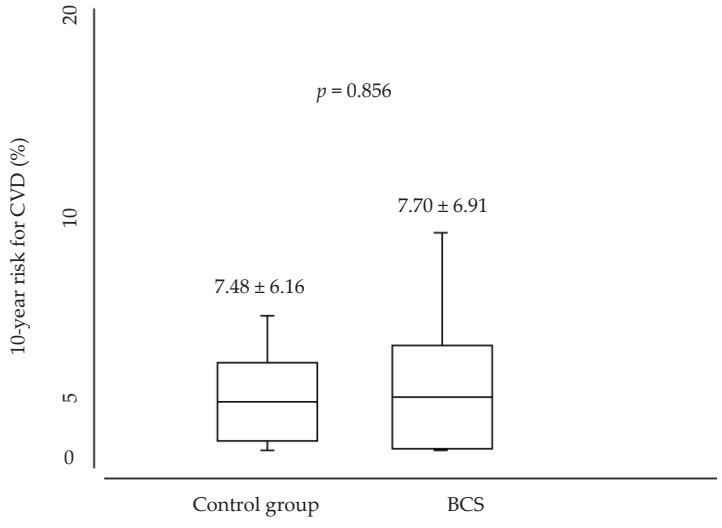
women with no cancer history.[20] In this study, we observed that almost half of our sample (45%) of BCS were diagnosed with MS. Similar results were observed in another study, where MS was present in 50% of female BCS and in 37.5% of participants in the control group. In this study, the most frequently observed diagnostic criteria were abdominal obesity (62.5%) and dyslipidemia (45.2%).[10] Another study, also performed with women with BC, reported that 69.2% of post-menopausal women had MS and 53.8% had advanced cancer stages, demonstrating that MS could influence a worsening of the BC prognosis.[4]

In a prospective study with 2092 patients followed-up due to BC, MS was significantly associated with menopause, HOMA-IR index, HC, and hypertension.[21] This corroborates findings from this study, where our logistic regression (Table 4) identified a higher risk of developing MS in women with increased HC. The occurrence of MS is 2.2 to 4.4 times higher in BCS than in the general population. These findings may reflect a lack of interest and education on MS among BCS.[5]

Drugs commonly used in cancer treatments, such as anthracyclines, camptothecins, epipodophyllotoxins, and platin-based agents, interrupt DNA replication and protein transcription and synthesis, thus compromising cell regeneration and growth. These agents may interact with receptors or second messengers, inducing gonadal hormone deficiencies, and produce reactive oxygen species leading to mitochondrial dysfunction. Anemia, apoptosis, and cell lysis may lead to tissue hypoxia, causing the liberation of pro-inflammatory cytokines and macrophage activation. All these effects



Graph 1 – Comparative analysis of metabolic syndrome (MS) diagnoses between female breast cancer survivors (BCS) and the control group, according to the National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III) criteria. Chi-squared test.



Graph 2 – Mean total 10-year risk for cardiovascular disease (CVD) in female breast cancer survivors (BCS) and the control group, according to the Framingham score. Student's t-test.

Table 4 – Impact of variables in the development of metabolic syndrome in female breast cancer survivors, after logistic regression. São Luís-MA, 2021

Variables	p	OR	(95% CI)
Menopause	0.630	0.684	0.15 to 3.12
Weight (Kg)	0.598	1.037	0.91 to 1.19
BMI (Kg/m²)	0.658	0.918	0.63 to 1.34
AC (cm)	0.455	1.056	0.91 to 1.22
HC (cm)	0.028	0.000	0.00 to 0.13
LDL (mg/dL)	0.853	0.998	0.98 to 1.20

OR: odds ratio; CI: confidence interval; BMI: body mass index; AC: abdominal circumference; HC: hip circumference; WHR: waist-to-hip ratio; LDL: low-density lipoprotein.

Table 5 – Risk of cardiovascular diseases in female breast cancer survivors (BCS) and the control group, according to the Framingham score. São Luís-MA, 2021

Cardiovascular risk	Control group		BCS group		*p*
	n	mean risk	n	mean risk	
Low	43 (73%)	4.48 %	44 (72%)	4.34 %	0.411[b]
Intermediate	15 (22%)	13.13 %	13 (25%)	14.48 %	0.750[a]
High	2 (5%)	29.50 %	3 (3%)	27.66 %	0.640[a]

A: Student's t-test; b: Mann-Whitney test. p < 0.05 (significant).
Note: the Student's t- and Mann-Whitney tests assessed differences between scores obtained in both groups in the Framingham scale (continuous variable). On table 5, such scores were transformed in percent values for risk stratification.

may contribute to the development of obesity, insulin resistance, and dyslipidemia, and ultimately to MS.[10]

Female BCS in this study had a mean Framingham risk score of 7.70%, thus being stratified as at low risk for CVD in 10 years (Graph 2). On the other hand, the WHR (which identifies the current cardiovascular risk according to an individual's body fat distribution) was above the threshold in both groups (Table 3), classifying them as at high CVD risk. Although the mean Framingham score in this study was lower than that reported by other studies, evidence shows that patients who underwent cancer treatment had a subsequent increase in CVD risk. The risk of developing CVD among patients with BC who underwent chemotherapy was 3 times higher than in patients who underwent surgery only, and it was 4.22 times higher in patients who had chemotherapy and radiotherapy.[22]

According to cardio-oncologists, cardiotoxic therapies (including chemotherapy or radiotherapy) are the main contributors to an increase in CVD risk in BCS.[23] In a case-control study with 2168 women from Northern Europe with breast adenocarcinoma treated with radiotherapy,[24] each 7 Gy of radiation corresponded to an increase in cardiovascular risk of 7.4%. The risk was observed 5 years after receiving radiotherapy and persisted for 30 years.[25] Moreover, depression, anxiety, and stress and/or anguish were associated with a 30% increase in MS prevalence among cancer survivors. Many subjacent pathophysiological associations may also be driven by psychological health. Stress involving the exposure to treatment may cause interruptions in the production of hormones and neurotransmitters, which influences cardiovascular risk.[26]

A meta-analysis of data from 289 109 patients demonstrated that mortality due to CVD was higher among women who underwent radiation therapy for BC in the left breast in comparison to those who had it in the right breast.[27] This way, our findings indicating that the right breast was more affected and a mean follow-up to the end of treatment of only 4 years (according to Table 2) may explain the low 10-year risk for CVD in female BCS and the absence of statistical differences when compared to the control group ($p > 0.05$).

Despite some limitations, such as the difficulty in establishing a causal association between the analyzed variables and MS due to the sample size and cross-sectional nature of the study, our work provided important clinical information on cardiometabolic factors present in BCS. This is the first step for identifying the frequency of risk factors in BCS, allowing the allocation of important subsidies for elaborating public health policies and personalized treatment plans that are less harmful and cardiotoxic.[28-29]

Conclusion

This study demonstrated a higher prevalence of MS among female BCS, possibly due to overweight. Although the studied population presented a low risk for CVD, we recommend that female BCS adopt healthy lifestyles, as well as rigorous screening and control of cardiometabolic risk factors. However, longitudinal cohort studies with these women are still needed for the development of more accurate risk prediction models for MS and CVD.

Author contributions

Conception and design of the research: LM Silva. Acquisition of data: LM Silva. Analysis and interpretation of the data: LM Silva. Statistical analysis: LM Silva, JA Figueiredo Neto. Writing of the manuscript: LM Silva, JA Figueiredo Neto. Critical revision of the manuscript for intellectual content: JA Figueiredo Neto.

Potential Conflict of Interest

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

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Study Association

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Ethics approval and consent to participate

This study was approved by the Ethics Committee of the *Universidade Federal do Maranhão* under the protocol number 2.386.296. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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