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Original Research Article

The Effect of Adjuvant Chemotherapy on Anthropometric Measurements, Energy and Nutrient İntake in Breast Cancer Patients

Ozlem Muhsiroglu[1], Cengizhan Acikel[2], Fikret Arpaci[3], Neslisah Rakicioglu[4]

[1]Gulhane Research and Education Hospital Department of Medical Oncology. Etlik Ankara/TURKEY.
[2]Gulhane Research and Education Hospital Department of Bioistatistic. Etlik Ankara/TURKEY-
[3]Liv Hospital Department of Medical Oncology. Ankara/TURKEY.
[4]Hacettepe University Faculty of Health Science Department of Nutrition and Dietetics- Ankara/TURKEY.

Corresponding Author: Neslisah Rakicioglu

ABSTRACT

The aim of this study was to examine the effect of adjuvant chemotherapy on intakes of energy, nutrient, anthropometric measurements in patients with breast cancer. The study included 20-64 years old, 21 patients with newly diagnosed non-metastatic breast cancer that were scheduled for adjuvant chemotherapy. The patients were followed-up during 4-6 courses of chemotherapy. 3-day food consumption, 24-hour physical activity record, anthropometric measurements, some blood biochemistry, body composition analysis and resting metabolic rate (RMR) measurements using the bioelectrical impedance were recorded on 3 period: before, during, after chemotherapy. It was found that patients' energy and fat intakes did not change during chemotherapy according to before chemotherapy, but after chemotherapy, energy and fat intakes reduced than during chemotherapy. Patients' energy balance was evaluated. According to before chemotherapy, patients' energy intakes did not change but energy expenditure decreased significantly during chemotherapy. After chemotherapy, both energy intake and expenditure decreased significantly. RMR measurementswere not different. Weight and body mass index (BMI) did not change but waist, hip, mid-upper-arm circumferences measurements and body fat mass increased during and after chemotherapy than before chemotherapy. So this result indicate that during treatment, despite a decrease in energy expenditure due to a decrease in physical activity, an increase in energy intake and/or a failure to decrease energy intake that might have caused the observed increase in body fat-mass.

Keywords: Breast cancer, adjuvant chemotherapy, food intake, anthropometric measurement, body composition.

INTRODUCTION

Weight gain is a common problem in patients with breast cancer that receiving adjuvant chemotherapy and was first reported in the 1970's. [(1-3)] It was reported that quite a few women gain weight after being diagnosed with breast cancer, in part, as a result of treatment regimens, especially chemotherapy. [(1,3)] The cause of this weight gain varies and it appears to be related to the dosage of the chemotherapeutic agents used, duration of the therapy, and menopausal state of patients. [(1)] Previous research has shown that weight gain occurred in premenopausal women and in those that received multi-agent treatment regimens. [(1,2)] A number of uncontrolled studies reported that 50-96% of patients with early-stage breast cancer that were treated with adjuvant chemotherapy had significant

weight gain (2.5-6.2 kg one year post treatment) [1,3] and on rare occasions weight gain may be higher. [1,2]

Some studies have evaluated the role of weight gain as a risk factor for the development of breast cancer and its negative impact on prognosis. The probable mechanisms by which obesity affects cancer cells are hormonal changes, such as elevated serum estrogen levels, local production of estrogen and inflammation. Another theory is that obese women may be more insulin-resistant and, therefore, have more insulin, which is postulated to trigger the growth of breast cancer cells. [4]

Generally, weight gain is the result of an imbalance between energy intake and expenditure. However, how a positive energy balance during and after adjuvant chemotherapy is achieved is not clearly understood. [5] It has been posited that possible mechanisms of this weight gain are fatigue and subsequent a decrease in physical activity, [6,7] decreased body muscle mass and RMR, [8] and therapy-related increase in appetite and food consumption. [6]

We aimed to investigate the effects of postoperative adjuvant chemotherapy on newly diagnosed breast cancer (stage I, II, IIIA) patient's anthropometric measurements, energy and nutrient intakes, energy balance and some blood parameters in this study. The data will likely be of more interest to health professionals to inform pre-chemotherapy education provided to patients to help elucidate mechanisms of weight gain and energy imbalance in breast cancer patients receiving chemotherapy.

MATERIALS AND METHODS

Subjects

This study included a consecutive sample of recently diagnosed 21 women with non-metastatic breast cancer presenting to the Gulhane Medical Academy (GATA), Medical Oncology Clinic, between 01 March and 30 May 2009. The patients between the 20-64 years age included in the study if they had histologically confirmed primary breast cancer (stage I, II, IIIA) and were candidates for postoperative chemotherapy. Chemotherapy was administered within 3-4 weeks following surgery and patients were followed up during 4-6 courses of chemotherapy.

Women were excluded if they met any of the following criteria: 1.Prior history of breast cancer or other malignancy, 2.completed medical treatment for breast cancer, 3.metastatic cases, 4.patients scheduled for only hormone therapy, 5.presence of chronic renal or hepatic failure, endocrine disorders (hypo/hyperthyroidism, diabetes mellitus) 6.patients with loss of extremities (amputation). The patients were administered 1 vial of setrone and dexamethasone (8 mg) intravenously before each chemotherapy course for nausea. This study was approved by The Medical Ethics Committee of the Gulhane Medical Academy.

Study plan

At the initiation of the study, a questionnaire about patient's demographic characteristics was administered to each patient. Breast cancer patient's 3-day food records, food frequency, anthropometric measurements and physical activity records were obtained on 3 occasion; at baseline 'before chemotherapy' (approximately 3-4 week after breast surgery and immediately preceding initiation of chemotherapy), 'during chemotherapy' (at the middle of the treatment period: at 2 week after second or third chemotherapy cycle for patients who received 4 or 6 course of chemotherapy, respectively) and 'after chemotherapy' (at 2 week after their final chemotherapy). All measurements were performed as described [9] and all data were collected by a trained dietitian.

Dietary intake and calculation of physical activity

Dietary intakes of the patients were obtained 3 times (before, during, after chemotherapy) with 3-day24-hours dietary food records. [9] These records were

obtained at 2 weeks after the administration of chemotherapeutics to eliminate the acute effects (nausea, oral toxicities) of chemotherapy on dietary intake. Food intake records were assessed using a photographic atlas of food portion sizes. [(10)] Energy and nutrient intakes were calculated using food composition tables by a computer program. [(11)] In addition, the patients were interviewed 2 times (before and after chemotherapy) about the frequency of food consumption and cooking method.

24-h physical activity records of patients were obtained 3 times and the records were obtained at 2 weeks after the administration of chemotherapeutics to reduce acute effects of chemotherapy (fatigue) on physical activity. Using the activity coefficient of the standard physical activity (Physical Activity Ratio-PAR) for each activity was calculated energy expenditure. [(12)] Daily energy intake and expenditure were compared to determine energy balance.

Anthropometric measurements

Weight was measured using a balance beam scale to the nearest 0.1 kg. Patients were weighed wearing light clothing without shoes, after an overnight fast. Height was measured barefoot to the nearest 1 mm using a stadiometer. Body mass index (BMI) was calculated as weight (kilograms) divided by height (meters) squared. Waist (WC), hip (HC) and mid-upper arm circumferences (MUAC) were measured with a tape measure to the nearest 1 mm. MUAC measurements were taken on the non-operated side. Body composition and RMR measurements was obtained using the bioelectrical body composition analyser (Body Stat 1500®) as described [(9)] and measurements were performed. During and after chemotherapy, anthropometric measurements were performed at 2 weeks after the administration of chemotherapeutics.

Symptoms follow-up

Symptoms, such as nausea, vomiting, mouth sores, fatigue were followed-up and recorded during three periods. These symptoms were evaluated with Common Terminology Criteriafor Adverse Events v3.0. [(13)]

Biochemical findings

Some blood parameters [Fasting blood glucose, hemoglobin (Hgb), red blood cell (RBC), hematocrit (Hct), mean cell hemoglobin concentration (MCHC)] were obtained before and 2 weeks after final chemotherapy in order to eliminate the most acute effects of chemotherapy administration.

Statistical analysis

Statistical analysis was performed using SPSS 15.0. Qualitative data were analyzed as number (n) and percentage (%). Friedman's one-way repeated measure of variance was used to analyze the differences between the values before, during and after chemotherapy. The Wilcoxon test was used to identify which period caused the observed differences. The level of $p<0.05$ was considered as the cut-off value for statistical significance.

RESULTS

The present study included 21 recently diagnosed consecutive patients (mean age:45.6±8.5 years old) with breast cancers that were scheduled for adjuvant chemotherapy. Characteristic of patients who participated in the study are shown in Table 1.

Table 1: Characteristics of patients

	n	%
Patient	21	100
Age (year)		
30-50	16	76.2
51-64	5	23.8
Mean age (year)	45.6 ±8.5	
Stage of disease		
I	6	28.6
II	7	33.3
IIIA	8	38.1
Chemotherapy regimens		
Cyclophosphamide+doxorubicin+5-fluorouracil	11	52.4
		14.3
Cyclophosphamide+doxorubicin+docetaxel	3	33.3
Cyclophosphamide+doxorubicin	7	

Energy and nutrient intake

Energy intake of the patients were found significantly different (p=0.012)

before, during and after chemotherapy. Energy intake did not change during chemotherapy according to before chemotherapy. But, energy intake significantly reduced after chemotherapy according to during chemotherapy ($p<0.05$) (1894.78±332.20 kcal/d, 2147.94±430.15 kcal/d, respectively). Total fat intake ($p=0.001$) and the percentages of energy supplied from fats ($p=0.041$) were found different before, during and after chemotherapy. Fat intake decreased significantly after chemotherapy according to before ($p<0.05$) and during chemotherapy ($p<0.05$) (total fat 86.62±18.26g, 90.28±18.16g, 74.80±13.74g, respectively). Also after chemotherapy, the percentages of energy supplied from fats decreased significantly (35.4±4.8%, 37.7±4.5%) ($p<0.05$) (Table 2).

Saturated fat ($p=0.001$), mono-unsaturated (MUFA) ($p=0.009$), poly-unsaturated (PUFA) ($p=0.031$), omega 3 ($p=0.047$) and omega 6 ($p=0.031$) fatty acid, cholesterol ($p=0.002$) consumption were found statistically different before, during and after chemotherapy. MUFA ($p<0.05$) and cholesterol ($p<0.05$) consumption were found significantly higher during chemotherapy than before chemotherapy (MUFA 36.20±10.32g, 32.22±7.69g; cholesterol 287.22±78.52mg, 229.48±45.46 mg respectively). Saturated fat intake decreased significantly after chemotherapy ($p<0.05$) than before and during chemotherapy. PUFA, omega 6, MUFA and cholesterol consumption was significantly lower after chemotherapy than during chemotherapy ($p<0.05$) (Table 2).

Food consumption

Patients' vegetable and fruits consumption significantly increased during (799.47±295.86g) and after chemotherapy (775.66±262.39g) according to before chemotherapy (638.52±196.98 g) ($p<0.05$). According to before chemotherapy, after chemotherapy patients' total butter/margarine (7.71±6.31g, 4.09±5.61g respectively) and sugar consumption (28.66±15.99g, 18.80±14.20g respectively) decreased significantly ($p<0.05$) (Table 3).

Energy balance

Energy expenditure was found lower significantly during and after chemotherapy according to before chemotherapy ($p<0.05$). The equilibrium of energy intake and expenditure during and after chemotherapy was found +221.00±442.26 and -66.19±384.61 kcal, respectively. When compared to energy intake and expenditure, energy intake was found higher than expenditure during chemotherapy and the energy intake was found lower than expenditure after chemotherapy ($p=0.009$). RMR values measured using BIA was not found different. (Table 4).

Anthropometric measurements

Patients' weight and BMI measurements were not found statistically different; but WC($p=0.001$), HC($p=0.001$), MUAC($p=0.001$), body fat mass (%)($p=0.008$), fat-free mass (%)($p=0.008$) measurements were found different before, during and after chemotherapy. (Respectively, WC86.38±10.84cm, 88.62±10.94cm, 89.10±10.77cm; HC 107.52±10.81 cm, 108.95±10.50cm, 109.88±10.43cm; MUAC 30.14±3.71cm, 30.67±3.91cm, 30.90±3.58 cm; body fat mass(%) 40.88±8.23, 42.61±7.32, 42.42±7.24; fat-free mass(%) 59.15±8.23, 57.36±7.35, 57.57±7.23).

According to before chemotherapy, WC, HC, MUAC measurements and body fat mass (%) were found higher but fat-free mass (%) was found lower during and after chemotherapy ($p<0.05$) (Table 4).

Biochemical results

Fasting blood glucose was found significantly higher after chemotherapy (97.04±7.01mg/dl) than before chemotherapy (92.71±6.83mg/dl) ($p=0.018$). Also, Hgb ($p=0.001$), RBC ($p=0.002$), Hct ($p=0.003$), and MCHC($p=0.03$) values were found significantly lower after chemotherapy.

Table 2.Daily dietary intakes of energy and nutrients before, during and after chemotherapy (n=21).

Nutritional Elements	Before Chemotherapy			During Chemotherapy			After Chemotherapy			P*	Binary test
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median		P**
Energy (kcal)	2070.52	297.33	2036.55	2147.94	430.15	2092.40	1894.78	332.20	1856.29	0.012*	b:0.035
	(1545.0-2632,4)			(1528.6-2884.7)			(1457.8-2598.7)				c:0.001
Carbohydrates (g)	242.1	34.78	243.49	247.09	65.54	237.76	223.77	46.76	214.08	0.084	
	(181.10-314.50)			(149.12-394.25)			(146.70-318.70				
Protein (g)	74.31	12.68	75.08	80.37	16.40	81.00	75.41	18.76	72.13	0.368	
	(49.30-94.70)			(52.00-106.72)			(51.56-116.21)				
Protein (%)	14.76	2.16	15.0	15.33	2.39	15.0	16.09	2.11	16.0	0.463	
	(10.0-18.0)			(12.0-22.0)			(12.0-20.0)				
Total fat (g)	86.62	18.26	84.17	90.28	18.16	93.33	74.80	13.74	77.75	0.001*	b:0.003
	(59.90-122.00)			(63.41-132.30)			(44.89-101.81)				c:0.001
Total fat (%)	37.14	3.71	37	37.76	4.59	38.0	35.42	4.87	35.0	0.041*	c:0.038
	(31.0-49.0)			(30.0-48.0)			(27.0-48.0)				
Saturated fat (g)	26.71	5.82	26.44	26.98	4.89	27.03	22.69	4.58	23.80	0.001*	b:0.001
	(14.60-35.75)			(17.98-34.08)			(11.88-31.50)				c:0.001
MUFA (g)	32.22	7.69	32.42	36.20	10.32	32.44	29.57	7.48	30.75	0.009*	a:0.025
	(19.10-47.80)			(21.31-54.24)			(17.34-44.41)				c:0.007
PUFA (g)	22.31	8.18	22.36	21.18	7.29	19.60	17.63	5.77	17.23	0.023*	c:0.005
	(9.60-36.30)			(6.20-36.93)			(8.50-29.30)				
Omega 3 fatty acid (g)	2.01	1.09	1.63	2.24	0.95	2.07	1.83	0.86	1.56	0.047*	c:0.019
	(0.85-4.57)			(1.14-4.18)			(0.72-3.68)				
Omega 6 fatty acid (g)	20.14	7.81	20.68	18.93	6.87	17.29	15.78	5.17	15.71	0.031*	c:0.008
	(7.96-32.84)			(4.73-32.74)			(6.89-26.16)				
Cholesterol (mg)	229.48	45.46	217.93	287.22	78.52	272.43	234.39	85.66	217.63	0.002*	a:0.001
	(146.20-348.50)			(192.60-464.50)			(102.63-426.47)				c:0.007

*P:Friedman'stest. **P:Wilcoxon test. Statistical differences: a: before chemotherapy-during chemotherapy; b:before chemotherapy-after chemotherapy; c:during chemotherapy-after chemotherapy. MUFA:Mono unsaturated fatty acids, PUFA:Poly unsaturated fatty acid.

Table 3.Daily consumption of food groups before, during and after chemotherapy (n=21).

Food Groups	Before Chemotherapy			During Chemotherapy			After Chemotherapy			p*	Binary test
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median		p**
Milk and dairy Products 406.57		217.16	417.00	434.28	201.24	467.00	381.47	202.40	350.00		
	(87.00-1037.00)			(62.00-770.00)			(110.00-930.00)				
Red meat chicken, fish	93.33	33.06	100.00	108.76	45.29	103.00	100.90	51.00	130.00	0.546	
	(13.00-140.00)			(33.00-230.00)			(27.00-230.00)				
Bread and grains	208.71	52.63	212.00	204.19	71.80	192.00	188.00	64.25	181.00	0.263	
	(143.00-376.00)			(90.00-369.00)			(99.00-294.00)				
Vegetables and fruits	638.52	196.98	604.00	799.47	295.86	792.00	775.66	262.39	757.00	0.027*	a:0.012 b:0.016
	(293.00-1093.00)			(195.00-1530.00)			(348.00-1319.00)				
Total oil	29.90	10.83	29.00	27.85	11.53	26.00	24.90	5.62	24.00	0.201	
	(15.00-55.00)			(7.00-48.00)			(10.00-34.00)				

Table 3 to be continued on next page…

Butter- margarine	7.71	6.31	7.00	5.71	5.33	6.00	4.09	5.61	0	0.042*	b:0.014
	(0-18.00)			(0-20.00)			(0-16.00)				
Sugar	28.66	15.99	27.00	22.71	16.94	17.00	18.80	14.20	17.00	0.037*	b:0.016
	(8.00-57.00)			(5.00-64.00)			(0-64.00)				

*P:Friedman's test. Values in parentheses represent minimum and maximum. **P:Wilcoxontest.Statistical differences: a:before chemotherapy-during chemotherapy; b:before chemotherapy-after chemotherapy; c:during chemotherapy-after chemotherapy.

Table 4.Daily energy balance, anthropometric measurements and body composition in patients before, during and after chemotherapy for (n=21)

	Before Chemotherapy			**During Chemotherapy**			**After Chemotherapy**			**Binary test**	
	Mean	**SD**	**Median**	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**p***	**p****
Energy Balance											
Energy expenditure (kcal)	2004.76	107.34	1990.0	1975.71	127.75	1940.00	1961.19	155.42	1960.00	0.013*	a:0.02
	(1740.0- 2220.0)			(1680.0- 2240.0)			(1675.0-2330.0)				b:0.03
Energy balance	66.00	327.23	-19.00	221.00	442.26	60.00	-66.19	384.61	-75.00	0.009*	c:0.02
Intake-Expenditure (kcal)	(-545.00-+664)			(-464.00-+90.8)			(-560.0-+731.0)				
RMR (kcal)	1376.90	182.26	1379.00	1362.10	176.70	1392.00	1374.86	187.74	1372.00	0.113	
	(1113.0-1816.0)			(1107.0-1853.0)			(1106.0-1872.0)				
Anthropometric Measurements											
Weight (kg)	70.43	14.43	73.00	71.43	15.01	71.00	71.67	14.81	72.00	0.215	
	(50.00 -110.00)			(50.00 -114.00)			(51.00 -114.00)				
BMI (kg/m^2)	27.63	5.19	27.68	28.02	5.35	27.05	28.11	5.24	27.00	0.215	
	(17.70-40.90)			(17.70-42.40)			(18.00 - 42.00)				
MUAC (cm)	30.14	3.71	30.00	30.67	3.91	30.50	30.90	3.58	31.00	0.001*	a:0.005
	(23.00 -39.00)			(23.00 -42.00)			(24.00 -39.00)				b:0.001
Waist circumference(cm)	86.38	10.84	87.00	88.62	10.94	89.00	89.10	10.77	89.00	0.001*	a:0.003
	(68.00 -105.00)			(68.00 -110.00)			(72.00 -109.00)				b:0.004
Hip circumference (cm)	107.52	10.81	109.00	108.95	10.50	108.00	109.88	10.43	110.00	0.001*	a:0.01
	(92.00 -130.00)			(93.00 -133.00)			(96.00 -136.00)				b:0.01
Fat mass (%)	40.88	8.23	40.80	42.61	7.32	42.90	42.41	7.24	41.50	0.008*	a:0.003
	(32.00 -61.00)			(30.40-59.90)			(26.20-59.50)				b:0.006
Fat-free mass (%)	59.15	8.23	59.40	57.36	7.35	57.10	57.57	7.23	58.50	0.008*	a:0.003
	(40.10- 68.00)			(40.10-69.50)			(40.50-70.80)				b:0.006

BMI:Body mass index; MUAC:mid-upper arm circumference.*P:Friedman'stest. **P:Wilcoxontest.Statistical differences: a:before chemotherapy-during chemotherapy; b:before chemotherapy-after chemotherapy; c:during chemotherapy-after chemotherapy

DISCUSSION

In the present study, the effects of adjuvant chemotherapy on the dietary energy and nutrients intake, weight gain, energy balance, anthropometric measurements, and some blood parameters were examined in detail in 20-64 years old patients recently diagnosed with breast cancer (stage I-II-IIIA).

Various studies on early-stage breast cancer patients report that some changes in the dietary habits and food preferences occurred following diagnosis. [14-16] The most common modification was a decrease in high sugar foods, red meat, butter/margarine, whole-fat milk products consumption and an increase in olive oil, whole grains, fish, vegetables and fruit, low-fat milk products consumption following diagnosis. [15-17] Similarly in this study, patient described that they preferred more often olive oil, vegetables, fruits, and low-fat milk products and less often sunflower/corn oil, desserts, pastry, fried foods, margarine, whole-fat milk products following diagnosis.

In a study breast cancer patient's total energy, total fat, fatty acid, protein intake were significantly decreased after diagnosis according to before diagnosis. The changes included reduction in redmeat, seafood,poultryintakeand an increase in fruits, vegetables, fish, low-fatmilkand soyproducts. [18] In our study patients' energy ($p=0.012$) and total fat consumption ($p=0.001$) were found significantly different all the period. Energy, total fat intake and the percentage of energy supplied from fats were significantly lower after chemotherapy ($p<0.05$) (Table 2). Similar to studies, the patients preferred low fat foods and healthy cooking methods (boiling, grilling, roasting) after chemotherapy. Also, butter/margarine and sugar consumption decreased significantly after chemotherapy and vegetable-fruits consumption increased during and after chemotherapy (Table 3). So these changes might have been contributed to the observed decrease in total fat and energy intake after chemotherapy. After chemotherapy saturated fat, cholesterol, MUFA, PUFA, omega 6 intake were lower after chemotherapy significantly ($p<0.05$). The observed decrease in the consumption of total fat after chemotherapy contributed to the decrease in the total intake of these fatty acids (Table 2).

Although various studies reported that most cancer patients adopt a healthier lifestyle, they reported that such change could not be generalized and that it could be transient and for a long time after diagnosis in breast cancer patients nutrition and lifestyle were similar in healthy women. [19-21] In our study, we observed that breast cancer patient's food choices and habits changed for short period. But if the follow-up period had been longer, these changes might have been similar in healthy women.

Some uncontrolled studies suggest that 50-96% of patients with early-stage breast cancer that were treated with adjuvant chemotherapy had significant weight gain. [1,3] In a prospective study included 272 patients with breast cancer who underwent adjuvant chemotherapy were followed during and after chemotherapy period (6 and 12 month after). At one year, the mean weight change was +1.5 kg (SD =4.1) and +2.3% (SD =6.0); 60% of the cohort had gained weight, with a median increase of 3.9 kg (SD=3.0) and 5.9% (SD=4.4). [22] In some studies reported that, the weight gain was the result of an increase in adipose tissue in the absence of a decrease or change in fat-free body weight. [8,23-25] In a prospective study, breast cancer (stage I-IIIA) patients' weight did not change, but body fat increased (2.3±4%,+4.0±6%) and fat-free body mass decreased (2.2±4%,–3.8±6%) between before and after chemotherapy. [24] Similar to other studies, in this study we observed that weight and BMI measurements did not change significantly but body composition changed. We demonstrated using BIA measurement that patient's fat-mass (%)($p=0.008$) were increased and fat-free body mass (%) ($p=0.008$) was decreased significantly during and after chemotherapy (Table 4).

Also increase in body fat-mass was observed via increased WC, MUAC and HC measurements (Table 4).

Weight gain due to chemotherapy can vary according the chemotherapeutic agents used. Both weight and fat mass increased significantly in women treated with cyclophosphamide, methotrexate and 5-fluorouracil. [26-28] No weight gain was observed in a study in which doxorubicin and cyclophosphamide were used; however, a loss of fat-free mass resulting in an increase in the body fat percentage was reported. [29] A study that included stage I-II breast cancer that underwent adjuvant chemotherapy containing cyclophosphamide, 5-fluorouracil, doxorubicin and methotrexate reported that RMR values, physical activity and energy intake decreased significantly, as compared to initial. These results suggested that chemotherapy provoked a number of significant changes in body composition and metabolic requirement. [23] In our study, 52.4% of the patients were treated with cyclophosphamide+doxorubicin+5-fluorouracil, 14.3% with cyclophospha-mide+ doxorubicin+docetaxel, and 33.3% with cyclophosphamide+ doxorubicin. (Table 1). Similar to other published results, it was not found the changes of weight gain and BMI. However, body fat increased and fat-free body mass decreased significantly. A significant difference in RMR was not observed in these patients (Table 4).

Possible mechanisms for weight gain include fatigue, decreased physical activity, [6,7] decreased fat-free mass, RMR [8] and increased food consumption or a treatment-related increase in appetite. [6] In a study, 17 early stage breast cancer patients had significant weight gain, increased body fat, WC, decreased fat-free body mass and RMR throughout the course of adjuvant chemotherapy and 6 months post-treatment. No significant changes occurred in their food consumption or level of physical activity during 1 year. The women's inability to decrease their energy intake, despite a decrease in energy expenditure during chemotherapy and 6 months after treatment was reported to have caused an increase in their body fat. [30]

In this study, we found that energy expenditure was found significantly lower during and after chemotherapy according to before chemotherapy ($p<0.05$). When compared to energy intake and expenditure, during chemotherapy energy intake was similar to before chemotherapy, energy expenditure was found lower than before chemotherapy; after chemotherapy both energy intake and expenditure was lower than before chemotherapy. So, this indicates that energy balance in the patients was positive during chemotherapy, but it was negative after chemotherapy due to a decrease in energy intake. RMR values were similar all stages (Table 4). Reduced physical activity and energy expenditure might be contributed to increase patient's body fat content.

Fatigue is one of the most common complaints of the cancer patients. Chemotherapy, radiotherapy, other agents used for treatment and complications may cause fatigue. Chemotherapy-related anemia and cell breakdown products may also cause fatigue. In fact, RBC, Hgb, Hct, MCHC values were significantly lower after chemotherapy due to transient suppression of the bone marrow by the chemotherapeutics. [31] In this study fatigue was the most common complaints of patients that they said. In addition, patients' Hgb, RBC, Hct, MCHC values were found lower after chemotherapy than before chemotherapy. Chemotherapeutics, steroids and anemia may have caused fatigue. As a result fatigue may have caused the observed decrease in physical activity and energy expenditure.

Mean fasting glucose levels in this study's patients were higher after chemotherapy period ($p=0.0018$). Increased weight, body fat and especially abdominal obesity are related to insulin resistance. The observed increase in blood glucose levels after chemotherapy might have been related to insulin resistance or hyperinsulinemia.

[32,33] In this study, increased body fat and energy intake and decreased physical activity might have caused the observed increase in blood glucose levels. Additionally, steroids that were used to decrease nausea might have caused this also.

This study has some limitations. This study has small sample size. Breast cancer patient's follow-up period was throughout the 4-6 course of chemotherapy period and 2 weeks after last chemotherapy. However our study's result demonstrated that patient's energy intake and expenditure, body composition and dietary habits was affected chemotherapy period. If the follow-up period was longer, there could have been more changes. So, future studies may be planned for a long period for these patient groups.

In conclusion, during chemotherapy total energy intake did not change but energy expenditure decreased. Both energy intake and expenditure decreased significantly after chemotherapy. Patients' weight did not change significantly but their body fat composition increased. Despite a decrease in energy expenditure during chemotherapy, an increase in energy intake and/or a failure to decrease energy intake might have caused the observed increase in patients' body fat-mass.

Purpose of the study: The aim of this study was to examine the effect of adjuvant chemotherapy on intakes of energy, nutrient, anthropometric measurements in patients with breast cancer.

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