BMC Oral Health

RESEARCH

Open Access

Oral frailty and its influencing factors in patients with cancer undergoing chemotherapy: a cross-sectional study

Fangyi Li[1†], Tian Xiao[1†], Xueqin Qiu[2†], Chunmei Liu[3], Qiumei Ma[3], Dongmei Yu[4], Linyu Zhou[1], Ruihan Xiao[1], Biao He[1], Ao Tang[1] and Xiaoju Chen[1*]

Abstract

Background Oral frailty is one of the easily overlooked complications in patients with cancer, which is as important as dietary dysfunction, malnutrition and other complications. However, limited research exists on the factors influencing oral frailty in patients with cancer undergoing chemotherapy. The objective of this study is to investigate the incidence of oral frailty in patients with cancer undergoing chemotherapy and to analyze the factors that influence it.

Methods A convenience sampling method was used to select patients with cancer undergoing chemotherapy from three tertiary hospitals in Chengdu, Sichuan Province. The Oral Frailty Index-8 (OFI-8) was utilized to assess the patients' oral frailty status. The Chemotherapy-induced Taste Alteration Scale(CiTAS), the Acceptance of Illness Scale(AIS), and the Family Adaptation, Partnership, Growth, Affection, Resolve Index(APGAR) were used to assess the patients' taste changes, levels of acceptance of illness, and family functioning levels, respectively. Additionally, descriptive analysis, univariate analysis, and multiple linear stepwise regression analysis were conducted.

Results The incidence of oral frailty among patients with cancer undergoing chemotherapy was found to be 57.58%. Additionally, oral frailty was positively correlated with chemotherapy-induced taste alteration, while it was negatively correlated with acceptance of illness and family functioning. Furthermore, multiple linear stepwise regression analysis revealed that factors such as disease duration, history of radiation therapy, dry mouth, dentures, chemotherapy-induced taste alteration, acceptance of illness, and family functioning significantly influenced oral frailty in these patients, accounting for a total variance of 54.6%.

Conclusion The incidence of oral frailty is notably high among patients with cancer undergoing chemotherapy. Several factors, such as disease duration, history of radiation therapy, dry mouth, the use of dentures, chemotherapy-induced taste alteration, acceptance of illness, and family functioning, significantly affect the degree of oral frailty. This highlights the necessity for healthcare providers to implement preventive management strategies based on these factors, and to modify oral care plans accordingly to prevent or mitigate the onset and progression of oral frailty in patients with cancer undergoing chemotherapy.

Keywords Oral frailty, Cancer, Chemotherapy, Cross-sectional survey, Influencing factors

†Fangyi Li, Tian Xiao and Xueqin Qiu contributed equally to this work and share first authorship.

*Correspondence:
Xiaoju Chen
chenxiaoju@cmc.edu.cn
Full list of author information is available at the end of the article

Background

Recent cancer statistics indicate that the incidence and mortality rates of cancer are rapidly increasing worldwide, with China reporting 4.8247 million new cases and 2.5742 million deaths, resulting in the highest rates globally [1]. Currently, chemotherapy is a key modality for antitumor treatment in patients with cancer; it can be combined with other methods, such as surgery, or used alone, thereby aiding in the control of local lesions and improving survival rates [2]. Oral health is closely linked to overall health and quality of life [3]. However, during chemotherapy, patients often experience oral health problems due to the toxic effects of chemotherapy drugs, including oral mucositis, dry mouth, and altered taste [4]. These issues negatively impact the patients' oral health, eating function, and quality of life.

Oral frailty (OF) refers to a long-term, progressive decline in oral function, commonly linked to aging, including tooth loss, edentulism, and poor oral hygiene. It is also accompanied by diminished interest in oral health, reduced physical and mental reserves, and eating dysfunction, all of which reflect both physical and psychological maladaptation [5]. Although oral complications during chemotherapy, particularly oral mucositis, can cause symptoms such as pain, loss of appetite, and difficulty eating, these symptoms are primarily side effects of the chemotherapy itself [6]. In contrast, OF is typically a long-term process that does not develop rapidly as a result of chemotherapy. Consequently, the oral symptoms induced by chemotherapy differ from both the definition and the underlying mechanisms of OF. Li conducted a survey revealing that the incidence of OF among hospitalized patients with cancer in China is 64.3% [7]. Identified contributing factors include age, smoking history, chemotherapy history, dry mouth, dentures, poor oral health, and physical frailty. Research has shown that poor oral hygiene (e.g., dry mouth, plaque accumulation) not only directly damages local oral health but may also indirectly contribute to the pathological progression of OF by affecting functional status (e.g., reduced chewing efficiency) [8]. Although there has been research on OF and its influencing factors, studies specifically related to patients with cancer remain limited [9]. The unique oral health challenges faced by patients with cancer undergoing chemotherapy have not received sufficient attention. Therefore, it is essential to prioritize oral health care and hygiene among patients with cancer undergoing chemotherapy in China. This study aims to investigate the current status and influencing factors of OF.

The Theory of Unpleasant Symptoms (TOUS) was first proposed by Elizabeth R. Lenz et al. in 1995 [10]. It consists of three main concepts: the individual symptoms that are being experienced, the influential factors that affect the symptoms, and the performance of the symptoms. Individual symptoms refer to the performance that the patient is experiencing, which is different from the normal function, serves as a danger signal threatening health, and is a subjective feeling of the patient. The factors affecting symptoms mainly include three aspects: physiological, psychological, and environmental. According to this theory, physiological, psychological, and environmental factors interact and influence each other to jointly affect disease symptoms and outcomes [10]. In this study, OF, as an unpleasant symptom being experienced by patients with cancer undergoing chemotherapy, is influenced by physiological, psychological and environmental factors.

Taste alteration may also be a physiological factor contributing to OF. Chemotherapy-induced taste alteration refers to abnormal taste sensations or impaired taste that patients experience during or after chemotherapy [11]. These changes can impact patients' food choices, reduce their appetite, and lead to deficiencies in vitamins and minerals, which ultimately impair the repair of oral tissues and result in OF [12]. Long-term chemotherapy and its side effects impose significant psychological, social, and economic pressures on patients with cancer, causing them to withdraw from social interactions and diminishing their acceptance of illness [13]. Acceptance of illness refers to a patient's ability to accurately assess their health status, actively adapt to their condition, and possess the capacity to fight against the disease [14]. Research indicates that patients with low acceptance of illness may subconsciously ignore their illness, leading to behaviors that exacerbate their condition [15]. Similarly, studies have shown a correlation between acceptance of illness and patients' self-management behaviors [16]; higher acceptance of illness encourages patients to proactively seek oral health knowledge and prioritize the prevention of oral diseases [17]. Thus, acceptance of illness plays a crucial role in the formation and development of OF in patients. It is worth mentioning that social support has also been shown to be an influential factor in the development of OF in patients [18]. Family functioning, as a vital form of social support, encompasses the daily processes by which families support the health and development of their members [19]. Patients with strong family functioning can receive early attention and clinical treatment for common oral issues from family members, thereby preventing further progression to OF [20]. Therefore, this study selects chemotherapy-induced taste alteration, acceptance of illness, and family functioning as independent variables for investigation.

Based on the Theory of Unpleasant Symptoms, this study hypothesizes that OF is influenced by chemotherapy-induced taste alteration (physiological factor),

acceptance of illness (psychological factor), and family functioning (environment factor), as illustrated in Fig. 1. Accordingly, this study conducts an investigative analysis of the occurrence of OF and its influencing factors among patients with cancer undergoing chemotherapy. The goal is to alter the perceptions and attitudes of patients with cancer and healthcare professionals regarding OF, thereby providing a foundation for developing preventive interventions for OF in this population.

Methods

Study design and participants

This cross-sectional study was conducted between June and August 2024, using a convenience sampling method to recruit patients with cancer undergoing chemotherapy from three tertiary hospitals in Chengdu, Sichuan Province. The inclusion criteria were as follows: participants had to be aged ≥ 18 years, possess a clinical pathological diagnosis of cancer requiring hospitalization for chemotherapy, have a clear understanding of their disease condition and diagnosis, demonstrate proficient language communication and comprehension skills, and provide informed consent for voluntary participation in the study. Exclusion criteria included a history of mental illness or communication disorders. This study adhered to the STROBE guideline.

According to the sample size estimation method for multiple linear regression analysis, the required sample size should be at least ten times the number of independent variables [21]. Given that this study included 29 independent variables and accounted for a 20% invalid response rate, the minimum sample size was estimated to be 348 participants. Ultimately, the study included 363 participants.

Procedure

In this study, the researchers and team members acted as the principal investigators and data collectors. Initially, patients were recruited by posting flyers in the oncology inpatient wards, which contained the study background, objectives, inclusion criteria, and contact information. With the assistance of clinical nurses, the researchers reviewed the electronic medical records daily to promptly identify patients meeting the inclusion criteria. After obtaining the patients' basic information, the researchers communicated with them to assess their willingness to participate. Upon receiving informed consent, the researchers distributed the questionnaires. In principle, all questionnaires were completed by the participants themselves; for those with visual impairments or reading difficulties, the researchers assisted by reading each item aloud in neutral and non-suggestive language. Once the questionnaires were completed, the investigators collected them on-site, checked for completeness, and confirmed with the participants whether anything had been overlooked. Participants spent an average of 15 to 20 min completing the questionnaires.

The questionnaire survey in this study was conducted 2 to 3 days after the patients began chemotherapy. Initially, the study approached 385 cancer patients undergoing chemotherapy. Among them, 10 patients declined to participate due to objections from their caregivers, and 12 patients discontinued the survey due to physical discomfort during completion. A total of 363 valid questionnaires were collected, resulting in a response rate of 94.3%. The data collection flowchart is presented in Fig. 2.

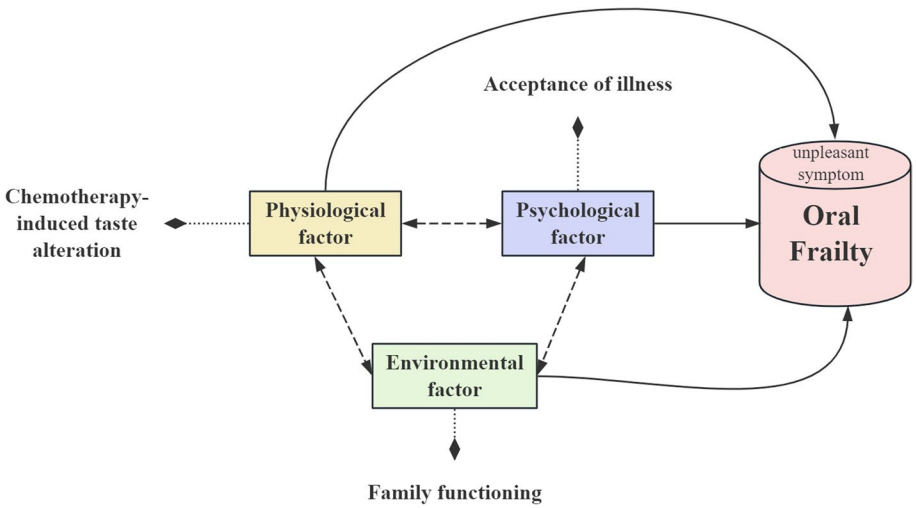

Fig. 1 Theoretical model diagram of this study

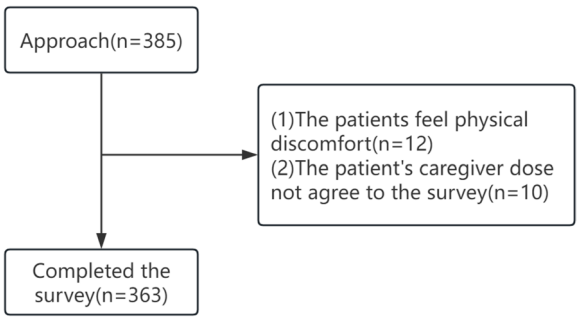

Fig. 2 A flow chart about data collection

Research instruments

Sociodemographic and disease characterization questionnaire

The sociodemographic data of the patients include age, gender, marital status, educational level, employment status, residence, and average monthly household income per capita. The disease-related data include the diagnosis, tumor stage, disease duration, comorbidities, number of chemotherapy cycles, history of radiation therapy, dry mouth, and dentures.

Oral frailty

This study used the Oral Frail Index-8 (OFI-8) developed by Tanaka et al. to assess the patients' levels of OF [22]. The scale consists of eight items: (1) whether it is harder to eat solid food than it was half a year ago; (2) whether they sometimes choke on tea or soup; (3) whether they have false teeth; (4) whether they have dry mouth symptoms; (5) whether the number social outings has decreased compared with half a year ago; (6) whether they can chew hard food, such as peanuts or pickled radish; (7) whether they have brushed their teeth at least twice a day; and (8) whether they see a dentist at least once a year. For items 1–3, answering "yes" scores 2 points; for items 4 and 5, answering "yes" scores 1 point; for items 6–8, reverse scoring is applied, with "no" receiving 1 point. The total score ranges from 0 to 11 points, with a score of ≥ 4 indicating the occurrence of OF. A lower score reflects better oral health. Since this scale uses binary response options, the reliability was calculated using the Kuder-Richardson 20 (KR-20) coefficient [23]. In this study, the KR-20 coefficient was 0.764.

Chemotherapy-induced taste alteration

In this study, the Chemotherapy-induced Taste Alteration Scale (CiTAS) was utilized to assess the taste alterations in patients [24]. The CiTAS comprises 18 items, which cover 4 dimensions: decreased taste, phantom and abnormal taste, altered overall taste, and eating disturbance. Each item is rated on a 5-point Likert scale, with 1 indicating "no change" and 5 indicating "very severe". The total score ranges from 18 to 90, where higher scores indicate more severe taste disorders. In this study, the Cronbach's α coefficient was 0.947.

Acceptance of Illness

The levels of acceptance of illness in patients with cancer undergoing chemotherapy were assessed using the Acceptance of Illness Scale (AIS) [25]. The AIS consists of 8 items, which cover 4 dimensions: limitations due to illness, reduced self-care, dependence on others and loss of self-confidence. It employs a 5-point Likert scale, with each item scored from 1 to 5, where 1 represents "strongly disagree" and 5 represents "strongly agree". The total score ranges from 8 to 40, with higher scores indicating greater acceptance of the illness. In this study, the Cronbach's α coefficient was 0.731.

Family functioning

This study used the Family Adaptation, Partnership, Growth, Affection, Resolve Index (APGAR) to assess patients' subjective satisfaction with family functioning [26]. The APGAR comprises 5 items, covering five dimensions: family adaptation, partnership, growth, affection, and intimacy. This scale uses a 3-point (0–2) scoring system, where "often" is assigned 2 points, "sometimes" is assigned 1 point, and "rarely" is assigned 0 points. The total score ranges from 0 to 10, with higher scores indicating better family functioning. In this study, the Cronbach's α coefficient was 0.932.

Data analysis

The data were analyzed using SPSS version 26 (IBM Corp, Armonk, NY). Categorical data were described using frequency and percentage. For normally distributed continuous data, statistical descriptions were presented as "mean ± standard deviation", and intergroup differences were compared using the independent samples t-test or one-way analysis of variance; for skewed continuous data, statistical descriptions were given as median and interquartile range, and intergroup differences were compared using the Mann–Whitney *U* test or Kruskal–Wallis H test. If the data followed a normal distribution, Pearson correlation analysis was used to assess the relationship between OF and the scores of various scales. If the data were skewed, Spearman correlation analysis was applied. Additionally, multiple stepwise linear regression was employed to identify the factors influencing OF in patients with cancer undergoing chemotherapy. A *P*-value of less than 0.05 was considered statistically significant.

Ethical considerations

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the Chengdu Medical College. The ethical approval number of the study is [2024No. 08]. The researchers provided a detailed explanation of the study to eligible participants, and each participant signed a written informed consent form prior to participation.

Results

Sample characteristics

In this study, 363 patients were assessed. More than half of the participants were male (63.4%), with an average age of 60.60 ± 9.95 years; 55.9% were aged 60 years or older. Nearly all patients were married (94.1%), while 43.8% had an education level of primary school or below, and only 7.2% had completed college or attained higher education. Nearly half of the patients were retired (44.6%), and the majority resided in urban areas (56.5%). The largest group of patients reported an average monthly household income per capita of $412 to $686 (38%). Gastrointestinal cancer was the most prevalent diagnosis, affecting 49.6% of patients, followed by lung cancer (21.2%). Additionally, 50.1% of patients were classified as being in clinical stage IV, and 46.6% had a disease duration of fewer than six months. More than half of the patients (67.2%) had no chronic comorbidities. Among the participants, 32.0% had undergone 1 to 2 chemotherapy sessions, and 64.7% had no history of radiation therapy. Notably, 55.9% of patients experienced dry mouth, while the majority (66.7%) did not wear dentures (see Supplementary Material 1).

OFI-8 and its individual item scores

The results of the Kolmogorov–Smirnov and Shapiro–Wilk normality tests indicated that OFI-8 and its individual item scores did not follow a normal distribution ($P<0.05$) (see Supplementary Material 2). Therefore, the data were described using median (M) and interquartile range (*P25, P75*).

The median OFI-8 score and interquartile range for the subjects were 4 (2, 6) points, with 209 patients (57.58%) meeting the criteria for OF (OFI-8 score ≥ 4) (see Table 1 for details).

Single factor analysis of OF in patients with cancer undergoing chemotherapy

The OFI-8 total scores within each group showed a skewed distribution, and differences between groups were compared using the Mann–Whitney *U* test or Kruskal–Wallis H test. The results of the normality test are available in Supplementary Material 3. The results of the univariate analysis revealed that age, educational level, disease duration, number of chronic diseases, history of radiation therapy, dry mouth, and denture use were significant influencing factors ($P<0.05$) (see Table 2).

The relationship among OF, chemotherapy-induced taste alteration, acceptance of illness and family function in patients with cancer undergoing chemotherapy

The results of the Spearman correlation analysis revealed a significant positive correlation between OF and chemotherapy-induced taste alteration ($r=0.181$, $P<0.01$). In contrast, significant negative correlations were found with both acceptance of illness ($r=-0.134$, $P<0.05$) and family functioning ($r=-0.186$, $P<0.01$), as illustrated in Table 3.

Influencing factors of OF in patients with cancer undergoing chemotherapy

The OFI-8 score of patients served as the dependent variable in a multiple stepwise linear regression analysis. The independent variables included those that showed statistical significance in both univariate and correlation analyses. The method of variable assignment is detailed

Table 1 OFI-8 and its individual item scores ($N=363$)

Variable	M	*P25, P75*
OFI-8 total score	4	(2, 6)
1. whether it is harder to eat solid food than it was half a year ago	0	(0, 2)
2. whether they sometimes choke on tea or soup	0	(0, 0)
3. whether they have false teeth	0	(0, 2)
4. whether they have dry mouth symptoms	1	(0, 1)
5. whether the number social outings has decreased compared with half a year ago	0	(0, 1)
6. whether they can chew hard food, such as peanuts or pickled radish	0	(0, 1)
7. whether they have brushed their teeth at least twice a day	0	(0, 1)
8. whether they see a dentist at least once a year	1	(1, 1)

Table 2 Comparison of OFI-8 scores of patients with different characteristics ($N=363$)

Variable		n (%)	*M* (*P25*, *P75*)	Z/H	P
Gender	Male	230 (63.4)	4 (2, 6)	−0.98[a]	0.33
	Female	133 (36.6)	4 (3, 6)		
Age group	< 45 years	22 (6.1)	3 (3, 5)	19.81[b]	< 0.001**
	45 ~ 59 years	138 (38.0)	3 (2, 5)		
	≥ 60 years	203 (55.9)	4 (3, 6)		
Marital status	Married	342 (94.1)	4 (2, 6)	−1.61[a]	0.10
	Unmarried/Divorce /Widowed	21 (5.9)	5 (3, 7)		
Educational level	Primary school or below	159 (43.8)	4 (3, 7)	23.09[b]	< 0.001**
	Junior high school	139 (38.3)	3 (2, 5)		
	High school or vocational school	39 (10.7)	4 (2, 6)		
	College or above	26 (7.2)	4 (2, 5)		
Employment status	Farmer	67 (18.5)	4 (3, 6)	4.09[b]	0.25
	Working	33 (9.1)	4 (2.5, 5)		
	Not working	101 (27.8)	4 (2, 5)		
	Retired	162 (44.6)	4 (3, 6)		
Residence	City	205 (56.5)	4 (3, 5)	−0.54[a]	0.59
	Rural area or Town	158 (43.5)	4 (2, 6)		
Average monthly household income per capita, USD	< 412	114 (31.4)	4 (2, 6)	0.29[b]	0.87
	412–686	138 (38.0)	4 (2.75, 6)		
	> 687	111 (30.6)	4 (3, 6)		
Diagnosis	Lung cancer	77 (21.2)	4 (2.5, 6)	6.46[b]	0.17
	Gastrointestinal cancer	180 (49.6)	4 (3, 6)		
	Gynecological cancer	26 (7.2)	3 (2.75, 5)		
	Esophageal cancer	30 (8.3)	5 (3, 6.25)		
	Others	50 (13.7)	4 (2, 5)		
Tumor stages	I	7 (1.9)	5 (3, 8)	2.34[b]	0.51
	II	46 (12.7)	4 (3, 6)		
	III	128 (35.3)	4 (2, 5.75)		
	IV	182 (50.1)	4 (2, 6)		
Disease duration	Half a year or below	169 (46.6)	3 (2, 5)	25.45[b]	< 0.001**
	Half to one year	75 (20.7)	4 (3, 5)		
	More than one year	119 (32.7)	5 (3, 7)		
Comorbidities	0	244 (67.2)	4 (2, 5)	9.35[b]	0.01*
	1	94 (25.9)	4 (3, 5.25)		
	≥ 2	25 (6.9)	6 (4, 7)		
Number of chemotherapy cycles	1 ~ 2	116 (32.0)	4 (3, 6)	0.39[b]	0.94
	3 ~ 4	92 (25.3)	4 (3, 6)		
	5 ~ 6	72 (19.8)	4 (2, 6)		
	≥ 7	83 (22.9)	4 (2, 6)		
History of radiation therapy	Yes	128 (35.3)	6 (3, 7)	−7.72[a]	< 0.001**
	No	235 (64.7)	3 (2, 5)		
Dry mouth	Yes	203 (55.9)	5 (3, 6)	−6.96[a]	< 0.001**
	No	160 (44.1)	3 (2, 4.75)		
Dentures	Yes	121 (33.3)	6 (4, 7)	−10.30[a]	< 0.001**
	No	242 (66.7)	3 (2, 4)		

[a] Mann-Whitney U test

[b] Kruskal-Wallis H test

* $P < 0.05$

** $P < 0.001$

Table 3 The relationship among OFI-8, CiTAS, AIS and APGAR in patients with cancer undergoing chemotherapy ($N = 363$)

Variable	OF	Chemotherapy-induced taste alteration	Acceptance of illness	Family functioning
OF	1			
Chemotherapy-induced taste alteration	0.181**	1		
Acceptance of illness	−0.134*	−0.196**	1	
Family functioning	−0.186**	−0.048	0.280**	1

* Significance at $P < 0.05$

** Significance at $P < 0.01$

in Supplementary Material 4. The results indicated that disease duration, history of radiation therapy, dry mouth, dentures, chemotherapy-induced taste alteration, acceptance of illness, and family functioning significantly influenced patients with cancer undergoing chemotherapy ($P < 0.05$), accounting for 54.6% of the total variation (see Table 4).

Discussion

The results of this study indicate that the incidence of OF among patients with cancer undergoing chemotherapy is 57.58%, which is higher than the 43.6% reported by Kugimiya et al. for elderly individuals in rural areas [27]. This difference arises from the unique triple pathological mechanisms of chemotherapy in patients with cancer. First, chemotherapy drugs induce an explosion of reactive oxygen species (ROS) in the tumor microenvironment, which directly causes DNA double-strand breaks in oral mucosal cells, accelerating the progression of oral mucositis [28]. Second, chemotherapy-induced neutropenia leads to a decrease in salivary lysozyme concentration, resulting in abnormal oral microbiome diversity indices and triggering ulcerative mucosal lesions [29]. Importantly, chemotherapy-related reductions in salivary secretion severely impair the oral self-cleansing ability, leading to an increase in the plaque index and forming a vicious cycle of "reduced saliva-plaque accumulation-caries progression" [30]. This pathological caries, particularly root caries, can decrease masticatory efficiency, induce occlusal disorders through functional compensation, accelerate the process of OF, and ultimately contribute to a higher incidence of OF in patients with cancer undergoing chemotherapy.

Research indicates that timely interventions through professional oral care can reduce the total bacterial load by 10 to 100 times, thereby decreasing oral complications arising from cancer treatment [4]. A study by Kusiak et al. found that most healthcare providers lack sufficient knowledge of oral care for patients with cancer and are recommended to undergo training in oral care for patients with cancer [31]. To address this gap, continuing education and training programs focused on oral care should be developed for healthcare providers, enhancing their knowledge and skills. This will ensure routine screening for OF in patients with cancer undergoing chemotherapy and provide comprehensive oral health education.

This study also found that the 8th item in the OFI-8, "whether they see a dentist at least once a year." scored 1 (1, 1), indicating that the majority of patients with cancer undergoing chemotherapy do not meet the standard of visiting a dentist at least once a year. This may be related

Table 4 Multiple stepwise linear regression analysis results of influencing factors of OF in patients with cancer undergoing chemotherapy ($N = 363$)

Variable	β	SE	β′	t	P
Constant	2.803	0.395		7.097	< 0.001
Disease duration	0.355	0.089	0.147	3.999	< 0.001
History of radiation therapy	1.270	0.167	0.284	7.610	< 0.001
Dry mouth	1.071	0.155	0.249	6.894	< 0.001
Dentures	0.986	0.083	0.436	11.893	< 0.001
Chemotherapy-induced taste alteration	0.010	0.005	0.079	2.150	0.032
Acceptance of illness	−0.024	0.010	−0.090	−2.402	0.017
Family functioning	−0.106	0.030	−0.132	−3.507	0.001

$R^2 = 0.555$; after adjustment $R^2 = 0.546$, $F = 4.622$, $P < 0.05$

to the fact that the majority of participants in this study are aged ≥ 60 years and have a lower educational level. Patients aged ≥ 60 and with lower education levels often experience difficulties in understanding health information. Their awareness of oral disease prevention tends to remain at the level of "pain treatment", and due to the digital divide, they have difficulty accessing modern medical services [32]. The combined effect of age and low educational level creates a dual dilemma of physical barriers to seeking medical care and a lack of oral health literacy. Therefore, healthcare providers need to develop an age-friendly, low-barrier oral health intervention system. For patients who are unable to attend regular visits due to physical limitations, tele-dentistry consultations (e.g., via video or phone) can serve as a supplementary method [33], helping with initial oral health screening and guidance. Furthermore, Irie suggested forming a multidisciplinary team—including nurses, doctors, dentists, and other healthcare professionals—to actively provide oral health services that meet patients' needs and ensure that hospitalized patients receive appropriate attention to their oral health [34].

This study found that a long disease duration and a history of radiation therapy are significant factors influencing OF in patients with cancer undergoing chemotherapy, aligning with the findings of Yan et al. [35] and Li et al. [7]. As the disease progresses, the accumulation of chemotherapy drugs in the body gradually increases. Prolonged exposure to these drugs causes severe damage to oral mucosal cells, which struggle to fully repair, ultimately leading to OF [29]. Moreover, patients may lose confidence due to the pain and discomfort associated with extended treatment, resulting in decreased treatment adherence, which can negatively impact the prevention and management of OF. It is important to note that radiotherapy can cause DNA strand breaks and cell apoptosis, promote the release of inflammatory mediators, and damage the oral mucosa [36]. In patients with cancer undergoing concurrent radiotherapy and chemotherapy, the risk of oral mucositis significantly increases, exacerbating OF.

This study also found that dry mouth and the use of dentures are significant factors influencing OF in patients with cancer undergoing chemotherapy. In this study, dry mouth, as one of the components of OFI-8, holds particular significance in the chemotherapy population. García-Chías et al.'s study indicated that chemotherapy drugs can increase the incidence of dry mouth by inhibiting salivary gland function [37], and the reduction in salivary secretion directly leads to the breakdown of the oral mucosal barrier, increased risk of candidiasis, and reduced chewing efficiency [38]. This unique pathophysiological characteristic suggests that dry mouth may influence the progression of OF through multiple mechanisms, such as changes in salivary dynamics and microbial dysbiosis, independent of other OFI-8 indicators (e.g., reduced occlusal force, dysphagia, etc.). It is noteworthy that, in this study, patients with dentures may be more prone to OF than those without dentures. Wearing dentures may have some impact on an individual's oral health, but this effect is influenced by a variety of factors [39]. Studies have shown that factors such as the type of dentures and the duration of denture wear may act as confounders affecting the quality of oral health in patients [40]. It should be noted that, in this study, no specialized dental expert assessed the installation, occlusion status, or management of dentures during the evaluation of general data, which presents certain limitations. Therefore, although this study suggests that patients with dentures may be more susceptible to OF, further research is needed to explore the causal relationship between the two, and additional professional and scientific studies should be conducted.

Regression analysis suggests that chemotherapy-induced taste alteration is one of the primary factors exacerbating OF among patients with cancer undergoing chemotherapy. Research has demonstrated that certain chemotherapy drugs can be secreted into the oral cavity through saliva or capillary networks, where they directly interact with taste receptors, resulting in a bitter or metallic taste [41]. When patients experience taste alterations, their appetite is often diminished, leading to malnutrition [42]. Malnutrition, in turn, compromises the health of the oral mucosa and can lead to decreased oral muscle strength, affecting chewing and swallowing functions, and further increasing the risk of OF [43]. A cross-sectional study revealed that patients with cancer undergoing chemotherapy rarely receive guidance or management for taste disorders, with most patients perceiving chemotherapy-induced taste alteration merely as a side effect of chemotherapy [12]. Therefore, healthcare providers should routinely assess patients' nutritional status, provide relevant nutritional counseling, and guide them in using enteral nutrition supplements under medical supervision to improve nutritional indicators, thereby preventing OF [44]. Additionally, healthcare providers should implement health education on chemotherapy-related taste alterations to raise awareness among cancer patients, enabling them to promptly recognize and respond appropriately when taste changes occur, thereby reducing the incidence of OF.

The results of this study indicate that acceptance of illness is a significant factor influencing OF in patients with cancer undergoing chemotherapy. Currently, research on the impact of acceptance of illness on OF is limited, and these findings may provide new perspectives and insights

for its management. Acceptance of illness, as a psychological state among patients with cancer undergoing chemotherapy, influences OF either directly or indirectly by affecting their emotional well-being and adherence to oral care practices [45]. Patients with high acceptance of illness are more likely to approach treatment positively and prioritize their overall health, including oral health. They are also more inclined to follow medical recommendations for oral care, such as regular tooth brushing and the use of mouthwash, thereby reducing the incidence of OF [46]. Therefore, during chemotherapy, clinical healthcare providers should prioritize assessing patients' levels of acceptance of illness, particularly identifying those with low acceptance. Targeted interventions should aim to enhance acceptance of illness and encourage patients to adopt positive coping strategies, thus promoting effective oral care management.

This study found that better family functioning in patients with cancer undergoing chemotherapy correlates with lower levels of OF and improved oral health. First, as a key component of the social support network, the family helps patients establish broader social connections [47]. When family functioning is strong, patients communicate more frequently with family members and engage in more social activities, which enhances the activity of their oral muscles and helps slow the decline of oral function [48]. Second, the family serves as the primary source of emotional support for patients. Strong family functioning improves a patient's ability to cope with illness and significantly enhances their psychological well-being [49]. When family members actively focus on the patient's oral health and provide necessary care, the patient is more likely to maintain good oral hygiene habits, thus reducing the risk of OF. Additionally, family caregivers play a crucial role in the diagnosis, treatment, and rehabilitation of cancer patients by providing both emotional and material support, thereby creating an optimal recovery environment [50]. Therefore, healthcare professionals should educate family members on the importance of family cohesion and support in maintaining the patient's oral health, aiming to alleviate OF symptoms during chemotherapy through a family-centered approach.

Limitations

This study has several limitations. First, due to time and personnel constraints, it was conducted solely in the oncology wards of three tertiary hospitals, which restricts both the representativeness of the sample and the generalizability of the results. Future research should focus on expanding the sample size and conducting multi-center investigations across various regions to validate the external applicability of the findings. Second, the analysis did not include relevant indicators, such as nutritional status, due to research constraints, which limits the depth of exploration into the causes of OF. Third, this study is cross-sectional with a brief research duration, and no follow-up or tracking surveys were conducted. Future longitudinal studies could offer a more comprehensive understanding of changes in OF among patients with cancer undergoing chemotherapy. Finally, this study used the OFI-8 to assess OF. The scale was originally developed for community-dwelling elderly populations, and some items may introduce contextual interpretative bias when applied to chemotherapy patients. For instance, "reduced outdoor activity" in cancer populations is more likely related to treatment-related contraindications, such as neutropenia, than to oral functional decline. The potential for "conceptual transfer" with this measurement tool suggests that future research should develop specific OF assessment tools for patients with cancer undergoing chemotherapy.

Implications for clinical practice

This study provides valuable insights into the management of oral health in patients with cancer undergoing chemotherapy in clinical practice. First and foremost, healthcare providers should prioritize oral care for chemotherapy patients, focusing on key factors such as disease duration, history of radiation therapy, dry mouth, denture use, chemotherapy-induced taste changes, acceptance of illness, and family functioning. Incorporating oral examinations into routine assessments, particularly before chemotherapy, is crucial for the early detection of potential oral issues. Moreover, healthcare professionals should collaborate closely with specialists in dentistry, nutrition, and mental health to create personalized oral care plans tailored to each patient's needs. Furthermore, regular oral health education must be provided to patients, emphasizing the importance of maintaining good oral hygiene. Healthcare providers should also offer guidance on self-care practices during chemotherapy, encouraging positive oral health behaviors. In the long run, these collective efforts will help prevent oral complications, reduce the incidence of OF, and ultimately enhance patients' quality of life.

Conclusion

The incidence of OF among patients with cancer undergoing chemotherapy reaches 57.58%. Several factors, such as disease duration, history of radiation therapy, dry mouth, the use of dentures, chemotherapy-induced taste alteration, acceptance of illness, and family functioning, significantly influence the severity of OF. Therefore, healthcare professionals should conduct a comprehensive assessment of each patient's specific

risk factors and develop individualized oral care plans. Nutritional counseling aimed at managing chemotherapy-related taste alteration may further help reduce the incidence of OF. Additionally, improving patient health education not only promotes better acceptance of the illness but also enhances adherence to recommended oral care routines. Furthermore, reinforcing communication and collaboration with the patient's family is critical, as a strong family support system can improve oral health outcomes and create a more favorable recovery environment.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-025-05789-7.

Supplementary Material 1.

Acknowledgements
We thank all the patients who participated in the survey and the people who helped us during the implementation of this research.

Authors' contributions
[L]1, [X]1, and Q: Conceptualization, Investigation, Methodology, Data curation, Formal analysis, Writing-Original draft. [L]2: Resources, Writing-review & editing, Supervision. M: Data curation, recruitment, Formal analysis, Writing-review & editing. Y: Data curation, recruitment, Formal analysis, Writing-review & editing. Z: Methodology, Software. [X]2: Visualization. H: Visualization. T: Visualization. C: Writing-Original and Revised draft preparation, Supervision, Project administration. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Funding
This research received funding from Chengdu Medical College-Mike IVD Clinical Joint Research Center (funding number: 23LHNBZYB27) and Chengdu Medical College graduate research innovation fund project in 2024 (funding number: YCX2024-01–84).

Data availability
The datasets generated and/or analyzed during the current study are not publicly available due to privacy issues of the participants. Data are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the Chengdu Medical College. The ethical approval number of the study is [2024No. 08]. The researchers explained the study to eligible participants. Each participant signed a written informed consent form before participating.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]School of Nursing, Chengdu Medical College, Chengdu, Sichuan, China. [2]Department of Nursing, Nanbu People's Hospital, Nanchong, Sichuan, China. [3]Department of Oncology, Chengdu Seventh People's Hospital, Chengdu, Sichuan, China. [4]Department of Oncology, Chengdu Second People's Hospital, Chengdu, China.

Received: 16 December 2024 Accepted: 12 March 2025
Published online: 24 March 2025

References

1. Bray F, Laversanne M, Sung H, et al. Global cancer statistics 2022: globocan estimates of incidence and mortality worldwide for 36 cancers in 185 countries. Ca Cancer J Clin. 2024;74(3):229–63. https://doi.org/10.3322/caac.21834.
2. Behranvand N, Nasri F, Zolfaghari ER, et al. Chemotherapy: a double-edged sword in cancer treatment. Cancer Immunol Immunother. 2022;71(3):507–26. https://doi.org/10.1007/s00262-021-03013-3.
3. Wong F, Ng Y, Leung WK. Oral health and its associated factors among older institutionalized residents-a systematic review. Int J Environ Res Public Health. 2019;16(21). https://doi.org/10.3390/ijerph16214132.
4. Wilberg P, Hjermstad MJ, Ottesen S, Herlofson BB. Oral health is an important issue in end-of-life cancer care. Support Care Cancer. 2012;20(12):3115–22. https://doi.org/10.1007/s00520-012-1441-8.
5. Zhao H, Wu B, Zhou Y, et al. Oral frailty: a concept analysis. BMC Oral Health. 2024;24(1):594. https://doi.org/10.1186/s12903-024-04376-6.
6. Meurman JH, Bascones-Martinez A. Oral infections and systemic health - more than just links to cardiovascular diseases. Oral Health Prev Dent. 2021;19:441–8. https://doi.org/10.3290/j.ohpd.b1993965.
7. Yi L, Ziyan Z, Yanling Z, et al. Oral frailty and its influencing factors among hospitalized cancer patients. J Nurs Sci. 2024;39(03):49–52.
8. Hu S, Li X. An analysis of influencing factors of oral frailty in the elderly in the community. BMC Oral Health. 2024;24(1):260. https://doi.org/10.1186/s12903-024-03946-y.
9. Ting L, Juan L, Simin L, Fengyin Z, Xiaoyue W. Visual analysis of the current situation and hotspots of oral frailty in the elderly based on citespace. Geriatrics Research. 2024;5(04):53–8.
10. Lenz ER, Suppe F, Gift AG, Pugh LC, Milligan RA. Collaborative development of middle-range nursing theories: toward a theory of unpleasant symptoms. Ans Adv Nurs Sci. 1995;17(3):1–13. https://doi.org/10.1097/00012272-199503000-00003.
11. Dominiak H, Hasselsteen SD, Nielsen SW, Andersen JR, Herrstedt J. Prevention of taste alterations in patients with cancer receiving paclitaxel- or oxaliplatin-based chemotherapy-a pilot trial of cannabidiol. Nutrients. 2023;15(13). https://doi.org/10.3390/nu15133014.
12. Al-Amouri FM, Badrasawi M. Taste alteration and its relationship with nutritional status among cancer patients receiving chemotherapy, cross-sectional study. PLoS One. 2024;19(5): e302990. https://doi.org/10.1371/journal.pone.0302990.
13. Yanxin Z, Li Y, Jiayan L, et al. Analysis of psycho-social adaptation of patients with nasopharyngeal carcinoma and its influencing factors. Chin Nurs Res. 2022;36(05):896–901. https://doi.org/10.12102/j.issn.1009-6493.2022.05.026.
14. Cipora E, Konieczny M, Sobieszczanski J. Acceptance of illness by women with breast cancer. Ann Agric Environ Med. 2018;25(1):167–171. https://doi.org/10.26444/aaem/75876.
15. Cramer P. Defense mechanisms in psychology today. Further processes for adaptation. Am Psychol. 2000;55(6):637–46. https://doi.org/10.1037/0003-066x.55.6.637.
16. Xihua W, Yu S, Min L, et al. Status quo of stoma acceptance in patients with temporary stoma and its relationship with self-management behavior. J Nurs Training. 2024;39(08):785–789. https://doi.org/10.16821/j.cnki.hsjx.2024.08.001.
17. Ajwani S, Jayanti S, Burkolter N, et al. Integrated oral health care for stroke patients - a scoping review. J Clin Nurs. 2017;26(7–8):891–901. https://doi.org/10.1111/jocn.13520.
18. Wu Y, Jiao M, Zhu M, Han Y, Tao X, Wang X. Current situation and influencing factors of oral frailty in the elderly hospitalized patients with chronic diseases. J Mudanjiang Med Univ. 2024;45(02):44–48. https://doi.org/10.13799/j.cnki.mdjyxyxb.2024.02.034.

19. Kuhne F, Krattenmacher T, Bergelt C, et al. "There is still so much ahead of us"-family functioning in families of palliative cancer patients. Fam Syst Health. 2013;31(2):181–93. https://doi.org/10.1037/a0032274.
20. Liang L, Li F, Shi T. Research progress of family function in chronic disease patients. Chinese Journal of Modern Nursing. 2020;26(26):3557–62. https://doi.org/10.3760/cma.j.cn115682-20200316-01801.
21. Ni P, Chen J, Liu N. The sample size estimation hi quantitative nursing research. Chin J Nurs. 2010;45(4):378–80. https://doi.org/10.3761/j.issn.0254-1769.2010.04.037.
22. Tanaka T, Hirano H, Ohara Y, Nishimoto M, Iijima K. Oral frailty index-8 in the risk assessment of new-onset oral frailty and functional disability among community-dwelling older adults. Arch Gerontol Geriatr. 2021;94:104340. https://doi.org/10.1016/j.archger.2021.104340.
23. Kuder GF, Richardson MW. The theory of the estimation of test reliability. Psychometrika. 1937;2(3):151–60. https://doi.org/10.1007/BF02288391.
24. Pang D, Qian L, Chen ZJ, et al. Psychometric properties of the chinese version of the chemotherapy-induced taste alteration scale. Eur J Oncol Nurs. 2019;42:7–13. https://doi.org/10.1016/j.ejon.2019.07.007.
25. Zhao W. Evaluation of reliability and validity of the chinese version of acceptance illness scale. Chinese Journal of Modern Nursing. 2018;24(22):2652–5. https://doi.org/10.3760/cma.j.issn.1674-2907.2018.22.012.
26. Fan L, Yuan G. Family apgar questionnaire and its clinical application. Foreign Med. 1995;2:56–9.
27. Kugimiya Y, Watanabe Y, Ueda T, et al. Rate of oral frailty and oral hypofunction in rural community-dwelling older japanese individuals. Gerodontology. 2020;37(4):342–52. https://doi.org/10.1111/ger.12468.
28. Huiying Y, Zhichao H, Yujiao Z, Rui T, Rui M, Yiqun T. Progress in prevention and treatment of chemoradiotherapy associated oral mucositis. J Modern Oncol. 2023;31(12):2347–52. https://doi.org/10.3969/j.issn.1672-4992.2023.12.031.
29. Curra M, Soares JL, Martins MD, Santos P. Chemotherapy protocols and incidence of oral mucositis. An integrative review. Einstein (Sao Paulo). 2018;16(1):eRW4007. https://doi.org/10.1590/s1679-45082018rw4007.
30. Mercadante V, Jensen SB, Smith DK, et al. Salivary gland hypofunction and/or xerostomia induced by nonsurgical cancer therapies: isoo/mascc/asco guideline. J Clin Oncol. 2021;39(25):2825–43. https://doi.org/10.1200/JCO.21.01208.
31. Kusiak A, Jereczek-Fossa BA, Cichonska D, Alterio D. Oncological-therapy related oral mucositis as an interdisciplinary problem-literature review. Int J Environ Res Public Health. 2020;17(7). https://doi.org/10.3390/ijerph17072464.
32. Cao C, Liao S, Cao W, et al. Differences in the association of oral health knowledge, attitudes, and practices with frailty among community-dwelling older people in china. BMC Oral Health. 2023;23(1):782. https://doi.org/10.1186/s12903-023-03477-y.
33. Alavi SE, Gholami M, Malik L, et al. Assessment of teledentistry in improving access to dental care: a systematic review. Aust Dent J. 2024. https://doi.org/10.1111/adj.13045.
34. Irie K, Mochida Y, Altanbagana NU, Fuchida S, Yamamoto T. Relationship between risk of oral frailty and awareness of oral frailty among community-dwelling adults: a cross-sectional study. Sci Rep. 2024;14(1):433. https://doi.org/10.1038/s41598-023-50818-6.
35. Xiaoyan Y, Jing H, Xia L, Jilian X. Analysis of risk factors for oral mucositis in gynecological tumor patients undergoing chemotherapy. Chin Nurs Res. 2023;37(16):2998–3001. https://doi.org/10.12102/j.issn.1009-6493.2023.16.026.
36. Gao Y. Analysis of factors affecting radiation oral mucositis and quality of life related to oral health [D]: Shanxi Medical University; 2020.
37. Garcia-Chias B, Figuero E, Castelo-Fernandez B, Cebrian-Carretero JL, Cerero-Lapiedra R. Prevalence of oral side effects of chemotherapy and its relationship with periodontal risk: a cross sectional study. Support Care Cancer. 2019;27(9):3479–90. https://doi.org/10.1007/s00520-019-4650-6.
38. Jensen SB, Pedersen AM, Vissink A, et al. A systematic review of salivary gland hypofunction and xerostomia induced by cancer therapies: prevalence, severity and impact on quality of life. Support Care Cancer. 2010;18(8):1039–60. https://doi.org/10.1007/s00520-010-0827-8.
39. Cui T, Qiu L, Hou D. Association between psychological resilience, social support and oral health behaviours in patients with implant dentures. BMC Oral Health. 2025;25(1):34. https://doi.org/10.1186/s12903-024-05226-1.
40. Tosun B, Uysal N. Examination of oral health quality of life and patient satisfaction in removable denture wearers with ohip-14 scale and visual analog scale: a cross-sectional study. BMC Oral Health. 2024;24(1):1353. https://doi.org/10.1186/s12903-024-05124-6.
41. Ijpma I, Renken RJ, Ter Horst GJ, Reyners AK. Metallic taste in cancer patients treated with chemotherapy. Cancer Treat Rev. 2015;41(2):179–86. https://doi.org/10.1016/j.ctrv.2014.11.006.
42. Mcgreevy J, Orrevall Y, Belqaid K, Wismer W, Tishelman C, Bernhardson BM. Characteristics of taste and smell alterations reported by patients after starting treatment for lung cancer. Support Care Cancer. 2014;22(10):2635–44. https://doi.org/10.1007/s00520-014-2215-2.
43. Yu J, Zhu H, Zhang Y, Wang D, Guo H, Liu X. Research hotspots and trends of oral health in older adults from 2013 to 2023: a bibliometric and visual analysis. Heliyon. 2024;10(3): e25243. https://doi.org/10.1016/j.heliyon.2024.e25243.
44. Fang P, Min F, Dan G. Survey on the risk of oral frailty among the elderly in the community and analysis of its influ-encing factors. Practical Journal of Clinical Medicine. 2024;21(03):163–6.
45. Qiu L. Positivity of self-management in patients with gynaecological malignant tumour undergoing chemotherapy:current current status, influencing factors, and strategies countermeasures of self-management enthusiasm in gynecological malignant tumor patients undergoing chemotherapy. Modern Clinical Nursing. 2023;22(06):38–45. https://doi.org/10.3969/j.issn.1671-8283.2023.06.006.
46. Howell D, Mayer DK, Fielding R, et al. Management of cancer and health after the clinic visit: a call to action for self-management in cancer care. J Natl Cancer Inst. 2021;113(5):523–31. https://doi.org/10.1093/jnci/djaa083.
47. Lau N, Steineck A, Walsh C, et al. Social support resources in adolescents and young adults with advanced cancer: a qualitative analysis. Bmc Palliat Care. 2024;23(1):193. https://doi.org/10.1186/s12904-024-01527-y.
48. Mikami Y, Watanabe Y, Motokawa K, et al. Association between decrease in frequency of going out and oral function in older adults living in major urban areas. Geriatr Gerontol Int. 2019;19(8):792–7. https://doi.org/10.1111/ggi.13715.
49. Lee MK. Caregiving strain, family functioning, and effort to change diet for patients with gastrointestinal cancer: a cross-sectional descriptive study. Eur J Oncol Nurs. 2023;62: 102264. https://doi.org/10.1016/j.ejon.2022.102264.
50. Schulman-Green D, Feder SL, Dionne-Odom JN, et al. Family caregiver support of patient self-management during chronic, life-limiting illness: a qualitative metasynthesis. J Fam Nurs. 2021;27(1):55–72. https://doi.org/10.1177/1074840720977180.

Publisher's Note