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Quality of life assessment in head and neck cancer patients undergoing radiation therapy in a tertiary referral university hospital

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Abstract

Background: There is considerable post-treatment morbidity in survivors of head and neck cancer (HNC) despite improved survival following multimodality therapy. Assessment of health-related quality of life (HR-QoL) gives valuable information about functional and psychosocial sequelae of radiation therapy (RT), especially in less-studied populations such as South Asians.

Method: A prospective observational study was conducted between August 2023 and December 2024, including biopsy-proven HNC patients receiving curative-intent RT (definitive or adjuvant). The EORTC QLQ-HN35 questionnaire (Urdu/English, interviewer-assisted) was administered at baseline and 12 ± 2 weeks post-RT. Mean ± standard deviations were calculated for each domain. Pre- and post-treatment differences were analysed using paired *t*-tests, while multivariate analysis (general linear model-multivariate analysis of variance) identified factors associated with HR-QoL outcomes.

Results: Fifty-six patients (mean age, 49 ± 13 years; male sex, 78.6%) were included in the analysis. There was a marked deterioration of xerostomia ($p = 0.004$), pain ($p = 0.011$) and taste/smell ($p = 0.018$), whereas social contacts ($p = 0.048$) and sexuality ($p < 0.001$) improved after therapy. Tumour site ($p < 0.001$), histological subtype ($p < 0.001$) and marital status ($p < 0.001$) were the main HR-QoL predictors detected. Both oropharyngeal/hypopharyngeal locations were related to more post-treatment pain and social-eating problems.

Conclusion: Within 3 months after curative-intent RT, HNC patients showed worsening of xerostomia, pain and sensory loss, with the improvement in social contact and sexuality. Tumour site, histopathology and marital status were the key predictors of HR-QoL, demonstrating anatomical, biological and psychosocial influences. Targeted follow-up and supportive care are important for future studies integrating patient-reported and objective outcomes to personalise survivorship care.

Keywords: *radiation therapy, multidisciplinary care, adjuvant treatment, head and neck cancer, acute side effects, late side effects, quality of life, survivorship, psychosocial re-integration, targeted follow-up*

Research

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Introduction

Survivorship in head and neck cancer (HNC) is increasing due to the changes in the epidemiology of the disease and improvement in the treatment efficacy [1]. Five-year survival rates for patients with non-metastatic disease are currently between 60% and 80% [2]. Treatment of HNC is multidisciplinary and includes combination of surgery, radiation and chemotherapy. Radiation therapy (RT) is an integral part of treatment, either in a definitive or an adjuvant setting [3]. Patients are therefore vulnerable to RT-related adverse effects ranging from immediate side effects such as mucositis during treatment to long-term effects such as xerostomia and dysphagia after therapy [4–6]. These adverse effects significantly compromise patients' functional abilities, overall quality of life, psychological and emotional wellbeing [7, 8]. As a result, HNC survivors have diverse post-treatment needs, and evaluation of health-related quality of life (HR-QoL) is therefore particularly significant in this population [9, 10]. Even though 40% of the global HNC burden arises in South Asia [11, 12], HRQoL in this population remains relatively underexplored, mainly due to the variations in the measurement tools and lack of comprehensive assessment strategies [13].

Various clinically reliable and validated modules and questionnaires have been developed to assess the HRQoL of patients during or after treatment [14]. These tools address different aspects of HRQoL and include generic tools, cancer-specific questionnaires (the European Organization for Research and Treatment of Cancer Quality of Life Core Questionnaire, version 3.0/EORTC QLQ-C30) and cancer-site specific modules (the head and neck module in EORTC/EORTC QLQ-HN35) [15–17]. The EORTC QLQ-HN35 is one of the most widely accepted, site-specific cancer modules as it depends on the patient's own assessment rather than perceived pre- and post-treatment changes [16, 18].

The objective of this study was to evaluate the HRQoL in HNC patients both before and 12 ± 2 weeks after the completion of RT, using the EORTC QLQ-HN35 questionnaire. The purpose of this evaluation is to identify factors that significantly impact patients' routine functioning and improve treatment outcomes for this patient group. The 12 ± 2 weeks post-treatment interval was chosen to ensure feasible data collection while minimising loss to follow-up and to capture both the early recovery phase following treatment and persistent treatment-related effects that may continue to influence the quality of life. Given the high prevalence of HNC in the South Asian population, this study holds strong relevance for this group.

Method

A prospective observational study was conducted between August 2023 and December 2024 at our institute. The study included all biopsy-proven HNC cases receiving curative-intent RT, either definitive or adjuvant. Eligible participants were aged ≥18 years, had an ECOG ≤2, and were able to understand and respond to the questionnaire in either English or Urdu-validated version, as per their preference [19]. Patients with distant metastasis, prior HN RT, concurrent malignancy, cognitive impairment or those with incomplete treatment were excluded from the study. Participants completed the EORTC QLQ-HN35 questionnaire via interviewer-assisted administration at two time points: baseline (prior to treatment planning and before undergoing CT simulation) and post-RT follow-up assessment at 12 ± 2 weeks. Missing responses were handled according to the EORTC Scoring Manual, allowing computation of mean scores when at least 50% of items in a scale were completed.

Ethical approval for the study was obtained from the Institutional Review Board (IRB) (2023-8578-25701). Written informed consent was obtained from all participants prior to enrolment.

Data were analysed using IBM SPSS v23. Descriptive statistics were used for demographic and clinical variables. Mean and standard deviation (SD) were reported for continuous variables, while categorical variables were expressed as frequencies and percentages. Paired-sample *t*-test was used to make comparisons between pre- and post-treatment HRQoL scores. General linear model (GLM) multivariate analysis of variance (MANOVA) was used to analyse the correlations between the factors and the HR-QoL scales. A p -value <0.05 was considered statistically significant.

Instruments of HR-QoL

The EORTC QLQ-H&N35 questionnaire was obtained from the Quality-of-Life Unit, EORTC Data Center in Brussels, Belgium. The QLQ-H&N35 particularly assesses HR-QoL symptoms in HNC patients. It incorporates seven multiple-item scales: pain, swallowing ability, senses (taste/smell), speech, social eating, social contact and sexuality. Also included are six single-item scales: problems associated with teeth, mouth opening, dry mouth, sticky saliva, coughing and feeling ill. Each scale score ranges from 0 to 100, with higher scores indicating greater symptom severity.

Statistical analysis

Mean ± SDs for each HR-QoL scale were computed in accordance with the EORTC QLQ scoring manual. Paired *t*-tests were used to compare pre- and post-treatment scores. GLM MANOVA was used to see the association between clinical factors and the HR-QoL scales. The GLM-MANOVA approach was used to test the hypothesis of a significant association between a set of interrelated dependent variables (HR-QoL scales) and independent variables.

To investigate the association of a given factor with HR-QoL scales, a univariate analysis was conducted to establish whether the factor was associated significantly with any of the HR-QoL scales. Wilks' *l* was used to test the impact of each variable included in the model. All variables were entered into the multi-factor model. In the case of a significant association between a factor and all HR-QoL scales taken together, a second ANOVA was performed to investigate the association between that prognostic factor and each HR-QoL scale separately, with post hoc testing using the Bonferroni method with a *p* -value.

Being the most concerned scale of HR-QoL in the study, pain was further analysed by multiple linear regression models to explore its associated prognosticators. All the data processing was performed using the statistical software SPSS for Windows (version 27).

Results

Study population

A total of 56 patients diagnosed with HNC undergoing RT were enrolled in the study. Patients had an average age of 49.03 years (range: 20–79 years); the majority were male (44 patients, 78.6%) versus female (12 patients, 21.4%). Most were married (51; 91.1%). Squamous cell carcinoma was the predominant histology (49; 87.5%). The oral cavity constituted the predominant tumour location (35; 62.5%), followed by the oropharynx (5; 8.9%) and the larynx (4; 7.1%) (Table 1). All patients successfully received curative RT using the volumetric modulated arc therapy (VMAT) technique. The domains and scoring structure of the questionnaire are detailed in Table 2.

Outcomes of HR-QoL

In Table 3, the descriptive statistics indicate both symptoms worsening and improvement across different domains of the QLQ-H&N35. Several symptom scales demonstrated a notable increase in mean scores post-RT, reflecting a deterioration in symptom burden. These included dry mouth (xerostomia); the mean score increased from 11.3 pre-treatment to 24.4 post-treatment (Δ [post−pre] = +13.1). Pain increased from 10.5 to 17.8 (Δ [post−pre] = +7.3), senses (taste/smell) from 3.27 to 7.14 (Δ [post−pre] = +3.87), feeling ill from 11.3 to 16.6 (Δ [post−pre] = +5.3) and difficulty in opening mouth from 17.2 to 20.8 (Δ [post−pre] = +3.6), indicating treatment-related aggravation of discomfort.

Conversely, several functional domains exhibited improvement, suggesting recovery in psychosocial and communicative aspects following treatment completion. These included speech problems: 12.1–8.13 (Δ [post−pre] = −3.97), social contact improvement: 15.0–10.3 (Δ [post−pre] = −4.7), coughing: 5.95–3.57 (Δ [post−pre] = −2.38) and sticky saliva: 9.52–6.54 (Δ [post−pre] = −2.98). A modest enhancement was also observed in sexual factors; the mean score declined slightly from 5.05 to 4.46 (Δ [post−pre] = −0.59), reflecting better psychosocial reintegration.

Table 1. Patient characteristics.

Variables	Total	Percentage (%)
Patient number	56	100
Age, mean (range) years	49.03 (20–79)	
Gender		
Male	44	78.6
Female	12	21.4
Marital status		
Married	51	91.1
Widow	2	3.6
Single	3	5.4
Histopathological diagnoses		
Squamous cell carcinoma	49	87.5
Others	7	12.6
Cancer site		
Oral cavity	35	62.5
Salivary gland	3	5.4
Hypopharynx	2	3.6
Nasopharynx	3	5.4
Thyroid gland	1	1.8
Oropharynx	5	8.9
Paranasal sinuses	3	5.4
Larynx	4	7.1
Stage		
II	8	14.3
III	20	35.7
IV	28	50.0
Induction chemotherapy		
Yes	8	14.3
No	48	85.7
Adjuvant chemotherapy		
Yes	50	89.3
No	6	10.7
Presence of Peg tube	56	100
Radiation technique (VMAT)	56	100
RT dose (Gy)		
65	2	3.6
66	13	23.2
70	41	73.2
Outcome		
Death	0	0

VMAT, Volumetric Modulated Arc Therapy; Gy, Gray

Table 2. Frequency and percentage distribution of survey responses.

Questions	Follow-up (3 months)	Not at all	A little	Quite a bit	Very much
Have you had pain in your mouth?	Start of RT	37 (66.1%)	17 (30.4%)	2 (3.6%)	0 (0%)
	Post-RT	29 (51.8%)	16 (28.6%)	11 (19.6%)	0 (0%)
Have you had pain in your jaw?	Start of RT	44 (78.6%)	11 (19.6%)	1 (1.8%)	0 (0%)
	Post-RT	33 (58.9%)	15 (26.8%)	8 (14.3%)	0 (0%)
Have you had soreness in your mouth?	Start of RT	41 (73.2%)	14 (25.0%)	1 (1.8%)	0 (0%)
	Post-RT	44 (78.6%)	9 (16.1%)	3 (5.4%)	0 (0%)
Have you had a painful throat?	Start of RT	39 (69.6%)	13 (23.2%)	4 (7.1%)	0 (0%)
	Post-RT	25 (44.6%)	27 (48.2%)	3 (5.4%)	1 (1.8%)
Have you had problems swallowing liquids?	Start of RT	44 (78.6%)	8 (14.3%)	4 (7.1%)	0 (0%)
	Post-RT	44 (78.6%)	7 (12.5%)	5 (8.9%)	0(0%)
Have you had problems swallowing pureed food?	Start of RT	41 (73.2%)	7 (12.5%)	7 (12.5%)	1 (1.8%)
	Post-RT	38 (67.9%)	13 (23.2%)	5 (8.9%)	0(0%)
Have you had problems swallowing solid food?	Start of RT	35 (62.5%)	10 (17.9%)	10 (17.9%)	1 (1.8%)
	Post-RT	10 (17.9%)	36 (64.3%)	8 (14.3%)	2 (3.3%)
Have you choked when swallowing?	Start of RT	49 (87.5%)	6(10.7%)	1 (1.8%)	0(0%)
	Post-RT	51 (91.1%)	5 (8.9%)	0 (0%)	0 (0%)
Have you had problems with your teeth?	Start of RT	44 (78.6%)	11 (19.6%)	1 (1.8%)	0(0%)
	Post-RT	48 (85.7%)	5 (8.9%)	3 (5.9%)	0(0%)
Have you had problems opening your mouth wide?	Start of RT	33 (58.9%)	18 (32.1%)	4 (7.1%)	1 (1.8%)
	Post-RT	29 (51.8%)	19 (33.9%)	8 (14.3%)	0(0%)
Have you had a dry mouth?	Start of RT	42 (75.0%)	10 (17.9%)	3 (5.4%)	1 (1.8%)
	Post-RT	25 (44.6%)	22 (39.3%)	8 (14.3%)	1 (1.8%)
Have you had sticky saliva?	Start of RT	45 (80.4%)	7 (12.5%)	3 (5.4%)	1 (1.8%)
	Post-RT	47 (83.9%)	7 (12.5%)	2 (3.6%)	0(0%)
Have you had problems with your sense of smell?	Start of RT	54 (96.4%)	1 (1.8%)	1 (1.8%)	0(0%)
	Post-RT	56 (100%)	0(0%)	0(0%)	0(0%)
Have you had problems with your sense of taste?	Start of RT	48 (85.7%)	8 (14.3%)	0(0%)	0(0%)
	Post-RT	37 (66.1%)	14 (25.0%)	5 (8.9%)	0(0%)
Have you coughed?	Start of RT	47 (83.9%)	8 (14.3%)	1 (1.8%)	0(0%)
	Post-RT	51 (91.1%)	4 (7.1%)	1 (1.8%)	0(0%)
Have you been hoarse?	Start of RT	43 (76.8%)	6 (10.7%)	5 (8.9%)	2 (3.6%)
	Post-RT	49 (87.5%)	6 (10.7%)	1 (1.8%)	0(0%)
Have you felt ill?	Start of RT	39 (69.6%)	16 (28.6%)	0(0%)	1 (1.8%)
	Post-RT	33 (58.9%)	18 (32.1%)	5 (8.9%)	0
Has your appearance bothered you?	Start of RT	19 (33.9%)	37 (66.1%)	0(0%)	0(0%)
	Post-RT	19 (33.9%)	36 (64.3%)	1 (1.8%)	0(0%)

Continued

Table 2. Frequency and percentage distribution of survey responses. *Continued*

Questions	Follow-up (3 months)	Not at all	A little	Quite a bit	Very much
Have you had trouble eating?	Start of RT	36 (64.3%)	13 (23.2%)	7 (12.5%)	0(0%)
	Post-RT	27 (48.2%)	23 (41.1%)	6 (10.7%)	0(0%)
Have you had trouble eating in front of your family?	Start of RT	44 (78.6%)	7 (12.5%)	5 (8.9%)	0(0%)
	Post-RT	44 (78.6%)	12 (21.4%)	0 (0%)	0(0%)
Have you had trouble eating in front of other people?	Start of RT	44 (78.6%)	7 (12.5%)	5 (8.9%)	0(0%)
	Post-RT	44 (78.6%)	12 (21.4%)	0(0%)	0(0%)
Have you had trouble enjoying your meals?	Start of RT	39 (69.6%)	12 (21.4%)	5 (8.9%)	0(0%)
	Post-RT	41 (73.2%)	15 (26.8%)	0(0%)	0(0%)
Have you had trouble talking to other people?	Start of RT	39 (69.6%)	14 (25.0%)	3 (5.4%)	0(0%)
	Post-RT	43 (76.8%)	10 (17.9%)	2 (3.6%)	1 (1.8%)
Have you had trouble talking on the telephone?	Start of RT	40 (71.4%)	13 (23.2%)	3 (5.4%)	0(0%)
	Post-RT	44 (78.6%)	9 (16.1%)	2 (3.6%)	1 (1.8%)
Have you had trouble having social contact with your family?	Start of RT	41 (73.2%)	9 (16.1%)	6 (10.7%)	0(0%)
	Post-RT	45 (80.4%)	10 (17.9%)	1 (1.8%)	0(0%)
Have you had trouble having social contact with friends?	Start of RT	39 (69.6%)	11 (19.6%)	6 (10.7%)	0(0%)
	Post-RT	44 (78.6%)	11 (19.6%)	1 (1.8%)	0(0%)
Have you had trouble going out in public?	Start of RT	40 (71.4%)	9 (16.1%)	7 (12.5%)	0(0%)
	Post-RT	44 (78.6%)	11 (19.6%)	1 (1.8%)	0(0%)
Have you had trouble having physical contact with family or friends?	Start of RT	40 (71.4%)	10 (17.9%)	6 (10.7%)	0(0%)
	Post-RT	45 (80.4%)	11 (19.6%)	0(0%)	0(0%)
Have you felt less interest in sex?	Start of RT	49 (87.5%)	7(12.5%)	0(0%)	0(0%)
	Post-RT	49(87.5%)	7 (12.5%)	0(0%)	0(0%)
Have you felt less sexual enjoyment?	Start of RT	48(85.7%)	6 (10.7%)	2 (3.6%)	0(0%)
	Post-RT	48(85.7%)	8 (14.3%)	0(0%)	0(0%)

Scoring: (1 = Not at All, 2 = A Little, 2 = Quite a Bit, 4 = Very Much)

Inferential analysis using paired *t*-tests (Table 4) further delineated the statistical significance of these changes. About 5 of the 13 scales demonstrated statistically significant pre- to post-treatment differences (Figure 1). Significant symptom worsening was observed for pain (95% CI [−12.84, −1.74], $p = 0.011$), dry mouth (95% CI [−21.72, −4.47], $p = 0.004$) and senses (taste/smell) (95% CI [−7.05, −0.69], $p = 0.018$), confirming that RT exerted a measurable adverse impact on these domains. In contrast, significant functional improvements were detected for social contact (95% CI [0.05, 9.23], $p = 0.048$) and sexual factors (95% CI [−2.70, 3.89], $p < 0.001$), reflecting enhanced psychosocial adjustment following treatment. The remaining domains, such as swallowing, teeth, opening mouth, sticky saliva, coughing, speech, feeling ill and social eating, did not reach statistical significance (all $p > 0.05$), suggesting that the observed mean differences in these scales likely represent random variation rather than a consistent RT effect.

Table 3. Calculated pre- and post-radiotherapy scores of EORTC QLQ-H&N35 scales for HNC survivors.

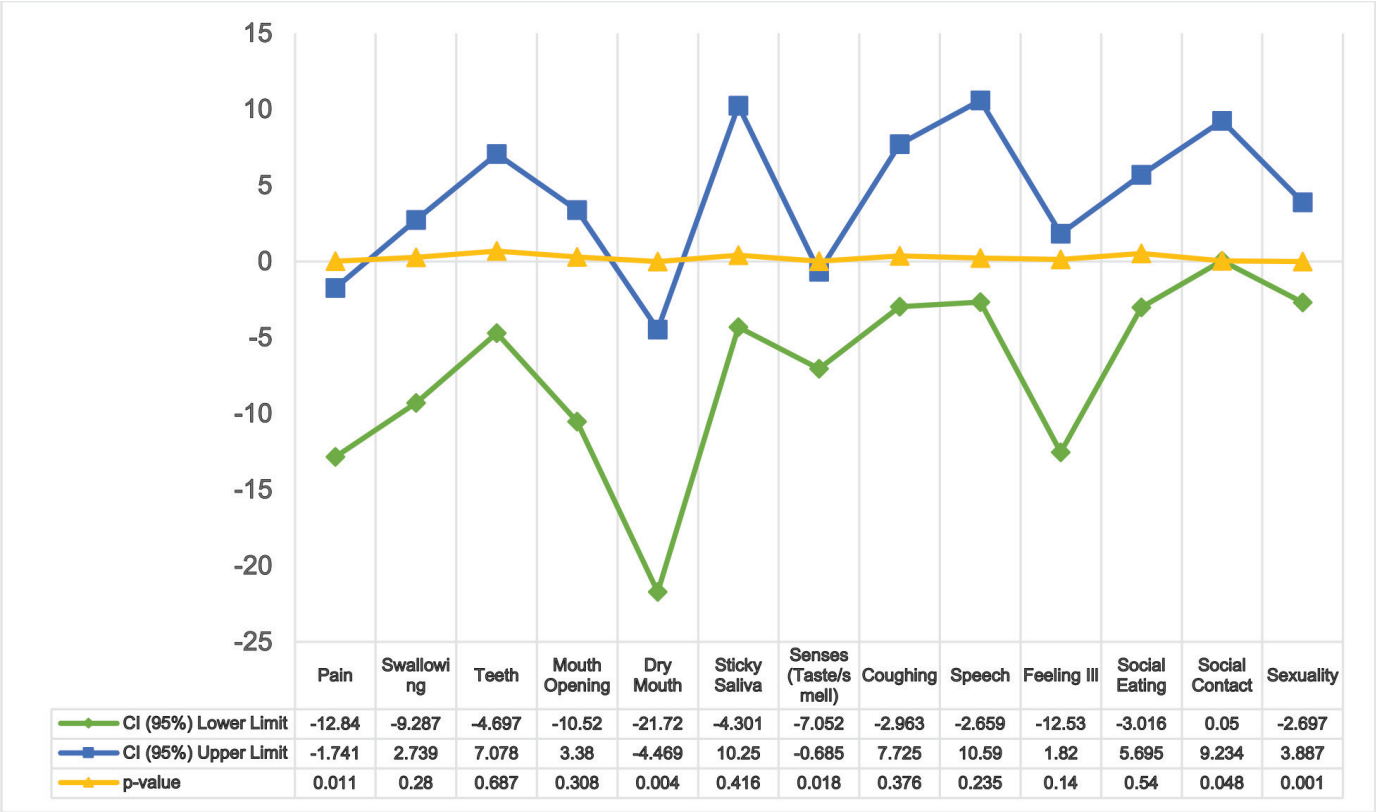
H&N35 scale	Pre-treatment mean (SD), (Median)	Post-treatment mean (SD), (Median)	Mean change (D = post − pre)	Range
Pain	10.5 (11.9), (8.33)	17.8 (18.0), (16.6)	+7.3	0.0–100.0
Swallowing	12.0 (18.5), (0.00)	15.3 (15.7), (8.33)	+3.3	0.0–100.0
Teeth	7.73 (15.5), (0.00)	6.54 (17.3), (0.00)	−1.1	0.0–100.0
Opening mouth	17.2 (23.7), (0.00)	20.8 (24.2), (0.00)	+3.6	0.0–100.0
Dry mouth	11.3 (22.2), (0.00)	24.4 (25.8), (3.33)	+13.1	0.0–100.0
Sticky saliva	9.52 (21.7), (0.00)	6.54 (16.1), (0.00)	−2.98	0.0–100.0
Senses (taste/smell)	3.27 (7.39), (0.00)	7.14 (10.9), (0.00)	+3.87	0.0–100.0
Coughing	5.95 (14.3), (0.00)	3.57 (12.1), (0.00)	−2.38	0.0–100.0
Speech	12.1 (18.7), (0.00)	8.13 (15.9), (0.00)	−3.97	0.0–100.0
Feeling ill	11.3 (19.3), (0.00)	16.6 (22.0), (0.00)	+5.3	0.0–100.0
Social eating	12.3 (18.7), (0.00)	11.0 (14.2), (8.33)	−1.3	0.0–100.0
Social contact	15.0 (19.3), (6.66)	10.3 (12.6), (6.66)	−4.7	0.0–100.0
Sexuality	5.05 (12.2), (0.00)	4.46 (11.2), (0.00)	−0.59	0.0–100.0

Abbreviations: EORTC QLQ-H&N35: European Organization for Research and Treatment of Cancer Quality of Life Questionnaire – Head and Neck Module; SD: Standard Deviation

Table 4. Comparison of pre- and post -radiotherapy EORTC QLQ-H&N35 scale scores using paired *t*-test.

H&N35 scale	95% Confidence interval		Changes after RT	Significance (*p*-Value)
	Lower limit	Upper limit		
Pain	−12.84	−1.741	↑ Worsened	**0.011**
Swallowing	−9.287	2.739	↑ Worsened	0.280
Teeth	−4.697	7.078	↓ Improved	0.687
Opening mouth	−10.52	3.380	↑ Worsened	0.308
Dry mouth	−21.72	−4.469	↑ Worsened	**0.004**
Sticky saliva	−4.301	10.25	↓ Improved	0.416
Senses (taste/smell)	−7.052	−0.685	↑ Worsened	**0.018**
Coughing	−2.963	7.725	↓ Improved	0.376
Speech	−2.659	10.59	↓ Improved	0.235
Feeling ill	−12.53	1.820	↑ Worsened	0.140
Social eating	−3.016	5.695	↓ Improved	0.540
Social contact	0.050	9.234	↓ Improved	**0.048**
Sexuality	−2.697	3.887	↓ Improved	**<0.001**

Abbreviations: ↑: Increased post-treatment mean; ↓: Decreased post-treatment mean; →: Unchanged post-treatment mean
Bold values are statistically significant



	Pain	Swallowing	Teeth	Mouth Opening	Dry Mouth	Sticky Saliva	Senses (Taste/smell)	Coughing	Speech	Feeling Ill	Social Eating	Social Contact	Sexuality
CI (95%) Lower Limit	-12.84	-9.287	-4.697	-10.52	-21.72	-4.301	-7.052	-2.963	-2.659	-12.53	-3.016	0.05	-2.697
CI (95%) Upper Limit	-1.741	2.739	7.078	3.38	-4.469	10.25	-0.685	7.725	10.59	1.82	5.695	9.234	3.887
p-value	0.011	0.28	0.687	0.308	0.004	0.416	0.018	0.376	0.235	0.14	0.54	0.048	0.001

Figure 1. Mean change in EORTC QLQ-HN35 symptom domains at 3 months post-radiotherapy with corresponding 95% confidence intervals (CI) and *p*-values. The green line represents the lower CI limit, the blue line represents the upper CI limit and the yellow line indicates the *p*-values for each symptom domain. Significant functional improvements were detected for social contact and sexual factors.

Variables associated with HR-QoL outcomes

In the first step of the GLM-MANOVA, the association between the independent variables (three sociodemographic and seven clinical variables) and the dependent variables (scales of QLQ-H&N35) was investigated (one-factor model, Table 5). This analysis showed that four of the ten variables (except the age, $p = 0.324$; gender, $p = 0.399$; AJCC stage, $p = 0.377$; definitive therapy/surgical resection, $p = 0.357$; adjuvant therapy, $p = 0.763$; radiation phase, $p = 0.074$) were associated with the overall outcome on QLQ-H&N35. The ten variables were then entered into the multifactor model analysis, which demonstrated that histopathological diagnosis and tumour site were the most influential determinants of HR-QoL, exhibiting highly significant effects in both models (histopathology: Wilk's $\lambda = 0.081$, $p = 0.007$ in the one-factor model; $\lambda = 0.012$, $p < 0.001$ in the multifactor model; tumour site: Wilk's $\lambda = 0.040$, $p < 0.001$ in the one-factor model; $\lambda = 0.003$, $p < 0.001$ in the multifactor model). Marital status also emerged as a significant psychosocial determinant, achieving greater significance in the multifactor model (Wilk's $\lambda = 0.052$, $p < 0.001$) compared to the one-factor model (Wilk's $\lambda = 0.422$, $p = 0.037$), indicating that social support plays a vital, independent role in post-treatment adaptation and recovery (Table 5).

The site of tumour also exerted a significant influence on certain HR-QoL scales, including pain (F (7,48) = 2.38, $p = 0.035$, partial $\eta^2 = 0.258$), feeling ill (F (7,48) = 4.08, $p = 0.001$, partial $\eta^2 = 0.373$) and social eating (F (7,48) = 2.46, $p = 0.030$, partial $\eta^2 = 0.265$). Patients

with oropharyngeal and hypopharyngeal tumours exhibited worse pain and social eating scores compared with those with nasopharyngeal or thyroid lesions, suggesting that tumour location plays a considerable role in determining post-treatment functional outcomes and overall HR-QoL. In contrast, the adjuvant chemotherapy variable showed a significant effect only for the feeling ill scale (F (1,54) = 4.06, p = 0.049, partial η^2 = 0.070), with patients receiving adjuvant chemotherapy reporting greater levels of general malaise following treatment.

Additional analysis of pain-associated variables using multiple linear regression (Table 6) identified several significant predictors. Marital status showed a significant correlation with pain (β = 11.53, p = 0.048), with married individuals reporting elevated pain levels compared to widowed or single patients. Histopathological type also proved significant (β = 5.40, p = 0.022), revealing that squamous cell carcinoma patients experienced more severe pain than those with alternative tumour types.

Discussion

Assessment of HR-QoL at 12 weeks following RT

The current research investigated HR-QoL at the beginning of treatment and 12 ± 2 weeks after the conclusion of curative RT. This specific 12 ± 2 weeks assessment period was chosen because it represents a transition in early survivorship; during this time, acute side effects from radiation typically start to subside, while more persistent symptoms related to the treatment remain evident. This timeframe thus offers a valuable window to study the balance between treatment-induced morbidity and the return of functional health. The reason for using EORTC QLQ-HN35 is its wide acceptance and high compliance, as it provides patient assessment-based scoring for specific adverse effects and does not underestimate a patient's own assessment of their pre-treatment physical performance as compared to post-treatment [16,18].

Table 5. GLM-MANOVA test of the overall effect of the sociodemographic and clinical variables on the EORTC QLQ-H&N35 scales.

	QLQ-H&N35			
	One-factor model*		Multifactor model**	
Variable	**Wilk's *l***	***p***	**Wilk's *l***	***p***
Sociodemographic variables				
Age: <40 versus 40–60 versus ≥60	0.541	0.324	0.253	0.191
Marital status: Married versus Widow versus Single	0.422	**0.037**	0.052	**<0.001**
Gender: Male versus Female	0.749	0.399	0.502	0.262
Clinical variables				
Histopathological diagnoses: SCC versus NPC versus MTC versus PC versus M versus SDC versus SCNT	0.081	**0.007**	0.012	**<0.001**
Site of tumour: Oral Cavity versus Salivary Gland versus Hypopharynx versus Nasopharynx versus Thyroid Gland versus Oropharynx versus Paranasal Sinuses versus Larynx	0.040	**<0.001**	0.003	**<0.001**
AJCC Stage: II versus III versus IV	0.554	0.377	0.195	0.059
Definitive therapy/surgical resection: Yes versus No versus Not applicable	0.549	0.357	0.167	0.027
Induction therapy: Yes versus No versus Not applicable	0.426	**0.041**	0.291	0.316
Adjuvant chemotherapy: Yes versus No	0.824	0.763	0.268	**0.005**
RT phase: P2 versus P3	0.642	0.074	0.649	0.698

*: The one-factor model: only one independent variable was entered into the model. **: The multifactor model: all mentioned variables were entered as independent variables in the model. Abbreviations: GLM-MANOVA: general linear model multivariate analysis of variance; EORTC-QLQ-H&N35: European Organization for Research and Treatment of Cancer Quality of Life Core questionnaire Head and Neck Module; SCC: Squamous Cell Carcinoma; NPC: Nasopharyngeal Carcinoma; MTC: Medullary Thyroid Carcinoma; PC: Papillary Carcinoma of Thyroid; M: Melanoma; SDC: Salivary Ductal Carcinoma; SCNT: Small Cell Neuroendocrine Tumour
Bold values are statistically significant

Table 6. Multiple linear regression analysis for pain.

			95% Confidence interval		
Variable	*β*	SE	Lower limit	Upper limit	*p*
Sociodemographic variables					
Age: <40 versus 40–60 versus ≥60	−3.92	3.66	−11.35	3.50	0.293
Marital status: Married versus Widow versus Single	11.53	5.67	0.110	22.96	**0.048**
Gender: Male versus Female	−0.88	5.69	−12.36	10.58	0.877
Clinical variables					
Histopathological diagnoses: SCC versus NPC versus MTC versus PC versus M versus SDC versus SCNT	5.40	2.27	0.826	9.97	**0.022**
Site of tumour: Oral Cavity versus Salivary Gland versus Hypopharynx versus Nasopharynx versus Thyroid Gland versus Oropharynx versus Paranasal Sinuses versus Larynx	−2.07	1.37	−4.84	0.69	0.138
AJCC stage: II versus III versus IV	−0.41	3.75	−7.97	7.15	0.913
Definitive therapy/surgical resection: Yes versus No	3.67	4.49	−5.37	12.72	0.418
Induction therapy: Yes versus No versus Not Applicable	2.54	4.77	−7.06	12.15	0.596
Adjuvant chemotherapy: Yes versus No	2.03	8.26	−14.60	18.67	0.807
RT phase: P2 versus P3	16.26	5.65	4.87	27.64	**0.006**

β: unstandardised regression coefficient; SE: standard error; R2 = 0.326 in the model for pain; SCC: Squamous Cell Carcinoma; NPC: Nasopharyngeal Carcinoma; MTC: Medullary Thyroid Carcinoma; PC: Papillary Carcinoma of Thyroid; M: Melanoma; SDC: Salivary Ductal Carcinoma; SCNT: Small Cell Neuroendocrine Tumour
Bold values are statistically significant

Overall HR-QoL pattern at 12 weeks

Throughout the 12 ± 2 weeks following RT, patients exhibited a varied HR-QoL profile. There was a notable decline in areas such as dry mouth (xerostomia), pain levels and sensory abilities, particularly taste and smell. In contrast, domains related to social engagement and sexual health showed marked improvement. These results imply that while physical toxicities from treatment continue to impact survivors in the early post-therapy stage, psychosocial healing may initiate shortly after the treatment cycle ends [20].

Worsening of xerostomia, pain and sensory function

Among all evaluated domains, xerostomia demonstrated the greatest deterioration with mean scores increasing from 11.3 at baseline to 24.4 at 12 ± 2 weeks (Δ = +13.1, $p = 0.004$). This finding is consistent with the known vulnerability of salivary glands to RT because of their critical location and reflects the persistence of salivary dysfunction beyond treatment completion. Since saliva plays a critical role in swallowing, taste perception, oral hygiene, nutritional intake and speech, xerostomia remains one of the most clinically relevant determinants of post-treatment QoL in HNC survivors [21–23].

Pain also worsened significantly during the study period. It increased from a mean score of 10.5 before treatment to 17.8 at 12 ± 2 weeks (Δ = +7.3, $p = 0.011$). Persistent pain during this phase reflects ongoing mucosal healing, neuropathic injury, residual treatment-related inflammation and fibrosis. Similar findings have been reported in previous studies evaluating early post-RT recovery, highlighting the need for continued symptom monitoring beyond treatment completion [24].

Likewise, sensory dysfunction increased significantly, with taste and smell scores worsening from 3.3 to 7.1 (Δ = +3.9, $p = 0.018$). Alterations in taste and smell substantially affect appetite, nutritional status and overall patient satisfaction. Given that recovery of sensory function often extends over several months, the persistence of these symptoms at 12 ± 2 weeks is not unexpected [25].

Improvement in psychosocial domains

While physical symptoms worsened, psychosocial areas showed encouraging signs of progress. Social interaction scores improved from 15.0 at baseline to 10.3 at follow-up ($\Delta = -4.7$, $p = 0.048$), and sexual health scores also saw a significant boost. These findings suggest that patients begin to reintegrate into their social lives once the intensive treatment phase is over.

Gains in social functioning stem from increased public confidence, better communication with family and fewer disruptions to daily routines [26]. Likewise, improvements in sexual health reflect a recovery in emotional well-being, self-regard and interpersonal connections. Altogether, these results emphasise that survivorship involves not just managing physical symptoms but also restoring emotional and social health [27, 28].

Determinants of HR-QoL at 12 weeks

The location of the tumour was found to be a major predictor of HR-QoL results. Patients with cancers in the oropharynx or hypopharynx suffered from significantly higher levels of pain, more difficulty with social eating and a greater sense of illness than those with tumours in other areas. This reflects the anatomical and functional burden of treating pharyngeal subsites [29].

Marital status was also an independent factor influencing pain and HR-QoL outcomes. The importance of marital status in the analysis highlights the critical role that social support plays during the recovery process. Patients with robust support networks are better prepared to handle treatment side effects, adjust to physical limitations and manage the general challenges of being a cancer survivor [30].

Clinical implications

The results of this study suggest that survivorship programs should go beyond disease monitoring to include early, multidisciplinary support. This should encompass symptom management, nutritional guidance, physical rehabilitation and psychological support, especially for patients at high risk of poor HR-QoL. Specific attention is needed for those with pharyngeal tumours or those who lack strong social support systems.

Strengths

This study is strengthened by its prospective design, assessment of HR-QoL changes from baseline to post-treatment within the same patient cohort with reduced recall bias. In addition, the use of the validated EORTC QLQ-HN35 questionnaire, interviewer-assisted bilingual administration and a relatively uniform VMAT-based curative-intent treatment approach provided a reliable evaluation of early survivorship outcomes in a South Asian population, an area where such data remain limited.

Limitations

As a single-centre study with a relatively small sample size, the findings may have limited generalisability. Furthermore, the 12 ± 2 weeks follow-up was designed to evaluate early survivorship and therefore does not capture long-term recovery patterns. Objective functional assessments, including swallowing evaluation, salivary flow measurements, nutritional assessment and trismus evaluation, were not performed, precluding correlation of patient-reported outcomes with functional recovery. Finally, the absence of a concurrent global HR-QoL instrument and minimally clinically important difference thresholds may limit interpretation of the clinical relevance of the observed changes.

Conclusion

This prospective study identified that within 3 months after curative-intent RT, HNC patients exhibited a significant aggravation of xerostomia, pain and sensory loss, while also showing significant improvement in the social contact and sexuality domains. Tumour site, histopathological

subtype and marital status emerged as the strongest predictors of HR-QoL, emphasising the significance of anatomical, biological and psychosocial factors in determining survivorship outcomes. These results emphasise the need for targeted follow-up and individualised supportive interventions.

Recommendations

Future research should utilise multicentre, longitudinal designs with larger groups and repeated HR-QoL checks at 3, 6 and 12 months or longer. Although patient-reported QoL scores capture the subjective experience of symptoms and recovery, the integration of these measures with objective functional endpoints, such as assessments of swallowing efficiency, salivary flow and trismus, would provide a more comprehensive and reliable method of assessing the impact of treatment. Furthermore, early involvement of multidisciplinary teams and structured survivorship interventions, such as salivary-sparing RT techniques, swallowing rehabilitation programmes and symptom-triggered psychosocial support, should also be a priority in future research in high-risk subgroups. This would offer the potential to achieve personalised, data-driven, evidence-based survivorship care for HNC patients.

Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

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Consent to participate

Informed consent was obtained from all individual participants included in the study.

Ethical approval

This study was conducted in accordance with institutional ethical standards. Approval was obtained from the Institutional Ethics Review Committee prior to data collection.

Author contributions

Mariam Hina: substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; drafting the article and revising it critically for important intellectual content.

Bilal Mazhar Qureshi: substantial contributions to analysis and interpretation of data; drafting the article and reviewing it critically for important intellectual content.

Habiba Zaheer: substantial contributions to the critical review of the article for important intellectual content.

Bilal Ahmed: revised the draft critically for important intellectual content.

Maham Khan: revised the draft critically for important intellectual content.

Laraib Khan: revised the draft critically for important intellectual content.

Tooba Ali: revised the draft critically for important intellectual content.

Fabiha Shakeel: revised the draft critically for important intellectual content.

Jawad Ahmad: substantial contributions to the analysis and interpretation of data.

M. Abdul Wasay Zuberi: substantial contributions to analysis and interpretation of data.

Maria Tariq: revised the draft critically for important intellectual content.

Nasir Ali: revised the draft critically for important intellectual content.

Asim Hafiz: revised the draft critically for important intellectual content.

Ahmed Nadeem Abbasi: substantial contributions to conception and design, acquisition of data, analysis and interpretation of data; drafting the article and revising it critically for important intellectual content.

Data availability

The datasets generated and/or analysed during the current study are stored in an institutional repository available from the corresponding author on reasonable request.

Use of artificial intelligence

The authors confirm that no artificial intelligence-assisted technologies were used in the generation of the data/scientific content of this manuscript. All content, analysis and conclusions are solely those of the authors.

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