

## Effects of chemotherapy on cognitive functioning and quality of life among cancer patients in Peshawar

Summaiya Arif, Um-e-Kalsoom

### Abstract

The time series study was planned to assess the possible effects of chemotherapy and radiotherapy on cognitive functioning and patients' quality of life. Conducted at the Institute of Radiotherapy and Nuclear Medicine Hospital, Peshawar, Pakistan, from 1st January, 2021 to 15th April, 2021, the study comprised 60 patients who were divided into chemotherapy, radiotherapy, and healthy control groups. Data was collected using the Functional Assessment of Cancer Therapy-cognitive questionnaire and the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire Core 30. Chemotherapy significantly affected the cognitive functioning of participants compared to the other groups ( $p < 0.05$ ). The quality of life of the patients in chemotherapy and radiotherapy groups was significantly impaired compared to the controls ( $p < 0.05$ ). The findings showed the negative side effects of chemotherapy and radiotherapy.

**Keywords:** Cancer, Chemotherapy, Radiation, Cognitive functioning, Quality of life, Oncology.

**DOI:** <https://doi.org/10.47391/JPMA.10319>

### Introduction

Cancer is an abnormal cell growth, and spreads in different body areas.<sup>1</sup> Technological development and advancement have enabled medical practitioners to provide treatment for various types of cancer.

A relationship between cancer duration and cognitive impairment has been reported. In a study, >50 of breast cancer patients mentioned cognitive trouble post-chemotherapy compared to 15-25% at the baseline.<sup>2</sup> In the same study, 41.7% patients were found to have a significantly negative impact on perceived cognition. The study indicated that patients with breast cancer who underwent chemotherapy had experienced cognitive impairments in executive functioning.<sup>2</sup> The findings

Department of Psychology, Shaheed Benazir Bhutto Women University, Peshawar, Pakistan.

**Correspondence:** Summaiya Arif. e-mail: [eshalk996@gmail.com](mailto:eshalk996@gmail.com) ORCID ID: [ORCID ID: 0009-0001-1458-3273](https://orcid.org/0009-0001-1458-3273)

**Submission completed:** 24-08-2023 **1st Revision received:** 16-04-2024

**Acceptance:** 14-12-2024 **Last Revision received:** 13-12-2024

supported the theory that cognitive impairment in breast cancer patients was significantly influenced by chemotherapy.<sup>3</sup>

A 2011 study reported that 16-75% of breast cancer patients experienced cognitive dysfunction compared to 4-11% healthy controls.<sup>4</sup> Empirical studies have revealed that chemotherapy and radiotherapy share comparable mechanisms of action in inducing negative effects in the brain with regard to cognitive functioning, as each therapy interferes with the proper function of the neural stem and precursor cells throughout the brain.<sup>5</sup> Radiotherapy, compared to chemotherapy, results in an inflammatory response in the brain that leads to the impairment of neuronal progenitor cells, and the generation of hippocampal neurogenesis and oligodendroglial cells.<sup>6</sup>

The current study was planned to assess the possible effects of chemotherapy and radiotherapy on cognitive functioning and patients' quality of life.

### Methods and Results

The time series study was conducted at the Institute of Radiotherapy and Nuclear Medicine Hospital, Peshawar, Pakistan, from 1st January, 2021 to 15th April, 2021. The sample size was calculated using  $G^*$ power<sup>7</sup> with effect size  $f=0.25$ , alpha ( $\alpha$ ) error probability=0.05, and power=0.8 with 3 groups and for 3 measures. After permission from the institution's administration, the sample was raised using purposive sampling technique. Those included were 60 participants of either gender aged 15-55 years. The sample was divided into chemotherapy, radiotherapy and control groups, with 20(33.3%) subjects in each of the 3 groups. Those with prior history of co-morbidities, psychiatric illness, substance abuse, chronic kidney disease, or previous chemotherapy were excluded.

After taking informed consent from the subjects, data was collected using the Functional Assessment of Cancer Therapy-cognitive (FACT-Cog) scale<sup>8</sup> and the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire Core 30 (EORTCQLQ-C30) scale.<sup>9</sup>

The ethical review committee approval was retained before the collection of the data. The self-reporting questionnaires were filled by the subjects at three time periods (T1, T2 and T3). Data was collected from all the participants at baseline

**Table-1:** Demographic characteristics.

Variables	n (%)
<b>Gender</b>	
Male	30 (50.0)
Female	30 (50.0)
<b>Education</b>	
Educated	37 (61.7)
Uneducated	23 (38.3)
<b>Occupation</b>	
Working	24 (40.0)
Non-Working	36 (60.0)
<b>Marital Status</b>	
Single	10(16.7)
Engaged	2 (3.3)
Married	48 (80.0)
<b>Perceived Financial Status</b>	
lower class	24 (40.0)
middle class	36 (60.0)
<b>Family System</b>	
Nuclear	22 (36.7)
Joint	38 (63.3)
<b>Diagnosis</b>	
Liver Cancer	7 (11.7)
Breast Cancer	27 (45.0)
Colon Cancer	14 (23.3)
Liver Cancer	4 (6.7)
Head and Neck Carcinoma	8 (13.3)
<b>Years of Diagnosis</b>	
1 month or below	24 (40.0)
between 1 month to 6 month	20 (33.3)
between 6 month to 1 year	10 (16.7)
between 1 year up to 2 years	6 (10.0)

**Table-2:** Comparison between chemotherapy and radiotherapy groups with respect to Functional Assessment of Cancer Therapy-cognitive (FACT- Cog) data.

Sub Scales of FACIT-Cog	Chemo Group (I) Mean±SD	Radio Group (II) Mean±SD	t-test	95% CI		p-value	Cohen's D
				LL	UL		
PCI	9.60±7.27	5.20±4.49	2.302	0.5310	8.268	0.002	0.72
CFO	1.35±1.75	0.500±0.76	1.987	-0.016	1.716	0.001	0.63
PCA	30.85±7.01	34.50±2.54	-2.188	-7.02	-0.272	0.001	0.69
IQL	5.10±1.85	2.45±1.53	4.954	1.567	3.732	0.005	1.56

PCI: Perceived cognitive impairments, CFO: Comments from others; PCA: Perceived cognitive abilities, IQL: Impact on quality of life, SD: Standard deviation, CI: Confidence interval, LL: Lower limit, UL: Upper limit.

**Table-3:** Comparison between chemotherapy and healthy control groups with respect to Functional Assessment of Cancer Therapy-cognitive (FACT- Cog) data.

Scale	Chemo Group (I) Mean±SD	Healthy Control Group (III) Me an±SD	t-test	95% CI		p-value	Cohen's d
				LL	UL		
PCI	9.60±7.27	0.90±0.96	5.303	5.379	12.020	0.001	1.67
CFO	1.35±1.75	0.20±0.41	2.852	0.333	1.966	0.001	0.90
PCA	30.85±7.01	35.80±0.89	-3.131	-8.150	-1.749	0.002	0.99
IQL	5.10±1.83	0.15±0.36	11.846	4.104	5.795	0.001	3.75

PCI: Perceived cognitive impairments, CFO: Comments from others; PCA: Perceived cognitive abilities, IQL: Impact on quality of life, SD: Standard deviation, CI: Confidence interval, LL: Lower limit, UL: Upper limit.

**Table-4:** Quality of life across the groups using simple linear regression

Variables	β	SE	95% CI		p-value
			UL	LL	
Constant	-0.486	1.55	47.62	53.84	0.001
Groups	0.720		-4.49	-1.6	0.001

R2=0.236

β: Beta value, SE: Standard error, CI: Confidence interval, LL: Lower limit, UL: Upper limit.

(T1). At T2, patients in chemotherapy and radiotherapy groups filled the questionnaires after 3 weeks of their first scheduled treatment. At T3, patients who completed the 1st cycle of chemotherapy were assessed after 3-4 weeks. The same questionnaire was given to the radiotherapy group. Radiotherapy dose 45-60Gy was given in fractions in which the total dose was further divided into daily doses 5 times a week for 3-8 weeks.

To control the overlapping of patients, only those who were diagnosed with any type of cancer and advised either chemotherapy or radiotherapy as first-line treatment were enrolled.

The data was analysed through SPSS Statistics 20. It was checked for normality, and was subjected to analysis of variance (ANOVA), P<0.05 was considered significant.

Of the 60 subjects, 30(50%) were males and as many were females. The most common diagnosis was breast cancer 27(45%), and time since diagnosis was up to 1 month in 24(40%) cases (Table 1).

There were significant differences between chemotherapy and radiotherapy groups on subscales of perceived

cognitive impairment (PCI), comments from others (CFO), perceived cognitive abilities (PCA) and impact on quality of life (IQL) (Table 2).

Cognitive functioning was more affected in the chemotherapy group than in the control group (Table 3).

The quality of life was significantly affected post-treatment (Table 4). At Baseline as well as T2 and T3 follow-up data showed significant difference within all the 3 study groups, indicating that the duration of chemotherapy and radiotherapy affected

**Table-5:** Descriptive data related to FACT-Cog and EORTCQLQ-C30 across the groups at baseline and follow-ups.

Variable	Baseline			T2		T3	
	Chemo Mean±SD	Radio Mean±SD	Healthy Control Mean±SD	Chemo Mean±SD	Radio Mean±SD	Chemo Mean±SD	Radio Mean±SD
FACT-Cog							
Perceived cognitive impairments	9.6±7.2	5.2±4.4	90±0.096)	24.4±4.1	8.2±3.9	37.4±3.8	15.2±7.1
Comments from others	1.35±1.7	0.5±0.76	0.2±0.41	3.0±1.4	0.70±0.80	5.3±1.17	2.45±1.4
Perceived cognitive abilities	30.8±7.1	34.5±2.5	35.8±0.89	15.2±1.8	33.5±2.3	27.7±8.1	29.05±3.6
Impact on quality of life	5±1.83	2.45±1.5	0.150±0.36	6.6±2.23	3.0±1.3	10.6±1.2	5.65±1.59
EORTCQLQ-C 30	8.6±1.14	44.2±3.0	41.8±0.83	59.1±9.03	44.6±3.7	88.2±6.8	50.15±4.2

FACT-Cog: Functional Assessment of Cancer Therapy-cognitive, EORTCQLQ-C30: European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire Core 30, SD: Standard deviation.

**Table-6:** Perceived cognitive impairment values in the study groups.

Subscales of ACT-Cog	Chemo therapy M±SD (n=20)	Radio Therapy M±SD (n=20)	Healthy Control M±SD (n=20)	F	(i-j)	MD	SE	95% CI	
								LL	UL
PCI	9.60±7.27	5.20±4.49	0.90±0.96	15.34**	172	4.40**	1.570	0.526	8.27
					173	8.70**	1.570	0.482	12.57
					273	4.30**	1.570	0.426	8.173

FACT-Cog: Functional Assessment of Cancer Therapy-cognitive, PCI: Perceived cognitive impairments, SD: Standard deviation, MD: Mean difference, SE: Standard error, CI: Confidence interval, LL: Lower limit, UL: Upper limit.

cognitive capacity (Table 5).

ANOVA values suggested significant difference among the groups, indicating that cognitive impairment was greater in participants who received chemotherapy compared to radiotherapy and control groups (Table 6).

## Discussion

In the current study, chemotherapy patients had worse cognitive functioning compared to the other groups (Table 2). Specifically, the chemotherapy group had significantly worse scores on all subscales than the radiotherapy group. In a study, 18 patients were divided into radiotherapy and chemotherapy groups, and assessed at baseline and after 6 months. Results showed both treatment groups had lower scores than the controls, with no difference found between the treatment groups, suggesting radiotherapy alone did not affect cognitive decline.<sup>10</sup>

In a study, differences were observed at varying time points between two patient groups, and concluded that cancer treatment would inevitably effect the quality of life of cancer patients.<sup>11</sup>

The current findings suggested that both chemotherapy and radiotherapy treatment exerted a deteriorating effect on the overall quality of life of cancer patients. A study comprising 534 patients with breast cancer investigated the impact of the duration of adjuvant chemotherapy treatment on patients' quality of life, and revealed a

negative correlation between longer periods of adjuvant chemotherapy treatment and the quality of life of the patients.<sup>12</sup>

According to a study having 800 cancer patients (40% male and 60% female) placed on chemotherapy regimens exhibited a significant difference in their quality of life, along with a deterioration in different aspects of their lives.<sup>13</sup>

In the current study, the chemotherapy group had higher mean score than the other two

groups, indicating that more cycles had led to cognitive impairment and decreased quality of life. Other researchers found significant impairment in memory, fluency, executive function, and attention.<sup>14</sup> In a study of 32 patients with malignant glioma, one group received radiotherapy and the other received chemotherapy. They were assessed at 1 year and 3.5 years later. There was a significant difference in scores compared to baseline values, with the chemotherapy group scoring slightly higher than the radiotherapy group.<sup>15</sup>

On the basis of current findings, it is recommended to conduct more studies to evaluate gender-based difference with respect to the cognitive effects of chemotherapy. Besides, more research is needed to compare chemotherapy with other cancer treatments, like targeted therapy, immunotherapy, stem cell or bone marrow transplant, and hormone therapy, to determine its efficacy. Longitudinal studies are needed to generate more accurate findings.

## Conclusion

Chemotherapy significantly affected cognitive functions and quality of life of cancer patients compared to those receiving radiotherapy and healthy controls.

**Disclaimer:** The text is based on an M.Phil thesis.

**Conflict of Interest:** None.

**Source of Funding:** None.

## References

1. World Health Organization (WHO). Cancer. [Online] 2018 [Cited 2025 January 12]. Available from URL: [https://www.who.int/health-topics/cancer/#tab=tab\\_1](https://www.who.int/health-topics/cancer/#tab=tab_1)
2. Ahles TA, Root JC, Ryan EL. Cancer- and cancer treatment-associated cognitive change: an update on the state of the science. *J Clin Oncol* 2012;30:3675-86. doi: 10.1200/JCO.2012.43.0116.
3. Durán-Gómez N, López-Jurado CF, Nadal-Delgado M, Pérez-Civantos D, Guerrero-Martín J, Cáceres MC. Chemotherapy-Related Cognitive Impairment in Patients with Breast Cancer Based on Functional Assessment and NIRS Analysis. *J Clin Med* 2022;11:2363. doi: 10.3390/jcm11092363.
4. Small BJ, Rawson KS, Walsh E, Jim HS, Hughes TF, Iser L, et al. Catechol-O-methyltransferase genotype modulates cancer treatment-related cognitive deficits in breast cancer survivors. *Cancer* 2011;117:1369-76. doi: 10.1002/cncr.25685.
5. Gibson E, Monje M. Effect of cancer therapy on neural stem cells: implications for cognitive function. *Curr Opin Oncol* 2012;24:672-8. doi:10.1097/CCO.0b013e3283571a8e.
6. Dietrich J, Monje M, Wefel J, Meyers C. Clinical patterns and biological correlates of cognitive dysfunction associated with cancer therapy. *Oncologist* 2008;13:1285-95. doi: 10.1634/theoncologist.2008-0130.
7. UCLA: Statistical Consulting Group. G\*Power: Statistical power analyses, Version 3.1.9.7. [Online] 2021 [Cited 2024 October 23]. Available from URL: <https://stats.oarc.ucla.edu/other/gpower/>
8. Cheung YT, Chan A. Linguistic validation of Functional Assessment of Cancer Therapy-Cognitive Function (FACT-Cog): methodological concerns. *Support Care Cancer* 2013;21:655-6. doi: 10.1007/s00520-012-1631-4.
9. Davda J, Kibet H, Achieng E, Atundo L, Komen T. Assessing the acceptability, reliability, and validity of the EORTC Quality of Life Questionnaire (QLQ-C30) in Kenyan cancer patients: a cross-sectional study. *J Patient Rep Outcomes* 2021;5:4. doi: 10.1186/s41687-020-00275-w.
10. Keime-Guibert F, Chinot O, Taillandier L, Cartalat-Carel S, Frenay M, Kantor G, et al. Radiotherapy for glioblastoma in the elderly. *N Engl J Med* 2007;356:1527-35. doi: 10.1056/NEJMoa065901.
11. Chen VC, Lin CK, Hsiao HP, Tzang BS, Hsu YH, Wu SI, et al. Effects of Cancer, Chemotherapy, and Cytokines on Subjective and Objective Cognitive Functioning Among Patients with Breast Cancer. *Cancers (Basel)* 2021;13:2576. doi: 10.3390/cancers13112576.
12. Hwang SY, Chang SJ, Park BW. Does chemotherapy really affect the quality of life of women with breast cancer? *J Breast Cancer* 2013;16:229-35. doi: 10.4048/jbc.2013.16.2.229.
13. Lewandowska A, Rudzki G, Lewandowski T, Próchnicki M, Rudzki S, Laskowska B, et al. Quality of life of cancer patients treated with chemotherapy. *Int J Environ Res Public Health* 2020;17:6938. doi:10.3390/ijerph17196938.
14. Cerulla N, Arcusa À, Navarro JB, de la Osa N, Garolera M, Enero C, et al. Cognitive impairment following chemotherapy for breast cancer: The impact of practice effect on results. *J Clin Exp Neuropsychol* 2019;41:290-9. doi: 10.1080/13803395.2018.1546381.
15. Rydelius A, Lätt J, Kinhult S, Engelholm S, Van Westen D, Pihlsgård M, et al. Longitudinal study of cognitive function in glioma patients treated with modern radiotherapy techniques and standard chemotherapy. *Acta Oncol* 2020;59:1091-7. doi: 10.1080/0284186X.2020.1778181.

---

### Author Contribution:

**SA:** Literature review, writing, data collection, analysis, drafting and revision.

**UK:** Supervision, methodology, research design, data analysis and revision.