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Original Article

Development and validation of the symptom assessment scale for patients with nasopharyngeal cancer undergoing radiotherapy

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ABSTRACT

Objective: This study aims to develop the Symptom Assessment Scale for Patients with Nasopharyngeal Cancer Undergoing Radiotherapy (SAS-NPC), based on the Symptom Experience Model.
Methods: In Phase 1, a content analysis of the literature and group discussions were conducted to construct an initial pool of 61 items. Following expert review by 16 specialists and cognitive interviews with 10 patients, the pool was refined to 56 items. In Phase 2, a convenience sampling method was used to recruit 625 patients with nasopharyngeal cancer (NPC) undergoing radiotherapy, who assessed and explored the scale items. Phase 3 focused on evaluating the scale's reliability and validity.
Results: The SAS-NPC consists of 7 dimensions and 33 items. Reliability analysis revealed a Cronbach's α coefficient of 0.928 for the total scale, a split-half reliability of 0.790, and a retest reliability of 0.828. Validity analysis showed content validity indices for each item ranging from 0.833 to 1.000, with an overall content validity index of 0.970 for the scale. Exploratory factor analysis (EFA) identified 7 common factors, which accounted for 74.505% of the total variance. Confirmatory factor analysis (CFA) demonstrated good overall model fit.
Conclusions: The SAS-NPC comprehensively captures acute and long-term symptoms associated with patients with NPC undergoing radiotherapy. The scale exhibits strong reliability and validity, making it an ideal tool for assessing NPC symptom burden and facilitating clinical symptom management.

Introduction

Nasopharyngeal cancer (NPC) is a malignant tumor primarily occurring in the upper and lateral walls of the nasopharynx, classified as a subtype of head and neck cancers.[1] Although its incidence is relatively low, significant regional differences exist, with over 70% of new cases concentrated in East and Southeast Asia, and China alone accounting for more than 40% of global cases.[2] Due to its unique anatomical location and sensitivity to radiation, combined treatment with radiotherapy is the primary therapeutic approach for NPC.[3] Radical radiotherapy primarily targets the nasopharyngeal primary tumor, cervical positive lymph nodes, subclinical lesions, and prophylactic irradiation zones, with the conventional total radiation dose ranging from 68 to 76 Gy.[4] In recent years, advances in radiation technology have significantly increased the 5-year survival rate for NPC to over 80%.[5] However, along with improved survival rates, radiotherapy-related adverse reactions and long-term quality of life issues have become increasing clinical concerns.

The radiotherapy target areas of NPC involve several important organs in the head and neck (e.g., nasal cavity, parotid gland, brainstem, temporal lobe, and inner ear, etc.), which results in patients experiencing specific symptoms such as epistaxis, sinusitis, dry mouth, vision loss, and ear discomfort during the course of treatment. Research shows that the incidence of epistaxis in primary NPC is approximately 2.7%, while in recurrent NPC, it increases to about 28%, with severe nasal bleeding potentially leading to fatal consequences.[6] Despite improvements in dose distribution with intensity-modulated radiotherapy (IMRT), the incidence of dry mouth remains between 54% and 59%, heightening the risk of dental caries, dysphagia, and bacterial infections. Additionally, radiation-induced sinusitis affects up to 83% of patients with NPC one month post-treatment, primarily involving the ethmoid and maxillary sinuses.[7] Furthermore, the routine use of platinum-based chemotherapy in combination with radiotherapy results in significant ototoxic symptoms, with hearing impairment occurring in up to 88% of patients, severely impacting their daily activities and quality of life.[8] Due to the unique treatment methods and target areas

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in NPC, patients often experience symptoms that are not commonly seen in other head and neck cancers. These symptoms not only complicate treatment but also contribute to a decline in quality of life, reduced treatment adherence, and poorer long-term prognosis. Thus, there is an urgent need to develop a specific symptom assessment scale for patients with NPC undergoing radiotherapy to enable early identification of symptom changes and facilitate timely interventions.

The main specific symptom assessment scales currently in use are the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-HN35 (EORTC QLQ-HN35),[9] M. D. Anderson Symptom Inventory-head and neck module (MDASI-HN),[10] Functional Assessment of Cancer Therapy Nasopharyngeal Cancer Subscale (FACT-NP),[11] Quality of Life Scale of Nasopharyngeal Carcinoma Patients (QOL-NPC),[12] and Edmonton-33,[13] with detailed information provided in Table 1.

The QLQ-HN35,[9] FACT-NP,[11] and QOL-NPC[12] scales primarily assess patients' physical, psychological, and social functions, with a focus on evaluating quality of life rather than comprehensively capturing symptom experiences. While the MDASI-HN[10] and Edmonton-33[13] scales include common symptoms of head and neck cancer, they inadequately address specific symptoms experienced by patients with NPC following radiotherapy, such as ear discomfort (e.g., ear fullness, hearing loss), eye discomfort (e.g., double vision, blurred vision), and nasal symptoms (e.g., epistaxis, blocked noses).[14,15] Therefore, both have a broad scope of application but relatively weak targeting. Additionally, the MDASI-HN[10] and the EORTC QLQ-HN35[9] lack a comprehensive and systematic framework for symptom assessment item arrangement, making it more difficult for patients to recall the questionnaires as they are filled out. Moreover, the symptom descriptions in these scales are often broad. For example, pain symptom is usually assessed as a whole item, even though patients with NPC may experience pain from various sources, including gum pain, oral ulcer pain, persistent ear pain, and neck skin pain. Therefore, when developing a specific scale, symptoms should be described in detail to enable accurate self-reporting, which would provide a solid basis for targeted interventions. Existing assessment tools primarily focus on acute symptoms, with limited attention given to long-term complications. To address the limitations of current scales, a multidimensional, NPC-specific symptom assessment scale should be developed to increase clinical applicability and relevance.

With the optimization of medical resources, outpatient radiotherapy has become increasingly prevalent, resulting in more personalized treatment management for patients with NPC. This shift underscores the need for more comprehensive and accurate symptom assessment tools capable of capturing the dynamic changes in individual symptoms.[16] Therefore, there is a need to develop patient-specific symptom assessment scales for NPC radiotherapy that cover both acute and long-term complications that may occur during the peri-radiotherapy period, to help health care professionals identify symptomatic changes so that they can develop individualized intervention plans and support strategies.

Methods

Study design

This study employed an exploratory mixed methods design, integrating qualitative and quantitative research approaches to develop and validate the symptom assessment scale for patients with NPC undergoing radiotherapy. The scale consists of three phases: phase 1 is the qualitative study: generation and revision of scale items, phase 2 is the quantitative study: evaluation and exploration of the scale items, and phase 3 is the quantitative study: validity and reliability testing of the scale.[17]

Phase 1: generation and revision of scale items

Theoretical framework

This study develops the scale's framework based on the Symptom Experience Model,[18] which explains the relationships between factors

Table 1
Symptom assessment tools for patients with NPC.

	EORTC QLQ-HN35	MDASI-HN	FACT-NP	QOL-NPC	Edmonton-33
Author (year)	Sherman (2000)	Rosenthal (2007)	Tong (2009)	Su (2016)	Mendez (2020)
Target population	Patients with head and neck cancer	Patients with biopsy-proven head and neck cancer	Patients with NPC radiotherapy	Patients with NPC radiotherapy	Patients diagnosed with squamous cell carcinoma of the head and neck
Objective	Assess quality of life	Assess the occurrence and severity of symptoms and the disruption of daily life	Assess quality of life	Assess quality of life	Assess the main functional areas of concern
Dimensions	7 multi-items (senses; speech; social eating; social contact; sexuality; pain; swallowing); 11 single-items	Core MDASI items; Head and neck cancer-specific items; Symptomatic impact items	Physical well-being; social/family well-being; emotional well-being; functional well-being; additional concerns with NPC	Physical function; Psychological function; Social function; Side effects	Swallowing; Speech; Xerostomia; Chewing
Items	35	28	43	26	33

EORTC QLQ-HN35, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-HN35; MDASI-HN, M. D. Anderson Symptom Inventory-head and neck module; FACT-NP, Functional Assessment of Cancer Therapy Nasopharyngeal Cancer Subscale; QOL-NPC, Quality of Life Scale of Nasopharyngeal Carcinoma Patients.

influencing symptoms, symptom perception, and symptom outcomes. Central to this model is the concept of symptom perception, which underscores the need to assess symptoms in terms of four dimensions: frequency, intensity, distress, and meaning of symptoms. In line with this, the scale evaluates symptoms across these four dimensions: frequency, intensity, distress level, and impact. Considering the variability in symptom influences, maximum individual differentiation should be incorporated in the inclusion of symptoms so that important symptoms are not missed.

Literature review

A systematic literature search was conducted using the keywords "nasopharyngeal cancer" "symptom/adverse reaction/side effect/toxic reaction/discomfort" and "radiotherapy" The search included databases such as CNKI, WanFang, PubMed, Embase, and Web of Science. Relevant studies on symptom assessment in NPC were reviewed to provide an objective basis for constructing the item pool.

Expert consultation

Sixteen experts in relevant fields were invited to participate in a Delphi consultation.[19] Selection criteria included: (1) more than 10 years of experience in medical, nursing, teaching, or management related to head and neck tumors; (2) medical experts with senior titles; (3) clinical nursing experts or nursing managers with at least an associate chief nurse title; (4) oncology nursing educators with an associate professor title or higher; and (5) voluntary participation in the study. The positive coefficient of experts was assessed by the valid response rate and the frequency of suggestions, while the expert authority coefficient was determined based on their judgment and familiarity with the topic. The expert opinion coordination coefficient was evaluated using the coefficient of variation and Kendall's W coefficient. Items retained for the scale had to meet the criteria of a mean importance rating ≥ 3.50 and a coefficient of variation ≤ 0.25.[19]

Cognitive interviews

Ten patients with NPC undergoing radiotherapy at a tertiary hospital's head and neck radiotherapy department in Zhejiang Province were selected for cognitive interviews to assess the scale's comprehensibility. The purpose of these interviews is to understand the cognitive processes involved in responding to scale items and to determine whether the patient's understanding of the content is correct. Inclusion criteria: (1) confirmed diagnosis of NPC via pathological examination; (2) no contraindications for radiotherapy and undergoing their first radiotherapy treatment; (3) no other malignant tumors or distant metastasis; (4) informed consent and willingness to participate in the study. Exclusion criteria: (1) patients with mental disorders or cognitive dysfunction; (2) patients whose radiotherapy treatment was interrupted for more than five consecutive sessions for any reason. Key questions included: "Can you understand this symptom item and describe it in your own words? Are there any specific terms that are difficult to understand?" "What were you thinking when you answered this question?" "Can you recall the circumstances when this symptom occurred?" "Are there any symptoms we missed that you think are important?" "How did you choose the corresponding option? Can you explain the difference between the five options in your own words?" "Is there an option you feel unable to choose? If so, how would you suggest modifying it?"

Phase 2: evaluation and exploration of scale items

Corrected item-total correlations

A series of analytical methods were used to evaluate the pre-test version of the scale. (1) Critical ratio method: this method assessed the discriminative power of each item in the target population. Independent samples *t*-tests were conducted between the top 27% (high score group) and bottom 27% (low score group) of the total scale score. Items with no statistical significance ($P > 0.05$) were removed.[20] (2) Correlation analysis: the correlation between each item's score and the total scale score was assessed, and items with a correlation coefficient less than 0.30 were deleted.[21] (3) Homogeneity tests: including Cronbach's α coefficient and principal component factor analysis. Items that led to an increase in the overall Cronbach's α coefficient when removed were discarded. A common factor was extracted to assess the variance explained by each item. Items with communalities lower than 0.20 were removed, as lower communalities indicate a weaker relationship between the item and the underlying factor.[22]

Phase 3: validity and reliability testing of the scale

Content validity

Sixteen experts evaluated the relevance of the scale items and their corresponding dimensions. Using a 5-point Likert scale, the importance and relevance of each item were rated, reflecting the alignment between the actual content measured and the intended content. This included the Item-Level Content Validity Index (I-CVI) and Scale-Level Content Validity Index (S-CVI), with required thresholds of I-CVI ≥ 0.78, Scale-level Content Validity Index/Universal Agreement (S-CVI/UA) ≥ 0.80, and Scale-level Content Validity Index/Average (S-CVI/Ave) ≥ 0.90.[22]

Construct validity

EFA was used to identify the scale's dimensions and reduce redundant items, while CFA tested the fit of the factor structure. Kaiser-Meyer-Olkin (KMO) tests and Bartlett's Test of Sphericity were performed, with EFA applied when the KMO value > 0.80. Items with factor loadings > 0.40 and communalities > 0.20 were retained.[23] CFA was conducted to validate the scale structure, with model fit assessed using χ^2/df, Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), and Incremental Fit Index (IFI).[24] A model fit was considered acceptable when χ^2/df < 3, RMSEA and SRMR ≤ 0.08, and IFI and CFI > 0.90, GFI ≥ 0.85.[25] The scale's convergent validity was evaluated by the correlations between items within the same factor, using Average Variance Extracted (AVE) and Composite Reliability (CR) with thresholds of AVE > 0.50 and CR > 0.70.[26] Discriminant validity was assessed by comparing the correlation coefficients between factors and the square root of each factor's AVE, with the criterion that the correlation between factors should be smaller than the square root of each factor's AVE.[26]

Internal consistency and retest reliability

The scale's reliability was assessed using internal consistency, split-half reliability, and retest reliability. A Cronbach's α coefficient > 0.80 and split-half reliability 0.70 indicated good internal consistency.[27] The questionnaire was repeated after 1 day in 30 patients through a discussion between the research team and the radiotherapist, taking into account the characteristics of the evolution of symptoms during radiotherapy.[27] The scale and its dimensions' retest reliability were calculated, with a correlation coefficient > 0.70 indicating good stability.

Participants

A convenience sampling method was used to recruit patients with NPC undergoing radiotherapy at a tertiary hospital in Zhejiang Province between May and August 2021. The inclusion and exclusion criteria were consistent with those used in the cognitive interviews. The sample size was determined according to the rules of factor analysis, the sample size should be 5–10 times the number of items for EFA, and it should be at least 200 cases or 10–20 times the number of items for CFA.[28]

Measurement

This study used both paper and electronic questionnaires. The questionnaire consisted of two parts: (1) a general information section, designed by the researchers, to collect demographic data including gender, age, marital status, education level, number of children, occupation, tumor stage, radiotherapy technology, and comorbidities; (2) a

pre-test version of the symptom assessment scale for patients with NPC undergoing radiotherapy. A 5-point Likert scale, ranging from 1 (very low) to 5 (very high), was employed to measure each item.

Data collection

In the first phase, expert consultation questionnaires were distributed via email. These included a letter outlining the research objectives, a basic information survey for experts (assessing general information and self-reported familiarity with judgment criteria), and a consultation form for the NPC symptom assessment scale items. The number of expert consultations was determined based on the research results. In the second and third phases, 685 patients with NPC undergoing radiotherapy were surveyed, all of whom completed questionnaires after providing informed consent.

Statistical analysis

Data were entered by two individuals, verified for accuracy, and subsequently compiled into an EXCEL database. Statistical analysis was performed using AMOS 24.0 and SPSS 22.0 software. Categorical data were described using frequency and percentage, while continuous data were represented as mean ± standard deviation. Corrected item–total correlations were performed using independent samples *t* test, Pearson correlation analysis, Cronbach's α coefficient and principal component factor analysis. Content validity was evaluated by expert ratings of each item, calculating I-CVI and S-CVI as indicators. EFA was performed using principal component analysis, and CFA was carried out with structural equation modeling (SEM) to assess construct validity. Reliability was examined through Cronbach's α coefficient for both the overall scale and its dimensions, alongside Pearson correlation analysis.

Results

Phase 1: generation and revision of scale items

Symptoms were summarized and consolidated based on existing literature, resulting in an initial list of 52 symptom items. Following group discussions and supplements, a pool of 61 symptom items was created. According to the scale item selection criteria and expert feedback, the research team made deletions, additions, modifications, and integrations to the scale items. In the first round of expert consultation, six items were deleted (e.g., “hair loss”), eight items were added (e.g., “nasal mucosal dryness”), six items were modified (e.g., “capillary dilation in the neck skin” was revised to “thread-like, star-shaped, or linear red spots in the neck”), and two items were combined (e.g., “memory impairment” and “slowed thinking response” were merged into “memory decline”). In the second round of expert correspondence, the relevant indicators met the criteria for selection of entries, and the experts’ opinions were relatively unified, so no further adjustments were made to the scale, and 56 items were initially established. The response rate for both rounds of expert consultation was 100%, with an authority coefficient of 0.897. The Kendall coordination coefficients for the two rounds of expert consultation were 0.224 and 0.232 ($P < 0.001$).

Cognitive interviews were conducted with 10 NPC radiotherapy patients in two rounds. Based on participant feedback, three items were modified: “unable to smell food or drink” was changed to “reduced sense of smell (inability to detect odors)”; “slurred vocal” was revised to “slurred speech”; and “head-down electrocution” was modified to “head-down electrocution (neck numbness with an electric shock feeling).”

Phase 2: evaluation and exploration of scale items

Participant demographics

This study involved two rounds of formal surveys, with the first round ($n = 340$) for EFA and the second round ($n = 285$) for CFA. The effective response rate for the first round was 90.67%. Among the 340 patients, 245 were male (72.06%) and 95 were female (27.94%), with ages ranging from 21 to 74 years, with a mean age of 52.99 ± 11.33 years. The majority of the tumors were staged III-IV (89.41%), and 82.06% of the patients had no chronic diseases. In the second round, the effective response rate was 91.9%. Among the 285 patients, 199 were male (69.82%) and 86 were female (30.18%), with ages ranging from 24 to 73 years, with a mean age of 52.29 ± 10.67 years. Most of the tumors were also staged III-IV (88.77%), and 78.95% of these patients had no chronic diseases. Approximately two-thirds of patients in both rounds were married, over three-quarters had at least a primary school education, and most participants had at least one child (97.48%), and nearly half of the patients treated with Tomotherapy.

Item analysis

The critical ratio method identified three items for deletion. Correlation analysis indicated that 23 items met the deletion criteria. The internal consistency analysis revealed a Cronbach's α coefficient of 0.919 for the overall scale. Deleting the item “Ptosis shmosis” increased the Cronbach's α coefficient. Based on these evaluations, 23 items were removed, resulting in the retention of 33 items.

Phase 3: validity and reliability testing of the scale

Content validity

The S-CVI/UA was 0.818, and the S-CVI/Ave was 0.970. The I-CVI for individual items ranged from 0.833 to 1.000. The results indicate that the symptom assessment scale for patients with NPC undergoing radiotherapy effectively captures their symptom experiences, suggesting strong content validity.

Construct validity

EFA was conducted on a sample of 340 participants, yielding a KMO value of 0.843 and Bartlett's test of sphericity $\chi^2 = 9232.366$ ($P < 0.001$), confirming the suitability of factor analysis. The results of the EFA revealed that seven factors with eigenvalues greater than 1 were extracted, accounting for a cumulative variance explanation of 74.51%. The contribution rates of each factor after rotation were 17.80%, 13.08%, 12.01%, 10.15%, 9.00%, 7.72%, and 4.75% (Fig. 1). The factor loadings for all items were greater than 0.40, and no cross-loadings were observed (Table 2). The scale's AVE values ranged from 0.496 to 0.770, and CR values ranged from 0.807 to 0.930, demonstrating good convergent validity, except for Factor 1, which had an AVE value of < 0.50 (Table 2). The square roots of the AVE for each factor exceeded the correlation coefficients, supporting good discriminant validity. When classifying and naming the symptom dimensions, both the results of EFA and the objective occurrence patterns of symptom clusters were considered. The 33-item scale was divided into seven dimensions: ocular symptoms, nasal symptoms, ear symptoms, oropharyngeal symptoms, neck symptoms, systemic symptoms, and symptom impact. Internal correlations between each dimension and the overall scale range from 0.440 to 0.804, whereas correlations among dimensions range from 0.092 to 0.485, indicating that the dimensions are consistent with the overall concept and that there are differences in the items within the dimensions (Table 3). CFA was conducted on a second sample of 310 participants, yielding $\chi^2/df = 1.279$, SRMR = 0.042, RMSEA = 0.031, CFI = 0.976, GFI = 0.885, and IFI = 0.977, indicating a good model fit. The SEM is shown in Fig. 2.

Internal consistency and retest reliability

The overall Cronbach's α coefficient for the scale was 0.928, with individual dimensions ranging from 0.725 to 0.932, all meeting the ideal standards for internal consistency. The split-half reliability coefficient was 0.790, with values for individual dimensions ranging from 0.725 to 0.943. The retest reliability coefficient was 0.828, with individual dimension values ranging from 0.705 to 0.967, indicating good stability in the measurement results (Table 4).

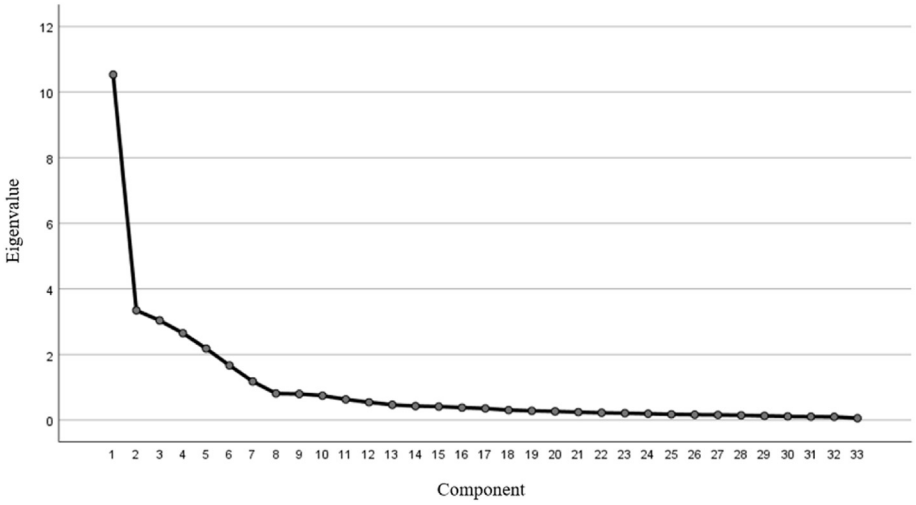

Fig. 1. Scree plot of EFA for the symptom assessment scale for patients with NPC undergoing radiotherapy. EFA, Exploratory factor analysis; NPC, nasopharyngeal cancer.

Discussion

This study ensures the scientific development of the scale through a structured theoretical framework, comprehensive literature review, expert consultations, and cognitive interviews. Relying on the symptom experience model as a framework, referring to the existing mature symptom assessment tools related to head and neck tumors, and combining the results of the literature review, a pool of NPC-specific symptom entries was constructed to ensure the scientific validity of the items. The Delphi method was employed, with experts from four different provinces and cities across fields such as clinical nursing, nursing management and education, and clinical medicine, who were invited to

Table 2
Exploratory factor analysis results ($N = 340$).

	Oropharyngeal symptoms	Systemic symptoms	Neck symptoms	Ocular symptoms	Nasal symptoms	Ear symptoms	Symptom impact
Dry eyes	0.080	0.104	0.124	**0.898**	0.000	0.022	0.132
Blurred vision	0.120	0.102	0.129	**0.891**	0.019	0.123	−0.027
Seeing objects with double vision	0.167	0.098	0.071	**0.871**	0.106	0.09	−0.041
Vision loss	0.205	0.108	0.153	**0.848**	0.031	0.051	0.149
Dryness of the nasal mucosa	0.188	0.050	0.177	0.110	**0.799**	0.170	0.014
Blocked noses	0.036	0.076	0.149	0.022	**0.769**	0.162	−0.095
Increased nasal secretions	0.161	0.019	0.107	−0.005	**0.715**	0.025	0.123
Blood-tinged nasal discharge/nosebleed	0.105	0.104	0.126	0.025	**0.865**	0.125	−0.007
Ear discomfort (tinnitus, ear fullness, hearing loss)	0.167	0.100	0.128	0.121	0.105	**0.877**	0.063
Fluid/bleeding from ear canal	0.115	0.109	0.147	0.124	0.166	**0.861**	0.001
Persistent ear pain	0.245	0.064	0.079	0.027	0.235	**0.844**	0.104
Swollen gums	**0.858**	0.046	−0.004	0.027	0.068	0.016	0.004
Dental caries (cavities), tooth loosening, displacement, fractures,	**0.759**	0.046	0.007	0.011	0.194	0.138	−0.073
Oral ulcers	**0.778**	0.064	0.132	0.168	0.152	0.111	0.064
Oral pain	**0.753**	0.120	0.153	0.133	0.129	0.139	0.054
Dry mouth	**0.739**	0.351	0.039	0.127	0.057	0.136	0.091
Increased salivary viscosity	**0.727**	0.395	0.085	0.099	−0.070	−0.012	0.070
Loss of taste perception	**0.729**	0.388	0.160	0.079	−0.006	0.164	0.011
Dysphagia	**0.747**	0.164	0.271	0.150	0.085	0.086	−0.003
Coughing with food or water	**0.794**	0.068	0.213	0.082	0.105	0.036	0.013
Increased sensitivity of the neck skin	0.114	0.099	**0.819**	0.068	0.182	0.051	0.086
Darkening of the skin color on the neck	0.131	0.205	**0.809**	0.141	0.119	0.162	0.059
Thread-like, star-shaped, or linear red spots in the neck (changes in capillary dilatation)	0.071	0.153	**0.763**	0.079	−0.012	0.004	0.036
Neck skin pain	0.123	0.042	**0.750**	0.109	0.303	0.154	0.006
Erythema and pruritus of the skin on the neck	0.278	0.127	**0.629**	0.076	−0.102	0.166	0.048
Blistering and peeling of the skin on the neck	0.097	0.044	**0.772**	0.089	0.304	−0.046	0.051
Anxiety	0.170	**0.836**	0.055	0.103	0.053	−0.007	0.170
Depression (low mood)	0.180	**0.820**	0.160	0.069	0.047	0.073	0.025
Insomnia	0.224	**0.862**	0.171	0.071	0.056	0.049	0.057
Fatigue	0.171	**0.859**	0.084	0.123	0.076	0.097	0.14
Weight loss	0.217	**0.808**	0.183	0.087	0.082	0.116	0.174
Work status	0.048	0.346	0.066	0.044	0.060	0.087	**0.770**
Sleeping condition	0.031	0.155	0.141	0.126	−0.019	0.059	**0.875**
AVE	0.496	0.721	0.577	0.770	0.622	0.741	0.679
CR	0.923	0.921	0.890	0.930	0.868	0.896	0.807

Bold numbers indicate factor loads > 0.40. AVE, Average Variance Extracted; CR, Composite Reliability.

Table 3
Correlation coefficients between scale dimensions and total score.

Dimensions	Ocular symptoms	Nasal symptoms	Ear symptoms	Oropharyngeal symptoms	Neck symptoms	Systemic symptoms	Symptom impact
Ocular symptoms	1	–	–	–	–	–	–
Nasal symptoms	0.150**	1	–	–	–	–	–
Ear symptoms	0.242**	0.366**	1	–	–	–	–
Oropharyngeal symptoms	0.330**	0.284**	0.356**	1	–	–	–
Neck symptoms	0.305**	0.355**	0.316**	0.383**	1	–	–
Systemic symptoms	0.275**	0.200**	0.255**	0.485**	0.352**	1	–
Symptom impact	0.214**	0.092**	0.193**	0.191**	0.240**	0.423**	1

**$P < 0.01$.

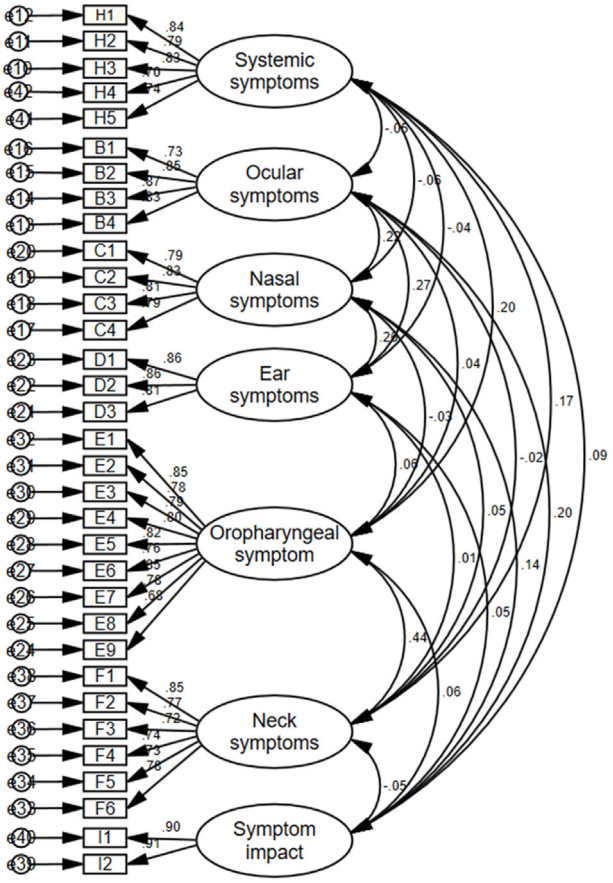

Fig. 2. The seven-factor model of the symptom assessment scale for patients with NPC undergoing radiotherapy. NPC, nasopharyngeal cancer.

evaluate and select the dimensions and item29s.[29] Two rounds of expert consultation yielded mean importance values for the items ranging from 3.13 to 4.75 and 3.69 to 5.00, with coefficient of variation between 0.094 and 0.361, and 0.000 and 0.248, respectively.

Table 4
Cronbach's α coefficient, split-half reliabilities, and retest reliabilities for scale dimensions and total scale.

Dimensions	Cronbach's α ($n = 340$)	Split-half reliability ($n = 340$)	Retest reliability ($n = 30$)
Ocular symptoms	0.927	0.943	0.740
Nasal symptoms	0.837	0.776	0.734
Ear symptoms	0.896	0.784	0.705
Oropharyngeal symptoms	0.930	0.927	0.801
Neck symptoms	0.874	0.827	0.880
Systemic symptoms	0.932	0.925	0.967
Symptom impact	0.725	0.725	0.716
Total scale	0.928	0.790	0.828

The symptom assessment scale for patients with NPC undergoing radiotherapy (SAS-NPC) demonstrates strong reliability and validity. Reliability was assessed through internal consistency, retest reliability, and split-half reliability. The overall Cronbach's α coefficient of 0.928 exceeds the recommended threshold of 0.70, indicating high reliability. Both EFA and CFA were performed to assess construct validity, evaluating the alignment between theoretical assumptions and actual measurements. EFA extracted seven factors, with each item loading higher than 0.40 on its respective factor and displaying stronger loadings compared to other factors. CFA indicated that all fit indices were within acceptable ranges, supporting a good model fit. Content validity was assessed by evaluating whether the items align with the measurement objectives. The content validity index for individual items ranged from 0.833 to 1.000, while the S-CVI/UA was 0.818, and the S-CVI/Ave was 0.970, confirming the scale's content validity.

Some symptom assessment tools (e.g., the MDASI-HN[10] and Edmonton-33[13]), primarily target head and neck tumor patients but overlook the damage to organs adjacent to the radiation target area in NPC, resulting in insufficient specificity. The generalizability of these tools also leads to a more general presentation of their symptom items, making it difficult to accurately capture symptomatic changes in NPC. Furthermore, while radiotherapy can induce both acute and long-term symptoms, existing tools focus predominantly on acute reactions during treatment (e.g., oral ulcers) and inadequately address long-term complications (e.g., radiation-induced dental caries and hearing loss). The SAS-NPC has been meticulously developed to encompass both acute and long-term NPC-specific symptoms through rigorous literature review and expert consultation. It distinguishes between symptom subtypes and dynamic changes in its descriptions, aiming for maximum precision. For instance, Pilśniak et al.[30] have demonstrated that skin damage in head and neck cancer patients during radiotherapy progresses dynamically. Accordingly, this scale categorizes radiation dermatitis into specific manifestations, including skin sensitivity, pigmentation changes, erythema, itching, blisters, and ulcerations, enabling health care professionals to better assess the severity of skin damage. The SAS-NPC is organized based on the anatomical regions where symptoms occur, allowing for comprehensive and systematic assessments while minimizing recall bias. Validation through patient cognitive interviews has confirmed its excellent comprehensibility. It facilitates accurate self-reporting of symptoms and enhances patients' self-management awareness. Regular monitoring of symptom changes via this scale supports home care and remote symptom management, providing valuable clinical insights.[31]

This study indicates that the oropharyngeal symptoms of patients with NPC should be prioritized. Among all the factors, the oropharyngeal symptom cluster had the highest variance contribution (17.80%), which included gingival swelling, dental problems, oral ulcers, oral pain, dry mouth, increased saliva viscosity, loss of taste perception, dysphagia, and coughing with food or water. These findings align with those reported by Liu et al.[32] During radiotherapy, nearly all patients experience varying degrees of oral mucositis (60%–100%),[33] resulting in mouth and throat pain that significantly affects the eating process. Due to the cumulative dose of radiotherapy, fibrosis of the swallowing-related muscles may develop, impairing muscle strength and swallowing function. While

IMRT has been shown to reduce damage to the parotid glands, patients still experience reduced salivation and oral dryness after IMRT, which increases the difficulty of swallowing and chewing.[34] Oropharyngeal symptoms severely affect patients with NPC' dietary intake, thereby increasing the risk of malnutrition. Peng et al.[35] found that 85% of patients with NPC were at high nutritional risk. Therefore, early screening and timely intervention for these symptoms are essential in clinical nursing to ensure adequate nutritional intake.

Implications for nursing practice and research

In the field of clinical practice, the SAS-NPC provides an assessment tool with specificity for nursing practice, which can help nurses to standardize the assessment criteria in the whole symptom management of patients, reduce subjective bias and inconsistency, and enhance the science and accuracy of symptom management. Through regular symptom self-reporting, it can enhance patients' awareness of the disease and self-management, while providing dynamic symptom data for the nursing team to promote real-time optimization of personalized care plans. In addition, the scale can be integrated into outpatient and home care systems through the Internet platform, enabling more accurate remote symptom monitoring and dynamic interventions, and optimizing cross-scenario continuity of care services. In the research field, the SAS-NPC scale is able to systematically collect symptomatic data from NPC radiotherapy patients, especially for monitoring acute and long-term symptoms. This provides more accurate symptom assessment data for subsequent studies, which can be used to explore the effects of different nursing interventions on symptom relief. Notably, the integration and application of the scale and remote monitoring technology contribute to the development of remote symptom monitoring and early warning systems, promote research on NPC patient care in digital health, and provide a scientific basis for cross-scenario symptom management.

Limitations

Although this study adhered to the standard procedures for scale development and validation, several limitations remain. First, due to the reference to the existing well-established symptom assessment scales for head and neck tumors, the complementary role of qualitative studies to the scale entries was neglected. Although cognitive interviews were used in the follow-up to supplement the items, the symptom impact part of the study is not in-depth enough and needs to be further strengthened. Second, the reference to the existing head and neck cancer symptom scales led to an underemphasis on the role of qualitative research in enriching the scale. Despite the follow-up was supplemented by the use of cognitive interviews, several details may have been overlooked, especially in the symptom impact section, which was not studied in sufficient depth and needs to be further strengthened. The sample was drawn exclusively from a single tertiary hospital in Zhejiang, China, which limits its diversity. Consequently, the findings may be influenced by specific treatment methods and patient characteristics. Third, the sample was categorized based on recruitment time rather than through random sampling, potentially affecting the robustness of the results. In addition, data collection for this study took place during COVID-19, a specific period that may have had some impact on patient contact and data collection.

Conclusions

The symptom assessment scale developed for patients with NPC undergoing radiotherapy in this study consists of 7 dimensions and 31 items, encompassing both common and specific symptoms throughout the course of radiotherapy. Overall, the SAS-NPC demonstrates strong reliability and validity and can serve as a specialized tool for assessing symptoms in patients with NPC undergoing radiotherapy. In addition, the scale provides important support for further clinical research and nursing practice, effectively facilitating continuous monitoring and remote management of symptoms, while enhancing patients' sense of self-management and improving their treatment experience and quality of life.

CRediT authorship contribution statement

Fangying Wang: Data Curation, Formal Analysis, Writing-Original Draft, Writing-Review & Editing. **Qingyu Zhao:** Investigation, Data Curation, Formal Analysis. **Guanmian Liang:** Writing-Review & Editing. **Wanying Wu**: Conceptualization, Methodology, Project Administration, Supervision, Writing-Review & Editing. All authors have read and approved the final manuscript.

Ethics statement

The study was approved by the Ethics Committee of Zhejiang Cancer Hospital (IRB-2021-88) and was conducted in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants provided written informed consent.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author, WW. The data are not publicly available due to information related to the privacy of the study participants.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

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Declaration of competing interest

The authors declare no conflict of interest.

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