DIETARY TOTAL ANTIOXIDANT CAPACITY IN CANCER PATIENTS UNDERGOING AMBULATORY TREATMENT

CAPACIDADE ANTIOXIDANTE TOTAL DA DIETA DE PACIENTES COM CÂNCER EM TRATAMENTO AMBULATORIAL

CAPACIDAD ANTIOXIDANTE TOTAL DE LA DIETA DE PACIENTES CON CÁNCER EN TRATAMIENTO AMBULATORIO

Paula Sabino Louzada[1], Naruna Pereira Rocha[2], Mayla Cardoso Fernandes Toffolo[3]

ABSTRACT
OBJECTIVE: To evaluate the dietary total antioxidante capacity and associated factors in cancer patients undergoing ambulatory treatment. **METHODS:** A cross-sectional study carried out with cancer patients in 2020, evaluating sociodemographic data, disease treatment, food frequency and a 24-hour recall. Anthropometric measurements were taken for weight classification. To determine the total antioxidant capacity of the diet (CATd) a database with the total content of food antioxidants was used. Statistical significance of $p<0.05$ was adopted. **RESULTS:** The median antioxidant consumption was 3.29 ± 1.82mmol/g. Patients with CATd above the median had higher consumption of carbohydrates, proteins, lipids, vitamin C and E ($p<0.05$). There was no relationship between CATd and anthropometric measurements. **CONCLUSION:** The antioxidant capacity of the diet was associated with the consumption of macronutrients and vitamin C and E, but was not related to anthropometric measurements.
Descriptors: Neoplasms, Eating, Antioxidants

[1] Nutritionist at Unifaminas University Center. Muriae, MG, Brazil. https://orcid.org/0000-0001-8797-3611

[2] Nutritionist at the Clinical Hospital of the Federal University of Triângulo Mineiro. PhD in Nutrition Science. Uberaba, MG, Brazil. https://orcid.org/0000-0001-7513-3906

[3] Professor of the Nutrition course at the Federal University of Ouro Preto. Doctor in Health. Ouro Preto, MG, Brazil. https://orcid.org/0000-0002-0260-6028

RESUMO

OBJETIVO: Avaliar a capacidade antioxidante total da dieta e fatores associados em pacientes com câncer em tratamento ambulatorial. **MÉTODOS:** Estudo transversal, realizado com pacientes oncológicos em 2020, sendo avaliados os dados sociodemográficos, tratamento da doença, frequência alimentar e um recordatório de 24 horas. Medidas antropométricas foram aferidas para a classificação do peso. Para a determinação da capacidade antioxidante total da dieta (CATd) foi utilizado um banco de dados com o conteúdo total de antioxidantes de alimentos. Adotada a significância estatística de p<0,05. **RESULTADOS:** A mediana do consumo de antioxidante foi de 3,29±1,82mmol/g. Os pacientes que apresentaram o CATd acima da mediana tiveram maior consumo de carboidratos, proteínas, lipídios, vitamina C e E (p<0,05). Não houve relação entre o CATd e as medidas antropométricas. **CONCLUSÃO:** A capacidade antioxidante da dieta esteve associada ao consumo de macronutrientes e de vitamina C e E, mas não apresentou relação com as medidas antropométricas.

Descritores: Neoplasias; Ingestão de Alimentos; Antioxidantes.

RESUMEN

OBJETIVO: Evaluar la capacidad antioxidante total de la dieta y factores asociados en pacientes oncológicos en tratamiento ambulatorio. **MÉTODOS:** Estudio transversal realizado con pacientes oncológicos en 2020, evaluando datos sociodemográficos, tratamiento de la enfermedad, frecuencia de alimentación y recordatorio de 24 horas. Se tomaron medidas antropométricas para la clasificación de peso. Para determinar la capacidad antioxidante total de la dieta (CATd) se utilizó una base de datos con el contenido total de antioxidantes de los alimentos. Se adoptó la significación estadística de p<0,05. **RESULTADOS:** La mediana del consumo de antioxidantes fue de 3,29±1,82mmol/g. Los pacientes con CATd por encima de la mediana tenían mayor consumo de carbohidratos, proteínas, lípidos, vitamina C y E (p<0,05). No hubo relación entre CATd y medidas antropométricas. **CONCLUSIÓN:** La capacidad antioxidante de la dieta se asoció con el consumo de macronutrientes y vitamina C y E, pero no se relacionó con las medidas antropométricas.

Descriptores: Neoplasias, Ingestión de Alimentos, Antioxidantes

INTRODUCTION

Cancer is a disease that comprises a wide group of diseases that are characterized by the uncontrolled, invasive and rapid growth and proliferation of cells, altering their genetic material.[1] Neoplastic diseases represent the second cause of death worldwide and it is expected that the number of new cases will increase significantly in the coming decades.[2] In Brazil, between the years 2020 and 2022, it is estimated that 625,000 new cases will occur each year.[3]

Tumor development and growth produce a cascade of changes in energy metabolism, nutrient utilization, and immune metabolism, changes consistent with the metabolic stress caused by cancer.[4]

Individuals with cancer have high concentrations of oxidant markers and low concentrations of antioxidant substances.[4] However, it is possible to intervene in this imbalance between pro-oxidant and antioxidant molecules through a balanced diet rich in antioxidants, such as a diet rich

in in vitamins A, E, C, selenium and carotenoids.[5]

Antioxidants act in the body's defense, acting at different levels of protection, including repairing damage already caused.[6] Their mechanism of action involves neutralizing or eliminating free radicals, reducing reactions with lipids and proteins, including DNA bases.[7]

The literature reports positive results between the consumption of foods with functional properties in antioxidant defenses and reduction of oxidative damage.[8] These compounds could help reduce the disease progression process, before and during treatment, which can lead to better results long-term.[9] Therefore, it is important to assess the quality of food in cancer patients.

Nutritional intervention, especially when performed at the beginning of the disease, can help reduce morphological changes, favoring treatment and providing adequate conditions for the nutritional status, immunity and quality of life of cancer patients.[1,6]

OBJECTIVE

To assess the total dietary antioxidant capacity and associated factors of cancer patients undergoing outpatient treatment.

METHODS

Search type and location

This is a cross-sectional study carried out with adult patients of both sexes from an oncological hospital in the city of Muriaé - MG, carried out from February to March 2020.

Population, sample, inclusion and exclusion criteria

The selection of participants was obtained through convenience sampling, including cancer patients undergoing outpatient treatment who were undergoing radiotherapy and/or chemotherapy at the time of the survey. There was no restriction regarding the type of cancer the patient had. Children, adolescents, pregnant women or patients who were not under outpatient follow-up were not included.

Ethical aspects

The research was guided by Resolution 466/12 of the National Health Council, which covers the ethical aspects involved in research with human beings, and was only carried out after being approved by the Human Research Ethics Committee of UNIFAMINAS under CAAE number 26729919.0. 0000.5105.

Procedures

The information collected was obtained through a structured questionnaire with socioeconomic questions, gender, age, education, lifestyle and current diet. Data on the frequency of food consumption were collected through a single Food Frequency Questionnaire (FFQ), which assessed food consumption in the last 6 months. Consumption ≥5 times/week was considered a dietary habit.

A 24-hour recall was also applied. In order to help determine portion sizes, an album was used with photos of utensils of different sizes, foods and preparations in different portions, which were shown to respondents when completing the 24-hour recall.

The weight (kg), height (m) and waist circumference of the participants were evaluated. For weight measurement, patients were barefoot and wearing light clothing. For the measurement of height, the patients remained standing, in the orthostatic position, being asked to perform a maximum inspiration, and at this moment the height measurement was taken at the vertex of the head. Body mass index (BMI-kg/m²) was calculated using weight and height. For BMI classification, the cutoff points of the World Health Organization (1995) were adopted.[10] The waist circumference was classified according to the World Health Organization (1998)[10], which determines the measurement at the midpoint between the iliac crest and the last costal arches. As a risk cutoff point, values ≥ 94cm for men and ≥ 80cm for women were used.

Food consumption data were analyzed using the Dietbox® software, and the average caloric intake of lipids, carbohydrates and proteins of the patients was evaluated.

For the determination of the total antioxidant capacity (CATd), a comprehensive database consisting of the total antioxidant content of typical foods, as well as other food items, such as traditional medicinal plants, spices and food supplements, was used.[11] The methodology used for the CATd determination in this previously published study was based on a modified version of the Ferric Reducing Antioxidant Power (FRAP) assay that measures iron reduction in the presence of antioxidants.

Each food or preparation has a certain amount of antioxidants which is expressed in mmol/100g. CATd was evaluated by the result of the sum of the antioxidant capacity of each food/preparation consumed by the individual during the day, expressed in mmol/day.[12]

To assign a CAT value to foods that were not available in the articles and in the database, food data with botanical similarity was used. When CAT values for cooked foods were not available, CAT levels of fresh foods were considered for estimation. Macronutrients were evaluated according to their acceptable distribution.[13]

Statistical analysis

Analyzes were performed using Stata software (version 13.0). The descriptive analyzes of the variables were presented using absolute and relative frequencies, means, medians, standard deviations and interquartile ranges of the variables of interest.

The Kolmogorov-Smirnov test was used for analysis of normality. Pearson's chi-square test was used for categorical variables and the Mann-Whitney test was used for continuous variables. For statistical analysis, the CATd was categorized into values above and below the median consumption presented by the participants, since there is no cut-off point so far. For all analyses, statistical significance of $p < 0.05$ was adopted.

RESULTS

This study had the participation of 58 people, the majority (62.07%) being male, with complete primary education (44.83%) and married (50.0%). The mean age of participants was 53.0±13.59 years.

It was found that 5.17% of the patients reported a diagnosis of diabetes mellitus and 34.48% of arterial hypertension, with 68.97% having a positive history for some non-communicable chronic disease. Regarding the type of cancer presented, there was a higher percentage of cancer of the gastrointestinal tract (36.21%), followed by breast cancer (34.48%) and genitourinary tract (13.79%).

Most patients underwent cancer treatment for 15±23.69 months. Chemotherapy associated with surgery was the treatment most cited by patients (41.38%), followed by chemotherapy (31.03%). Regarding lifestyle, it was observed that 58.62% of those evaluated had already consumed alcohol at some point in their lives. Almost half of the participants (46.55%) reported being smokers or ex-smokers. Only 17.24% of patients had the habit of practicing physical activity, and 63.79% considered that before the cancer diagnosis they had good lifestyle habits. More than half of the patients (63.79%) reported currently worrying about eating (Table 1).

Table 1. Lifestyle of cancer patients in outpatient treatment, Muriaé-MG (2020)

Variable		No	%
Consumption of alcoholic beverage*	Yes	34	58.62
	No	24	41.38
Smoking**	Yes	27	46.55
	No	31	53.45
practice of physical activity	Yes	10	17.24
	No	48	82.76
Good Life Habits Before Diagnosis***	Yes	37	63.79
	No	21	36.21
Concern about food	Yes	37	63.79
	No	21	36.21

note: N: sample size; %: percentage,
*Patients who have already consumed alcohol.
** Current smoking or patients who have stopped smoking.
***According to self-report

Regarding anthropometric data, the mean current BMI was 24.94±5.78 kg/m². It was observed that 34.48% of those assessed were overweight by BMI and that 56.90% of the patients were at risk for cardiovascular disease. Overweight/obesity was found in 34.48% of participants by AC and in 58.71% by PCT (Table 2).

Table 2. Classification of the nutritional status of cancer patients undergoing outpatient treatment Muriaé, MG (2020)

Variables	No	%
BMI		
Malnutrition	9	15.52
Eutrophy	29	50.00
Overweight	9	15.52
Obesity	11	18.96
Waist Circumference		
No cardiovascular risk	25	43.10
With cardiovascular risk	33	56.90
CMB		
Eutrophy	38	65.52
Malnutrition	20	34.48
Arm Circumference		
Malnutrition	19	32.76
Eutrophy	26	44.83
Overweight/obesity	13	34.48
PCT		
Malnutrition	14	24.14
Eutrophy	10	17.15
Overweight/obesity	34	58.71

Note: BMI: body mass index; AMC: arm muscle circumference; PCT: triceps skinfold.

More than half (53.45%) of the patients reported weight reduction during cancer treatment, with an average of 11.52 ± 7.34 kg. Regarding the symptoms presented during treatment, it was observed that 62.07% had some symptoms such as nausea, vomiting, fatigue, dysphagia, among others. It was found that all patients had an average daily intake of 4±1.12 meals/day and only 20.69% used some food supplement.

With regard to eating habits, most patients (58.62%) reported changing eating habits after the cancer diagnosis. It was observed that 65.52% reported regular consumption of vegetables, on the other hand, 51.72% of the evaluated did not have the habit of consuming leafy vegetables. Regarding meat and eggs, it was observed that consumption was not usual for most patients, with only 20.69% habitually consuming beef (Table 3).

Table 3. Eating habits (consumption $\geq$ 5/week) of cancer patients undergoing outpatient treatment Muriaé, MG (2020)

Group	Eating habits	
	< 5 times/week	≥ 5 times/week
Rice	13.79	86.21
Bread	43.10	56.90
Cookie/cake	58.62	41.38
Noodle	94.83	5.17
Legumes	12.07	87.93
Vegetables	34.48	65.52
Leafy vegetables	51.72	48.28
Fruits	44.83	55.17
Eggs	84.48	15.52
Skimmed milk and derivatives	89.66	10.34
Whole milk and derivatives	34.48	65.52
Beef	79.31	20.69
Pork	94.83	5.17
Chicken	84.48	15.52
Fish	98.28	1.72
Fried food	94.83	5.17
Sausages	98.28	1.72
Artificial Drinks	93.10	6.90

Note:%: percentage.

Regarding the caloric contribution of macronutrients, it was observed that on average 55% of calories came from carbohydrates, 18% from proteins and 28% from lipids. The caloric average observed through the 24-hour recall was 1082.62 ± 590.52 kcal/day.

Regarding antioxidant consumption, it was observed that patients had a median intake of 3.29±1.82 mmol/g per day. When verifying the association between the median of antioxidant capacity and the consumption of macro and micronutrients, patients who had CATd above the median had a higher consumption of carbohydrates, proteins, lipids, vitamin C and E (p<0.05) (Table 4).

Table 4. Median nutrient intake according to the total antioxidant capacity of cancer patients undergoing outpatient treatment Muriaé, MG (2020)

Variables	catd		P
	< 3.29 mmol/g Mean ± SD	≥ 3.29 mmol/g Mean ± SD	
Carbohydrates (grams)	101.79 ± 50.91	197.43 ± 98.02	0.001*
Protein (grams)	33.50 ± 15.92	60.63 ± 35.18	0.006*
Lipids (grams)	24.14 ± 13.13	42.23 ± 18.96	0.001*
Vitamin A (ug)	516.62 ± 732.34	1138.35 ± 2485.93	0.132
Vitamin C (mg)	38.67 ± 51.22	79.55 ± 74.21	0.006*
Vitamin E (mg)	3.06 ± 2.52	6.89 ± 4.68	<0.0001*

SD: Standard deviation. Mann Whitney test. P<0.05= statistical significance.

There was no association between consumption of CATd and anthropometric variables among the evaluated patients (p>0.05) (Table 5).

Table 5. Mean of anthropometric variables according to the Catd of cancer patients undergoing outpatient treatment Muriaé, MG (2020)

Variables	Catd (mmol/g)		P
	< 3.29 mmol/g Mean ± SD	≥ 3.29 mmol/g Mean ± SD	
Age	51.20 ± 14.31	53.89 ± 12.94	0.651
Current weight	68.49 ± 14.10	65.52 ± 14.55	0.528
BMI	24.64 ± 4.20	25.21 ± 7.09	0.839
CMB	23.20 ± 3.07	22.07 ± 2.40	0.178
CC	88.44 ± 11.68	88.18 ± 12.84	0.956
PCT	21.58 ± 7.86	22.79 ± 10.02	0.634

SD: Standard deviation. Mann Whitney test. $P < 0.05$= statistical significance.

DISCUSSION

The present study examined the total dietary antioxidant capacity of cancer patients undergoing outpatient treatment and explored the relationships between diet, anthropometric variables, lifestyle and sociodemographic characteristics.

It was observed that patients withCATd equal to or above the median (3.29 mmol/g) showed higher consumption of carbohydrates, proteins, lipids, vitamin C and E. The relationship between the highest median CATd and higher consumption of macro and micronutrients may be associated with greater variety in the diet, allowing greater consumption of food sources of antioxidants.[14]

Antioxidants are compounds that can delay or inhibit the oxidation of lipids, their function is to combat free radicals, prevent inflammatory processes, improve the immune system and act in the cellular reconstruction of damaged cells, as happens with cancer patients undergoing chemotherapy and/or radiotherapy.[6] The imbalance between oxidant and antioxidant compounds results in damage known as oxidative stress, which is related to several pathologies, including the process of carcinogenesis.[15]

Higher levels of CATd before and during cancer treatment promote a

protective effect against the exacerbation of oxidative stress caused by it, and it seems that the variety of antioxidant sources is important for these results, since antioxidant molecules derived from food can act in synergism.[16] In that study, there was no association between the CATd and the anthropometric measurements of the evaluated patients. The lack of association may be related to the characteristics of the patients, who are in constant anthropometric alteration due to the treatment, such as loss of weight and muscle mass.[17,18]

This alteration can be seen by the anthropometric changes found in the sample, since more than half of the patients reported weight loss. During the treatment of the oncological disease, several patients present, in addition to weight loss, anorexia and specific nutrient deficiencies that aggravate their clinical and nutritional condition. These patients evolve acutely to severe protein-calorie malnutrition, mainly due to the presence of systemic inflammation.[1]

Although more than half of the patients reported weight loss during cancer treatment, the presence of abdominal fat and cardiovascular risk was present in most of them (56.90%). Cancer and cardiovascular disease have many risk factors in common and often coexist in the same individuals.[19] The overlapping of CVD and cancer risk and prevention factors suggests that these diseases apparently have some common basic molecular pathways. Chronic inflammation may play a considerable role, as it contributes so much to disease and occurs in conditions such as obesity, diabetes, hypertension, and dyslipidemia.[20]

The high prevalence of cardiovascular risk factors in cancer patients was demonstrated in the study of the pioneer cardio-oncology program at the University Hospital of Cancer in Brazil, with 60.4% of patients with hypertension, 23.9% with diabetes and 22, 4% with dyslipidemia.[21]

Most patients had gastrointestinal symptoms that made it impossible or reduced their ability to maintain adequate nutrition. Of these, less than a third used food supplements.

The food intake of cancer patients should always be investigated, since the presence of nutritional deficiencies is common, considering the increased needs and losses associated with the decrease in food intake.[2] Symptoms such as vomiting, nausea, mucositis, diarrhea, constipation, dysgeusia , dysosmia, among others, are commonly observed in these patients.[1,17]

With regard to eating habits, most patients reported changes in eating habits after the cancer diagnosis. When evaluating the food groups, there was

regular consumption of vegetables, but low consumption of leafy vegetables, meat and eggs was observed. A study carried out at the Hospital das Clínicas of UFMG showed that the consumption of foods from the rice, bread, pasta, potatoes, cassava, vegetables, fruits and dairy products groups were below the recommended number of servings.[22] The low consumption of fibers, calcium and iron has been evidenced in the diet of patients undergoing cancer treatment.[23]

Unhealthy eating patterns such as the Western diet and high consumption of saturated/trans fats and high-fat dairy products may worsen cancer prognostic outcomes. However, animal proteins such as fish, poultry, low-fat dairy products and meat should not be excluded from the cancer patient's diet.[24] A dietary pattern with higher consumption of antioxidant foods should be encouraged among patients undergoing treatment and câncer remission.

Cancer patients generally undergo treatment with chemotherapy, radiotherapy and/or surgery to resect the tumors.[24] These procedures can cause side effects that lead the patient to have difficulty eating, having to change their eating routine according to the symptoms and side effects of the treatment, making them unable to tolerate different types of food.[1,2,17] In the anamnesis of cancer patients, it is important to verify the type of treatment performed or that will be established by the clinical team, since depending on the type of treatment, side effects can be improved and/or minimized.[1]

Food adequacy with the inclusion of foods from all food groups should be offered to this public. Changes in consistency, form of presentation and need for oral nutritional supplementation may be required as a way to maintain or restore nutritional status.[1,17] Since nutritional deficit has been associated with reduced response to treatment, and risk of increased toxicity, with consequent worsening of quality of life.[2,5]

The average caloric contribution of macronutrients in the patients' diet was within the values established by the DRIs for adults.[15] The adequacy of macronutrient consumption is important to avoid nutritional insufficiencies and excesses that can negatively impact the nutritional status of individuals, influencing the decrease in quality of life.[1,2,5]

CONCLUSION

This study found that the antioxidant capacity of the diet was associated with the consumption of macronutrients and vitamin C and E, but was not related to anthropometric

measurements. Most patients were eutrophic in relation to anthropometric indices, with the exception of waist circumference and WC, which were overweight/obese; however, more than half of the patients reported weight loss during cancer treatment.

Most of the patients presented dietary changes after the diagnosis of cancer, with non-habitual consumption of leafy vegetables, meat and eggs.

As a limitation, we highlight the small and convenience sample, belonging to the scope of a single hospital, not allowing the generalization of the results found.

Despite the limitations found, studies that evaluate the food consumption and nutritional status of cancer patients should be carried out with the aim of improving the quality of life of patients and allowing preventive actions to be carried out.

REFERENCES
1. Pinho NB, organizador. I Consenso brasileiro de nutrição oncológica da SBNO [Internet]. Rio de Janeiro: Sociedade Brasileira de Nutrição Oncológica; 2021 [citado em 10 jan 2023]. 64 p. Disponível em: https://www.sbno.com.br/wp-content/uploads/2021/07/consenso_2021.pdf
2. Muscaritoli M, Arends J, Bachmann P, Baracos B, Barthelemy N, Bertz H, et. al. ESPEN practical guideline: clinical Nutrition in câncer. Clin Nutr. [Internet]. 2021 [citado em 28 mar 2022]; 40(5):2898-2913. Disponível em: https://www.clinicalnutritionjournal.com/article/S0261-5614(21)00079-0/fulltext
3. Instituto Nacional de Câncer. Estimativa da incidência e mortalidade por câncer no Brasil 2018. Rev Bras Cancerol. [Internet]. 2018 [citado em 28 mar 2022]; 64(1):119-20. Disponível em: https://rbc.inca.gov.br/index.php/revista/article/view/115/55
4. Mendonça P, Carioca AAF, Maia FFM. Interações entre estresse oxidativo, terapia utilizada e estadiamento em pacientes com câncer colorretal. Rev Bras Cancerol. [Internet]. 2014 [citado em 28 mar 2022]; 60(2):129-31. Disponível em: https://rbc.inca.gov.br/index.php/revista/article/view/477/281
5. Portantiolo TS, Vale IAV, Bergman RV, Abib RT. Consumo de vitaminas antioxidantes por mulheres com câncer de mama submetidas ao tratamento quimioterápico na cidade de Pelotas RS. Rev Bras Cancerol. [Internet]. 2014 [citado em 28 mar 2022]; 60(4):323-24. Disponível em: https://rbc.inca.gov.br/revista/index.php/revista/article/view/450/265
6. Santos HS, Cruz WMA. A Terapia nutricional com vitaminas antioxidantes e o tratamento quimioterápico oncológico. Rev Bras Cancerol. [Internet]. 2001 [citado em 28 mar 2022]; 47(3):303-8. Disponível em: http://www1.inca.gov.br/rbc/n_47/v03/pdf/artigo7.pdf
7. Bastos DH, Rogero MM, Arêas JA. Mecanismos de ação de compostos bioativos dos alimentos no contexto de processos inflamatórios relacionados à obesidade. Arq Bras Endocrinol Metab. [Internet]. 2009 [citado em 28 mar 2022]; 53(5):646-56. Disponível em: http://www.scielo.br/pdf/abem/v53n5/17.pdf

8. Bacchetti T, Turco I, Urbano A, Morresi C, Ferretti G. Relationship of fruit and vegetable intake to dietary antioxidant capacity and markers of oxidative stress: a sex-related study. Nutrition. [Internet]. 2019 [citado em 28 mar 2022]; 61:164-72. Disponível em: https://pubmed.ncbi.nlm.nih.gov/30716560/. doi: 10.1016/j.nut.2018.10.034

9. Reitz LK, Baptista SL, Santos EDS, Hinnig PF, Rockenbach G, Vieira FGK, et al. Diet quality is associated with serum antioxidant capacity in women with breast cancer: a cross sectional study. Nutrients. [Internet]. 2020 [citado em 28 mar 2022]; 13(1):115. Disponível em: https://pubmed.ncbi.nlm.nih.gov/33396963/. doi: 10.3390/nu13010115

10. Ribeiro SML, Melo CM, Quaresma MVLS. Avaliação nutricional de adultos. In: Ribeiro SML, Melo CM, Tirapegui J. Avaliação nutricional: teoria e prática. 2a ed. Rio de Janeiro: Guanabara Koogan; 2018. 32-40 pp.

11. Carlsen M, Bente L, Halvorsen BL, Holte K, Bøhn SK, Dragland S, et al. The total antioxidant content of more than 3100 foods, beverages, spices, herbs and supplements used worldwide. Nutr J. [Internet]. 2010 [citado em 28 mar 2022]; 9(3). Disponível em: https://nutritionj.biomedcentral.com/articles/10.1186/1475-2891-9-3

12. Felício MB. Risco cardiometabólico de pacientes do programa DICA-BR com ênfase na capacidade antioxidante total da dieta e grau de processamento dos alimentos [Internet]. [dissertação]. Viçosa, MG: Universidade Federal de Viçosa; 2018 [citado em 10 jan 2023]. 117p. Disponivel em: https://www.locus.ufv.br/handle/123456789/23709

13. Institute of Medicine. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids [Internet]. Washington, DC: The National Academies Press; 2005 [citado em 10 jan 2023]. Disponível em: https://nap.nationalacademies.org/catalog/1 0490/dietary-reference-intakes-for-energy-carbohydrate-fiber-fat-fatty-acids-cholesterol-protein-and-amino-acids

14. Ferrari CKB. Capacidade antioxidante total (CAT) em estudos clínicos, experimentais e nutricionais. J Health Sci Inst. [Internet]. 2010 [citado em 28 mar 2022]; 28(4);307-10. Disponível em: https://repositorio.unip.br/wp-content/uploads/2020/12/V28_n4_2010_p307-310.pdf

15. Barbosa KB, Costa NMB, Alfenas RCG, Paula SO, Minim VPR, Bressan J. Estresse oxidativo: conceito, implicações fatores modulatórios. Rev Nutr. [Internet]. 2010 [citado em 28 mar 2022]; 23(4):629-43. Disponível em: https://www.readcube.com/articles/10.1590%2FS1415-52732010000400013

16. Reitz LK, Schroeder J, Longo GZ, Boaventura BCB, Di Pietro PF. Dietary Antioxidant capacity promotes a protective effect against exacerbated oxidative stress in women undergoing adjuvant treatment for breast cancer in a prospective study. Nutrients. [Internet]. 2021 [citado em 28 mar 2022]; 13(12):4324. doi:https://doi.org/10.3390/nu13124324

17. Horie LM, Barrére APN, Castro MG, Liviera AMB, Carvalho AMB, Pereira A, et al. Diretriz BRASPEN de terapia nutricional no paciente com câncer. Braspen J. [Internet]. 2019 [citado em 28 mar 2022]; 34(Supl):2-32. Disponível em: https://f9fcfefb-80c1-466a-835e-5c8f59fe2014.filesusr.com/ugd/a8daef_19da407c192146e085edf67dc0f85106.pdf

18. Costa JO, Vásquez CMP, Santana GJ, Silva NJ, Braz JM, Jesus AMR, et al. Capacidade antioxidante total do plasma e risco cardiometabólico em adultos jovens, não obesos e clinicamente saudáveis. Arq Bras Cardiol. [Internet]. 2017 [citado em 28 mar 2022]; 109(2): 140-47. Disponível em: https://www.scielo.br/pdf/abc/v109n2/pt_0066-782X-abc-20170095.pdf

19. Handy CE, Quispe R, Pinto X, Blaha MJ, Blumenthal RS, Michos ED et al. Synergistic opportunities in the interplay

between cancer screening and cardiovascular disease risk assessment: together we are stronger. Circulation. [Internet]. 2018 [citado em 28 mar 2022]; 138(7):727-34. Disponível em: https://pubmed.ncbi.nlm.nih.gov/30359131/

20. Koene RJ, Prizment AE, Blaes A, Konety SH. Shared risk factors in cardiovascular disease and cancer. Circulation. [Internet]. March 2016 [citado em 18 de nov 2022]; 133(11): 1104-14. Disponível em: https://pubmed.ncbi.nlm.nih.gov/26976915/

21. Costa IBSS, Bittar CS, Fonseca SMR, Silva CMPD, Rehder MHHS, Rizk SI, et al. Brazilian cardio-oncology: the 10-year experience of the Instituto do Cancer do Estado de São Paulo. BMC Cardiovasc Disord. [Internet]. 2020 [citado em 28 mar 2022]; 20(206):1-10. Disponível em: https://bmccardiovascdisord.biomedcentral.com/articles/10.1186/s12872-020-01471-8

22.Oliveira DR, Carvalho ESC, Campos LC, Leal JA, Sampaio EV, Cassali GD. Avaliação nutricional de pacientes com câncer de mama atendidas no serviço de mastologia do Hospital das Clínicas, Belo Horizonte (MG), Brasil. Ciênc Saúde Colet. [Internet]. 2014 [citado em 18 nov 2022]; 19(5):1573-80. Disponível em: https://www.scielo.br/j/csc/a/FV4VjWsG6gc58BZcL57nZjd/?format=pdf&lang=pt

23. Borges IF, Marinho EC, Custódio IDD, Gontijo CA, Paiva CE, Crispim CA, et al. Consumo alimentar e estado nutricional de mulheres em quimioterapia. Ciênc Saúde Colet. [Internet]. 2016 [citado em 18 nov 2022]; 21(7):2209-18. Disponível em: https://doi.org/10.1590/1413-81232015217.05412015

24. Rinninella E, Mele MC, Cintoni M, Raoul P, Ianiro G, Salerno L, et al. The facts about food after cancer diagnosis: a systematic review of prospective cohort studies. Nutrients. [Internet]. 2020 [citado em 18 nov 2022]; 12(8):2345. doi: https://www.mdpi.com/2072-6643/12/8/2345

25. Han D, Chung M, Park Y. Association of dietary total antioxidant capacity with cancer recurrence and mortality among breast cancer survivors: a prospective cohort study. Nutr Cancer. 2022 [citado em 18 nov 2022]; 74(9):3253-62. doi: https://pubmed.ncbi.nlm.nih.gov/35535682/