Diet Phytochemical Index: Application in Patients under Oncological Treatment

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Índice de Fitoquímicos da Dieta: Aplicação em Pacientes em Tratamento Oncológico

Índice Fitoquímico Dietético: Aplicación en Pacientes en Tratamiento Oncológico

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ABSTRACT

Introduction: Cancer treatment causes adverse effects that can change food consumption and consequently the intake of vitamins, fiber and phytochemicals. **Objective:** To apply the dietary Phytochemical Index (PI) in the food records of patients undergoing cancer treatment. **Method:** Cross-sectional study with individuals in cancer treatment. The participants' sociodemographic and clinical information was collected to characterize the population. Feeding was obtained through a 24-hour dietary recall and entered into the Nutrabem Pro® software to obtain macro and microchemical values, as well as phytochemical data. To evaluate the study with PI, the formula proposed by McCarty was applied. **Results:** Ten patients, predominantly females, with an average age of 58±2.1 years participated of the study. The overall mean of PI was 20.44±11.55, and the rising order of consumption was: lutein-zeaxanthin, alpha-carotene, lycopene, cryptoxanthin and beta-carotene. The foods that contributed the most for the intake of phytochemicals were: beetroot, carrots and Japanese pumpkin for beta and alpha-carotene; orange and papaya for beta-cryptoxanthin; tomato sauce, watermelon and papaya for lycopene; chicory and beetroot for lutein/zeaxanthin; and apple, banana and olive oil for phytosterol. PI was not associated with sociodemographic and clinical variables of the population. **Conclusion:** Patients in cancer treatment had a low consumption of phytochemicals. This result is consistent with an insufficient intake of fruits and vegetables, as they represent the main sources of carotenoids in meals, in addition to the low consumption of oilseeds and seeds, which are an important source of phytosterols.

Key word: neoplasms; feeding behavior; phytochemicals; diet, healthy.

RESUMO

Introdução: O tratamento do câncer provoca efeitos adversos que podem alterar o consumo alimentar e, consequentemente, a ingestão de vitaminas, minerais, fibras e fitoquímicos. **Objetivo:** Aplicar o Índice de Fitoquímicos (IF) da dieta nos registros alimentares de pacientes em tratamento oncológico. **Método:** Estudo transversal com indivíduos em tratamento oncológico. Foram coletadas informações sociodemográficas e clínicas dos participantes para caracterização da população. Os dados alimentares foram obtidos por meio de recordatório alimentar de 24 horas e inseridos no *software* Nutrabem Pro® para obtenção dos valores de macro e micronutrientes, bem como dos fitoquímicos. Para avaliar o IF, aplicou-se a fórmula proposta por McCarty. **Resultados:** Participaram do estudo 50 pacientes predominantemente do sexo feminino e com média da idade de 58±12,1 anos. A média geral do IF foi de 20,44±11,55, e a ordem crescente de consumo foi: luteína-zeaxantina, alfacaroteno, licopeno, criptoxantina e betacaroteno. Os alimentos que mais contribuíram para a ingestão dos fitoquímicos foram: beterraba, cenoura e abóbora-japonesa para beta e alfacaroteno; laranja e mamão para betacriptoxantina; molho de tomate, melancia e mamão para licopeno; almeirão e beterraba para luteína/zeaxantina; e maçã, banana e azeite para fitoesterol. O IF não se associou com as variáveis sociodemográficas e clínicas da população. **Conclusão:** Os pacientes em tratamento oncológico apresentaram baixo consumo de fitoquímicos. Esse resultado condiz com a ingestão insuficiente de frutas e hortaliças, as quais representam as principais fontes de carotenoides nas refeições, além do baixo consumo de oleaginosas e sementes, que configuram uma importante fonte de fitoesteróis.

Palavras-chave: neoplasias; comportamento alimentar; compostos fitoquímicos; dieta saudável.

RESUMEN

Introducción: El tratamiento del cáncer provoca efectos adversos que pueden modificar el consumo de alimentos y consecuentemente la ingesta de vitaminas, minerales, fibra y fitoquímicos. **Objetivo:** Aplicar el Índice Fitoquímico dietético (IF) en los registros alimentarios de pacientes en tratamiento oncológico. **Método:** Estudio transversal con individuos en tratamiento oncológico. Se recopiló la información sociodemográfica y clínica de los participantes para caracterizar la población. Los datos alimentarios se obtuvieron a través de un registro alimentario de 24 horas y se ingresaron al software Nutrabem Pro® para obtener valores de macro y micronutrientes, así como fitoquímicos. Para evaluar la FI se aplicó la fórmula propuesta por McCarty. **Resultados:** Participaron del estudio 50 pacientes, predominantemente del sexo femenino, con una edad media de 58±12,1 años. La media general de FI fue de 20,44±11,55, y el orden creciente de consumo fue: luteína-zeaxantina, alfacaroteno, licopeno, criptoxantina y betacaroteno. Los alimentos que más contribuyeron a la ingesta de fitoquímicos fueron: remolacha, zanahoria y calabaza japonesa para beta y alfacaroteno; naranja y papaya para betacriptoxantina; salsa de tomate, sandía y papaya para licopeno; achicoria y remolacha para luteína/zeaxantina; y manzana, plátano y aceite de oliva para fitosterol. El FI no se asoció con las variables sociodemográficas y clínicas de la población. **Conclusión:** Los pacientes en tratamiento oncológico presentaron un bajo consumo de fitoquímicos. Este resultado es consistente con el consumo insuficiente de frutas y verduras, que representan las principales fuentes de carotenoides en las comidas, además del bajo consumo de oleaginosas y semillas, que son una fuente importante de fitoesteroles.

Palabras clave: neoplasias; conducta alimentaria; composés phytochimiques; dieta saludable.

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INTRODUCTION

Cancer is a set of organic alterations that eventually causes the abnormal growth of cells whose etiology is multifactorial and is associated with modern lifestyle characterized by sedentarism, increase of intake of industrialized food, tobacco and alcohol use among other environmental and carcinogenic pollutant agents[1,2].

Annually, according to epidemiologic data, the number of cases diagnosed globally is approximately 12.7 million with estimates of rising to 21.3 million new cases and 13.1 million deaths until 2030[2].

The most common treatment options for the current types of cancer are surgery, radiotherapy and chemotherapy associated or not[3].

Chemotherapy is the modality of treatment utilized at the most, consisting in the administration of cytotoxic drugs to fight and kill cancerous cells. However, this therapy causes several side effects on healthy cells as well[4], the most frequent are: dysphagia, diarrhea or constipation, nausea, xerostomia, taste changes, among others. Many of these reactions can affect food intake and consequently, the patient's nutritional status[5,6].

It is known that reduction of food intake depletes fat and muscle tissues, aggravates the fragility of the patient and negatively impacts the tolerance to the treatment. Literature shows that less nutrients in the diet as vitamins and minerals and bioactive compounds worsens the clinical and nutritional status of oncologic patients[7,8].

Studies have shown that the intake of fruits, vegetables and greens are promising to inhibit the progression of cancer and increase survival after the diagnosis and treatment of the disease. The authors affirm that the benefits are attributed to the components as vitamins, minerals, fibers and phytochemicals[9,10].

"Phytochemical" originates from the Greek word *phyto*, which means plant. Phytochemicals are naturally occurring, antioxidant biologically active chemical compounds or produced by the secondary metabolism of the plants and may help to resist to infections caused by bacteria, fungi and virus. To be defined as a phytochemical, the effects must benefit the organism and sometimes, are responsible for the food colors[11,12].

The present study aims to apply the Phytochemical Index to the patients dietary recall to estimate the antioxidant action.

METHOD

Cross-sectional study utilizing diet recall of 50 patients in outpatient oncologic treatment at a countryside hospital of the State of São Paulo. It complied with Resolution number 466/2012[13] of the National Health Council and approved by the Institutional Review Board of the hospital, report number 3,588,356 (CAAE (submission for ethical review): 17466319.8.0000.5438).

A 24-hour recall data were obtained and inserted in the software Nutrabem Pro®[14] to obtain values of energy, macro and micronutrients and the following phytochemicals: beta-carotene, alpha-carotene, beta cryptoxanthin, lycopene, lutein-zeaxanthin, phytosterols, stigmasterol, campesterol and beta-sitosterol.

The formula proposed by McCarty[15] was applied to evaluate the Phytochemical Index:

$$\text{Phytochemical Index (PI)} = \frac{\text{Calories from foods rich in phytochemicals}}{\text{Total food calories}}$$

Food preferences and aversions further to the use of nutritional supplement were collected. In addition to dietary data, information about sex, age, type of neoplasm, body weight, Body Mass Index (BMI), arm and calf circumference were also obtained. BMI was classified according to the World Health Organization (WHO) for adults[16] and according to Lipschitz[17] for older adults.

Frisancho[18] percentile distribution table was utilized to analyze the measures of the arm circumference and the cutoff of 33 cm for women and 34 cm for women was adopted[19] to measure the calf circumference

After the data were tabulated, the measures of central tendency (mean and median) and the measures of dispersion (standard-deviation, minimum and maximum) were calculated for the descriptive analysis. The statistical analysis was based on the Student *t* and ANOVA tests to verify the difference of the mean of the Phytochemical Index between the groups in relation to the descriptive characteristics with level of significance of 5%. The software SPSS was utilized.

RESULTS

Of the 50 individuals of the study sample, most were women (68%) with mean age of 58±12.1 years. Table 1 presents sociodemographic and clinical data of the sample.

The mean of energy intake of the food recall was 1,405.8±536.2 calories and 68.2±38.8 grams of protein, the mean of the ratio protein/kg of body weight is 1 gram.

The overall mean of the index was 20.44±11.55. Graph 1 portrays the phytochemicals analyzed in the current study and the mean of the quantities found in the food of the patients investigated.

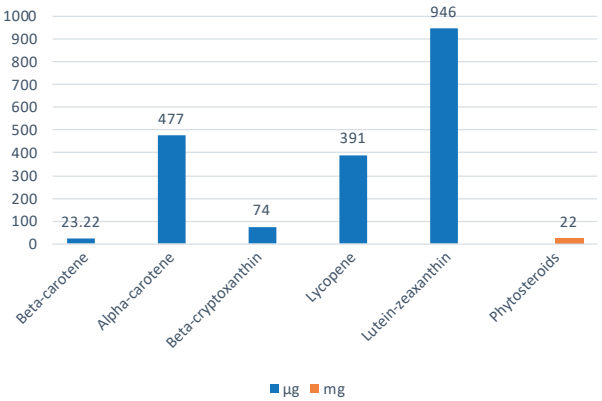
The food that contributed the most for the intake of phytochemicals were: beetroot, carrot and Japanese pumpkin for beta and alpha carotene; orange and papaya for beta cryptoxanthin; tomato sauce, water melon and

Table 1. Sociodemographic and clinical data of patients in oncologic treatment (n=50). Franca (SP), 2019

Variable	n	%
Sex		
Female	34	68
Male	16	32
Age		
Younger than 60 years	25	50
60 years or older	25	50
Type of neoplasm		
Breast cancer	16	32
GIT cancer	18	36
Others*	16	32
Classification of BMI of adults		
Malnutrition grade I	1	2
Eutrophy	9	18
Overweight	9	18
Obesity grade I	5	10
Obesity grade II	1	2
Classification of BMI of older adults		
Low weight	6	12
Eutrophy	10	20
Overweight	9	18
Arm circumference		
Satisfactory	14	28
Unsatisfactory	36	72
Calf circumference		
Satisfactory	31	62
Unsatisfactory	19	38

Captions: GIT = Gastrointestinal tract; BMI = Body Mass Index.

(*) Others: pancreas, leukemia, multiple myeloma, prostate, endometrial, urothelial and Hodgkin's lymphoma.



Graph 1. Mean values of phytochemicals evaluated

Table 2. Mean and standard-deviation of the Phytochemical Index according to the study population (n=50). Franca (SP), 2019

Variable	Phytochemical Index	*p*-value
Sex		
Female	21.00±12.60	0.547
Male	19.10±9.20	
Age		
Younger than 60 years	22.05±13.58	0.329
60 years or older	18.82±9.10	
Type of neoplasm		
Breast cancer	22.91±15.83	
GIT cancer	19.91±9.97	0.560
Others*	18.56±7.87	
Classification of BMI		
Low weight	14.84±6.24	
Eutrophy	21.68±14.35	0.387
Overweight	21.09±10.09	
Arm circumference		
Satisfactory	18.54±9.37	0.422
Unsatisfactory	21.18±12.34	
Calf circumference		
Satisfactory	19.23±8.80	0.410
Unsatisfactory	22.41±15.08	

Captions: GIT = Gastrointestinal tract; BMI = Body Mass Index.

papaya for lycopene; chicory and beetroot for lutein-zeaxanthin and apples and olive oil for phytosteroids.

Table 2 presents the mean of the Phytochemical Index of the diet of the groups of individuals divided in categories of the descriptive variables and the absence of statistical difference among these categories.

DISCUSSION

Females were predominant in the study sample, evenly distributed in adults and older adults, most of them overweighted.

According to the data of the last National Health Research[20], 60.3% of the adult Brazilian population are overweighted. Obesity was found in 21.8% of the men and 29.5% of the women aged 18 years or older[20]. Even oncologic patients with important nutritional deficit and risks of malnutrition have excess of body fat. The sample formed by women with breast cancer follows this pattern as weight gain can be detected before the diagnosis but may aggravate during the treatment of this neoplasm[21,22].

The findings of the literature indicate that the overweight of the population is associated with high energy density food, most of the times with low nutritional content[23]. In addition of not being a proper source of macro and micronutrients, they do not favor the intake of phytochemicals[23].

Although no cutoff value exist to adjust the PI of the diet, the mean revealed low contribution of these bioactive compounds in the diet of the patients evaluated when compared to the values suggested for good health and prevention of diseases[24]. The low intake is consistent with the findings of a national investigation about phytochemicals. The median of polyphenols intake adjusted to energy was 204 mg/1.000 kcal/day. The investigators concluded that the food which contributed the most for phytochemicals was coffee and orange juice and illustrates the low quality of the diet of the Brazilian population according to the values encountered[25].

Scholars who utilized the PI to evaluate the nourishment of individuals with breast cancer showed that the intake of fruits, greens, vegetables, nuts, soy products, olive oil and olives are rich in phytochemicals and suggested that the increase of intake of these food is associated with less odds of developing breast cancer[26]. Even with the disease already in development, the investigators indicated the benefit of eating more vegetables to obtain antioxidant protection of non-tumor cells. Women with breast cancer who participated of a counseling intervention about increase of phytochemicals intake not only elevated the serum levels of antioxidants but brought benefits for body composition[27].

Lutein was the phytochemical most consumed in the present study because it can be found in several green vegetables[28]. The second was alpha carotene, present especially in orange food as carrot, squash and red palm oil[28].

The other phytochemicals found in the food of oncologic patients were lycopene, cryptoxanthin, and beta carotene but in small quantities.

Lycopene is the carotenoid responsible for the red color of tomatoes and is also found in watermelon, guava and, in small quantities, in other foods as papaya and Surinam cherry. This pigment of antioxidant action appears to be better absorbed when warmed and due to this, tomato sauce and purée are more concentrated and bioavailable sources of this phytochemical[29,30].

A study with 48 patients with oral cavity and oropharynx cancer investigated the intake of carotenoids and found the presence of protective pigments in areas affected by the neoplasm. The investigators emphasize the importance of the intake to differentiate normal cells and increase of apoptosis of neoplastic cells[31].

Antioxidants as vitamin A, E and C, lutein, lycopene and beta carotene help to reduce chronic inflammation, an etiologic and proliferative factor of cancer as it is being increasingly found. A study with 160 women who submitted to breast cancer surgery showed that these antioxidants can create biological effects on the breast tissue and improving the inflammation[32].

In addition to carotenoids, the concentrations of phytosteroids in the food of the participants was also investigated, they are plant-based natural compounds with a similar structure of cholesterol that can help to treat dyslipidemia. The sources of these compounds are vegetable oils, oleaginous, cereals with wheat germ and bran, some vegetables and fruits as fruit-of-passion, orange and cauliflower[33].

The interest for phytochemicals as flavonoids, polyphenols and phytosteroids occurs due to the proven chemopreventive action protecting healthy cells from the oxidative stress caused by the oncologic treatment[34].

Not all the phytochemicals were evaluated with the software selected for the study as the source of information about their presence in food are scarce, which is a limitation of the study. It is possible that the values of the Phytochemical Index are slightly high. In addition, as in any clinical study utilizing food records, missing data or forgetfulness about what was ingested is an important bias and already anticipated in articles on that theme.

CONCLUSION

Patients in oncologic treatment present low intake of food phytochemicals, consistent with the insufficient consumption of fruits and vegetables, the main source of carotenoid of the meals, in addition to low intake of oleaginous and seeds, an important source of phytosteroids.

Strategies of nutritional education in oncologic patients should stimulate the intake of phytochemicals in the meals to promote the antioxidant action and protect the organism from the excessive damages provoked by the disease and treatment.

CONTRIBUTIONS

Marina Maria de Martino Melo and Amanda Cristina Torralbo Pugliesi contributed substantially to the study design, acquisition, analysis and interpretation of the data. Maisa Rodrigues de Paula and Fabiola Pansani Maniglia contributed substantially to the wording and critical review. All the authors approved the final version to be published.

DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interests to declare.

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