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Original article

The DianaWeb cohort during the first COVID-19 lockdown: changes in eating behaviour in women with breast cancer

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Abstract. *Background and Aim of the Work:* Home confinement during the first wave of COVID-19 subverted people's routines and generated a lot of stress among individuals. In addition to the '*pure*' mental health consequences—a major public health concern, itself—this stressful situation led to a risk of worsening eating behaviours. The aim of this study was to investigate the potential deterioration of dietary habits in a cohort of women with breast cancer (BC). *Methods:* We used data from 781 women with BC enrolled in the DianaWeb project. We used validated questionnaires to collect data concerning socio-demographic/anthropometric parameters, quality of life (QoL), lifestyle and the change in dietary habits before and during the lockdown period (December 2019 and June 2020). *Results:* Data showed that psychiatric treatment, QoL and health perception significantly affected the food choices of the cohort (p = 0.048, p=0.002, and p=0.001, respectively), decisively contributing to a worsening in their eating behaviour. Moreover, sedentary behaviour during the lockdown also influenced food choice (p = 0.010): individuals who increased their sedentary behaviour were more likely to decrease their intake of recommended foods (p = 0.033). *Conclusions:* In summary, emotional state and mood—here investigated as QoL and health perception—definitely affected dietary habits in women with BC in the first COVID-19 lockdown. Given the centrality of correct eating behaviour in BC management, psychological aspects should not be contemplated merely as confined mental health matters but should be definitely taken into consideration also as factors that seriously affect an individual's healthy lifestyle.

Key words: Breast cancer, DianaWeb, COVID-19, mental health, food choice, eating behaviours

Introduction

Emotions and eating are essential parts of everyone's daily life and interact with each other in a bi-directional relation: one's psychological state can affect the quantity and quality of food intake, and eating can affect one's mood and mental health (1). The tendency to eat in response to negative - but also positive - emotions has been faced and discussed in several disciplines, such as social and clinical psychology, psychotherapy, nutrition sciences, physiology, and public health, and can be named using the term '*emotional eating*' (2,3).

This trend does not concern exclusively severe disorders (*e.g.*, bulimia and binge-eating disorder), but regards also individuals with moderate psychological distress (4). Stress-influenced eating patterns can take a different direction, with some individuals tending to eat more, while others tend to eat less (5–8).

Stressful situations often address individual food choices towards foods that are rich in fat or sugar. Higher intake of soda and sweetened fruit drinks, French fries, savoury snacks, cakes, cookies, pies, chocolate, ice cream, biscuits and desserts have been associated with psychological distress (4,5). These foods do not share similar textural/taste features or similar chemical compositions. All of them are, however, characterised by high palatability, ease of preparation, availability and high energy density. Given that these foods are highly discouraged by the most renowned international guidelines for the prevention of chronic diseases (9,10), each context that leads to or might lead to an increase in the intake of such foods represents a matter of public health.

Among the shocking events populations might experience (*e.g.*, wars, natural disasters, etc.), the COVID-19 pandemic is unprecedented in terms of worldwide social impact resulting from strict quarantines and restrictions, especially during the so-called '*first wave*' (the first months of the year 2020). Coping with fear of infection and death, worry for relatives and friends, along with social isolation and a deterioration in the economic situation profoundly subverted individuals' daily routines and generated a lot of stress. Various psychological symptoms were reported in the general population (11) and in vulnerable individuals, such as patients with breast cancer (BC) (12).

In some cases, this highly stressful context led to a deep worsening in physical activity (PA) levels and eating behaviours, whereas in others the effects were milder (11,13–15).

In this scenario, patients with BC are among the most vulnerable population that has to be monitored. Indeed, diet and PA are the foundations of the European Code Against Cancer (ECAC) (9,16), the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) (17), and the American Cancer Society (ACS) (18) recommendations for the reduction of BC recurrences and mortality. Particularly, the Mediterranean diet (MD) has been proposed to possess a potential protective effect for BC mortality by virtue of its anti-inflammatory potential (19,20).

The DianaWeb project, community-based participatory research (CBPR), offers Italian women with a BC diagnosis an interactive website (www.dianaweb.org) where patients themselves can find evidence-based diet/lifestyle recommendations, recipes, exercises, and practical tips concerning how to manage the change in the daily routine (21,22). The project—based on the promotion of MD and WCRF guidelines—also monitors lifestyle changes over time, in order to verify whether the metabolic syndrome-related risk factors for BC recurrences/metastasis and mortality are reduced by adhering to these recommendations.

A previous study in this specific cohort of patients with BC showed that most of the participants reduced their PA levels and increased unhealthy behaviours (*e.g.,* sitting/lying time) during the quarantine period in the first wave of COVID-19 emergency, along with a worsening in the perceived quality of life (QoL) (23).

In light of the above, it is crucial to investigate whether the highly stressful period these women experienced during the first wave of COVID-19 has also led to a deterioration in their dietary habits.

Patients and methods

Study design

The current study draws on data collected as part of the ongoing DianaWeb project, originally designed to test the efficacy of dietary changes and PA to prevent or delay the development of relapses in patients with BC. The DianaWeb is an open cohort established in September 2016 in which Italian patients diagnosed with BC can participate, whatever the stage of the disease at diagnosis, the histological diagnosis, the time elapsed since diagnosis, with or without metastases, local relapses or seconds tumours, and with *in situ* or invasive cancer.

The study followed the international ethical recommendations contained in the Declaration of Helsinki, and has received ethical approval from the local Ethics Committee of the Fondazione IRCCS Istituto Nazionale dei Tumori di Milano, Protocol No. INT

24/16 (27 July 2016). This trial is registered on ClinicalTrials (gov: NCT05019989). The study protocol has been published elsewhere (21).

Setting

This study uses data collected through the DianaWeb internet platform (www.dianaweb.org) where patients with BC sign up on a voluntary basis and are enrolled in the study after signing an informed consent form. Once registered, participants can access a series of updated and evidence-based information concerning nutrition and PA and are encouraged to adhere to the lifestyle recommendations proposed by the WCRF. In addition, on the website, participants can access further practical information such as characteristics of nutrients, recipes, and calls to perform PA of moderate intensity. In addition to the services provided through the platform, a series of events (*e.g.*, cooking classes, walking groups and meetings on the latest evidence-based recommendations for a healthy lifestyle) are organised by the staff to reinforce the social and convivial aspects as crucial elements in this project. Such activities were suspended during the first lockdown and were intensely resumed from June 2020 onward. After registration, participants are asked to fill in—twice a year—online questionnaires to gather information about general information (*i.e.*, demographic and anthropometric data, medical history, and results of routine biochemical analysis) and specific information (*i.e.*, MD adherence, PA level and QoL).

Study cohort

To date (February 2023) the DianaWeb cohort counts a total of 1527 participants. For the present study, we considered a sub-cohort of DianaWeb patients with BC (n = 781) that completed the questionnaires during the first wave of the COVID-19 pandemic.

Data collection

Data collected in both December 2019 and June 2020 were selected for this study. Data selected for this study was collected through the different sections of the questionnaire (the sections used for this study are described below) which the participants could access only with personal ID and password.

Questionnaire

The questionnaire considered a section dedicated to the collection of general information that included:

- socio-demographic characteristics such as age, education level, marital status, and region of residence;
- anthropometric parameters such as body weight, body height, and waist circumference (WC). In a previously published work, self-reported body weight and height have been shown to be accurately reported by participants in the DianaWeb project, whereas the overestimation in WC has been managed by providing easy-to-follow video instruction (24). Body mass index (BMI) was calculated as the body weight divided by the square of the body height (kg/m^2). Subsequently, the weight status was established according to the criteria of the World Health Organization (WHO): BMI: 18.5–24.9 kg/m^2, normal weight; BMI: 25.0–29.9 kg/m^2, overweight (pre-obesity); BMI: 30.0–34.9 kg/m^2, obesity class I; BMI: 35.0–39.9 kg/m^2, obesity class II; and BMI ≥ 40.0 kg/m^2, obesity class III (25). Analogously, the cut-off point for WC was set to 80 cm (26).

In addition, validated questionnaires were used to collect specific information.

Changes in dietary habits during the first wave of the COVID-19 pandemic were assessed with a 15-point questionnaire, which included questions about the amount of food consumed. In particular, for each food, participants were asked if they consumed more or less than before the pandemic or, if they had not made any changes. Vegetables (excluding potatoes), fresh fruit, nuts, whole grains, fish and seafood products, legumes and water and unsweetened tea were considered as recommended foods, whereas meat and processed meat, milk and cheeses, sauces, seed oils and

other seasoning fats, refined foods, sweets/desserts, sweetened beverages, alcoholic beverages were considered as discouraged foods. To quantify changes in heating habits during the lockdown, the methodology of Grant et al. (27) was adapted to the data recorded by the questionnaire adopted in this study. Specifically, 1 point was assigned if the women increased their consumption of recommended foods (such as vegetables, extra virgin olive oil, fresh fruit, nuts, whole grains, fish, legumes, water and unsweetened tea) or decreased the consumption of discouraged foods (such as meat and processed meat, milk and cheeses, seed oils and other seasoning fats, refined foods, pastries, sweetened and alcoholic beverages), 0 points were assigned when no changes in food intake were recorded, and −1 point was assigned if the women decreased or increased the consumption of recommended or of discouraged foods, respectively. Points were added up (the score could range from −15 to +15) and 3 changing classes were defined: (i) no change (score ranging from −1 to +1), (ii) decreased healthy eating behaviour (score < −1), increased healthy eating behaviour (score > +1).

QoL and health perception were assessed through the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30) (28). The global health perception/QoL scale has response options ranging from 1 ("very poor") to 7 ("excellent").

Self-reported PA was assessed with the International Physical Activity Questionnaire Short Form (IPAQ-SF), whose reliability and validity are documented (29,30). With the IPAQ-SF questionnaire, the participants answer questions concerning the activities carried out for at least 10 minutes in the last 7 days. Particularly, vigorous (*e.g.*, intense home or gardening activity, performing intense aerobic exercises, and using a bike or treadmill) and moderate (*e.g.*, moderate home activity, working out in the garden, carrying light loads, and bicycling at a steady pace) level of PA and walking duration and frequency was recorded.

Statistical analysis

Data are reported as the number and percentage for the categorical variables or by the mean ± standard deviation for continuous variables. The education variable was dichotomized into high school or some college (≤13 years) and college graduates or higher (>13 years).

Total PA levels were calculated from IPAQ-SF. The activity duration and frequency was multiplied by the corresponding metabolic equivalent of task (MET) score (3.3 for walking, 4.0 for moderate and 8.0 for vigorous MET-min/week) (31). Then, the total PA score was recorded as MET-min/week. Sitting time was an additional variable of IPAQ-SF. Minutes were used to reflect the time of sitting (sedentary) behaviours rather than MET-min. The average sitting minutes/days was calculated according to the following formula: average sitting minutes/day = (weekday sitting minutes per day × 5 + weekend day sitting minutes per day × 2) / 7.

Our study's cut-off point for being sedentary was 7 h/day (32).

To calculate before/after variations on anthropometric parameters (BMI and WC), lifestyles (PA, sedentary behaviour), and health status (QoL and health perception), values recorded during the pandemic have been subtracted from the values of the pre-pandemic period. The results indicate whether the status increased, decreased, or did not change during the COVID-19 period.

ANOVA was used to compare means of normally distributed quantitative data. In the case of statistically significant F-statistics, ANOVA was followed by a Dunnet posthoc analysis. Categorical variables were compared by using the χ^2 test. Subsequently, all variables significantly associated with diet quality changes were included in a logistic regression model. The results of logistic regression analyses were expressed as crude odd ratios (OR) with 95% confidence intervals (95% CI).

Statistical analysis was performed using SPSS ver. 21.0 (IBM, Chicago, IL, USA) and statistical significance was determined at $p<0.05$. Graphs were generated using GraphPad Prism software (GraphPad Software, Inc., San Diego, CA, USA).

Results

A total of 781 women with BC diagnosis (about 51% of women included in the DianaWeb Study)

participated in the study. The main sociodemographic characteristics of women enrolled in this study were described elsewhere (23). Briefly, the participants came from all the Italian Regions, with a prevalence from Northern Italy (61.3%); 27.2% of participants lived in Central Italy, and 11.5% in Southern Italy and the Islands (Sicily and Sardinia). The women had a mean age of 53.58 (± 8.83), most of them were married (61.8%) and over 44% held a university degree. In terms of employment status, 45.1% of women had full-time remote/flexible jobs during theCOVID -19 pandemic. Before the COVID-19 pandemic, 70 (9.0%) out of 781 BC patients were current cigarette smokers; none of the women enrolled in the study declared a change in smoking status during the first lockdown.

Only four BC patients (0.5%) received a positive diagnosis for COVID-19 during the first lockdown. Changes in eating habits during the first wave of the COVID-19 pandemic are shown in Table 1. A high number of participants reported having changed their eating habits during the lockdown. Data show an increase in consumption of discouraged foods, such as sweets or desserts (about 45%), refined foods (about 25%), milk and cheeses (about 21%), and meat and processed meat (about 20%). Interestingly, 140 responders (17.9%) increased their consumption of recommended foods, such as vegetables (excluding potatoes), nuts, and whole grains. Regarding alcohol consumption during the first quarantine, 15% of women with BC reported an increased consumption.

Then, we evaluated the magnitude of food habit changes during the lockdown in relation to the usual diet, by calculating a score which ranges from −15 to +15 points. Specifically, 1 point was given for each increased intake of recommended foods or each decreased intake of discouraged foods, 0 points were assigned when no changes in food consumption occurred, and −1 point was assigned if the women decreased or increased the consumption of recommended or of discouraged foods, respectively. Points were added up and 3 changing classes were defined: (i) no change (score ranging from −1 to +1), (ii) decreased healthy eating behaviour (score < −1), increased healthy eating behaviour (score > +1). In almost half of patients with BC (43.9%), the lockdown had no impact on dietary habits, however, 39.1% of the women of the DianaWeb cohort showed a worsening in dietary habits (Figure 1 and Supplementary Table 1).

Table 1. Variation of food categories consumption during the COVID-19 first lockdown in the DianaWeb cohort.

		Eating habits changed	
	Eating habits unchanged, *n* (%)	**Decreased, *n* (%)**	**Increased, *n* (%)**
Vegetables (excluding potatoes)	538 (68.9)	103 (13.2)	140 (17.9)
Extra virgin olive oil	645 (82.6)	65 (8.3)	71 (9.1)
Fresh fruit	558 (71.4)	111 (14.2)	112 (14.3)
Nuts	513 (65.7)	130 (16.6)	138 (17.7)
Whole grains	525 (67.2)	116 (14.9)	140 (17.9)
Fish, molluscs, and crustaceans	435 (55.7)	266 (34.1)	80 (10.2)
Legumes	549 (70.3)	106 (13.6)	126 (16.1)
Water and unsweetened tea	488 (62.5)	107 (13.7)	186 (23.8)
Meat and processed meat	550 (70.4)	79 (10.1)	152 (19.5)
Milk and cheeses	575 (73.6)	44 (5.6)	162 (20.7)
Seed oils and other seasoning fats	645 (82.6)	69 (8.8)	67 (8.6)
Refined foods	531 (68.0)	59 (7.6)	191 (24.5)
Sweets/desserts	370 (47.4)	60 (7.7)	351 (44.9)
Sweetened beverages	722 (92.4)	39 (5.0)	20 (2.6)
Alcoholic beverages	602 (77.1)	64 (8.2)	115 (14.7)

In Table 2, changes in diet quality were profiled according to the socio-demographic variables. The patients with BC, middle-aged, separated or divorced, and with fewer years of formal education reported an improvement in eating habits during the lockdown.

Most of the women in the DianaWeb study had a BMI corresponding to normal weight (69.5%) and WC < 80 cm (57.5%), whereas, during the pandemic, 43.4% of the total sample reported having increased BMI and 44.6% gained in WC. BMI and WC of BC patients that worsened their diet quality during lockdown (Table 3) significantly increased. Table 3 also shows the percentage of participants who reported dietary changes during the lockdown correlating with changes in BMI and WC. We observed that among women with an increased BMI, about 41% modified their food habits by increasing their consumption of discouraged foods. Analogously, among women with an increased WC, 42.5% (n = 148) worsened their usual dietary habits.

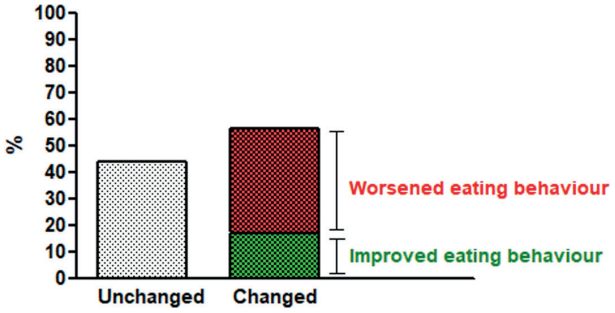

Figure 1. Percentage of women in the DianaWeb cohort who did not change, worsened or improved eating behaviour during the COVID-19 first lockdown.

Concerning PA levels, most of the participants reported that they were physically active (93.7%) during the lockdown period. However, only 6.9% maintained their habitual total PA (MET-min/week assessed with IPAQ-SF score) during the lockdown, with the largest part of women decreasing their total PA (77%). Simultaneously, lockdown measures have increased sedentary behaviour: in this cohort, sedentary women

Table 2. General socio-demographic characteristics of participants with and without changes in diet quality during the lockdown.

	Changes in heating habits score [a]			p-value [b]
	No changes n (%)	Increased n (%)	Decreased n (%)	
Region of residence				
Northern Italy	253 (43.9)	98 (17.0)	225 (39.1)	0.999
Central Italy	57 (44.5)	22 (17.2)	49 (38.3)	
Southern Italy and Islands (Sicily and Sardinia)	33 (42.9)	13 (16.9)	31 (40.3)	
Age				
21–40 years	17 (45.9)	6 (16.2)	14 (37.8)	0.907
41–60 years	244 (43.4)	93 (16.5)	225 (40.0)	
Over 60 aged	82 (45.1)	34 (18.7)	66 (36.3)	
Marital status				
Married	235 (44.7)	75 (14.3)	216 (41.1)	0.027
Separated/divorced	36 (39.1)	25 (27.2)	31 (33.7)	
Widowed	6 (28.6)	4 (19.0)	11 (52.4)	
Never married	66 (46.5)	29 (20.4)	47 (33.1)	
Level of education				
High school or some college (≤ 13 years)	165 (42.1)	68 (17.3)	159 (40.6)	0.576
College graduates or higher (> 13 years)	178 (45.8)	65 (16.7)	146 (37.5)	

[a]An increased score corresponds to an improvement in diet quality; whereas, a decreased score corresponds to a worsening in diet quality
[b]calculated among the studied groups using χ^2 tests.

Table 3. BMI and WC changes in study participants with and without changes in diet quality during the lockdown.

	Changes in heating habits score[a]			*p*-value[c]
	No changes ***n*** **(%)**	**Increased** ***n*** **(%)**	**Decreased** ***n*** **(%)**	
BMI[b]	22.78 ± 3.94	23.06 ± 3.15	23.55 ± 4.06[d]	
No changes	85 (45.9)	36 (19.5)	64 (34.6)	0.643
Decreased	114 (44.4)	41 (16.0)	102 (39.7)	
Increased	144 (42.5)	56 (16.5)	139 (41.0)	
WC[b]	79.75 ± 10.13	81.23 ± 10.05	81.87 ± 10.66[d]	
No changes	73 (44.0)	27 (16.3)	66 (39.8)	0.326
Decreased	127 (47.6)	49 (18.4)	91 (34.1)	
Increased	143 (41.1)	57 (16.4)	148 (42.5)	

[a]An increased score corresponds to an improvement in diet quality; whereas, a decreased score corresponds to a worsening in diet quality
[b]mean ± SD.
[c]calculated among the studied groups using χ^2 tests.
[d]ANOVA, $p < 0.05$ Increased or Decreased *vs* No changes.

Table 4. Total physical activity and sedentary behaviour change in study participants with and without changes in diet quality during the lockdown.

	Changes in heating habits score[a]			*p*-value[d]
	No changes ***n*** **(%)**	**Increased** ***n*** **(%)**	**Decreased** ***n*** **(%)**	
IPAQ-SF Total [b]	1352.12 ± 1270.80	1323.14 ± 1221.72	1327.74 ± 1381.18	
No changes	30 (56.6)	7 (13.2)	16 (30.2)	0.432
Decreased	257 (42.8)	105 (17.5)	239 (39.8)	
Increased	56 (44.1)	21 (16.5)	50 (39.4)	
Sedentary behaviour c	6:47 ± 3:06	7:06 ± 3:07	7:35 ± 3:09[e]	
No changes	93 (52.2)	31 (17.4)	54 (30.3)	0.010
Decreased	40 (50.0)	16 (20.0)	24 (30.0)	
Increased	208 (40.2)	85 (16.4)	225 (43.4)	

[a]An increased score corresponds to an improvement in diet quality; whereas, a decreased score corresponds to a worsening in diet quality
[b]Results expressed as MET-min/week, mean ± SD
[c]Results expressed as h:min/day sitting/lying, mean ± SD
[d]calculated among the studied groups using χ^2 tests
[e]ANOVA, $p < 0.05$ Increased or Decreased *vs* No changes

resulted in 67% of the total. Considering together PA/sedentary behaviour and dietary habits (Table 4), 39.8% of women (n = 239) that have decreased their total PA, and 43.4% (n = 225) have increased their sedentary time during the lockdown worsened their usual dietary habits. Changes in sedentary behaviour showed a significant correlation (p=0.05) with changes in diet quality. Daily sitting time significantly increased in women which decreased the consumption of recommended foods with respect to women that did not change their diet quality during the lockdown.

In this study, 3.5% of the participants were receiving psychiatric treatment during the lockdown and the most common diagnosis was an anxiety disorder (2.3%). QoL and health perception worsened during the lockdown, compared with the pre-pandemic

Table 5. Psychiatric treatment, QoL and health perception change in study participants with and without changes in diet quality during the lockdown.

	Changes in heating habits score[a]			*p*-value[b]
	No changes *n* (%)	Increased *n* (%)	Decreased *n* (%)	
Psychiatric treatment				
No changes	325 (44.4)	123 (16.8)	284 (38.8)	0.048
Decreased	8 (36.4)	8 (36.4)	6 (27.3)	
Increased	10 (37.0)	2 (7.4)	15 (55.6)	
QoL				
No changes	208 (50.0)	67 (16.1)	141 (33.9)	< 0.002
Decreased	115 (36.6)	53 (16.9)	146 (46.5)	
Increased	20 (39.2)	13 (25.5)	18 (35.3)	
Health perception				
No changes	265 (48.6)	90 (16.5)	190 (34.9)	< 0.001
Decreased	58 (29.4)	35 (17.8)	104 (52.8)	
Increased	20 (51.3)	8 (20.5)	11 (28.2)	

[a]An increased score corresponds to an improvement in diet quality; whereas, a decreased score
[b]calculated among the studied groups using χ^2 tests

period, in 40.2% and 25.2% of BC patients, respectively. In Table 5, the changes in psychiatric treatment, QoL and health perception are compared with changes in diet quality during the restriction period. Changes in the use of psychiatric drugs, in QoL and in health perception showed a significant correlation (p=0.05) with the outcome variable (changes in food quality).

In the bivariate analysis, sedentary lifestyle, psychiatric treatment, QoL, and health perception showed a significant correlation with the outcome variable (changes in diet quality) (p=0.05 for all the independent variables, χ^2 test). The regression model (Table 6) confirmed the observation that these variables (except for QoL) were significantly associated with the outcome (*i.e.*, changes in diet quality score). During the pandemic, patients with BC that never married (OR = 0.512; 95% IC [0.289 – 0.908]), with an increase in sedentary lifestyle (OR = 0.563; 95% IC [0.332 – 0.956]) or currently using a psychiatric drug (OR = 0.286; 95% IC [0.088 – 0.926]) had a higher probability of worsening their diet. The same trend was observed in women with a decrease in their health perception (OR = 0.560; 95% IC [0.326 – 0.962]).

Discussion

After the outbreak of the COVID-19 pandemic, some population studies showed a decrease in healthy food consumption during the lockdown, while others found either an increase in favourable food choices. Nevertheless, the COVID-19 first lockdown mainly resulted in unfavourable changes in eating habits, and this may have short- and long-term consequences on individuals' health (33).

In this study, we observed an increase in the intake of vegetables (excluding potatoes), legumes, whole grain and water and unsweetened tea, but also an increase in the intake of meat and processed meat, refined foods, sweets and dessert, and alcoholic beverages. These high-calorie foods are called *comfort foods* due to the feeling of well-being or consolation they provide (34).

It was previously highlighted that the increase in *comfort foods* intake occurs when people experience negative emotions or try to regulate one's emotions. Interestingly, gender differences were observed and summarised with the sentence: "*Women like sugar, men like*

Table 6. Odds ratios for the association between potential predictor variables and changes in diet quality score.

	OR	95% IC	*p*-value
Marital status			
Married	1		
Separated/divorced	0.496	0.122 – 2.023	0.329
Widowed	1.227	0.547 – 2.756	0.619
Never married	0.512	0.289 – 0.908	0.022
Sedentary behaviour			
No changes	1		
Decreased	1.018	0.445 – 2.331	0.966
Increased	0.563	0.332 – 0.956	0.033
Psychiatric treatment			
No changes	1		
Decreased	4.721	1.291 – 17.267	0.019
Increased	0.286	0.088 – 0.926	0.037
QoL			
No changes	1		
Decreased	0.649	0.399 – 1.058	0.083
Increased	1.361	0.530 – 3.491	0.522
Health Perception			
No changes	1		
Decreased	0.560	0.326 – 0.962	0.036
Increased	1.489	0.516 – 4.295	0.461

meat" (34). The results of a web-based survey of 277 participants (196 female and 81 male), showed that the consumption of comfort food for women is associated with loneliness, depression, and guilt, whereas for men the consumption of comfort food is associated with success (35). This is in line with our results, which exclusively considered a female population.

In this study, we observed a reduction in the nutritional score in never-married women ($p = 0.022$). An interesting study showed that only 24.5% of people living alone did not experience discomfort consequent to restrictions, while 48.9% reported little/moderate distress and 26.5% felt highly stressed (36). In our study, it can be hypothesised that, in single women living alone, loneliness has pushed them to refuge in comfort food.

As expected, in this subcohort of the DianaWeb population, although not significantly, women who reduced their nutritional score, also increased their BMI (41%) and WC (42.5%). Furthermore, our study shows that an increase in sedentary behaviour is also associated with a reduction in nutritional score ($p = 0.033$).

In addition, women who reported a decrease in their health perception, and an increase in psychiatric care were more likely to worsen their dietary habits ($p = 0.036$ and $p = 0.037$, respectively). On the other hand, the reduction of treatments for psychiatric problems has been shown to be associated with a healthier diet ($p = 0.019$).

This trend has already been highlighted in the literature. About that, many studies and surveys, worldwide, have shown that the COVID-19 lockdown has affected the psychological well-being of individuals (37–39). On the one hand, the quarantine was necessary to limit the spread of the virus, but on the other hand, has exacerbated many psychological symptoms, and induced emotional distress and psychological disorders in the population (40). BC patients revealed themselves as a particularly vulnerable population in that regard (12), but this frailty is not only limited to the extraordinary pandemic scenario. Indeed, studies have shown that BC diagnosis and treatment expose patients to a 5-fold higher risk of depression compared with healthy women, with an estimated prevalence rate of 10–25% (41,42). A recent study described five different patterns of the evolution of depressive symptoms in BC patients in the first 36 months after the diagnosis, highlighting the heterogeneity in the expression of depressive symptoms, and the need for personalised care of patients in that sense (43). Moreover, BC diagnosis and treatment might induce also other psychological problems, which include, among others, anxiety, anger, hopelessness, fear of cancer recurrence and death, decrease in self-esteem, and sleep disorders (44). In addition to the enormous impact on individuals' life, these psychological disorders or symptoms definitely make BC patients highly exposed to the '*emotional eating*' risk. In our context, this trend of pandemic-induced psychological symptoms coincided with the interruption of face-to-face activities and also a reduction in online activities which, under normal conditions, are provided to members of the DianaWeb internet platform. Milder trends have been observed in studies in which support for the correct lifestyle of women with BC has been maintained (45,46). In fact, even in our case, the resumption of activities (in person

and online) made it possible to reduce this trend of worsening in lifestyle behaviour (47).

In light of our findings, psychological aspects should not be contemplated merely as confined mental health matters but should be definitely taken into consideration also as factors that seriously affect an individual's healthy lifestyle.

Conclusions

These results suggest that unfavourable changes should be monitored to prevent the nutrition- and lifestyle-related worsening of BC prognosis. The DianaWeb site represents an effective tool under normal conditions but, in light of the results obtained, researchers should consider new strategies to deal with emergencies. Encouraging positive changes is extremely important both in stressful situations like the COVID-19 lockdown and in the daily life of fragile populations such as women diagnosed with BC.

The DianaWeb study will have to be more interactive and promote webinars that help women make healthy choices even in conditions of non-normal life. Posting health recipes and advice on correct lifestyles did not seem to be enough to encourage healthy habits to overcome extraordinarily negative periods.

The future intent is to be able to schedule webinars that can contribute to the achievement of good food awareness, and lifestyle with the aim to avoid an increase in all those psychological discomforts that can be favoured or aggravated by an incorrect lifestyle. To achieve this goal, it could be useful to promote webinars addressed to small groups for health promotion and also involving other figures (*e.g.*, psychologists, nutritionists and exercise specialists).

The main strength of this study is the availability of data regarding lifestyle habits before and during the first COVID-19 lockdown, which allowed us to assess changes in women's behaviours consequent to home isolation. The results have to be seen also in light of some limitations. A limitation could lie in self-reporting of PA and dietary habits; however, a previous study suggests that self-reporting can be considered as satisfactorily accurate for women enrolled in the DianaWeb project (24). Another limitation is represented by the non-probabilistic nature of the sample, which impedes the generalizability of the results to the entire population of Italian women with BC. Moreover, the data are obtained using self-reported questionnaires, which are subject to social desirability and memory bias.

In summary, emotional state and mood—here investigated as QoL and health perception—definitely affected dietary habits in BC patients in the first COVID-19 lockdown. Given the essential value of correct eating behaviour in BC management, psychological aspects should not be contemplated merely as confined mental health matters but should be definitely taken into consideration also as factors that seriously affect an individual's healthy lifestyle. These results corroborate the importance of psychological support in BC patients' care and lays the foundation for the development of the DianaWeb project.

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APPENDIX

Supplementary Table 1. Number and percentage of women in the DianaWeb cohort who did not change, worsened or improved eating behaviour during the COVID-19 first lockdown.

	Changes in food habits during lockdown
Score value [a]	–0.97 ± 3.14
No changes [b]	343 (43.9)
Improvement in the usual dietary habits [b]	133 (17.0)
Worsening in the usual dietary habits [b]	305 (39.1)

[a] Mean ± SD; [b] number and (percentage)