Original Article

EGG SUPPLEMENTATION AND DIETARY INTAKE VARIABILITY DURING CYTOTOXIC CHEMOTHERAPY CYCLES OF BREAST CANCER PATIENTS

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ABSTRACT

Background: The variability in dietary intake during chemotherapy, coupled with the adverse effects of cytotoxic agents, highlights the critical need for targeted nutritional strategies to mitigate malnutrition and support recovery. This study aims to assess dietary intake variability among breast cancer patients undergoing cytotoxic chemotherapy with egg supplementation.

Methods: The study was conducted among breast cancer patients receiving chemotherapy at the National Institute of Cancer Research and Hospital (NICRH) from December 2022 to November 2023. Fifty-two patients were enrolled in each group (control and experimental). The experimental group received a supplementation of three eggs (one whole egg and white portion of two eggs). Nutritional status was assessed using the 7-point Subjective Global Assessment (SGA) tool, classifying patients as well-nourished or moderately to severely malnourished. Dietary intake was evaluated using a 7-day food frequency questionnaire. **Results:** The intervention group showed significant improvements in dietary habits and health outcomes compared to the control group. Rice intake was higher in the intervention group (90.3% vs. 78.8%), and they consumed more roti (59.6% vs. 40.4%). Egg consumption increased to 100% in the experimental group, while the control group showed no change. Milk intake also increased in the intervention group (80.7% vs. 73.1%). Vegetable intake improved in both groups, with the experimental group increasing from 40.4% to 59.6%, while the control group saw a larger increase (21.2% to 76.9%). Fruit intake increased in the intervention group (78.8% to 84.5%) but decreased in the control group. The intervention group consumed significantly more egg protein (20.07 g vs. 12.53 g, $p<0.001$). The intervention group effectively mitigated weight loss over time, with 76.9% maintaining no weight loss at the end line compared to only 32.7% in the control group ($p < 0.05$) and better food habits and fewer GI symptoms compared to the control group.

Conclusion: Egg supplementation significantly increased egg protein intake in the experimental group, but overall dietary intake remained inadequate, highlighting the need for comprehensive nutritional interventions addressing barriers such as taste changes, gastrointestinal symptoms, and fatigue to improve nutritional status and quality of life for chemotherapy patients.

JOPSOM 2024; 43(2): 17-28
DOI: https://doi.org/10.3329/jopsom.v43i2.84194

***Keywords*:** Dietary intake variability, Cytotoxic chemotherapy, Egg supplementation

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INTRODUCTION

Cancer remains a leading global health concern, with a projected 19.3 million new cases and about 10 million deaths from the disease in 2020 [1]. With 11.7% of all new cancer cases, breast cancer is the most common kind among the others[2]. Survival rates have increased dramatically due to advancements in oncological therapies, especially cytotoxic

chemotherapy[3]. However, patients frequently experience nutritional intake variability as a result of the negative side effects of chemotherapy, which include nausea, vomiting, anorexia, mucositis, and impaired taste perception. Treatment tolerance, nutritional health, and general quality of life can all be adversely affected by such variations[4].

The nutritional status significantly influences treatment outcomes in cancer care[5]. Malnutrition affects up to 40% of cancer patients receiving chemotherapy and is linked to heightened morbidity, decreased treatment adherence, and lower survival rates[6]. Optimal nutritional intake can enhance immune function, reduce treatment-related toxicities, and improve therapeutic efficacy[7]. The variability of dietary intake during chemotherapy cycles is significant yet underexplored[8], especially in low- and middle-income countries (LMICs) such as Bangladesh, where distinct dietary practices and inadequate nutritional support services present further challenges.

During chemotherapy, nutritional intake varies depending on a number of factors[9]. Physiological elements such as gastrointestinal upsets, fatigue, and changes in metabolic needs interplay with psychological factors like anxiety and depression[10]. Furthermore, dietary practices are further shaped by sociocultural factors such as food preferences, meal schedules, and socioeconomic position[11]. Crucially, research has revealed that patients' eating habits frequently worsen throughout the chemotherapy cycle, resulting in inadequate intake of protein, vitamins, and other vital nutrients that are necessary for sustaining energy levels and promoting the body's healing processes. New research highlights how customized dietary therapies may help address these issues[12].

From a systematic review it was said that In order to reduce treatment-related toxicities, promote treatment effectiveness, and avoid recurrence, food and beverage consumption and weight status can be integrated with cancer treatment[13]. However, these findings predominantly emerge from high-income settings, with limited representation of LMICs, where dietary habits and healthcare access differ significantly.

In Bangladesh, dietary patterns are characterized by high carbohydrate consumption, with limited intake of protein-rich and micronutrient-dense foods. These dietary habits, coupled with the metabolic demands and side effects of chemotherapy, may exacerbate malnutrition risk. To date, there is limited data on how chemotherapy impacts dietary intake variability in Bangladeshi breast cancer patients. Understanding this variability is crucial for developing context-specific nutritional interventions that align with cultural preferences and resource availability.

This study aims to assess dietary intake variability among breast cancer patients undergoing cytotoxic chemotherapy with egg supplementation. By identifying patterns of intake fluctuations and their underlying causes, the findings will inform evidence-based strategies to optimize nutritional support during chemotherapy. Such interventions could enhance treatment tolerance, improve nutritional status, and ultimately contribute to better clinical outcomes and quality of life. Additionally, this research addresses a critical gap in the literature, providing data from an LMIC perspective, which is essential for global cancer care strategies.

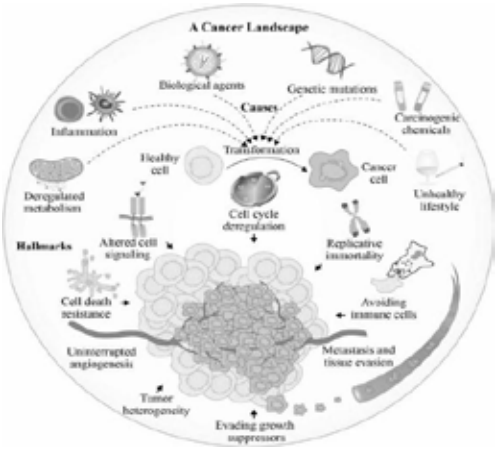

Figure 1: Schematic diagram showing different intrinsic and extrinsic biological/molecular events potentiating the transformation of a normal cell to the cancer cell, while the lower part of this diagram showing different hallmarks of a transformed cancer cell[3].

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

METHODS

Participants: The study was performed in-patients receiving chemotherapy for breast cancer at the Department of Oncology at National Institute of Cancer Research and Hospital (NICRH) from December 2022 to November 2023. Patients in this trial were eligible if they had been receiving at least 2 cycles of chemotherapy with histopathological confirmed breast cancer. Exclusion criteria were as follows: Patients with a history of recurrence, metastasis, or treatment failure. Patients with advanced stages of breast cancer, extreme ages (<18 and >50 years), and Those who have comorbidities such as diabetes mellitus, thyroid disease, coronary or peripheral vascular insufficiency, renal disease, liver disease, para-thormone deficiency, high lipid profile, and blood pressure, and a history of mental illness or a history or taking drug(s) antagonist to omega 3 fatty acid or vitamin D will be excluded. H/O bleeding disorder. Fifty-two breast cancer patients in each group (control arm and experimental arm) were eligible for the study. Three eggs were supplemented (one full egg and two white portion of eggs). The study was performed in accordance with the Helsinki declaration; the subjects gave their written consent for the study. The control group showed a significant increase in vegetable intake, while the experimental group had improvements in fruit consumption, with both groups increasing the proportion consuming ≤½ cup of vegetables and fruits.

Nutritional status

The 7-point Subjective Global Assessment(SGA) tool was used to classify a patient's nutritional status as either well-nourished or moderately to severely malnourished on the basis of 7 point. From three components of SGA, in this article SGA uses information focused on medical history (i.e., weight loss, changes in dietary intake, gastrointestinal symptoms); other parameters (functional capacity and physical examination i.e., loss of sub cutaneous fat, muscle wasting, and edema or ascites) were excluded from this study. Each of these factors is rated (1-7) to provide a comprehensive overview of the patient's nutritional health. The assessment begins by asking about unintentional weight loss, with specific attention to duration and amount, as this can indicate malnutrition. Patient was measured usual weight from height-weight chart, then measured current weight by bathroom scale(±0.5kg). Overall loss of weight was measured and % of loss was calculated. If increase weight trend, add 1 point, if decrease weight trend within 1 month, minus 1 point, and rated 1-7: 7=0% weight loss; 1= ≥ 15% weight loss. Dietary intake history was taken to any change in past 2 weeks that was examined to detect reductions or changes due to illness or treatment. Gastrointestinal symptoms that persist for > 2 weeks like nausea, vomiting, diarrhea, or anorexia, are also noted as they can impact nutrient absorption and overall intake.

Dietary intake evaluation

Dietary intake was assessed using a 7-day food frequency questionnaire, with a dietitian verifying the completeness and accuracy of the data. Measurements were conducted at two time points: baseline and 12 weeks' post-intervention (end line). To estimate portion sizes, visual aids were utilized: one closed fist approximated a cup of cooked vegetables or fruits (Fig. 2a), one cupped hand represented half a cup of carbohydrates (Fig. 2b), and the palm of a hand equated to 3 to 4 ounces of protein (Fig. 2c). One glass means 250 ml glass.

Fig 2.a **Fig 2.b** **Fig 2.c**

Statistical analysis

Statistical analysis was performed with the use of statistical software (SPSS, version 23). For association chi square test and independent sample's t-tests was done. Descriptive analysis was presented by mean standard deviation, frequency, percentage. Data were presented at 95 % confidence intervals (CI). The level of significance was set at $\alpha = 0.05$.

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

Table 1: Carbohydrate pattern before and after intervention for both group breast cancer patients

Amount of food items consumed		Consumed by the experimental group (n=52) n (%)		Consumed by the control group (n=52) n (%)		P value
		Baseline	End-line	Baseline	End-line	
Rice intake frequency						
One-times		04 (7.7)	5 (9.6)	10 (19.2)	10 (19.2)	>0.05
Two-three times daily		46 (88.4)	47 (90.3)	40 (76.9)	41(78.8)	
>3-times		02 (3.9)	0 (0)	02 (3.9)	1(1.9)	
Every day/week		52 (100)	52 (100)	52 (100)	52 (100)	
Amount of Rice						
<1 cup		07 (13.5)	09(17.3)	03 (5.7)	5(9.6)	
1 cup		27 (51.9)	25(48.1)	24 (46.2)	24(46.2)	
>1 cup		18 (34.6)	18 (34.6)	25 (48.1)	23(44.2)	
Roti intake						
No		19 (36.5)	18 (34.6)	24 (46.2)	24 (46.2)	>0.05
One-two times	daily	30 (57.7)	31(59.6)	20 (38.5)	21(40.4)	
	weekly	14 (26.9)	13 (25.0)	05 (9.6)	04(7.7)	
Two-three times daily		03 (5.8)	04 (7.7)	08 (15.3)	07(13.5)	
Every day/week		18 (34.6)	19 (36.5)	23 (44.8)	22(42.3)	
3-4 times/week		01 (1.9)	0 (0)	0 (0)	0 (0)	
Quantities of Roti						
No		19 (36.5)	18 (34.6)	24 (46.2)	24 (46.2)	
Two		11 (21.2)	12 (23.1)	13 (25.0)	12 (23.1)	
Three		22 (42.3)	22 (42.3)	15 (28.8)	16(31.5)	
Potato intake						>0.05
No		07 (13.5)	06 (11.5)	06 (11.5)	07 (13.5)	
One-two times	daily	22 (42.3)	23 (44.2)	17 (32.7)	17(33.4)	
	weekly	10 (19.2)	12 (23.1)	10 (19.2)	10 (19.2)	
Two-three times daily		23 (44.2)	22 (42.3)	29 (55.8)	30 (57.7)	
Every day/week		22 (42.3)	21(40.4)	24 (46.2)	24 (46.2)	
3-4 times/week		13 (25.0)	13 (25.0)	12 (23.1)	13 (25.0)	
Amount of potato						
No		07 (13.5)		06 (11.5)		
≤ 1/2 cup		41 (78.8)	44(84.5)	46 (88.5)	44(84.5)	
One cup		04 (7.7)	1(1.9)	-	02(3.8)	

Table 1 summarized the carbohydrate consumption patterns among breast cancer patients in the experimental and control groups before and after the intervention. A notable finding was the higher frequency of rice intake (2–3 times daily) in the experimental group compared to the control group at the end line (90.3% vs. 78.8%). The control group consistently had a slightly greater proportion consuming more than 1 cup of rice at both baseline and end line (48.1% and 44.2% vs. 34.6% in the experimental group). Regarding roti intake, the experimental group consumed roti 1–2 times daily more frequently at both baseline and end line compared to the control group (59.6% vs. 40.4% at end line). Additionally, a larger proportion of the experimental group consumed 3 rotis per serving at both time points. For potato intake, the majority in both groups consumed ≤½ cup of potatoes, with similar proportions at the end line (84.5% in both groups).

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

Table 2: Protein intake pattern before and after intervention for both group breast cancer patients

Amount of food items consumed		Consumed by the experimental group (n=52) n (%)		Consumed by the control group (n=52) n (%)		P value
		Baseline	End line	Baseline	End line	
Fish intake						
No		01 (1.9)	01 (1.9)	03 (5.8)	03 (5.8)	>0.05
One-two times	daily	50 (96.2)	50 (96.2)	27 (51.9)	27 (51.9)	
	weekly	14 (26.9)	14 (26.9)	09 (17.3)	09 (17.3)	
Two-three times daily		01 (1.9)	01 (1.9)	01 (1.9)	01 (1.9)	
Every day/week		22 (42.3)	22 (42.3)	22 (42.3)	22 (42.3)	
3-4 times/week		15 (28.8)	15 (28.8)	15 (28.8)	15 (28.8)	
Amount of fish						
No		01 (1.9)	01 (1.9)	03 (5.8)	03 (5.8)	>0.05
One Piece		50 (96.2)	50 (96.2)	48 (92.3)	48 (92.3)	
Two		01 (1.9)	01 (1.9)	01 (1.9)	01 (1.9)	
Meat intake						
No		10 (19.2)	8(15.4)	13 (25.0)	15 (28.8)	>0.05
One-two times	daily	40 (76.9)	42(80.7)	37 (71.2)	35 (67.3)	
	weekly	34 (65.4)	36(69.2)	35 (67.3)	35 (67.3)	
Two-three times daily		02 (3.8)	02 (3.8)	02 (3.8)	02 (3.8)	
Every day/week		-	07 (13.5)	-	01(1.9)	
3-4 times/week		08 (15.4)	01(1.9)	04 (7.1)	01(1.9)	
Amount of meat intake						
No		10 (19.2)	10 (19.2)	13 (25.0)	13 (25.0)	
One Piece		42 (80.8)	42 (80.8)	39 (75.0)	39 (75.0)	
Dal Intake						
No		05 (9.6)	03 (5.8)	14 (26.9)	10 (19.2)	>0.05
One-two times	daily	13 (25.0)	15(28.8)	18 (15.4)	22(42.3)	
	weekly	20 (38.5)	23(44.2)	14 (26.9)	14(26.9)	
Two-three times daily		34 (65.4)	34 (65.4)	30 (57.7)	20(57.7)	
Every day/week		11 (21.2)	12 (23.1)	13 (25.0)	15(28.8)	
3-4 times/week		16 (30.8)	14 (26.9)	11 (21.2)	13(25.0)	
Amount of Dal intake						
No		05 (9.6)	03 (5.8)	14 (26.9)	10 (19.2)	
≤ 1/2 cup		22 (42.3)	25 (48.1)	28 (53.9)	21(59.6)	
One cup		25 (48.1)	22 (42.3)	10 (19.2)	21(59.6)	
Egg intake frequency						
No		06 (11.5)	0	09 (17.3)	11(21.2)	>0.05
One times	daily	45 (86.5)	52(100)	42 (80.8)	40 (80.8)	
	weekly	13 (25.0)	-	14 (26.9)	12 (23.1)	
Two times daily		01 (1.9)	-	01 (1.9)	01 (1.9)	
Every day/week		27 (51.9)	-	22 (42.3)	19(36.5)	
3-4 times/week		06 (11.5)	-	07 (13.5)	10 (19.2)	
Egg Amount						
No		06 (11.5)	-	09 (17.3)	11(21.2)	
One		27 (51.9)	-	42 (80.8)	40 (80.8)	
Two		01 (1.9)	-	01 (1.9)	01 (1.9)	
Three			52		0	
Milk intake						
No		14 (26.9)	10 (19.2)	29 (55.8)	23 (44.2)	>0.05
One-two times	daily	38 (73.1)	38(73.1)	23 (44.2)	23 (44.2)	
	weekly	16 (30.8)	24(46.2)	09 (17.3)	10 (19.2)	

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

Two-three times daily	-	4(7.7)	-	06 (11.5)	
Every day/week	13 (25.0)	8(15.4)	12 (23.1)	10 (19.2)	
3-4 times/week	09 (17.3)	10 (19.2)	02 (3.8)	09 (17.3)	
Amount of Milk					
No	14 (26.9)	10 (19.2)	29 (55.8)	23 (44.2)	
One glass	38 (73.1)	42 (80.7)	23 (44.2)	29 (55.8)	

Table 2 summarized the protein intake patterns of breast cancer patients in both the experimental and control groups before and after the intervention. Key findings revealed notable changes in dietary habits. In the experimental group, nearly all participants (96.2%) consumed fish 1-2 times daily at both baseline and end line, significantly higher than the control group (51.9%). Most participants in both groups consumed one piece of fish per serving (96.2% in the experimental group and 92.3% in the control group). Meat intake showed a slight increase in daily consumption in the experimental group (from 76.9% to 80.7%), while the control group experienced a decrease (from 71.2% to 67.3%). Weekly meat consumption remained stable in the control group (67.3%), while it increased slightly in the experimental group (from 65.4% to 69.2%). For dal intake, the experimental group had a modest increase in those consuming dal 1-2 times daily (from 25.0% to 28.8%), while the control group showed a substantial increase from 15.4% to 42.3%. The proportion of participants consuming ≤½ cup of dal also rose in both groups, with the experimental group increasing from 42.3% to 48.1%. Regarding egg consumption, the experimental group saw a remarkable increase, with 100% of participants consuming eggs daily at the end of the intervention, compared to 86.5% at baseline. In contrast, the control group showed no change in the daily egg consumption (80.8% at both baseline and end line). The majority of participants in both groups consumed one egg daily (experimental: 51.9%; control: 80.8%). Finally, milk intake increased in the experimental group, with daily milk consumption rising from 73.1% to 80.7%, while the control group saw a smaller increase from 44.2% to 55.8%. The proportion of participants not consuming milk decreased in both groups, with a more notable reduction in the experimental group (from 26.9% to 19.2%).

Table 3: Vegetable and fruits intake pattern before and after intervention for both group breast cancer patients

Amount of food items consumed		**Consumed by the experimental group (n=52) n (%)**		**Consumed by the control group (n=52) n (%)**		**P value**
		Baseline	**End line**	**Baseline**	**End line**	
Vegetables intake						
No		00 (0.00)	00 (0.00)	01 (1.9)	01 (1.9)	>0.05
One/two times	Daily	21 (40.4)	31 (59.6)	11 (21.2)	40 (76.9)	
	Weekly	06 (13.5)	06 (13.5)	04 (7.7)	10 (19.2)	
Two-three times daily		31 (59.6)	21 (59.6)	40 (76.9)	11 (21.2)	
Every day/week		33 (63.5)	33 (63.5)	37 (71.2)	27(51.9)	
3-4 times/week		13 (25.0)	13 (25.0)	10 (19.2)	14 (26.9)	
Amount of vegetables						
No		00 (0.00)	00 (0.00)	01 (1.9)	1(1.9)	
≤ 1/2 cup		27 (51.9)	25(48.1)	37 (71.2)	40(76.9)	
One cup		25 (48.1)	27(51.9)	14 (26.9)	9(17.3)	
Fruits intake						>0.05
No		7 (13.5)	6(11.5)	09 (17.3)	11 (21.2)	
One/two times	Daily	41 (78.8)	44 (84.5)	42 (80.8)	38(73.1)	
	Weekly	13 (25.0)	15(28.8)	17 (32.7)	17(32.7)	
Two-three times daily		04 (7.7)	2(3.8)	-	03 (5.8)	
Every day/week		24 (46.2)	28(53.9)	22 (42.3)	18(15.4)	
3-4 times/week		08 (15.4)	03 (5.8)	05 (9.6)	6(11.6)	
Amount of Fruits						
No		07 (13.5)	06 (11.5)	09 (17.3)	11 (21.2)	

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

≤ 1/2 cup	32 (61.5)	36(69.3)	06 (11.5)	24 (46.1)	
One cup	14 (26.9)	10 (19.2)	37 (71.2)	17(32.7)	

Table 3 summarized the vegetable and fruit intake patterns of breast cancer patients in both the experimental and control groups before and after the intervention. Key findings highlighted significant changes in vegetable and fruit consumption. In the experimental group, daily vegetable intake increased from 40.4% at baseline to 59.6% at end line, while the control group showed a remarkable rise from 21.2% to 76.9%. Weekly vegetable intake remained unchanged in the experimental group (13.5%), but it increased in the control group from 7.7% to 19.2%. The proportion of participants consuming ≤½ cup of vegetables remained stable in the experimental group (51.9% to 48.1%), while it increased slightly in the control group (71.2% to 76.9%). For fruit intake, daily consumption rose in the experimental group from 78.8% to 84.5%, whereas it declined in the control group from 80.8% to 73.1%. Weekly fruit intake also increased in the experimental group (from 25.0% to 28.8%), while the control group maintained the same level at 32.7%. The proportion of participants consuming ≤½ cup of fruits grew significantly in the experimental group (from 61.5% to 69.3%), while the control group showed a substantial increase from 11.5% to 46.1%.

Table 4: Dietary Nutrients intake difference between intervention vs. controls

Variables	Group	N	Mean	SD	P*-value
Total kilocalorie					
Baseline	Control	52	1040.44	192.99	0.534
	Experimental		1018.38	166.76	
End line	Control		1118.67	174.55	0.481
	Experimental		1140.98	146.06	
Total carbohydrate					
Baseline	Control	52	119.93	18.74	0.565
	Experimental		117.79	18.98	
End line	Control		120.75	17.66	0.943
	Experimental		120.98	15.52	
Egg protein					
Baseline	Control	52	5.42	1.78	0.166
	Experimental		4.84	2.38	
End line	Control		12.53	8.05	0.001
	Experimental		20.07	4.46	
Total protein with egg supplementation					
Baseline	Control	52	75.93	29.79	0.549
	Experimental		72.68	25.22	
End line	Control		88.12	31.02	0.494
	Experimental		84.29	25.60	

*Independent sample's t-tests

Table 4 assessed dietary nutrient intake differences between the intervention and control groups among breast cancer patients. Notably, there was a significant difference in egg protein intake at the end line. The intervention group, which received egg protein supplementation, consumed significantly more egg protein (20.07 g) compared to the control group (12.53 g). There was significant association found between egg protein (end line) intake between groups ($p<0.001$). For total kilocalorie, carbohydrate, and total protein intake (including egg protein), no significant differences were observed between the groups at either baseline or end line, indicating that the supplementation primarily impacted egg protein intake rather than overall nutrient intake.

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

Table 5. Categories of seven points Subjective Global Assessment (SGA) on Categories of weight loss between the intervention and control group

Seven points Subjective Global Assessment (SGA)	Intervention group (n=52) across 3-timelines			Control group (n=52) across 3-timelines			P-value Between groups (Case Verses Control)
	Baseline	Follow-up1	End line	Baseline	Follow-up1	End line	
Comprehensive Seven points SGA							
SGA1: Categories of weight loss	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
>15%	01 (1.9)	01 (1.9)	00 (0.0)	00 (0.0)	01 (1.9)	00 (0.0)	P*<0.05
10- <15%	02 (3.8)	00 (0.0)	01 (1.9)	00 (0.0)	02 (3.8)	07 (13.4)	
7-<10%	05 (9.6)	01 (1.9)	00 (0.0)	00 (0.0)	06 (11.5)	03 (6.5)	
5-<7%	08 (15.4)	03 (5.8)	02 (3.8)	06 (11.5)	08 (15.4)	07 (13.4)	
3-<7%	07 (13.5)	06 (11.5)	09 (17.4)	08 (15.4)	15 (28.8)	18 (34.6)	
<3%	01 (1.9)	01 (1.9)	00 (0.0)	00 (0.0)	06 (11.5)	00 (0.0)	
0% (No weight loss)	28 (53.8)	40 (76.9)	40 (76.9)	38 (73.1)	14 (26.9)	17 (32.7)	

Significant; *P<0.05. All are Chi-square tests

Table 5 highlights the significant differences in weight loss categories between the intervention and control groups over three timelines. In the intervention group, the proportion of participants with no weight loss increased from 53.8% at baseline to 76.9% at both follow-up and end line, while in the control group, this proportion declined markedly from 73.1% at baseline to 26.9% at follow-up and 32.7% at the end line. Severe weight loss (>15%) remained negligible in both groups, but the proportion of participants with moderate weight loss (10–<15%) increased significantly in the control group, rising from 0% at baseline **to** 13.4% at the end line. Additionally, mild weight loss (3–<7%) rose in the control group from 15.4% to 34.6%, while the intervention group saw relatively stable trends in this category. These findings indicate that the intervention effectively mitigated weight loss over time compared to the control group.

Table 6. Categories of seven points Subjective Global Assessment (SGA) on Change of food habit between the intervention and control group

Seven points Subjective Global Assessment (SGA)	Intervention group (n=52) across 3-timelines			Control group (n=52) across 3-timelines			P-value Between groups (Case Verses Control)
	Baseline	Follow-up1	End line	Baseline	Follow-up1	End line	
SGA2: Change of food habit							
Poor (<1/2 of usual meal intake), but increasing	06 (11.5)	00 (0.0)	00 (0.0)	00 (0.0)	07 (13.4)	07 (13.4)	P>0.05
Borderline (1/2-3/4 of usual meal intake), no change or decreasing	45 (86.6)	18 (34.6)	18 (34.6)	30 (57.7)	34 (65.5)	42 (80.8)	
Good (>3/4 -<1 share of usual meal)	01 (1.9)	34 (66.7)	34 (66.7)	18 (34.6)	10 (19.2)	03 (5.8)	
Good (Full share of usual meal)	00 (0.0)	00 (0.0)	00 (0.0)	04 (7.7)	01 (1.9)	00 (0.0)	

Significant; *P<0.05. All are Chi-square tests

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

Table 6 illustrates the changes in food habits between the intervention and control groups across three timelines. In the intervention group, the proportion of participants with good food habits (>3/4 to <1 share of usual meal intake) increased significantly from 1.9% at baseline to 66.7% at both follow-up and end line. In contrast, the control group showed a decline in this category, from 34.6% at baseline to 19.2% at follow-up and 5.8% at the end line. Additionally, the intervention group completely eliminated cases of poor food intake (<1/2 of usual meal intake) by the follow-up period, while the control group saw 13.4% of participants persist in this category at both follow-up and end line. These findings suggest a substantial improvement in food habits in the intervention group compared to the control group over time.

Table 7. Categories of seven points Subjective Global Assessment (SGA) on Gastro-Intestinal (GI) symptoms and changes between the intervention and control group

Seven points Subjective Global Assessment (SGA)	Intervention group (n=52) across 3-timelines			Control group (n=52) across 3-timelines			P-value Between groups (Case Verses Control)
	Baseline	Follow-up1	End line	Baseline	Follow-up1	End line	
SGA 3: Gastro-Intestinal (GI) symptoms							
No GI symptoms	26 (50.0)	02 (3.8)	00 (0.0)	31 (59.6)	02 (3.8)	06 (11.5)	P>0.05
Yes have	26 (50.0)	50 (96.2)	52 (100)	21 (40.4)	50 (96.2)	46 (88.5)	
Nausea	07 (13.5)	25 (48.1)	19 (36.5)	07 (13.5)	10 (19.2)	10 (19.2)	
Anorexia	01 (1.9)	02 (4.3)	19 (36.5)	10 (19.2)	18 (34.6)	24 (46.2)	
Dysphasia	06 (11.5)	17 (32.7)	01 (1.9)	00 (0.0)	00 (0.0)	00 (0.0)	
Constipation	05 (9.6)	06 (11.5)	13 (25.5)	03 (5.8)	05 (9.6)	10 (19.2)	
Diarrhea	01 (1.9)	00 (0.0)	00 (0.0)	01 (1.9)	03 (5.8)	01 (1.9)	
Vomiting	06 (11.5)	00 (0.0)	00 (0.0)	00 (0.0)	04 (7.7)	01 (1.9)	
SGA 4: Category of GI changes							
No change (2-3 symptoms)	01 (1.9)	00 (0.0)	00 (0.0)	00 (0.0)	07 (13.4)	03 (5.8)	P*<0.05
Improving (2-3 symptoms)	10 (19.2)	06 (11.5)	16 (30.8)	07 (13.5)	22 (42.3)	40 (76.9)	
Very few intermittent symptoms (1 symptoms)	15 (28.8)	43 (82.7)	36 (69.2)	14 (26.9)	21 (40.5)	03 (5.8)	
No Symptoms	26 (56.5)	03 (5.8)	00 (0.0)	31 (59.6)	02 (3.8)	06 (11.5)	

Significant; *P<0.05. All are Chi-square tests

In Table 7, The intervention group experienced a notable increase in nausea and anorexia during the study, with nausea peaking at 48.1% at follow-up before decreasing to 36.5% at the end line, and anorexia rising sharply from 1.9% at baseline to 36.5% by the end line. In contrast, the control group showed a more gradual rise in anorexia, highlighting differing symptom trajectories. Despite these trends, the intervention group had a higher proportion of participants with very few intermittent symptoms (82.7% at follow-up), though this declined to 69.2% by the end line, while the control group saw a lower proportion in this category by the end line. At the end line, participants with 2–3 GI symptoms were significantly higher in the control group (76.9%) compared to the intervention group (30.8%, $p < 0.05$).

DISCUSSION

The findings of this study align with existing literature that underscores the suboptimal dietary intake observed among breast cancer patients undergoing chemotherapy. At baseline, the mean energy intake was 1040.44 kcal for the control group and 1018.38 kcal for the experimental group, with no significant differences between the groups ($p = 0.534$). At the end-line, the control group consumed 1118.67 kcal

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

and the experimental group 1140.98 kcal, showing no statistically significant difference (p = 0.481). These energy intakes fall significantly below the recommended dietary intake of 1900–2300 kcal, as reported for similar populations, such as the Icelandic cohort[14]. The observation of low energy intake in this study is consistent with previous findings by Ravasco et al., who reported that chemotherapy patients often exhibit insufficient caloric intake, nearing approximately 25 kcal/kg body weight for normal-weight and overweight patients but significantly lower for obese patients (12.3 kcal/kg). This trend can be attributed to chemotherapy's adverse effects, including appetite loss, taste alterations, and gastrointestinal disturbances[15]. Despite dietary counselling and written guidance provided during the intervention, participants' energy intake remained inadequate, underscoring the challenges in achieving dietary recommendations during chemotherapy. On the other hand, carbohydrate consumption remained similar between the groups throughout the study. At baseline, the control group consumed 119.93 g, and the experimental group consumed 117.79 g (p = 0.565). At the end-line, carbohydrate intake was 120.75 g for the control group and 120.98 g for the experimental group (p = 0.943). Protein intake also showed no significant differences at baseline (control: 75.93 g, experimental: 72.68 g; P = 0.549) or end-line (control: 88.12 g, experimental: 84.29 g; P = 0.494). However, the experimental group demonstrated a significant increase in egg protein intake at the end-line (control: 12.53 g, experimental: 20.07 g; P = 0.001), indicating the direct impact of the supplementation intervention. These results align with Ravasco's findings, which highlight that individualized nutritional counselling can significantly improve energy and protein intake compared to standard dietary advice[14]. The variability in energy intake during chemotherapy cycles observed in this study resonates with Boltong et al.'s findings, which suggest that taste alterations peak within the first week post-treatment and resolve after a few cycles. These alterations, along with gastrointestinal symptoms and fatigue, contribute to the overall inadequate dietary intake during treatment.

Regarding nutritional outcome, from a study it was stated that Most RCTs of dietary interventions in cancer are small and measure nonclinical endpoints[16]. However, the experimental group, which received egg protein supplementation, showed better weight maintenance and reduced weight loss compared to the control group. This finding is consistent with Burden et al.'s observation that dietary interventions can positively affect anthropometric outcomes, such as body weight and BMI, among women with breast cancer[17]. Structured nutritional support and counseling in this study also resulted in marked improvements in food intake habits among the intervention group, further highlighting the value of dietary interventions during chemotherapy. Although gastrointestinal symptoms were more frequently reported in the experimental group, these symptoms were generally manageable, with most participants experiencing only intermittent issues by the end-line. This reflects the importance of addressing side effects associated with dietary interventions to optimize compliance and outcomes. Moreover, the findings from the Subjective Global Assessment (SGA) analysis emphasize the critical role of dietary interventions in improving nutritional outcomes during chemotherapy. The intervention group showed better outcomes in terms of weight stabilization, improved food habits, and manageable gastrointestinal symptoms compared to the control group. Additionally, this study's findings align with Ravasco et al.'s observation that improved nutritional intake is associated with enhanced quality of life (QoL) scores. After radiotherapy, patients in group 1 maintained or improved QoL function scores, whereas groups 2 and 3 reported deteriorations. This supports the notion that integrating nutrition-focused strategies into cancer care can significantly enhance patient outcomes and QoL.

Strength: Homogeneous breast cancer patients with no metastasis or recurrence were randomized. **Limitation:** The absence of methodologically similar studies makes it difficult to compare findings. It was a single-center study. These include insufficient blinding leading to an increased probability of a false negative finding due to contamination of the control arm.

CONCLUSION

Overall, while egg supplementation effectively increased egg protein intake in the experimental group, total dietary intake remained inadequate. This underscores the need for more robust nutritional interventions that address the multifaceted barriers to adequate dietary intake, including taste changes, gastrointestinal symptoms, and fatigue. Targeted nutritional strategies, combined with individualized counseling and symptom management, can help optimize dietary intake, improve nutritional status, and enhance the overall quality of life for breast cancer patients undergoing chemotherapy.

Ethical clearance: Ethical approval for the study was obtained from the National Ethical Review Committee (NREC) of the Bangladesh Medical Research Council

DOI: https://doi.org/10.3329/jopsom.v43i2.84194

(BMRC) (Ref. No. BMRC/HPNSP-Grant/2019-2020/569(1-60)), the Faculty of Biological Sciences at the University of Dhaka (Ref. No. 92/Biol. Scs), and the National Institute of Cancer Research and Hospital (Ref. No. NICRH/Ethics/2020/240).

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