



Eating behaviors and physical activity during the COVID-19 pandemic lockdown: experiences of breast cancer patients on adjuvant hormonal therapy

Navike u ishrani i fizička aktivnost tokom restrikcije kretanja izazvane COVID-19 pandemijom: iskustva bolesnica sa karcinomom dojke na adjuvantnoj hormonalnoj terapiji

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Abstract

Background/Aim. Since the coronavirus disease 2019 (COVID-19) pandemic led to a strict lockdown in Serbia, the population has experienced drastic lifestyle changes. Physical distancing, self-isolation, limited availability of essential food products, and the stress related to the availability of therapy during the pandemic particularly affected the lives of vulnerable groups, such as breast cancer (BrC) patients. The aim of this study was to examine the changes in eating behaviors and physical activity of postmenopausal BrC patients on adjuvant hormonal therapy under the COVID-19 lockdown conditions. **Methods.** This observational retrospective *pre-post* cohort study included 32 women treated with aromatase inhibitors (AIs) who responded to telephone interviews using a structured questionnaire. The questionnaire aims to collect data on eating habits (intake of certain foods on a daily/weekly basis, as well as changes in

the usual choice of food), intake of supplements, changes in weight, and physical activity before and during the lockdown. **Results.** The results showed that, due to problems in obtaining groceries, the patients cooked and consumed homemade sweets and fruit more often (47% of the respondents), while fewer (31%) consumed fresh fish. Nearly 41% of patients reported increased food intake, and 88% reported decreased physical activity, which led to an increase in body weight in as many as 47% of subjects. The intake of supplements was doubled. **Conclusion.** The COVID-19 lockdown with home confinement exacerbated health risks and affected dietary patterns and physical activity, which may have had a negative impact on the long-term health of BrC patients treated with AIs.

Key words:

breast neoplasms; covid-19; eating; feeding behavior; home environment.

Apstrakt

Uvod/Cilj. S obzirom na to da je pandemija *coronavirus disease 2019* (COVID-19) dovela do stroge restrikcije kretanja u Srbiji, stanovništvo je doživelo drastične promene u načinu života. Fizičko distanciranje, samoizolacija, ograničena dostupnost osnovnih prehrambenih proizvoda i stres nastao usled otežane dostupnosti terapije tokom pandemije posebno su uticali na život ranjivih grupa, poput bolesnica sa karcinomom dojke (KD). Cilj rada bio je da se ispituju promene u navikama u ishrani i fizičkoj aktivnosti kod

bolesnica sa KD u postmenopauzi, koje su bile na adjuvantnoj hormonalnoj terapiji tokom restrikcije kretanja uvedene za vreme COVID-19 pandemije. **Metode.** U opservacionu retrospektivnu *pre-post* kohortnu studiju uključene su ukupno 32 žene, lečene inhibitorima aromataze (IA), koje su odgovarale na telefonske intervjuue putem strukturisanog upitnika. Upitnik je strukturisan sa ciljem prikupljanja podataka o navikama u ishrani (unos određene namirnice na dnevnom/nedeljnom nivou, kao i promena u uobičajenom izboru hrane), unosu suplemenata, promenama težine i zastupljenosti fizičke aktivnosti pre i tokom restrikcije

kretanja. **Rezultati.** Rezultati su pokazali da su bolesnice, usled problema u nabavci namirnica, češće (47% ispitanica) kuvale i konzumirale domaće slatkiše i voće, dok su manje (31%) konzumirale svežu ribu. Skoro 41% bolesnica prijavile su povećan unos hrane, a 88% smanjenu fizičku aktivnost, što je kod čak 47% ispitanica dovelo do povećanja telesne mase. Unos suplemenata bio je udvostručen. **Zaključak.** Restrikcija kretanja usled COVID-19, koja je podrazumevala

zabranu izlaska iz kuće, dovela je do pogoršanja zdravstvenih rizika i uticala na navike u ishrani i redovnu fizičku aktivnost, što je moglo imati negativan uticaj na dugoročno zdravlje bolesnica sa KD lečenih primenom IA.

Ključne reči: dojka, neoplazme; COVID-19; ishrana; ishrana, navike; životno okruženje, kuća.

Introduction

In the last three years, healthcare systems worldwide have been challenged by the novel coronavirus that causes severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in humans. The so-called coronavirus disease 2019 (COVID-19) was first reported in the city of Wuhan in China in December 2019, and since then, it has spread rapidly around the world¹. The first confirmed case of SARS-CoV-2 infection in Serbia emerged on March 6, and already on March 15, the government declared a state of emergency. All shops, except the pharmacies and grocery stores, were closed. Many jobs and all schools moved to work from home and online. All elderly people (over 65 years old) were prohibited from going outside of their homes. Due to these decisions, a sudden and radical change has appeared in everyday behaviors, eating habits, and the lifestyles of the whole population. Not only could self-isolation and physical inactivity adversely affect physical health but they can also increase stress². The reduced level and intensity of physical activity interact with body fat and appetite dysregulation³, increasing the risk of body weight (BW) gain. The closing of the markets made getting some groceries difficult. On the other hand, constant stress and negative emotions could have resulted in the loss of appetite⁴, suggesting that eating behaviors certainly changed during the COVID-19 pandemic. Therefore, studies on these adverse changes are essential for responding to and preventing public health consequences, especially in vulnerable population groups in future pandemics and lockdown conditions⁵. Among the most endangered populations were cancer patients. For many of them, the therapy and the follow-up examination were postponed, and the stress of both primary illness outcome and potential infection with the SARS-CoV-2 increased. Namely, cancer patients had a higher risk of COVID-19 infection and COVID-19-associated mortality compared to the general population^{6,7}.

In such circumstances, healthy and balanced nutrition is crucial. COVID-19 complications and mortality have often been related to cytokine storms, and gene expressions of all the cytokines are influenced by food components and can modulate courses of inflammation and oxidative stress⁸. The only study about the dietary habits and food preferences during the lockdown in the general population in Serbia⁹ has shown markedly increased intake of various supplements. Still, there is no data for the vulnerable groups, such as cancer patients. The most common cancer among postmenopausal women is breast cancer (BrC). A high energy intake, lack of physical activity, and an increased body mass index (BMI)

negatively affect the efficacy of the therapy and increase the risk of recurrence in BrC patients on adjuvant therapy¹⁰. Moreover, lifestyle changes in lockdown may aggravate these risk factors. Therefore, the aim of the study was to examine the changes in eating behaviors and physical activity under the COVID-19 pandemic lockdown conditions in postmenopausal women receiving adjuvant endocrine therapy for BrC.

Methods

Study design and setting

This study was designed as an observational retrospective *pre-post* cohort study. The assessment of dietary intake was based on a subjective retrospective report of the participants, using questions on eating habits and physical activity asked in relation to the period before the pandemic and during the lockdown from March 15 to May 6, 2020, when all residents were required to stay in quarantine in Serbia. The participants in this study were postmenopausal BrC patients receiving adjuvant hormone therapy with aromatase inhibitors (AIs). Before the COVID-19 pandemic, in December 2019, we monitored their nutritional status. Patients were recruited from the Department of Hematology at the Military Medical Academy (MMA), Belgrade, Serbia. Inclusion criteria were postmenopausal women with estrogen receptor (ER) positive and human epidermal growth factor receptor 2 (HER-2) negative BrC who received adjuvant hormonal therapy with AIs for at least six months. Excluding criteria were a metastatic or locally advanced disease, HER-2 positive BrC, previous stroke or heart attack, presence of significant neurological deficit and consciousness disorder, dementia, presence of other malignancies, thyroid disease, and use of statins. The study was conducted in accordance with the national and international regulations and principles stated in the Declaration of Helsinki. The study was approved by the Ethics Committee of the MMA (No. 14/2020). All participants were fully informed about the study and voluntarily provided written informed consent to participate in this research at the time of their inclusion in the study. We also excluded women who were hospitalized during the survey, had COVID-19 before the interview, and women who voluntarily followed a specific type of diet. The study finally involved 32 postmenopausal women (age range 50 to 65 years) who answered questions during phone interviews with a nutrition research expert. The interviews were conducted by the same researcher.

Anthropometric data

The baseline anthropometric parameters were measured in December 2019, with individuals wearing light clothes and no shoes. Height was measured using a wall-mounted stadiometer to the nearest 0.5 cm. BW, BMI, waist-to-hip ratio (WHR), total body water, soft lean mass, fat-free mass, body fat mass, percent of body fat, skeletal muscle mass (SMM), and visceral fat area (VFA) were measured using a body composition analyzer InBody720 (Biospace Co., Ltd., Seoul, Korea). All patients had a stable BW before the pandemic for at least six months. For nutrition status, the following BMI standards were applied: normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥ 30.0 kg/m²).

Questionnaire

We used a structured questionnaire that inquired about dietary habits information (intake of certain foods *per day/week* and changes in usual food choices), supplement intake, weight gain, and physical activity during the COVID-19 lockdown. Quantities of food consumed were estimated in reference to common household measures, natural units, and standard measuring kitchen tools, as well as packaging information for commercial products. The Breast Cancer Survivors Eating Habits and Lifestyle Changes in COVID-19 lockdown (BCS-EHLC-COVID-19 lockdown) questionnaire was adapted from the validated Serbian Food Frequency Questionnaire (FFQ)¹¹ with modifications reflecting the situation under investigation and study participants and harmonized with the part about dietary habits from the Rodriguez-Perez et al.¹² questionnaire as a reference to a healthy diet, processed foods intake, and changes in usual food choices during the COVID-19 outbreak confinement. The survey was reviewed and piloted by a group of multidisciplinary scientists at the Group of Nutritional Biochemistry and Dietology, Institute for Medical Research, University of Belgrade. We slightly simplified the questionnaire to prevent the negative effects of its length on the response rate during the difficult period of lockdown. In brief, this questionnaire consisted of 30 diet and lifestyle-related questions with sub-questions. The questionnaire was structured into three main sections: 1) Dietary pattern: food intake (vegetables, fruits, meat/meat products, fish/seafood, fats/oils, legumes, bread, pasta and rice, dairy products and eggs, carbonated/sweetened beverages, alcohol, water, sweets/pastries/cakes, nuts, seeds, and cereals) *per day* or *week* and additional information regarding the change in the consumption of these food items compared to the usual intake (18 items); 2) Dietary habits: shopping behavior, applied cooking methods, and preferred food choices during the lockdown (7 items); 3) Lifestyle: physical activities, weight gain, and supplements intake (5 items). Intakes of each food item were assessed on a 5-point scale: none; ½ portions; 1 portion; 2 portions; > 2 portions of serving or tablespoons *per day* or *week*. Two answers were asked for each question, one about the time frame before the lockdown and the other about the period during the COVID-19 quarantine. Changes in eating behavior and lifestyle factors

during isolation, such as alcohol intake, applied cooking methods, intake of fried food and fast food, frequency of snacking, the quantity of food eaten, and physical activity were assessed on a 3-point scale: No, Yes more, or Yes less. Participants were asked if they practiced some type of physical activity during the period of confinement. Furthermore, information on the difficulty of buying groceries, changes in weight gain, and consumption of nutritional supplements were also recorded. Before the study, the survey was pretested on a small group of healthy female population to allow for the elimination of substantial and formal errors.

All questions were designed to determine whether participants increased, decreased, or maintained their habits during the COVID-19 lockdown, and the answers were collected in a single telephone call interview. The full version of the questionnaire is available as Appendix.

Statistical analyses

Statistical analysis was performed using the SPSS 20 program (IBM, Armonk, NY, USA). The normality of the data was checked by the Shapiro-Wilk test. The difference in the intake before and during the lockdown was assessed using Wilcoxon's test and paired *t*-test depending on the normality of the data. Relationships between categorical data before and during the COVID-19 pandemic were evaluated using the Chi-square independence test. The value of $p < 0.05$ was considered statistically significant.

Results

Baseline characteristics of the study cohort

The anthropometric characteristics of BrC patients before the COVID-19 lockdown are shown in Table 1. The mean age of the patients was 62 ± 4 years, BMI 26.05 ± 4.20 kg/m², and WHR 0.95 ± 0.08 . Among them, 14 (44%) patients had normal weight (BMI < 25 kg/m²), 12 (37%) were overweight (BMI 25–29.9 kg/m²), and 6 (19%) were

Table 1

Anthropometric characteristics of the study participants before the COVID-19 pandemic

Parameters (December 2019)	Values
Age (years)	62.00 ± 4.00
Height (cm)	162.00 ± 7.00
Weight (kg)	69.00 ± 11.00
Body mass index (kg/m ²)	26.05 ± 4.20
Waist-to-hip ratio	0.95 ± 0.08
Total body water (L)	32.01 ± 4.03
Soft lean mass (kg)	40.98 ± 5.17
Fat-free mass (kg)	43.49 ± 5.51
Body fat mass (kg)	25.80 ± 8.67
Body fat (%)	36.28 ± 7.24
Skeletal muscle mass (kg)	23.47 ± 3.23
Visceral fat area (cm ²)	109.00 ± 32.00

COVID-19 – coronavirus disease 2019. Values are expressed as mean ± standard deviation.

obese ($\text{BMI} \geq 30 \text{ kg/m}^2$) according to BMI. VFA, measured by bioimpedance, was below 100 cm^2 (considered normal VFA) in only 47% of patients (Table 2). BW of the patients was stable for at least six months before the pandemic.

Table 2
Percentage of patients with normal weight, overweight, and obese before the COVID-19 pandemic, based on BMI and VFA

Parameters	Values (%)
BMI (kg/m^2)	
normal	44
overweight	37
obese	19
VFA (cm^2)	
normal	47
overweight	44
obese	9

COVID-19 – coronavirus disease 2019; BMI – body mass index; VFA – visceral fat area.

BMI: normal (18.5–24.9 kg/m^2); overweight (25–29.9 kg/m^2); obese ($\geq 30 \text{ kg/m}^2$); VFA: normal ($< 100 \text{ cm}^2$); high ($100\text{--}160 \text{ cm}^2$); very high ($> 160 \text{ cm}^2$).

Eating behavior changes during the COVID-19 lockdown

In this study, 41% of BrC patients reported an increase in their food intake, while 59% did not change their food consumption during the COVID-19 lockdown.

Changes in eating behavior in consumption of certain foods in patients with BrC during the COVID-19 lockdown are presented in Figure 1, with the percentage of patients with increased, decreased, or the same intake of foods. The

most marked increase in consumption was reported for fruits (38% of patients), homemade sweets (31%), eggs (25%), vegetables and nuts (22%), and bread and salted snacks (19%). When we excluded the respondents who do not consume sweets at all, among those who do consume sweets, almost 50% increased their intake. On the other hand, the intake of packaged sweets declined in 16% of respondents. Furthermore, 19% of patients reported consuming less fish and seafood, as well as dairy products (such as butter or sour cream). Increased water intake was reported in 16% of respondents (Figure 1).

When we compared the food intake (g/day or week) for the select products of BrC patients before the start of the COVID-19 pandemic and during the lockdown, we found a significant increase in the amount of fruit, water ($p < 0.05$), and homemade sweets ($p < 0.01$) intake and a decrease in fish/seafood ($p < 0.05$) consumption. The differences between other foods were not statistically significant, although the intake of vegetables has shown an increasing trend (from 200 to 275, $p = 0.083$) (Table 3).

Changes in cooking habits and type of food consumed during the COVID-19 lockdown

When we compared the cooking frequency among BrC patients before and during the COVID-19 lockdown, the collected responses showed that 47% of patients prepared cooked meals at home more often during the pandemic, while 53% of patients kept their previous cooking habits. Among the 50% of BrC patients who occasionally consumed fried food before the COVID-19 pandemic, during the lockdown, 13% reported lower intake, 34% the same, while only 3% of them increased their intake of fried food (Table 4).

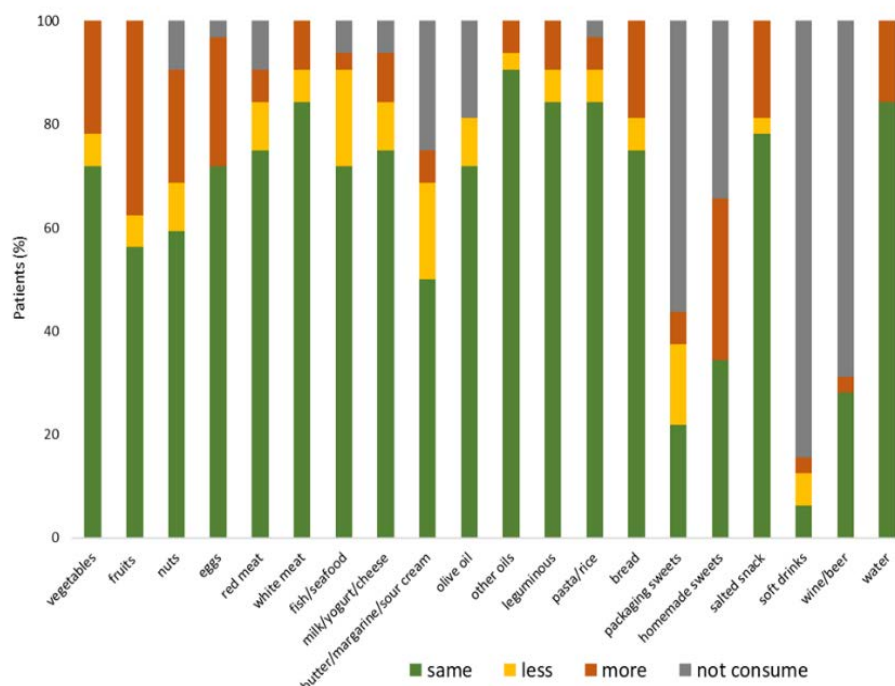


Fig. 1 – Changes in eating habits in consumption of certain foods during coronavirus disease 2019 lockdown of breast cancer patients.

Figure 2 displays the preferred oils and fats for cooking, types of bread and meat, as well as the most commonly chosen methods of meal preparation during the COVID-19 lockdown. The most common choice regarding oil for preparing meals was sunflower oil (66%), followed by pork lard (47%). Only 22% of patients preferably used olive oil for preparing meals.

Over 80% of respondents stated that they used white chicken meat more often than red meat. Cooking was a usual method of meal preparation for 91% of respondents, followed by baking in the oven (34%). Half of the survey participants acknowledged intermittent utilization of frying as a culinary approach, with none specifying it as their predominant or pre-

Table 3

Comparison of food intake before and during the COVID-19 lockdown in breast cancer patients

Food items	Before lockdown	During lockdown	<i>p</i>
Vegetables (g/day)	200 (100)	275 (150)	0.083
Fruits (g/day)	300 (287.5)	400 (237.5)	< 0.05
Nuts (g/week)	100 (145)	100 (145)	NS
Eggs (number/week)	3 (2.19)	4 (3.75)	NS
Red meat (g/week)	200 (187.5)	200 (187.5)	NS
White meat (g/week)	325 (275)	300 (200)	NS
Fish/sea food (g/week)	275 (187.5)	200 (332.5)	< 0.05
Milk/yogurt/cheese (g/day)	175 (118)	200 (118.8)	NS
Butter/margarine/sour cream (g/week)	22 (46)	16 (40.5)	NS
Olive oil (mL/day)	7.5 (12.8)	6.75 (10.8)	NS
Other oils (mL/day)	15 (7.5)	15 (7.5)	NS
Leguminous (g/week)	150 (100)	150 (125)	NS
Pasta/rice (g/week)	150 (110)	150 (110)	NS
Bread (g/day)	50 (70)	60 (70)	NS
Packaging sweets (g/week)	0 (120)	0 (75)	NS
Homemade sweets (g/week)	80 (285)	150 (550)	< 0.01
#Wine/beer (mL/week)	75 (115)	50 (123.8)	NS
Water intake (mL/day)	1423 ± 631	1483 ± 647	< 0.05

COVID-19 – coronavirus disease 2019. #Wine/Beer intake is calculated after excluding patients (20) who do not drink alcohol; Wilcoxon's test and paired *t*-test for the water intake were applied. NS – non-significant.

All values are expressed as median (interquartile range) except for water intake which is shown as mean ± standard deviation.

Table 4

Cooking frequency and variations in the consumption of fried food intake during COVID-19 lockdown in breast cancer patients

Parameters	Increase	Decrease	Same as before	NA
Cooking frequency	47	0	53	/
Fried food intake	3	13	34	50

COVID-19 – coronavirus disease 2019; NA – not applicable/do not cook/do not eat fried food.

All values are given as percentages.

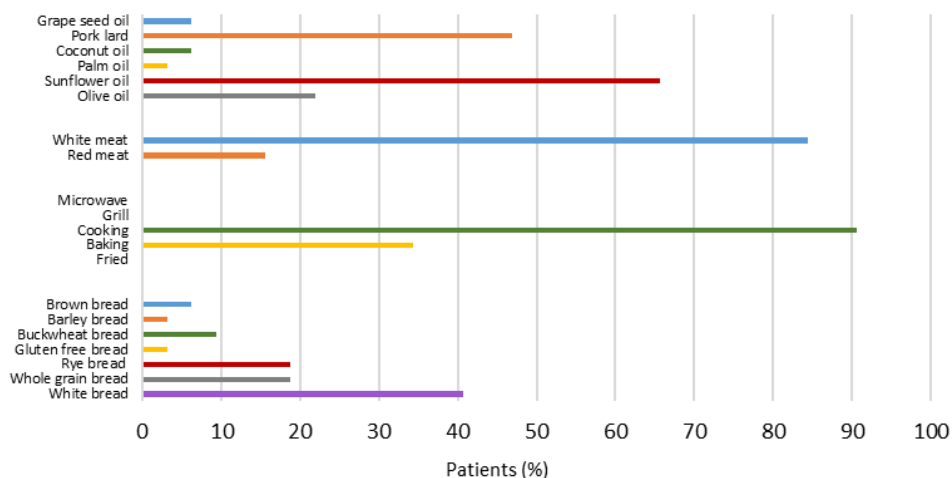


Fig. 2 – The main preferred oils and fats, types of bread and meat, as well as preferred cooking methods for meal preparation among breast cancer patients during the coronavirus disease 2019 lockdown (for preferred cooking methods and oil type, multiple-choice questions were used).

vailing method of food preparation. Most (41%) patients consumed white bread and 3% gluten-free bread, and the remaining commonly ate other types of bread rich in dietary fiber (such as whole grain bread, rye bread, brown bread, etc.).

Availability of groceries during the lockdown affected their cooking/eating habits; hence, 31% of patients stated that they had experienced difficulties in the procurement of foodstuffs. Among the patients who stated they could not access all groceries, 80% had difficulties purchasing fresh fish, while 30% could not have bought yeast (Table 5).

Physical activity changes during the COVID-19 lockdown

Due to the isolation during the COVID-19 lockdown, most of the BrC patients treated with AIs had to change their lifestyle, which led to changes in physical activity and BW. As many as 88% of surveyed women stated that the lockdown condition led to a reduction in the frequency of their physical activity. Among BrC patients included in this study, 41% declared no changes in BW. An increase in BW during the COVID-19 lockdown was reported by 47% of BrC pa-

tients, 6% reported weight loss, and the same percentage had no information on weight change (Table 6).

Supplements intake

Before the COVID-19 pandemic, 25% of BrC patients included in this study used one or more different supplements, such as vitamin C (12%), vitamin D (6%), selenium (6%), zinc (6%), and magnesium (9%). During the COVID-19 lockdown, over 50% of BrC patients used supplements ($p = 0.01$, assessed by Chi-square). Among them, 31% consumed vitamin C, 12% vitamin D, and 19% selenium and zinc. The percentage of BrC patients who used omega-3 supplements decreased during the lockdown from 16% to 3% (Table 7).

Discussion

The present qualitative descriptive study demonstrated that the COVID-19 lockdown conditions affected BW, eating behavior, and physical activity of postmenopausal BrC patients on adjuvant AI therapy. To the best of our knowledge,

Table 5
Difficulties in obtaining groceries during COVID-19 lockdown of breast cancer patients

Parameter	*Patients (%)
Fresh fish	80
Nuts	10
Chicken	10
Fresh fruits and vegetables	20
Yeast	30

COVID-19 – coronavirus disease 2019. *From the total number of patients who reported difficulties in obtaining groceries.

Table 6
Reported changes in the frequency of physical activity and weight changes during COVID-19 lockdown in breast cancer patients

Parameter	Increase	Decrease	Same as before	NA
Physical activity	3	88	9	/
Weight changes	47	6	41	6

COVID-19 – coronavirus disease 2019; NA – not applicable/do not know. All values are given as percentages.

Table 7
Dietary supplements intake in breast cancer patients before and during lockdown

Parameter	Before lockdown	During lockdown
Vitamin C	4 (12)	10 (31)*
Vitamin D	2 (6)	4 (12)
Omega-3 fatty acid	5 (16)	1 (3)
Selenium	2 (6)	6 (19)
Magnesium	3 (9)	3 (9)
Zinc	2 (6)	6 (19)
Calcium	2 (6)	2 (6)
Vitamins B mix	0 (0)	1 (3)
Vitamin E	2 (6)	0 (0)
Multivitamin complex	1 (3)	0 (0)
Iron	1 (3)	1 (3)
Probiotic	0 (0)	1 (3)

*** $p < 0.05$, evaluated by Chi-square.**

All values are given as numbers (percentages).

this is the first study that investigates the impact of the COVID-19 lockdown on BrC patients treated with AIs. Although several papers have been published in the general population, the present paper provides new information on this topic, primarily in BrC patients on adjuvant therapy with AIs, who are susceptible to weight gain and cardiovascular comorbidities as a side effect of the therapy. The obtained results were compared to the dietary guidelines for cancer patients¹³. To reduce the risk of BrC recurrence and mortality, it is recommended that BrC patients follow a diet high in vegetables, fruits, and whole grains and have an exercise regimen that includes 150 minutes *per* week of moderate-intensity exercise. We have shown that almost half of the BrC patients on AIs increased BW, nearly 41% reported higher food intake, and 88% reduced physical activity during the COVID-19 lockdown. The findings from our study are in line with the results of previous studies for the healthy population in Europe^{9, 14}. The main indicators that show changes in eating habits in our patients are increased consumption of homemade dough (egg cakes, pizzas, and bread), vegetables and fruits, and decreased intake of fresh fish. The changes observed in these patients reflect the national trend in purchasing foodstuffs during the pandemic in Serbia, which shows that during the first period of isolation, there was an increased demand for canned goods and comfort food and a decrease in the sale of fresh products⁹. The findings of this study have already been applied to develop personalized dietary approaches for the BrC patients treated with AIs included in this study, which corrected the intake of certain nutrients and adapted the diets to healthy ones after the period of COVID-19 lockdown.

Initial weight status, diet quality, and physical exercise pattern before lockdown are important factors for the general condition of BrC patients^{15, 16}. Body composition assessment conducted prior to the lockdown revealed the prevalence of undesirable VFA in 53% of BrC patients in our study. According to BMI, 37% of study participants were overweight and 19% were obese. Patients' BW was stable before the pandemic, but in 47% of BrC patients on AIs, it increased during the lockdown. Obesity is a significant risk factor for complicated COVID-19 and diminishes the effects of the BrC treatment^{8, 17}. Therefore, maintaining normal BW is important to control the risk of comorbidities, recurrence, and mortality in BrC¹⁷, especially during the COVID-19 pandemic. Furthermore, greater visceral fat depot correlates with extra-glandular estrogen production by aromatization of androstenedione, with adverse effects on the AIs therapy¹⁸. While the study on the general population in Serbia revealed weight gain in 25% of respondents⁹, our study showed that in 47% of BrC patients, lockdown led to a weight gain, 6% of women recorded weight loss, and the same percentage had no information about weight change. Weight gain occurred predominantly in participants who were already overweight or obese. Khan et al.¹⁹ reported the determinants of BW changes during the pandemic as past dietary behaviors, physical activity patterns, psychosocial and economic factors, and preexisting co-morbidities.

Our BrC patients consumed more fruits (400 g/week vs. 300 g/week) and vegetables (275 vs. 200 g/week) during the COVID-19 lockdown than before the pandemic. In contrast to literature data showing a reduction in the intake of fresh prod-

ucts, including fruits and vegetables, our BrC patients followed the recommendations of health authorities who promoted the importance of fruit and vegetable consumption during quarantine²⁰. This is also in line with recommendations for the nutrition of cancer patients¹³. In a study on 2,206 Serbian adults, similar results on the higher intake of fruits and vegetables during lockdown were reported by 32% and 24% of respondents, respectively⁹. Likewise, the increased intake of sweets and the frequency of snacking is in accordance with the results of other studies, where the consumption of "comfort foods" such as chocolate, ice cream, desserts, and salty snacks have been described as a potential mechanism to cope with loneliness, boredom, and anxiety during lockdown^{21, 22}. A recent Polish study found a link between higher consumption of dairy products and eggs during the COVID-19 lockdown and the presence of overweight and obesity²³. However, in most of our respondents, the consumption of dairy products remained constant, and 19% of them even reduced their intake of fatty dairy products such as butter or sour cream. Increased consumption of nuts among some of our respondents is a favorable change. Nevertheless, the median consumption of dairy products, eggs, and nuts did not change significantly in the study patients. Significantly higher water intake in BrC patients treated with AIs during the lockdown was a positive change, even though water consumption did not reach the daily recommended amount of 2.2 liters for females.

The increased cooking frequency during the COVID-19 lockdown, as reported by almost half of BrC patients treated with AIs, concurs with the literature and could be considered a favorable change¹⁵. This is in line with the results for the general population in Serbia during the lockdown, where almost 45% of respondents reported that they cook more⁹ since they spend more time at home.

Fried foods were recognized as the strongest dietary risk factor for BrC in a case-control study among women under 50 years of age²⁴, and by-products of reheating frying oils, such as aromatic hydrocarbons and aldehydes, show carcinogenic properties and promote tumorigenesis and the risk of metastases²⁵. Despite the increased consumption of fried food during the COVID-19 lockdown in the general population²⁶, a positive observation in this study was that only 3% of the patients increased their intake of fried food, while 13% of women reported reduced intake of fried food.

Oil types differ in susceptibility to chemical changes during heating and/or reuse, creating harmful products²⁷. They are also a main source of fatty acids, which could both prevent and deteriorate obesity and its metabolic complications²⁸. During the lockdown, the most used (66%) fat source in the Serbian population was sunflower oil⁹, and our BrC patients followed this trend (66%), but almost half of the participants also used pork lard. Sunflower oil is rich in linoleic omega-6 acid, which is a precursor of proinflammatory eicosanoids. Pork lard is more energy-dense than sunflower oil and may influence BW. On the other side, it is a source of stearic acid, which has been found to reduce plasma cholesterol and cardiometabolic risk in postmenopausal women²⁹. The consumption of olive oil was reported by 22% of the study participants, and 10% of our BrC patients increased their intake of olive oil during the quarantine.

Current findings support the advice not to limit the consumption of oleic acid-rich meals to maintain a healthy BW²⁸. However, *in vitro* studies on BrC cells treated with oleic acid revealed an increase in cell proliferation, migration, and invasion³⁰, suggesting that further evaluation of oleic acid effects in BrC patients is needed.

The majority of respondents reported eating white meat more often than red meat before the pandemic, and these habits were kept during the lockdown. Namely, there were no statistically significant differences in the amount of meat consumption before and during the lockdown. A lower intake of red meat, in comparison to white meat, is in line with the guidelines for patients with BrC³¹. On the other hand, during the lockdown, total consumption of red meat decreased in the adult population in Serbia⁹.

Still, reduced opportunities to go out during the lockdown caused difficulties in obtaining fresh fish. This is also seen in significantly reduced fish intake from 275 g/week to 200 g/week. Buying less fresh food, such as fish, as a result of difficult access to food stores during lockdown was previously reported elsewhere³². This is an unfavorable change for our patients because it means reduced omega-3 fatty acids intake, which has protective effects against cardiometabolic disorders, which are one of the most common side effects of AIs³³.

Furthermore, a substantial proportion of patients exhibit a dietary preference for bread with low fiber content, reaching up to 44%. Namely, a high percentage of our patients consumed white bread with higher caloric and lower nutritional value, which makes maintaining healthy BW in the patients even more challenging. In this regard, 56% of respondents who eat some types of bread rich in dietary fiber constitute more than half of the patients, but this is still a modest result, especially considering the potential role of dietary fiber in reducing the progression of BrC³⁴. In some of the previously published studies, most respondents reported more frequent cooking and baking during the pandemic^{8,20}. Our study results are consistent with the results of those studies, since cooking and baking in the oven were also the most frequently used methods of meal preparation (91% and 34% of respondents, respectively).

Deterioration of pre-existing weight status (overweight/obese) may occur due to confinement and increased time spent at home³⁵. Furthermore, almost 88% of BrC patients reported limited physical activity, which may be related to the abrupt changes in daily routine and lack of motivation due to the COVID-19 lockdown³⁶. This negative trend in women with BrC was more prominent compared to the general population in Serbia, where physical activity was lower in less than 60% of respondents during quarantine⁹.

Before the COVID-19 pandemic, 25% of women with BrC treated with AIs involved in this study used supplements, such as vitamin C and D and magnesium, while this percentage more than doubled during the period of the statement. The most consumed supplements were vitamins C and D, as well as zinc and selenium, which have immunomodulatory effects with benefits in infectious diseases³⁷. Our findings were similar to other studies³⁸. Although it is considered that dietary supplements (i.e., vitamins C and D, zinc, and selenium) during the COVID-19 pandemic should be administered to individuals

with or at risk of respiratory viral infections or in whom deficiency is detected³⁹, these supplements could improve immune response in this vulnerable group of patients.

Limitations and strengths

Our study has several limitations. First, this study consists of self-reported responses by BrC patients, which could affect the reliability of the responses. The fact that eating habits are based on participants' perception of food intake may not reflect the true intake during isolation. Second, we did not measure the weight of BrC patients during the lockdown. We rather used self-reported values *via* telephone interviews, so we had to compare measured (pre-pandemic) and self-reported (during lockdown) weight. Third, patients were recruited from one hospital (out of five in Serbia) where the BrC patients are treated and monitored, and the sample size is relatively small. Nevertheless, this paper also has several strengths: patients were from different towns in Serbia, and the telephone interview was performed by a trained nutritionist, which decreased potential response bias. Further, our research is the first study on BrC patients using AIs that addressed the impact of imposed restrictions and COVID-19 lockdown conditions on eating behaviors and physical activity.

Conclusion

The COVID-19 pandemic lockdown with home quarantine exacerbated health risks, leading to altered dietary patterns and physical activity, which could potentially affect the long-term health of BrC women. In this study, we have provided the first data on changes in the eating behavior of BrC patients using AIs during the COVID-19 lockdown. Favorable changes were observed, such as increased frequency of cooking, increased intake of fruits, vegetables, home-made products, and water, as well as some adverse changes, which include a lower intake of fish and more patients consuming sweets and salted snacks. Furthermore, increased daily food consumption and reduced physical activity led to weight gain in BrC patients using AIs involved in this study. As a healthy diet and maintenance of normal BW are important to the effect of AI therapy and the overall well-being of these particularly vulnerable population groups, an effective personalized dietary approach to correct the adverse outcome of the lockdown in BrC patients is of great importance. Our study is designed to contribute to this effort. Likewise, this study provides a useful contribution to the debate on nutritional recommendations for cancer patients in case of a future lockdown.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix

NUTRITION AND LIFESTYLE MODIFICATION QUESTIONNAIRE DURING LOCKDOWN QUARANTINE FOR BREAST CANCER PATIENTS (TRANSLATED)

Dietary patterns/food intake/changes

1a. How many portions of vegetables do you usually consume *per* day?

(one portion = 200 g vegetables; a side dish = 1/2 serving)

None 1/2 portions 1 portion 2 portions > 2 portions

Intake g/day _____

1b. Did you change your consumption of vegetables during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

2a. How many portions of fruit do you usually consume *per* day?

(80 g of each, including glasses of fresh fruit juice)

None 1/2 portions 1 portion 2 portions > 2 portions

Intake g/day _____

2b. Did you change your consumption of fruit during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

3a. How many portions of red meat, hamburgers, burgers, sausages, and other meat products do you usually consume *per* day? (1 serving = 100–150 g)

None 1/2 portions 1 portion 2 portions > 2 portions

Intake g/day _____

3b. Did you increase the amount of red meat, burgers, sausages, and other meat products you consumed during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____ Intake g/week _____

3c. Do you prefer white meat (chicken, turkey) compared to red meat (veal, pork, hamburgers, burgers, or sausages)?

Yes/No

How many portions *per* day/week (1 serving = 100–150 g)?

Intake g/day _____ Intake g/week _____

3d. Did you increase the amount of chicken and turkey during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____ Intake g/week _____

4a. How many servings of butter, margarine, or full-fat sour cream do you usually consume *per* day? (one serving = 12 g or about one tablespoon)

None 1/2 serving 1 serving 2 servings > 2 servings

Intake g/day _____

4b. Did you increase the amount of butter, margarine, or full-fat sour cream during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

5a. Is olive oil the main culinary fat you use?

Yes/No

5b. What is the average amount of olive oil that you consume each day (for cooking and frying, meals outside the house, salads)? (serving tablespoon = 15 mL)

None 1/2 tablespoon 1 tablespoon 2 tablespoons > 2 tablespoons

Intake mL/day _____

Do you use other types of oil?

Yes/No Type: _____ How often: _____ How many tablespoons: _____

5c. Did you use olive oil or any other oil more during the COVID-19 lockdown emergency compared to your usual intake?

No Yes, more Yes, less

Intake mL/day _____ Intake mL/week _____

6a. How many servings of legumes (beans, lentils, chickpeas) do you usually consume *per* week? (one serving = 150 g cooked)

None 1/2 serving 1 serving 2 servings 3 servings or more

6b. Did you increase the amount of legumes (beans, lentils, chickpeas) that you consume during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

7a. How many servings of fish and/or seafood do you consume *per week*? (1 serving: 100–150 g of fish or 4–5 pieces or 200 g of seafood)

None ½ serving 1 serving 2 servings 3 servings or more

7b. Did you increase the quantity of fish or seafood you consumed during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

8a. How many portions of milk, yogurt, and cheese do you usually consume *per day* (1 serving = 200 mL in a cup, cheese = 50 g)

None ½ serving 1 serving 2 serving 3 serving or more

milk, yogurt g/day _____ cheese g/week _____

8b. Did you increase the amount of milk and dairy products you consumed during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

9a. How many eggs do you usually consume *per week*?

None 1 egg 2 eggs 3 eggs 4 eggs > 4 eggs

eggs/week _____

9b. Did you increase your egg consumption during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

eggs/week _____

10a. How many portions of bread do you usually consume? (1 piece = 30 g)

None 1 serving 2 servings 3 servings or more

Intake g/day _____

Type of bread: _____

10b. Did you increase your intake of bread during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake g/day _____

11a. How many times *per week* do you usually consume pasta, rice, cooked vegetables, or similar dishes that are prepared on a low heat with tomato, garlic, onion, or leek with the addition of oil (olive)? (1 medium portion = 80 g)?

None 1 serving 2 servings 3 servings or more

Intake g/week pasta/rice _____

11b. Did you increase the intake of pasta and rice during the COVID-19 lockdown emergency compared to your usual intake (1 medium portion = 80 g)?

No Yes, more Yes, less

Intake g/day pasta/rice _____

12a. How many servings of carbonated and/or sugar-sweetened beverages such as cola, tonic, bitter, or similar do you usually consume *per day*? (1 serving = 200 mL)

None 1 serving 2 servings 3 servings or more

mL/day _____

12b. Did you increase the amount of carbonated and/or sweetened beverages (cola, tonic, bitters, or similar) that you consumed during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

Intake mL/day _____

13a. Do you drink wine? How much wine do you usually drink *per week*?

Yes, one glass Yes, 2 glasses Yes, 3 glasses or more

No

mL/week _____

13b. Did you increase the intake of alcoholic beverages (wine, beer, spirits) during the COVID-19 lockdown compared to your usual intake?

No Yes, more Yes, less

mL/week _____

14a. Did you increase water intake during the COVID-19 lockdown?

No Yes, more Yes, less

mL/day _____

14b. How much water did you drink before lockdown?

mL/day _____

15a. How often do you usually consume packed sweets/pastries/cakes per week? (cake portion = 120 g) None 1 serving 2 servings 3 servings or more

Intake g/week _____

15b. Did you increase the amount of commercial sweets/pastries/cakes that you consumed during the COVID-19 lockdown compared to your usual intake? No Yes, more Yes, less**16a. How often do you usually consume homemade baked sweets/pastries/cakes per week? (cake portion = 120 g)** None 1 serving 2 servings 3 servings or more

Intake g/week _____

16b. Did you increase the amount of homemade baked sweets/pastries/cakes that you consumed during the COVID-19 lockdown compared to your usual intake? No Yes, more Yes, less**17a. How often do you consume nuts (peanuts, almonds, hazelnuts, walnuts, etc.) flakes and seeds, and cereals per week (portion = 30 g)?** None 1 serving 2 servings 3 servings or more

Intake g/week _____ nuts _____ flakes _____ seeds _____

17b. Did you increase your consumption of nuts during the COVID-19 lockdown compared to your usual intake? No Yes, more Yes, less

Intake g/day _____

18. How many daily meals (breakfast, lunch, dinner) did you usually have outside of the house before the COVID-19 period? None 1 2 3 or more**Dietary habits: Shopping behavior, cooking method, type of food****19. Did you have difficulty buying groceries during the COVID-19 lockdown?** Yes/NoIf you had difficulty purchasing certain groceries, what were these foods?
_____**20a. Which method of food preparation did you use most often during the COVID-19 lockdown?** Frying Baking in the oven Microwave oven Barbecue, grill Cooking on the stove**20b. Did you cook more often during the COVID-19 lockdown compared to the period before the pandemic?** No Yes, more Yes, less**21a. Did you increase the amount of fried food that you consumed during the COVID-19 lockdown compared to your usual intake?** No Yes, more Yes, less**21b. How often did you consume fried food during the COVID-19 lockdown?** < 1/week 1–3/week 4–6/week > 7/week**21c. When you eat fried foods, what type of oil do you use for frying?** Olive/sunflower/other oil _____**22. Did you consume snacks (salty/sweet) more often during the COVID-19 lockdown compared to the period before the pandemic?** No Yes, more Yes, less Type: _____**23. Did you increase the amount of fast food that you consumed during the COVID-19 lockdown compared to your usual intake?** No Yes, more Yes, less**24. Do you think you ate more during the COVID-19 lockdown compared to the period before?** Yes/No**25. Did you change the number of daily meals during the COVID-19 lockdown period?** No Yes, more Yes, less**Lifestyle:****Physical activity:****26a. Did your physical activity change during the COVID-19 lockdown period?** No Yes, more Yes, less

26b. What activity did you follow during quarantine?

walking weightless workout yoga postural gymnastics other

Weight gain:**27. Did you gain weight during the COVID-19 lockdown?**

Yes/No/I don't know

28. Did you lose weight during the COVID-19 lockdown?

Yes/No/I don't know

Supplements:**29. Did you take supplements during the COVID-19 lockdown?**

Yes/No

If yes, state the names of the supplements:

30. Did you take supplements before the COVID-19 lockdown?

Yes/No

If yes, state the names of the supplements:
