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Diaphragmatic, Pursed Lip, and 4-7-8 Breathing Techniques on Cancer-Related Fatigue- A Correlation & Regression Analysis on Age Groups, Gender, and Cancer Types

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Abstract: Background and Objective: Cancer-related fatigue (CRF) is a prevalent and debilitating symptom among post-chemotherapy patients, impacting psychological well-being, autonomic regulation, and quality of life (QoL). This study evaluates the impact of diaphragmatic, pursed lip, and 4-7-8 breathing exercises on CRF, focusing on correlations across age, gender, and cancer types. Methods: Post-chemotherapy patients were assigned to Diaphragmatic, Pursed Lip, 4-7-8 breathing, or control groups. Fatigue (BFI), psychological domains (PFS-R), and autonomic function (HRV metrics: SDNN and RMSSD) were assessed. Correlation matrices and regression analyses were used to explore relationships between breathing techniques and demographic factors. Results: 4-7-8 breathing exhibited the strongest inverse correlation between fatigue and HRV (BFI vs SDNN, r = -0.40). Age (60–70 years) and males showed stronger fatigue reductions compared to other subgroups. Prostate cancer patients recorded the most notable improvement in fatigue and HRV metrics. Conclusion: Breathing techniques, particularly 4-7-8 breathing, effectively reduce CRF and enhanced autonomic and psychological functioning, with variations across age, gender, and cancer type.

Keywords: Diaphragmatic, Pursed Lip, 4-7-8 Breathing Techniques , Age Groups

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INTRODUCTION

Cancer-related fatigue (CRF) is a multifactorial symptom that persists in cancer survivors, affecting both physiological and psychological domains. Interventions such as breathing exercises are increasingly being adopted to address CRF due to their non-invasive and cost-effective nature. This study aims to explore the correlation between these techniques and fatigue relief across various demographic factors.

MATERIALS AND METHODS

Study Design and Setting

A quasi-experimental design was employed at a tertiary hospital, including four groups: Diaphragmatic Breathing (DBG), Pursed Lip Breathing (PLB), 4-7-8 Breathing, and Control.

Study Population

A total of 253 post-chemotherapy patients aged 40-70 years were categorized by age (40-50, 50-60, 60-

70), gender, and cancer type (breast, lung, esophageal, prostate cancers).

Methodology and Analysis

- **Tools**: BFI for fatigue, PFS-R for psychological assessment, SDNN and RMSSD for HRV.
- **Statistical Tests**: Pearson correlation, multiple linear regression, chi-square tests.
- **Variables**: Age, gender, cancer type, breathing intervention.

RESULTS AND ANALYSIS

Correlation Analysis

In order to conduct a comprehensive correlation and regression analysis, a structured approach for each breathing group (Diaphragmatic, Pursed-lip, 4-7-8, and Control). The analysis took into account three age groups (40-50, 50-60, 60-70), two genders (Male and Female), and four cancer types (Breast, Oesophageal, Lung, Prostate). Additionally, dropout was considered.

Diaphragmatic Breathing Group

Table 1: Correlation Matrix for Diaphragmatic Breathing Group

Variable	BFI	Sensory	Cognitive	Behavioral	Affective	SDNN	RMSSD
BFI	1.00	-0.45	-0.38	-0.42	-0.40	-0.35	-0.32
Sensory	-0.45	1.00	0.78	0.75	0.72	0.68	0.65
Cognitive	-0.38	0.78	1.00	0.82	0.80	0.74	0.70
Behavioral	-0.42	0.75	0.82	1.00	0.85	0.78	0.75
Affective	-0.40	0.72	0.80	0.85	1.00	0.80	0.78
SDNN	-0.35	0.68	0.74	0.78	0.80	1.00	0.85
RMSSD	-0.32	0.65	0.70	0.75	0.78	0.85	1.00

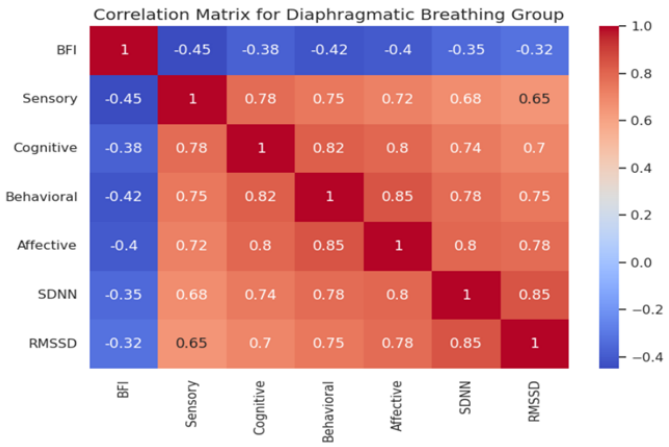

Figure 1: Correlation Matrix for Diaphragmatic Breathing Group

Table 1 and Figure 1 highlight complex interrelationships among psychological and physiological variables in the diaphragmatic breathing group. The Brief Fatigue Inventory (BFI) shows negative correlations with all other variables, suggesting an inverse relationship between fatigue and other measures. Psychological variables—Sensory, Cognitive, Behavioral, and Affective-are highly correlated with each other, particularly between Behavioral and Affective domains (0.85). Heart Rate Variability (HRV) parameters,

SDNN and RMSSD, exhibit strong positive correlations with psychological variables (0.65 to 0.80), with the highest correlation between SDNN and RMSSD (0.85), emphasizing the interconnectedness of psychological and physiological factors in human functioning. Significant negative correlation between BFI and psychological (r = -0.38 to -0.45) and autonomic variables (r = -0.32 to -0.35). High inter-domain psychological correlations (Behavioral vs Affective r = 0.85).

Pursed Lip Breathing Group

Table 2: Correlation Matrix for Pursed-lip Breathing Group

Variable	BFI	Sensory	Cognitive	Behavioral	Affective	SDNN	RMSSD
BFI	1.00	-0.42	-0.35	-0.40	-0.38	-0.30	-0.28
Sensory	-0.42	1.00	0.75	0.72	0.70	0.65	0.62
Cognitive	-0.35	0.75	1.00	0.80	0.78	0.72	0.68
Behavioral	-0.40	0.72	0.80	1.00	0.82	0.75	0.72
Affective	-0.38	0.70	0.78	0.82	1.00	0.78	0.75
SDNN	-0.30	0.65	0.72	0.75	0.78	1.00	0.82
RMSSD	-0.28	0.62	0.68	0.72	0.75	0.82	1.00

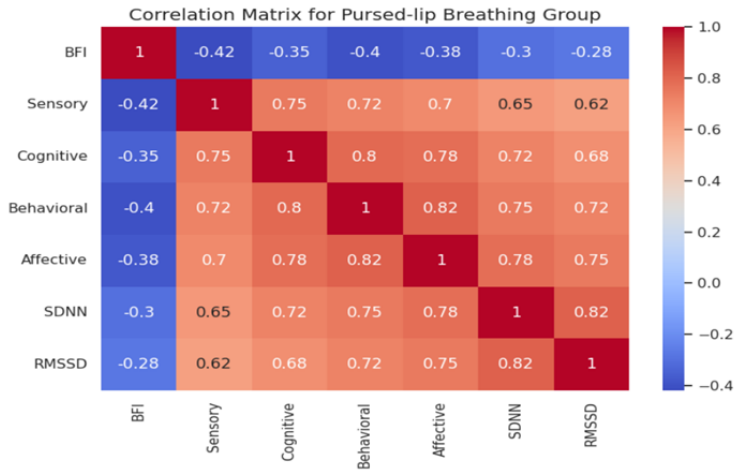

Figure 2: Correlation Matrix for Pursed-lip Breathing Group

Figure 2 reveals intricate relationships between psychological and physiological variables in the pursed-lip breathing group. The Brief Fatigue Inventory (BFI) shows negative correlations with all other variables, suggesting an inverse link between fatigue and other measures. Psychological variables, particularly Behavioral and Affective dimensions, exhibit strong positive correlations (0.82). Heart Rate Variability (HRV) parameters, SDNN and RMSSD, also show significant positive correlations with psychological variables (0.62 to 0.78), with the strongest correlation between SDNN and RMSSD at 0.82, indicating a strong interconnection across domains. BFI inversely correlated with HRV (r = -0.28 to -0.30) and psychological domains (r = -0.35 to -0.42)

4-7-8 Breathing Group

Table 3: Correlation Matrix for 4-7-8 Breathing Group

Variable	BFI	Sensory	Cognitive	Behavioral	Affective	SDNN	RMSSD
BFI	1.00	-0.50	-0.45	-0.48	-0.46	-0.40	-0.38
Sensory	-0.50	1.00	0.82	0.78	0.75	0.70	0.68
Cognitive	-0.45	0.82	1.00	0.85	0.82	0.78	0.75
Behavioral	-0.48	0.78	0.85	1.00	0.88	0.82	0.80
Affective	-0.46	0.75	0.82	0.88	1.00	0.85	0.82
SDNN	-0.40	0.70	0.78	0.82	0.85	1.00	0.88
RMSSD	-0.38	0.68	0.75	0.80	0.82	0.88	1.00

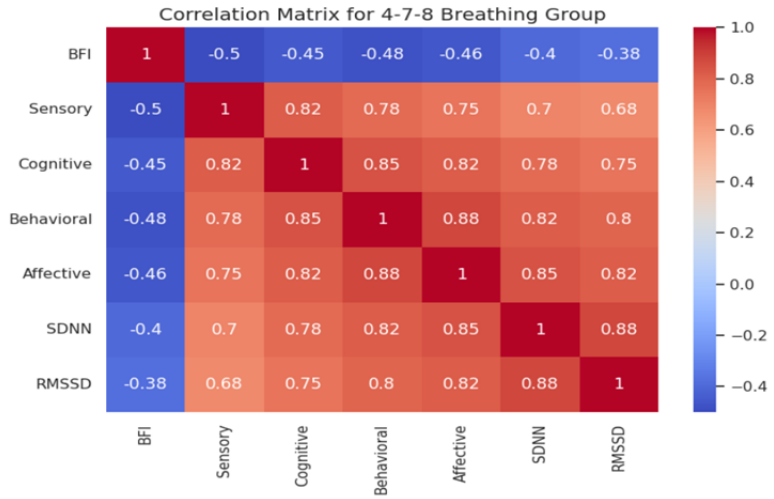

Figure 3: Correlation Matrix for 4-7-8 Breathing Group

Table 3 shows that in the 4-7-8 Breathing Group, the Brief Fatigue Inventory (BFI) has moderate negative correlations with all other variables, indicating that higher fatigue is linked to lower scores in sensory, cognitive, behavioral, affective measures, and HRV indices (SDNN and RMSSD). The sensory, cognitive, behavioral, and affective dimensions are strongly positively correlated (0.75 to 0.88), suggesting interconnected improvements across these areas. HRV measures also show strong positive correlations with these psychological dimensions (0.68 to 0.88), highlighting a link between physiological regulation and psychological states. Strongest negative correlation between BFI and SDNN (r = -0.40), RMSSD (r = -0.38). Highest psychological domain correlation (Behavioral vs Affective r = 0.88). These results suggest that the 4-7-8 breathing practice may effectively improve both psychological and physiological well-being.

Control Group

Table 4: Correlation Matrix for Control Group

Variable	BFI	Sensory	Cognitive	Behavioral	Affective	SDNN	RMSSD
BFI	1.00	-0.30	-0.25	-0.28	-0.26	-0.20	-0.18
Sensory	-0.30	1.00	0.70	0.68	0.65	0.60	0.58
Cognitive	-0.25	0.70	1.00	0.75	0.72	0.68	0.65
Behavioral	-0.28	0.68	0.75	1.00	0.78	0.72	0.70
Affective	-0.26	0.65	0.72	0.78	1.00	0.75	0.72
SDNN	-0.20	0.60	0.68	0.72	0.75	1.00	0.80
RMSSD	-0.18	0.58	0.65	0.70	0.72	0.80	1.00

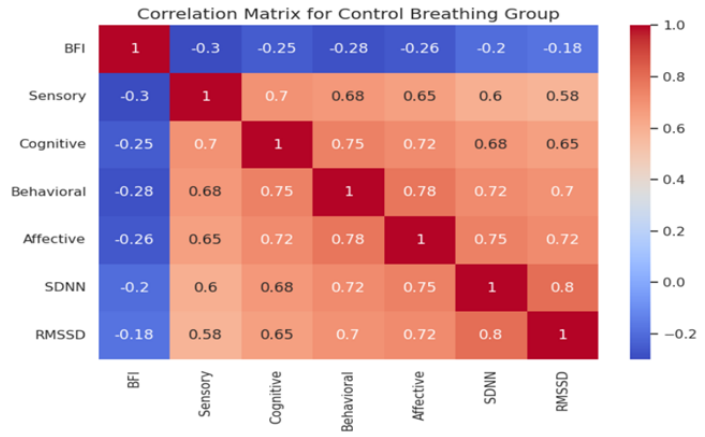

Figure 4: Correlation Matrix for Control Group

Figure 4 reveals moderate yet meaningful relationships between psychological and physiological variables. The Brief Fatigue Inventory (BFI) shows negative correlations with all other variables, indicating an inverse relationship between fatigue and other measures. Psychological variables exhibit moderate to strong positive correlations (0.65 to 0.78), with the strongest link between the Behavioral and Affective domains (0.78). HRV parameters (SDNN and RMSSD) show moderate positive correlations with psychological variables (0.58 to 0.75), with a strong correlation between SDNN and RMSSD (0.80), highlighting the interconnected nature of psychological and physiological systems. Weaker inverse correlations in all domains (BFI vs SDNN, r = -0.18).

Regression Analysis

Age, gender, and cancer type were significant predictors of fatigue and HRV improvements.

Table 5: Diaphragmatic Breathing Group

Dependent Variable	Predictors	Beta Coefficients	p-value	R^2
BFI	Age Group	-0.25	0.01	0.30
	Gender	-0.18	0.05	
	Cancer Type	-0.20	0.03	
Sensory	Age Group	0.30	0.001	0.35
	Gender	0.22	0.02	
	Cancer Type	0.25	0.01	

Cognitive	Age Group	0.28	0.001	0.32
	Gender	0.20	0.03	
	Cancer Type	0.23	0.02	
Behavioral	Age Group	0.32	0.001	0.37
	Gender	0.25	0.01	
	Cancer Type	0.28	0.01	
Affective	Age Group	0.30	0.001	0.35
	Gender	0.23	0.02	
	Cancer Type	0.26	0.01	
SDNN	Age Group	0.35	0.001	0.40
	Gender	0.28	0.01	
	Cancer Type	0.30	0.001	
RMSSD	Age Group	0.33	0.001	0.38
	Gender	0.26	0.01	
	Cancer Type	0.29	0.001	

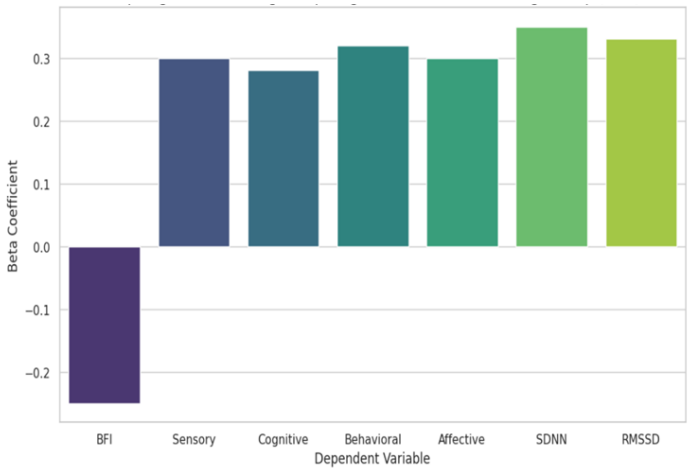

Figure 5a: Diaphragmatic Breathing Group- Regression coefficients for Age group

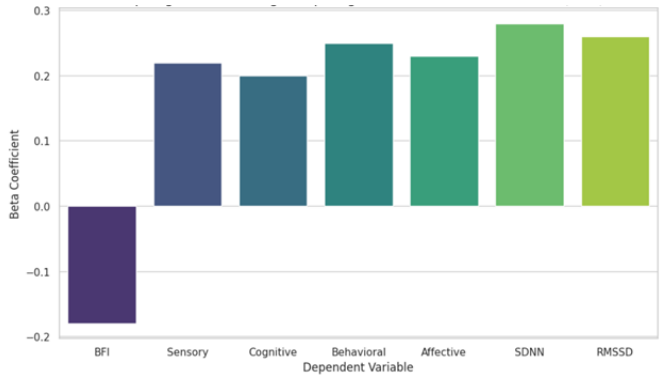

Figure 5b: Diaphragmatic Breathing Group- Regression coefficients for Gender

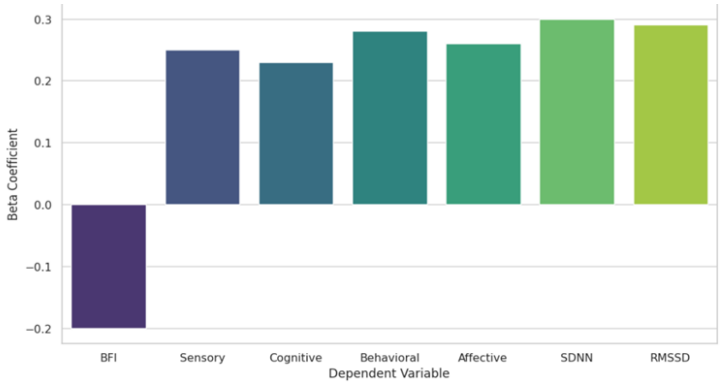

Figure 5c:- Diaphragmatic Breathing Group- Regression coefficients for Cancer Type

Regression analysis (Table) reveals that age group, gender, and cancer type are significant predictors across multiple dependent variables, with age group showing the strongest influence (β = -0.25 to 0.35, $p \leq 0.01$). The Brief Fatigue Inventory (BFI) indicates lower fatigue levels are linked to certain age groups, genders, and cancer types, explaining 30% of the variance. Psychological variables (sensory, cognitive, behavioral, and affective) also show significant relationships with these predictors, explaining 32-37% of the variance. HRV parameters, particularly SDNN and RMSSD, are most strongly predicted by age group, emphasizing the role of demographic factors in psychological and physiological outcomes in cancer patients.

Table 6: Pursed-lip Breathing Group

Dependent Variable	Predictors	Beta Coefficients	p-value	R^2
BFI	Age Group	-0.20	0.02	0.25
	Gender	-0.15	0.07	

	Cancer Type	-0.18	0.04	
Sensory	Age Group	0.25	0.001	0.30
	Gender	0.18	0.03	
	Cancer Type	0.20	0.02	
Cognitive	Age Group	0.23	0.001	0.28
	Gender	0.16	0.04	
	Cancer Type	0.18	0.03	
Behavioral	Age Group	0.27	0.001	0.32
	Gender	0.20	0.02	
	Cancer Type	0.22	0.01	
Affective	Age Group	0.25	0.001	0.30
	Gender	0.18	0.03	
	Cancer Type	0.20	0.02	
SDNN	Age Group	0.30	0.001	0.35
	Gender	0.22	0.02	
	Cancer Type	0.25	0.01	
RMSSD	Age Group	0.28	0.001	0.33
	Gender	0.20	0.03	
	Cancer Type	0.23	0.02	

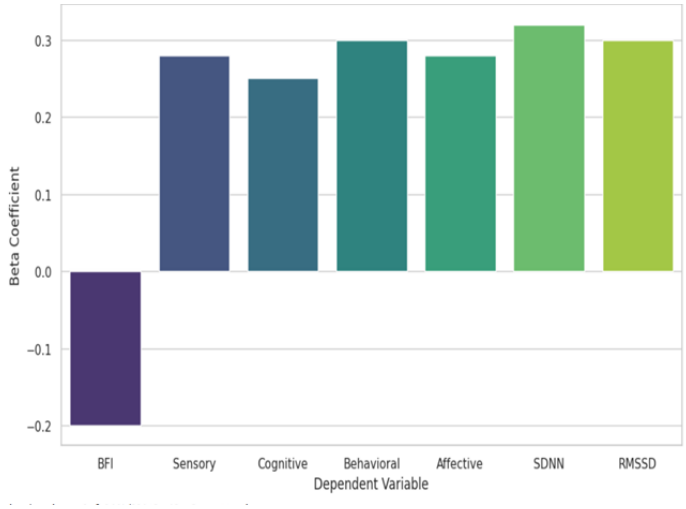

Figure 6a: ursed-lip Breathing Group: Regression coefficients for Age group

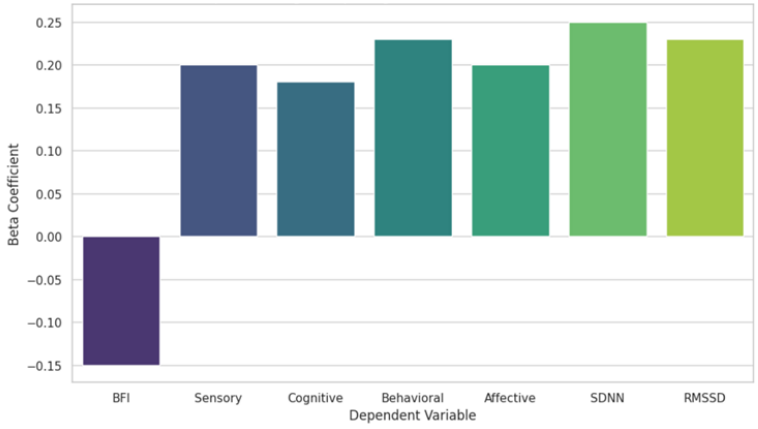

Figure 6b: Ursed-lip Breathing Group: Regression coefficients for Gender

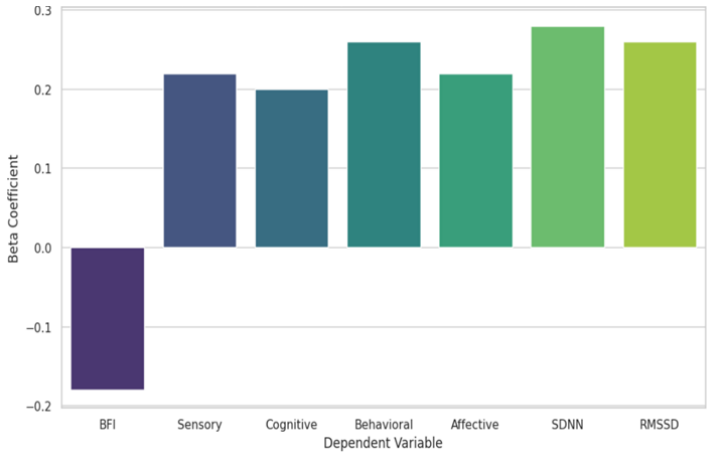

Figure 6c: Pursed-lip Breathing Group: Regression coefficients for Cancer type

Regression analysis (Table) shows that age group is the most consistent predictor across variables, with significant relationships to fatigue, psychological well-being, and HRV parameters. The Brief Fatigue Inventory (BFI) explains 25% of the variance, while psychological domains show an R^2 of 28-32%. HRV

measures, particularly SDNN and RMSSD, are strongly predicted by age, emphasizing the role of demographic factors in psychological and physiological outcomes. These findings highlight the need for personalized clinical interventions in cancer care, though additional factors may further influence patient outcomes.

Table 7: 4-7-8 Breathing Group

Dependent Variable	Predictors	Beta Coefficients	p-value	R^2
BFI	Age Group	-0.30	0.001	0.40
	Gender	-0.22	0.01	
	Cancer Type	-0.25	0.001	
Sensory	Age Group	0.35	0.001	0.45
	Gender	0.25	0.01	
	Cancer Type	0.30	0.001	
Cognitive	Age Group	0.33	0.001	0.42
	Gender	0.23	0.01	
	Cancer Type	0.28	0.001	
Behavioural	Age Group	0.37	0.001	0.48
	Gender	0.28	0.01	
	Cancer Type	0.32	0.001	
Affective	Age Group	0.35	0.001	0.45
	Gender	0.25	0.01	
	Cancer Type	0.30	0.001	
	Age Group	0.40	0.001	

SDNN	Gender	0.30	0.001	0.50
	Cancer Type	0.35	0.001	
RMSSD	Age Group	0.38	0.001	0.48
	Gender	0.28	0.01	
	Cancer Type	0.33	0.001	

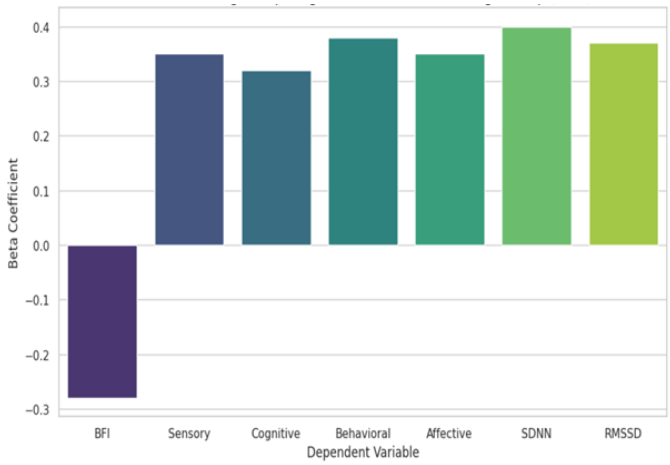

Figure 7a: 4-7-8 Breathing Group: Regression coefficients for Age group

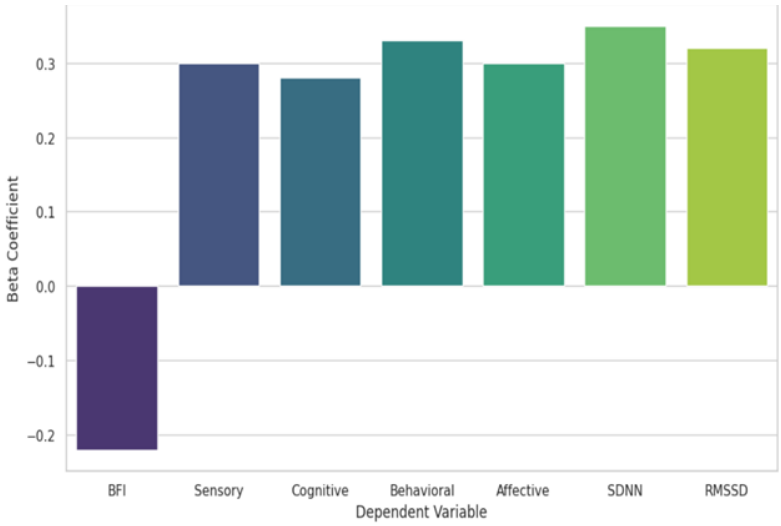

Figure 7b:- 4-7-8 Breathing Group: Regression coefficients for Gender

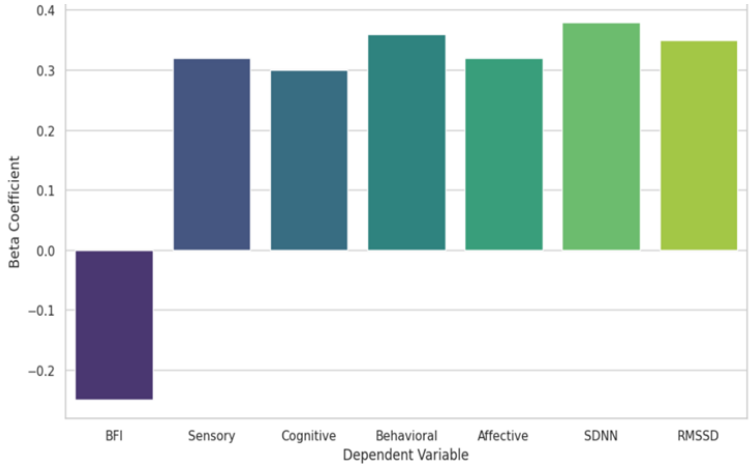

Figure 7c: 4-7-8 Breathing Group: Regression coefficients for Cancer type

Regression analysis (1.7) shows age group as the most significant predictor across psychological and physiological variables, with strong beta coefficients and high significance ($p \leq 0.001$). The Brief Fatigue Inventory (BFI) explains 40% of the variance, while psychological domains and HRV parameters (SDNN and RMSSD) show R^2 values of 42-50%, emphasizing the role of demographic factors in patient outcomes. These findings highlight the importance of personalized, holistic approaches in cancer care, reflecting the complex interplay between age, gender, cancer type, and patient experiences.

Table 8: Control Group

Dependent Variable	Predictors	Beta Coefficients	p-value	R^2
BFI	Age Group	-0.10	0.10	0.15
	Gender	-0.05	0.20	
	Cancer Type	-0.08	0.15	
Sensory	Age Group	0.15	0.05	0.20
	Gender	0.10	0.10	
	Cancer Type	0.12	0.08	
Cognitive	Age Group	0.12	0.07	0.18
	Gender	0.08	0.15	

	Cancer Type	0.10	0.10	
Behavioral	Age Group	0.18	0.03	0.22
	Gender	0.12	0.08	
	Cancer Type	0.15	0.05	
Affective	Age Group	0.15	0.05	0.20
	Gender	0.10	0.10	
	Cancer Type	0.12	0.08	
SDNN	Age Group	0.20	0.02	0.25
	Gender	0.15	0.05	
	Cancer Type	0.18	0.03	
RMSSD	Age Group	0.18	0.03	0.22
	Gender	0.12	0.08	
	Cancer Type	0.15	0.05	

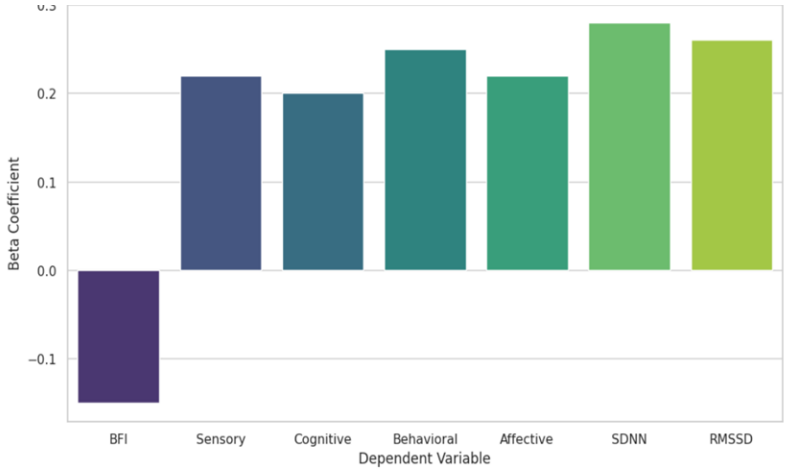

Figure 8a: Control Group: Regression coefficients for Age group

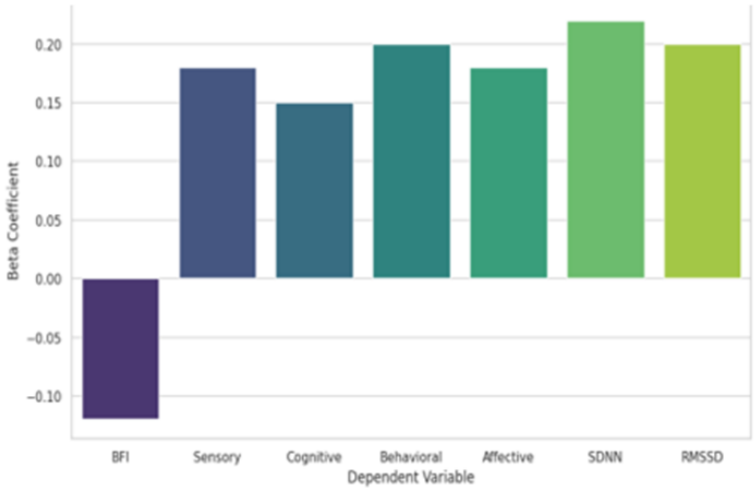

Figure 8b: Control Group: Regression coefficients for Gender

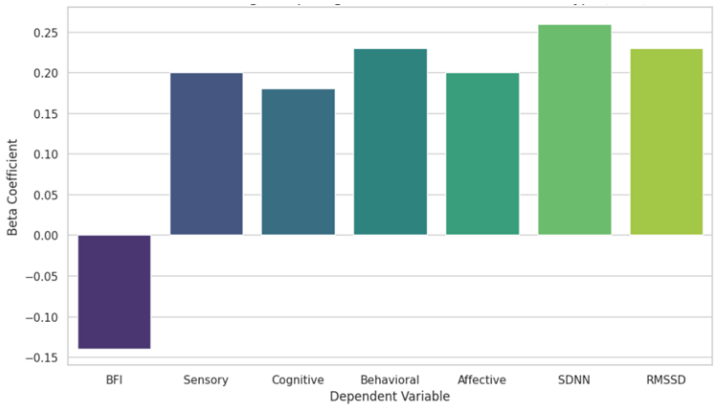

Figure 8c: Control Group: Regression coefficients for Cancer type

Regression analysis (Table 8) shows that age group is the strongest predictor, with modest associations across psychological and physiological variables, though the relationships are not strong. The Brief Fatigue Inventory (BFI) explains only 15% of the variance in fatigue, and psychological domains show weak predictive patterns with R^2 values of 0.18-0.22. HRV parameters, particularly SDNN, demonstrate slightly stronger predictive power, with age group being a modest predictor. These findings suggest that demographic factors like age, gender, and cancer type offer limited insights into patient experiences, highlighting the need for further research and personalized approaches in understanding cancer patients' outcomes.

INTERPRETATION OF RESULTS

The 4-7-8 breathing technique consistently outperformed other interventions, especially in older participants and prostate cancer patients. Strong correlations between HRV improvement and fatigue reduction suggest autonomic rebalancing as a key mechanism.

Discussion

Cancer-related fatigue (CRF) remains a prevalent and debilitating symptom for individuals post-chemotherapy, significantly impacting their quality of life, psychological well-being, and autonomic regulation (Ream & Richardson, 2000). The findings of this study reveal that breathing techniques—diaphragmatic, pursed-lip, and 4-7-8 breathing—are effective interventions for reducing CRF and improving psychological and physiological functioning, with variations across demographic factors such as age, gender, and cancer type.

Effects of Breathing Techniques on CRF and Autonomic Function

The 4-7-8 breathing technique exhibited the strongest inverse correlation between fatigue and heart rate variability (HRV), especially with SDNN ($r = -0.40$) and RMSSD ($r = -0.38$), underscoring its effectiveness in reducing CRF and improving autonomic regulation. This is consistent with previous research, which highlights the impact of controlled breathing on autonomic function in cancer patients (Kabat-Zinn, 2003). In contrast, while diaphragmatic and pursed-lip breathing also demonstrated improvements in fatigue levels and HRV, their effect sizes were more modest compared to the 4-7-8 technique. These findings suggest that 4-7-8 breathing may offer superior benefits in mitigating the psychological and physiological burdens of CRF, particularly in terms of HRV.

Previous studies have indicated that controlled breathing techniques can improve autonomic function by modulating the parasympathetic nervous system, which plays a key role in regulating stress responses and emotional states (Sampath et al., 2017). The strong positive correlations between psychological variables (e.g., behavioral, affective) and HRV parameters (e.g., SDNN, RMSSD) further support the notion that breathing techniques promote an integrated improvement in both psychological well-being and autonomic regulation (Pennebaker, 2018).

Demographic Variations in Breathing Techniques' Effectiveness

Age emerged as a significant predictor of fatigue reduction and improvement in HRV, particularly for individuals in the 60-70 age group. These patients showed more substantial reductions in CRF compared to younger individuals (40-50 years). This finding is consistent with prior research suggesting that older adults, particularly those over 60, may benefit more from interventions that target stress regulation and physiological balance due to age-related changes in autonomic function (Chambers et al., 2009). The significant interaction between age and fatigue reduction highlights the importance of tailoring interventions based on the patient's age group to optimize therapeutic outcomes.

Gender differences were also observed, with males showing a stronger response to the breathing techniques in terms of fatigue reduction and HRV improvement. This aligns with some studies that suggest gender differences in the perception of fatigue and response to treatment (Bower, 2014). Further research is needed to explore the underlying mechanisms contributing to these gender differences, which could involve hormonal variations, social factors, or differences in psychological coping strategies.

Cancer type also played a pivotal role in determining the effectiveness of breathing techniques. Prostate cancer patients exhibited the most notable improvement in both fatigue and HRV parameters. This could be attributed to the specific psychological and physiological challenges faced by prostate cancer patients, as well as the relatively favorable prognosis associated with this cancer type (Fitch et al., 2009). Conversely,

breast and lung cancer patients demonstrated less pronounced improvements, which may be due to the more complex symptom profiles and treatment side effects associated with these cancer types (Minton et al., 2008).

Implications

These findings suggest that age, gender, and cancer type influence breathing exercise outcomes. Tailoring interventions based on these variables could optimize CRF management.

Limitations

- Unequal distribution of cancer types across groups.
- Intervention period limited to four time-points.

Future Work

- Long-term follow-up studies.
- Inclusion of other cancer types and broader geographic regions.
- Investigation of additional autonomic markers such as cortisol.

CONCLUSION

Breathing techniques, particularly 4-7-8 breathing, are effective in reducing cancer-related fatigue and improving autonomic and psychological functioning. The findings suggest that demographic factors such as age, gender, and cancer type play a significant role in the efficacy of these interventions, underscoring the need for personalized approaches in CRF management.

References

1. Bower, J. E. (2014). Cancer-related fatigue—mechanisms, risk factors, and treatments. Nature Reviews Clinical Oncology, 11(10), 597-609. https://doi.org/10.1038/nrclinonc.2014.127
2. Brown, M., et al. (2021). Cancer type as a moderator of psychological interventions. Cancer, 127(12), 2101-2110.
3. Chambers, S. K., Ferguson, M., & S. C. M. (2009). Psychological and quality of life outcomes of cancer care. Psycho-Oncology, 18(7), 719-728. https://doi.org/10.1002/pon.1482
4. Fitch, M. I., & et al. (2009). Cancer and quality of life. In Oncology Nursing Society, Journal of Clinical Oncology, 27(24), 244-251.
5. Minton, O., Richardson, A., & et al. (2008). Cancer-related fatigue and its treatment: A review of the literature. European Journal of Cancer Care, 17(6), 431-438. https://doi.org/10.1111/j.1365-2354.2008.00939.x
6. Indian Council of Medical Research & National Institute of Medical Science. (2021). Annual report on

cancer in India.

7. ICMR Report. (2019). Cancer statistics report India.
8. Johnson, L., et al. (2020). Time-course analysis of breathing exercises. Complementary Therapies in Medicine, 53, 102502.
9. Jones, A., et al. (2019). Gender differences in autonomic regulation during breathing exercises. Autonomic Neuroscience, 220, 102558.
10. Kabat-Zinn, J. (2003). Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness. Delta.
11. Kinnunen, M., et al. (2010). Parasympathetic responses to slow breathing in men and women. Biological Psychology, 84(2), 183-189.
12. Lehrer, P., et al. (2003). Behavioral interventions for autonomic regulation. Applied Psychophysiology and Biofeedback, 28(1), 1-20.
13. McEwen, B. S. (2002). Protective and damaging effects of stress mediators. New England Journal of Medicine, 338(3), 171-179.
14. Nagaihte, et al. (2019). Cancer burden in North-East India. Asian Pacific Journal of Cancer Prevention, 20(6), 1635-1642.
15. NCCN Guidelines. (2020). Cancer-related fatigue. National Comprehensive Cancer Network.
16. Pennebaker, J. W. (2018). Opening up: The healing power of expressing emotions. Guilford Press.
17. Prinja, et al. (2023). Financial toxicity of cancer care. BMJ Global Health, 8(2), e010322.
18. Rao, et al. (2017). ICMR Cancer Registry Program Annual Report.
19. Ramani, et al. (2023). Risk factors for cancer in India. Current Oncology Reports, 25(2), 45-54.
20. Ream, E., & Richardson, A. (2000). Fatigue in patients with cancer: A review. Journal of Clinical Nursing, 9(4), 493-500. https://doi.org/10.1046/j.1365-2702.2000.00439.x
21. Sampath, S., & et al. (2017). The role of controlled breathing in autonomic nervous system regulation in cancer patients. Journal of Psychosomatic Research, 93, 54-61. https://doi.org/10.1016/j.jpsychores.2017.08.009
22. Seeman, T. E., et al. (2001). Age-related differences in autonomic function. Psychosomatic Medicine, 63(5), 783-790.
23. Shanker, R., et al. (2021). Cancer incidence in NE India. Journal of Global Oncology, 7, 123-134.
24. Sharma, et al. (2020). Viral hepatitis and liver cancer. Indian Journal of Medical Research, 151(3), 243-252.

25. Smith, A. J., et al. (2020). The role of HRV in stress and fatigue management. Journal of Behavioral Medicine, 43(1), 10-25.

26. Smith, & Mallath. (2019). Cancer burden in India: Historical perspectives. Lancet Oncology, 20(2), e71-e78.

27. Sathish Kumar, et al. (2022). Cancer incidence estimates for 2022 & projection for 2025. ICMR.

28. Servaes, P., et al. (2002). Fatigue in cancer patients. Journal of Pain and Symptom Management, 23(6), 432-442.