RESEARCH ARTICLE

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Validation of the Tamil Version of the Taste and Smell Questionnaire for Assessing Sensory Dysfunction in Head and Neck Cancer Patients Undergoing Chemoradiotherapy

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Abstract

Introduction and objectives: Chemoradiation-induced sensory dysfunction, including altered taste and smell, is a common yet underreported consequence of chemoradiotherapy (CRT) in patients with Head and Neck Cancer (HNC). A culturally and linguistically adapted tool in Tamil is crucial for the symptom assessment and supportive care among Tamil-speaking populations. The Taste and Smell Questionnaire (TSQ) is a self-reported measure that facilitates the evaluation of taste and smell difficulties in patients with HNC. This study aimed to translate and validate the Tamil version of the TSQ (TSQ-T), and to evaluate self-perceived taste and smell disturbances in healthy adults and HNC patients after CRT. **Methods:** This cross-sectional study was conducted in two phases: (i) forward–backward translation of the TSQ, expert panel review, pilot testing, and cognitive debriefing; and (ii) administration of the finalized Tamil TSQ to 264 HNC patients and 75 healthy controls. Internal consistency, known-group comparisons, and symptom correlations with clinical aspects were analyzed. **Results:** The Tamil TSQ demonstrated excellent internal consistency (Cronbach's $\alpha = .98$). Patients with HNC reported significantly higher taste ($M = 3.38$) and smell ($M = 1.19$) scores compared with healthy controls ($M = 0.40$ and $M = 0.03$, respectively; $p < 0.001$). Symptom severity was greatest within the first three months following CRT and declined gradually with longer post-CRT duration. When compared across cancer sites, patients with tongue cancer reported the highest TSQ scores. The treatment modality (surgery vs. CRT) did not yield significant differences in scores. Patients who reported greater swallowing difficulties also reported higher taste and smell symptom scores, supporting the association between dysphagia and chemosensory changes. **Conclusion:** The Tamil version of the TSQ is a reliable and valid instrument for assessing taste and smell dysfunction in HNC patients.

Keywords: Head and Neck Cancer- Chemoradiotherapy- Taste and Smell Dysfunction- Tamil Questionnaire

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Introduction

Sensory dysfunction, encompassing alterations in taste (dysgeusia) and smell (anosmia or hyposmia), is a prevalent but often under-recognized consequence of cancer and its treatment, particularly in patients with Head and Neck Cancer (HNC). These changes may arise due to direct tumor involvement, damage to cranial nerves, infections, or as adverse effects of chemoradiation therapy (CRT) [1]. Changes in taste and smell could reduce appetite, impair nutritional intake, cause malnutrition, weight loss, and diminish the quality of living [2-8]. Moreover, these symptoms may also lead to psychological distress, social withdrawal, and even poorer treatment adherence, thereby impacting cancer outcomes [3, 9].

Taste disorders are prevalent among cancer patients [10], manifesting as taste loss (ageusia), altered taste perception (dysgeusia), or heightened sensitivity (hypergeusia). In patients receiving CRT for HNC, taste and smell changes are reported by 60% to 95% of individuals [11-13]. In low-resource settings, where nutritional support and psychosocial care may be limited, these chemosensory and radiation-induced symptoms are particularly concerning. Early identification of taste and smell changes is essential for initiating timely dietary and supportive interventions to reduce symptom burden and improve treatment tolerability [14].

Taste can be assessed both subjectively and objectively. Objective methods are effective in evaluating the physiology of taste–smell changes and in measuring

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taste and smell acuity. Self-reported questionnaires provide a feasible alternative, capture the patient's subjective experience and its functional impact, and serve as better predictors of changes in dietary behavior. Several tools have been developed internationally to assess self-perceived sensory changes, including the Chemosensory and Chemotherapy-Induced Taste Alteration Scale (CiTAS) [15], the Questionnaire for the Assessment of Subjective Chemosensory Complaints (QASSC, 34 items) [16], and the Taste and Smell Tool for Evaluation (TASTE) Questionnaire [17].

Among them, the Taste and Smell Questionnaire developed by Leyrer et al. [18] stands out for its balanced focus on both taste and smell domains and its applicability to cancer populations. The taste and smell questionnaire (TSQ) evaluated the participants' self-perceived taste and smell disturbances due to cancer, and this tool was validated in 22 participants with gliomas who reported changes in both taste and smell during RT. This TSQ is a self-reported questionnaire and consists of nine questions related to taste and five in the smell domain. Taste domains specifically assess the perception of sweet, salty, sour, and bitter tastes. Compared to other taste and smell questionnaires, the TSQ questionnaire stands out by giving equal priority to both domains, taste and smell.

The use of TSQ facilitates early detection of sensory dysfunction, supports timely nutritional interventions, minimizes their adverse effects and rehabilitative interventions, and improves patient-provider communication. It is important to evaluate changes using a tool specifically designed for the specific language to ensure accuracy and relevance to the intended population. Existing tools are not culturally or linguistically appropriate for Tamil-speaking individuals in South India. Cross-cultural adaptation and validation of symptom assessment tools are essential for accurate evaluation and patient-centered care in the HNC population. This study aims to translate, culturally adapt, and psychometrically validate the TSQ for Tamil-speaking HNC patients undergoing CRT. By developing a linguistically and contextually appropriate tool, this study seeks to enhance early symptom monitoring, guide supportive interventions, and improve quality of life outcomes for cancer patients in South India.

Materials and Methods

Study design

This cross-sectional study was conducted from May 2023 to May 2024 at Sri Ramachandra Medical Centre and Hospital, Chennai, India. The study comprised two phases: (i) cross-cultural adaptation and translation of the Taste and Smell Questionnaire (TSQ) into Tamil and (ii) psychometric validation of the Tamil TSQ (TSQ-T) among individuals with HNC undergoing CRT and healthy controls. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was collected from all participants.

Phase I: Translation and cultural adaptation of Taste and Smell Questionnaire (TSQ-T) in Tamil

The TSQ was translated into Tamil by the World Health Organization (WHO) guidelines (2001) for instrument translation and adaptation. The translation process consisted of the following steps:

Forward Translation and Backward Translation

Three independent bilingual translators, two of whom were skilled Speech Language Pathologists (SLPs) with practice in dysphagia rehabilitation and one Tamil literature specialist, translated the TSQ from English into Tamil. They were all equally proficient with both languages and cultures. The panel cross-checked and settled on any ambiguous expressions or meanings, compiling the versions into a single translation. Another bilingual translator, unaware of the original, translated the Tamil version back to English. Inconsistencies or poor phrasing in existing or past versions were then found and settled.

Expert opinion

Five speech-language pathologists (SLPs), each with a minimum of three years of experience managing patients with HNC, reviewed the bilingual version of the questionnaire. The forward-translated, back-translated, and reconciled versions were systematically compared with the original instrument. Experts rated each item for adequacy, clarity, coherence, and relevance on a 4-point scale, where 1 indicated "no change needed" and 4 indicated "major change needed."

Item-level content validity (I-CVI) values were calculated by dividing the number of experts who rated an item as 3 or 4 (indicating adequacy) by the total number of experts. The scale-level CVI (S-CVI/Ave) was computed as the average of the I-CVI values across all items, while the universal agreement method (S-CVI/UA) reflected the proportion of items with an I-CVI of 1.00. The CVI results for each item are presented in Table 1. Based on expert feedback, selected words and phrases were revised to improve clarity and accessibility for patients with varying literacy levels. For instance, the original phrase ("The taste of food is different from before") was simplified to ("The taste has changed when eating"), thereby reducing linguistic complexity and enhancing comprehension.

Pilot Study

The preliminary Tamil TSQ was pilot-tested on five HNC patients undergoing CRT and five age-matched healthy individuals. The primary purpose of this pilot testing was to refine item wording, assess clarity, and evaluate the structure of the questionnaire. All participants completed the questionnaire in a face-to-face interview format, with researchers providing clarification where needed. Written and verbal feedback was obtained regarding item clarity and comprehension. Both written and verbal feedback were obtained based on item clarity, comprehension, and ease of response. All participants reported that the final wording was understandable, culturally appropriate, and easy to complete, supporting the face validity of the Tamil TSQ.

Table 1. Content Validity Index of the Taste and Smell questionnaire Tamil

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert in agreement	I-CVI	UA
Item								
I noticed a change in my sense of taste while eating.	1	1	1	1	1	5	1	1
The taste of food is different from what it used to be.	1	1	1	1	1	5	1	1
There is a persistent bad taste in the mouth.	1	1	1	1	1	5	1	1
It seems like my sense of taste is changing after taking medication.	1	1	1	1	1	5	1	1
This is how I would rate my extraordinary sense of taste	1	1	1	1	1	5	1	1
I experience an unusual sensitivity when I taste salt.	1	1	1	1	1	5	1	1
I experience an unusual sensitivity when I taste sweets.	1	1	1	1	1	5	1	1
I experience unusual sensitivity when tasting sour	1	1	1	1	1	5	1	1
I experience unusual sensitivity when tasting bitter	1	1	1	1	1	5	1	1
I experience changes in my sense of smell A food smells	1	1	1	1	1	5	1	1
differently than it used to smell	1	1	1	1	1	5	1	1
Certain medications seem to change my sense of smell	1	1	1	1	1	5	1	1
This is how I would rate my unusual sense of smell	1	1	1	1	1	5	1	1
I experience unusual smells of any kind	1	1	1	1	1	5	1	1
						S-CVI/Ave	1	
Proportion relevance	1	1	1	1	1	S-CVI/UA		1

Note: Items were rated for adequacy, clarity, coherence, and relevance on a 4-point scale (1 = no change needed, 4 = major change needed), I-CVI, Item-level Content Validity Index; calculated as the number of experts rating an item 3 or 4 divided by the total number of experts. S-CVI/Ave, Scale-level Content Validity Index (average of all I-CVI values); S-CVI/UA, Scale-level Content Validity Index using the universal agreement method (proportion of items with I-CVI = 1.00); UA, Universal agreement; A value of 1.00 indicates perfect agreement among experts.

Cognitive Debriefing

Cognitive interviews were conducted with five HNC patients to assess item clarity and interpretability. Participants were encouraged to verbalize thoughts and supply feedback on clarity. Based on participant feedback, items 2, 4, and 5 were linguistically simplified; structural revisions were made to items 3, 6, and 7 to enhance clarity. The final Tamil TSQ (TSQ-T) incorporated all expert and patient feedback and was prepared for validation in Phase II.

Phase II: Psychometric Validation of the Tamil TSQ (TSQ-T)

Sample size determination

Purposive sampling, a non-probability method, was utilized for participant recruitment. A priori power analysis revealed that a two-sided comparison of total scores on the Taste and Smell Questionnaire (TSQ) between patients and controls, with a moderate effect size ($d = 0.50$), $\alpha = .05$, and power $(1 - \beta) = .80$, necessitated a minimum of 63 participants in each group. The target sample size was established at 75 participants per group to account for an expected 15% attrition rate. A total of 264 individuals with HNC who had undergone CRT were recruited, along with 75 healthy controls. The control group met the predetermined target, whereas the HNC group was purposefully included to improve representativeness across clinical subgroups categorized by time since CRT (<3 months, 4–6 months, 7–12 months, >12 months) and to augment the precision of psychometric analyses, encompassing reliability and validity assessments. The actual sample achieved over 95% power to identify the intended effect size, surpassing the initial criteria and facilitating both primary comparisons and exploratory

subgroup analyses.

Participants

A total of 339 Tamil-speaking adults were enrolled: 264 individuals with HNC who had completed CRT and 75 healthy controls aged 18–80 years. In the HNC group, 195 participants (74%) were male and 69 (26%) were female, whereas in the healthy control group, 29 participants (39%) were male and 46 (61%) were female (Table 2). Participants with HNC were stratified based on time since completion of the CRT: Group 1 (<3 months, n=125), Group 2 (4–6 months, n=100), Group 3 (7–12 months, n=25), and Group 4 (>12 months, n=14).

Inclusion and exclusion criteria

The HNC group included individuals diagnosed with HNC malignancies without any coexisting or prior malignancy in the head and neck region. Participants were required to be in their first year of post-CRT follow-up. Those with a history of taste-related complaints within the past six months, surgical resection involving a total or partial tongue, or the removal of major salivary glands were excluded. Additionally, individuals with a known history of oral or nasal infections, neurological disorders, acute respiratory illnesses, gastroesophageal reflux, eating disorders, middle ear diseases, or renal disease, or those on medications known to impair taste function, were excluded.

The healthy group comprised individuals with normal or corrected thyroid, kidney, and metabolic function, as well as adequate cognitive ability to follow instructions. Verification was based on participants' self-reported medical history. Participants with no prior history of taste or smell changes before the commencement of CRT were included. Exclusion criteria for this group encompassed individuals who were bedridden due to terminal illnesses or mental health disturbances, those with severe nasal congestion, those receiving enteral or parenteral nutritional support, and individuals with dental diseases or dementia, including Alzheimer's or vascular dementia, or changes in taste or smell within the last six months.

Measures and Stimuli

The current study included both clinician-rated and self-report scales

Taste and Smell Questionnaire-Tamil (TSQ-T) is the Tamil-translated and culturally adapted version of the original Taste and Smell Questionnaire developed by Leyrer et al. [18]. The questionnaire is divided into two parts: taste (9 items) and smell (5 items), for a total of 14 questions. In the taste section, 4 items are yes/no questions (scored 0 for "no problem" and 1 for "problem present"), and 5 items are severity questions (scored 0 for "no problem," 1 for "mild," and 2 for "moderate to severe"). In the smell section, 1 item is a yes/no question, and 4 items are severity questions scored in the same manner. The total score ranges from 0 to 14 for taste and 0 to 9 for smell, with higher scores indicating greater dysfunction.

The University of Washington Quality of Life Questionnaire Tamil Version (UW-QOL v4.1)

The UW-QOL v4.1 is a self-reported tool in Tamil that assesses the impact of HNC on life quality, with scores ranging from 0 to 100. The taste domain was used for convergent validity [19, 20].

Eating Assessment Tool-10 (EAT-10-Tamil)

A self-reported inventory [21, 22] measuring swallowing-specific symptoms scored from 0 (no problem) to 40 (severe problem).

Subjective Total Taste Acuity (STTA)

A clinician-rated scale assessing taste loss severity, graded from 0 (normal taste) to 4 (complete taste loss), was used for external validation of TSQ-T scores [4].

Data Collection Procedure

Participants completed a demographic and clinical stimulus form, followed by administration of the TSQ-T, UW-QOL V4.1 (Tamil), and EAT-10 (Tamil). Clinical information, including cancer type, stage, treatment modality, RT dose, and anatomical site, was collected for the HNC group. STTA was scored by the attending clinician. Clear Tamil instructions were provided, with assistance as needed. Questionnaires were self-administered or interviewer-assisted, based on

Table 2. Characteristics of the Participants in the HNC Group and the Healthy Groups.

Variables		HNC group	Healthy group
N		264	75
Sex [n (%)]			
Male		195 (74%)	29 (39%)
Female		69 (27%)	46 (61%)
Age [n]			
18-40		29	41
41-60		140	18
61 and above		95	16
Site of the lesion [n (%)]			
Tongue		72 (27%)	
Mouth		166 (63%)	
Pharynx		12 (5%)	
Larynx		9 (3%)	
Others		5 (2%)	
TNM Classification (n)			
T1-T2 / T3-T4	T	127/ 137	
N0-N2/ N3-N4	N	222/ 42	
Tumour stage (n)			
Stage I/II/III/IV		22/41/71/130	
Cancer treatment [n (%)]			
CRT/ RT		177 (67%)	
Surgery + CRT /RT		87 (33%)	

Note: N, number of participants; Percentages (%) are calculated within each group; TNM, Tumor–Node–Metastasis classification; CRT, Chemoradiotherapy; RT, Radiotherapy; Tumor stage is based on TNM classification (Stage I–IV).

participant preference and literacy level. Family members were allowed to assist participants with cognitive or visual limitations. Completion time was approximately 10–15 minutes.

Statistical analysis

Data were analyzed using IBM SPSS (Statistics SPSS version 23.0; IBM Corp., Armonk, NY, USA). For group comparisons, the Mann–Whitney U test was used when comparing two groups, and the Kruskal–Wallis test was applied for comparisons across more than two groups. Correlation analyses were performed using Spearman's rho. Internal consistency was assessed using Cronbach's alpha.

Results

Reliability

Internal Consistency

The Tamil version of TSQ demonstrated excellent internal consistency. Cronbach's alpha for the total TSQ-T (14 items) was α = .98. Subscale analyses also revealed high reliability for both the taste domain (9 items, α = .98) and the smell domain (5 items, α = .98), indicating that all components of the questionnaire consistently measured the underlying constructs.

Validity

Known-Groups Validity: Comparison of TSQ-T scores among the healthy and HNC groups

The Mann–Whitney U test was used to compare TSQ-T scores between the healthy and HNC groups. The HNC group scored a mean score of 3.38 (SD = 4.94) on taste domains, compared to 0.40 (SD = 2.57) for the healthy group, and the differences were statistically significant (U = 6436.50, p < 0.001). Similarly, there was a considerable difference (U = 7531.00, p < 0.001) in the mean score for smell changes between the HNC group and the healthy group, with the HNC group scoring 1.19 (SD = 2.24) and 0.03 (SD = 0.23), respectively. HNC groups scored higher in taste, smell, and total scores (mean rank = 183.12, 178.97, 183.40) than healthy groups (mean rank = 123.82, 138.41, 122.83) (Table 3).

Table 3. Comparing Changes in Smell and Taste Using TSQ-T between the HNC Group and the Healthy Groups

TSQ-T domains	Group	N	Mean ±SD	Mean Rank	Sig
Taste	Clinical	264	3.38 ± 4.94	183.12	<0.001
	Healthy	75	0.40 ± 2.57	123.82	
Smell	Clinical	264	1.19 ± 2.24	178.97	<0.001
	Healthy	75	0.03 ± 0.23	138.41	
Total	Clinical	264	4.56 ± 6.70	183.4	<0.001
	Healthy	75	0.07 ± 4.74	122.83	

Note: TSQ-T, Taste and Smell Questionnaire–Tamil; N, sample size; SD, standard deviation; U, Mann–Whitney U statistic; Sig, significance level, p <0 .05 **p <0.001

Comparison of TSQ-T scores within the HNC group

Temporal variability post-treatment comparison

The Kruskal-Wallis test was used to compare TSQ-T scores across different post-CRT periods. TSQ-T scores varied significantly across different post-CRT periods (Table 4). Patients within the first three months post-CRT exhibited the highest mean scores for taste (6.46 ± 5.33) and smell (2.27 ± 2.73) abnormalities. Subsequent periods showed a gradual reduction in these scores, with statistical significance confirmed through chi-square analyses (taste: $\chi^2 = 99.242$, $p < 0.001$; smell: $\chi^2 = 60.445$, $p < 0.001$).

Site-specific comparison

The Mann–Whitney U test was used to compare TSQ-T scores across different tumor sites. Analysis revealed that patients with tongue cancer reported the most severe taste (3.96 ± 5.10) and smell (1.57 ± 2.59) alterations, while those with laryngeal cancer reported the least severe impairments (taste: 1.13 ± 3.18; smell: 0.25 ± 0.71). These differences underscore the impact of tumor location on sensory dysfunction (Table 5).

Table 4. Comparing TSQ-T Scores among HNC Groups (Subgroup based on Treatment Period)

TSQ	-T Treatment Period	N	Mean TSQ-T ± SD	w	Mean Rank	Sig
Taste	0-3 months	125	6.46 ± 5.33	0.83*	96.82	<0.001
	4-6 months	100	78 ± 2.49	0.34*	91.26	
	7-12 months	25	24 ± 88.	0.31*	84	
	12 and above	14	00 ± 00	--	161.44	
Smell	0-3 months	125	2.27 ± 2.73	0.72*	109.2	<0.001
	4-6 months	100	29 ± 1.09	0.28*	99.5	
	7-12 months	25	00 ± 00	--	99.5	
	12 and above	14	00 ± 00	--	175.58	
Total	0-3 months	125	8.72 ± 7.24	0.87*	96.19	<0.001
	4-6 months	100	1.08 ± 3.40	0.35*	90.08	
	7-12 months	25	24 ± 88	0.31*	83	
	12 and above	14	00 ± 00	--		

Note: TSQ-T, Taste and Smell Questionnaire–Tamil; N, sample size; SD, standard deviation; Mean Rank, average rank score, χ^2, Kruskal–Wallis chi-square statistic; Sig, significance level; Test, Kruskal–Wallis H test; degrees of freedom (df) = 3, *p < 0.05; **p < 0.01; ***p < 0.001.

Table 5. Comparing Taste and Smell Abnormalities among HNC Groups based on the Site of Cancer

TSQ-T	Site of cancer	Clinical HNC group			
		Mean TSQ-T ± SD	W	Mean Rank	Sig
Taste	Tongue	3.96 ± 5.10	0.71*	139.45	0.55
	Mouth	3.27 ± 4.98	0.68*	130.21	
	Pharynx	3.33 ± 4.91	0.73*	134.75	
	Larynx	1.13 ± 3.18	0.42*	99.81	
	Others	3.00 ± 4.24	0.77*	129	
Smell	Tongue	1.57 ± 1.57	0.62*	141.74	0.42
	Mouth	1.12 ± 2.16	0.55*	129.84	
	Pharynx	0.58 ± 1.51	0.47*	119.13	
	Larynx	0.25 ± 0.71	0.42*	112.19	
	Others	1.00 ± 2.24	0.55*	126.2	
Total	Tongue	5.39 ± 7.13	0.73*	139.45	0.53
	Mouth	4.45 ± 6.71	0.69*	130.58	
	Pharynx	3.92 ± 5.55	0.71*	130.54	
	Larynx	1.38 ± 3.89	0.42*	97.5	
	Others	4.00 ± 6.16	0.76*	130.5	

Note: TSQ-T, Taste and Smell Questionnaire–Tamil; SD, standard deviation; W, sum of ranks; Mean Rank, average rank score, Test, Kruskal–Wallis H test; df, 4, *p < 0.05; **p < 0.01; ***p < 0.001.

Table 6. Comparing Taste and Smell Abnormalities among Clinical Groups based on UW QOL (v4.1) Taste Scores

TSQ-T	UW QOL V4.1	Clinical HNC group			
	(Taste)	Mean TSQ-T±SD	W	Mean Rank	Sig
Taste	0	9.78 ± 3.35	0.75*	220.19	0.001*
	30	8.67 ± 4.02	0.84*	207.11	
	70	0.31 ± 1.19	0.30*	91.89	
	100	0.18 ± 1.24	0.13*	87.34	
Smell	0	4.37 ± 2.15	0.69*	218.29	0.000*
	30	1.26 ± 2.36	0.60*	140.91	
	70	0.06 ± 0.48	0.10*	101.07	
	100	0.00 ± 0.00	--	99.5	
Total	0	14.41 ± 3.98	0.77*	227.76	0.000*
	30	9.15 ± 5.00	0.90*	191.54	
	70	0.41 ± 1.35	0.35*	92.11	
	100	0.19 ± 1.25	0.14*	86.65	

Notes: TSQ-T, Taste and Smell Questionnaire–Tamil; UW-QOL, University of Washington Quality of Life Questionnaire, Version 4.1, SD, standard deviation; W, sum of ranks; Mean Rank, average rank score, χ^2, Kruskal–Wallis chi-square statistic; Test, Kruskal–Wallis H test; df, 3. Post-hoc pairwise comparisons were performed using Dunn–Bonferroni analysis, *p < 0.05; **p < 0.01; ***p < 0.001

Treatment Modality Comparison

The Mann–Whitney U test was applied to compare TSQ-T scores between patients treated with chemoradiotherapy (CRT/RT) alone and those who underwent surgery combined with CRT/RT. No significant differences were observed between the groups, indicating that treatment modality did not substantially affect the severity of taste and smell alterations. Patients in the CRT/RT group reported mean scores of 3.41 ± 4.76 for taste and 1.22 ± 2.29 for smell, while those in the surgery + CRT/RT group reported scores of 3.30 ± 5.32 and 1.12 ± 2.15, respectively, reflecting minimal variation. Combined taste and smell scores also remained consistent across groups (CRT/RT: 4.56 ± 6.52; surgery + CRT/RT: 4.56 ± 7.08), further supporting that both treatment modalities resulted in comparable levels of taste and smell alterations.

TSQ-T associations with swallowing function

Spearman's correlation was used to examine the relationship between TSQ-T scores and the Eating Assessment Tool-10 Tamil (EAT-10) scores. A significant positive correlation was observed between TSQ-T scores and the Eating Assessment Tool-10 Tamil (EAT-10). Patients with higher EAT-10 scores (>3) reported more severe taste (3.97 ± 5.19) and smell (1.49 ± 2.43) disturbances compared to those with lower EAT-10 scores (<3) (taste: 1.21 ± 3.09; smell: 0.07 ± 0.53), indicating

that sensory dysfunction may exacerbate swallowing difficulties.

TSQ-T associations with clinician-rated measure

Subjective Taste and Smell Abnormalities (STTA) grades correlated with TSQ-T scores, with higher STTA grades associated with more severe sensory dysfunction. Spearman's correlation was also applied to assess the association between STTA grades and TSQ-T scores. Patients with STTA grade 0 reported minimal changes (TSQ-T score of 0.09 ± 0.87), while those with grade 2 reported the most severe impairments (TSQ-T score of 12.85 ± 4.01), supporting the construct validity of the TSQ-T.

TSQ-T associations with Quality of Life Measure

The TSQ-T demonstrated significant inverse relationships with the taste and smell domains of the University of Washington Quality of Life (UW-QOL) V4.1 scale. Spearman's rho correlation was used to compare TSQ-T scores across categories of the UW-QOL V4.1 taste and smell domain scores. Patients reporting complete taste loss (UW-QOL V4.1 score: 0) had the highest TSQ-T scores (9.78 ± 3.35), while those with normal taste (UW-QOL score: 100) had the lowest TSQ-T scores (0.00), indicating that sensory dysfunction negatively impacts quality of life (Table 6). Post-hoc Dunn-Bonferroni analysis with corrections revealed that patients with a UW-QOL v4.1 taste score of 0, indicating complete taste loss, had the highest TSQ-T scores, while those with better UW-QOL v4.1 scores (30, 70, 100) showed progressively lower TSQ-T scores, suggesting milder sensory disruption. A similar trend was observed for smell, emphasizing the role of sensory deficits in affecting daily functioning.

Discussion

This study highlights the development and validation of a culturally and linguistically adapted Tamil version of the TSQ for assessing self-perceived taste and smell changes in HNC patients post-CRT. The TSQ-T tool demonstrated excellent internal consistency ($\alpha = 0.98$) across taste and smell subdomains and established strong content validity through a rigorous translation process tailored to the Tamil-speaking population. These findings underscore the robust psychometric properties of the adapted TSQ-T, consistent with previous validation studies of sensory questionnaires [23]. The high internal consistency suggests that the items cohesively measure self-perceived taste and smell functions, affirming the reliability of the Tamil TSQ as a screening and evaluation tool in HNC populations.

Significant differences in TSQ-T scores between the healthy control group and the HNC group confirmed strong known-group validity. These differences validate the TSQ-T's sensitivity in distinguishing between populations with and without taste and smell dysfunction. Findings are consistent with literature documenting sensory damage in HNC patients post-CRT due to injury to taste buds and olfactory epithelium [24]. Chemoradiotherapy causes mucosal injury and neuropathy of cranial nerves involved in chemosensory processing, damage to taste buds, along with reduced saliva production, which could lead to diminished taste perception [23-26].

Taste and smell abnormalities in HNC patients were most severe within the first three months post-CRT, with a gradual decline over time, indicating partial sensory recovery [27-29]. Maes et al. [29] noted peak taste loss at two months, highlighting individual variability in recovery timelines [30]. The persistence of altered scores in later periods suggests that for some individuals, sensory recovery may be incomplete or delayed, which emphasizes the necessity of long-term sensory monitoring. Also, the variations in recovery patterns emphasize the complexity of taste alterations and the influence of radiation therapy on sensory recovery. Additionally, taste and smell changes varied by cancer site, with tongue cancer patients showing the most severe impairments compared to laryngeal cancer patients, who had the least significant disturbances. This suggests that the location of the cancer influences the extent of sensory dysfunction, likely due to the proximity of the cancer site to sensory organs involved in taste and smell [30].

The stages of HNC significantly influence taste and smell disturbances, with the advanced stages requiring more aggressive treatments, like higher doses of radiotherapy and extensive surgeries, leading to severe sensory deficits. Early-stage patients might experience milder disturbances due to less intensive treatments [31]. Chemotherapy causes transient taste changes due to systemic cytotoxic effects on taste receptor cells, with quicker recovery post-treatment [23]. In contrast, radiotherapy leads to more persistent taste dysfunction by directly damaging taste buds and salivary glands, especially when the oral cavity is irradiated [26].

The study also aimed to investigate the self-perceived impact of taste and smell changes on swallowing-related quality of life in individuals with HNC treated with CRT by comparing sensory abnormalities with swallowing symptoms. Patients with higher EAT-10 scores, indicative of more severe swallowing difficulties, reported significantly greater taste and smell impairments, suggesting that sensory impairments may worsen the severity of swallowing difficulty [32]. While comparing clinician- and patient-reported measures, the findings from STTA and UW-QOL v4.1 highlight the significant association between sensory impairments and reduced quality of life in HNC patients, with higher STTA grades correlating with more severe taste and smell abnormalities and lower UW-QOL v4.1 scores. Post-hoc Dunn-Bonferroni analysis revealed that patients with a UW-QOL v4.1 taste score of 0, indicating complete taste loss, had the highest TSQ-T scores, while those with better UW-QOL v4.1 scores (30, 70, 100) showed progressively lower TSQ-T scores, suggesting milder sensory disruption. A similar trend was observed for smell, emphasizing the role of sensory deficits in affecting daily functioning. These results underline the clinical relevance of monitoring taste and smell changes post-treatment and the need for individualized care strategies to manage their impact on swallowing [23, 33].

Limitations and future research

This study has several limitations. Reliance on self-report may have introduced recall bias and subjective variability. The cross-sectional design limits causal inferences between treatment variables and sensory dysfunction. Objective assessments of taste and smell were not included, restricting opportunities for concurrent validation. Future studies should incorporate longitudinal designs, larger and more diverse samples, and objective sensory assessments to enhance reproducibility and provide complementary validation. Further work should also examine test–retest reliability and apply factor-analytic approaches to confirm the dimensionality of the Tamil TSQ.

In conclusion, the current study demonstrates the clinical importance of assessing taste and smell alterations in Tamil-speaking head and neck cancer patients undergoing chemoradiotherapy. The validated Tamil version of the TSQ emerges as a culturally sensitive, reliable tool that enables early identification of sensory dysfunction, guides timely interventions to improve nutrition, reduces treatment-related complications, and enhances quality of life.

Author Contribution Statement

Conceptualization: Jasmine Lydia Selvaraj, Divya Sivagnanapandian; Data curation: Riya T Nikkesh; Writing-Original Draft: Riya T Nikkesh, Violet Priscilla S; Writing-Review & editing: Jasmine Lydia Selvaraj, Divya Sivagnanapandian.

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Approval

Institutional Ethics Committee Approval Obtained

Ethical Declaration

Institutional Ethics Committee Approval Obtained

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest

The Authors declare that they do not have a conflict of interest

References

1. Wrobel BB, Leopold DA. Olfactory and sensory attributes of the nose. Otolaryngol Clin North Am. 2005;38(6):1163–70. https://doi.org/10.1016/j.otc.2005.07.006
2. Comeau TB, Epstein JB, Migas C. Taste and smell dysfunction in patients receiving chemotherapy: a review of current knowledge. Supportive Care in Cancer. 2001;9(8):575–80. https://doi.org/10.1007/s005200100279
3. Wismer WV. Assessing alterations in taste and their impact on cancer care. Curr Opin Support Palliat Care. 2008;2(4):282–7. https://doi.org/10.1097/SPC.0b013e32831a6eb3
4. Epstein JB, Barasch A. Taste disorders in cancer patients: Pathogenesis and approach to assessment and management. Oral Oncol. 2010;46(2):77–81. https://doi.org/10.1016/j.oraloncology.2009.11.008
5. McLaughlin L, Mahon SM. Understanding taste dysfunction in patients with cancer. Clin J Oncol Nurs. 2012;16(2):171-8. https://doi.org/10.1188/12.Cjon.171-178.
6. Baharvand M, ShoalehSaadi N, Barakian R, Jalali Moghaddam E. Taste alteration and impact on quality of life after head and neck radiotherapy. J Oral Pathol Med. 2012;42(1):106–12. https://doi.org/10.1111/j.1600-0714.2012.01200.x
7. Barbosa L, Anzolin LK, Nicacio SP, Doty RL, de F, Voegels RL, et al. High prevalence of olfactory dysfunction detected in treatment-naive patients with head and neck cancer. Acta Oto-Laryngologica. 2023;143(2):201–4. https://doi.org/10.1080/00016489.2023.2181984
8. adav N, Mittal S, Reddy P, Parihar A, Agrawal S, Mandlik R, et al. A subjective assessment of chemotherapy drug-induced taste and smell alteration in non-head and neck cancer patients: A questionnaire-based cross-sectional study. Cureus. 2024;16(4):e57787. https://doi.org/10.7759/cureus.57787
9. Tristin Dawne Brisbois, Joanne Louise Hutton, Baracos VE, Wismer WV. Taste and Smell Abnormalities as an Independent Cause of Food Intake Failure in Patients with Advanced Cancer—An Argument for the Application of Sensory Science. J Palliat Care. 2006;22(2):111–4. https://doi.org/10.1177/082585970602200208
10. Buttiron Webber T, Briata IM, DeCensi A, Cevasco I, Paleari L. Taste and Smell Disorders in Cancer Treatment: Results from an Integrative Rapid Systematic Review. Int J Mol Sci. 2023;24(3):2538. https://doi.org/10.3390/ijms24032538
11. Irune E, Dwivedi RC, Nutting CM, Harrington KJ. Treatment-related dysgeusia in head and neck cancer patients. Cancer Treatment Reviews. 2014;40(9):1106–17. https://doi.org/10.1016/j.ctrv.2014.06.011
12. Álvarez-Camacho M, Gonella S, Campbell S, Scrimger RA, Wismer WV. A systematic review of smell alterations after radiotherapy for head and neck cancer. Cancer Treatment Reviews. 2017;54:110–21. https://doi.org/10.1016/j.ctrv.2017.02.003
13. Suresh VP, Selvaraj JL, Divya S, Nikesh RT. Taste and Smell Alterations and their Impact on Swallowing, Oral Intake, and Quality of Life in Head and Neck Cancer Patients. Indian J Otolaryngol Head Neck Surg. 2025. https://doi.org/10.1007/s12070-025-05858-x
14. Mainland JD, Barlow LA, Munger SD, Millar SE, Vergara MN, Jiang P, et al. Identifying Treatments for Taste and Smell Disorders: Gaps and Opportunities. Chemical Senses. 2020;45(7):493–502. https://doi.org/10.1093/chemse/bjaa038
15. Kano T, Kanda K. Development and validation of a chemotherapy-induced taste alteration scale. Oncol Nurs Forum. 2013;40(2):E79-85. https://doi.org/10.1188/13.Onf.E79-e85
16. Amézaga J, Alfaro B, Ríos Y, Larraioz A, Ugartemendia G, Urruticoechea A, et al. Assessing taste and smell alterations in cancer patients undergoing chemotherapy according to treatment. Supportive Care in Cancer. 2018 May 31;26(12):4077–86. https://doi.org/10.1007/s00520-

018-4277-z
17. Niklassen AS, Christensen KB, Fjaeldstad AW, Ovesen T. Development and psychometric validation of the taste and smell tool for evaluation (taste) questionnaire. JAMA Otolaryngol Head Neck Surg. 2022;148(12):1164-72. https://doi.org/10.1001/jamaoto.2022.3392.
18. C. Marc Leyrer, Chan MD, Peiffer AM, Horne E, Harmon M, Carter A, et al. Taste and smell disturbances after brain irradiation: A dose–volume histogram analysis of a prospective observational study. Pract Radiat Oncol. 2014;4(2):130–5. https://doi.org/10.1016/j.prro.2013.06.003
19. Lowe D, Rogers SN. University of Washington quality of life questionnaire (UW-QOL v4). Head and Neck Cancer Support. 2012.
20. Ganesan S, Thulasingam M, Gunaseelan K, Kalaiarasi R, Penumadu P, Ravichandran S, et al. Validity and Reliability of Tamil-translated University of Washington Quality of Life Questionnaire for Head and Neck Cancers. Asian Pac J Cancer Prev. 2019;20(12):3649–54. https://doi.org/10.31557/APJCP.2019.20.12.3649
21. Belafsky PC, Mouadeb DA, Rees CJ, Pryor JC, Postma GN, Allen J, et al. Validity and Reliability of the Eating Assessment Tool (EAT-10). Ann Otol Rhinol Laryngol. 2008;117(12):919–24. https://doi.org/10.1177/000348940811701210
22. Selvaraj JL, Venkatesh L, Vasudharany Varadharajan, Chandrasekar K, Satish Srinivas Kondavetti, John C. Development and Evaluation of the Psychometric Properties of the Tamil Version of Eating Assessment Tool − 10 (EAT-10): Preliminary Findings from Persons with Head and Neck Cancer. Indian J Otolaryngol Head Neck Surg. 2022;75(2):632–40. https://doi.org/10.1007/s12070-022-03376-8
23. Epstein JB, Smutzer G, Doty RL. Understanding the impact of taste changes in oncology care. Support Care Cancer. 2016;24(4):1917–31. https://doi.org/10.1007/s00520-016-3083-8
24. Mirza N, Machtay M, Devine PA, Troxel A, Abboud SK, Doty RL. Gustatory Impairment in Patients Undergoing Head and Neck Irradiation. Laryngoscope. 2008;118(1):24–31. https://doi.org/10.1097/MLG.0b013e318155a276
25. Nelson GM. Biology of taste buds and the clinical problem of taste loss. Anat Rec. 1998;253(3):70-8. https://doi.org/10.1002/(SICI)1097-0185(199806)253:3<70::AID-AR3>3.0.CO;2-I
26. Yamashita H, Nakagawa K, Nakamura N, Abe K, Takahiro Asakage, Makoto Ohmoto, et al. Relation between acute and late irradiation impairment of four basic tastes and irradiated tongue volume in patients with head-and-neck cancer. Int J Radiat Oncol Biol Phys. 2006;66(5):1422–9. https://doi.org/10.1016/j.ijrobp.2006.08.037
27. Martini S, Iorio GC, Arcadipane F, Olivero F, Silvetti P, Rampino M, et al. Prospective assessment of taste impairment and nausea during radiotherapy for head and neck cancer. Med Oncol. 2019;36(5). https://doi.org/10.1007/s12032-019-1269-x
28. Asif M, Moore A, Yarom N, Popovtzer A. The effect of radiotherapy on taste sensation in head and neck cancer patients – a prospective study. Radiat Oncol. 2020;15(1). https://doi.org/10.1186/s13014-020-01578-4
29. Maes AI, Huygh, Weltens C, Vandevelde G, Delaere P, Evers G, et al. De Gustibus: time scale of loss and recovery of tastes caused by radiotherapy. Radiother Oncol. 2002;63(2):195–201. https://doi.org/10.1016/S0167-8140(02)00025-7
30. Gunn L, Gilbert J, Nenclares P, Soliman H, Newbold K, Bhide S, et al. Taste dysfunction following radiotherapy to the head and neck: A systematic review. Radiother Oncol. 2021;157:130–40. https://doi.org/10.1016/j.radonc.2021.01.021
31. Jin S, Lu Q, Jin S, Zhang L, Cui H, Li H. Relationship between subjective taste alteration and weight loss in head and neck cancer patients treated with radiotherapy: A longitudinal study. Eur J Oncol Nurs. 2018;37:43–50. https://doi.org/10.1016/j.radonc.2021.01.021
32. Moritz Allner, Rak A, Balk M, Rupp R, Almajali O, Tamse H, et al. Patient-reported outcomes in head and neck cancer: a cross-sectional analysis of quality of life domains across early and advanced UICC stages. Support Care Cancer. 2025;33(4). https://doi.org/10.1007/s00520-025-09204-3
33. Riantiningtyas RR, Carrouel F, Amandine Bruyas, Wender L.P. Bredie, Kwiecien C, Agnès Giboreau, et al. Oral Somatosensory Alterations in Head and Neck Cancer Patients—An Overview of the Evidence and Causes. Cancers. 2023;15(3):718–8. https://doi.org/10.3390/cancers15030718