Association Between Oral Health Complaints and Nutritional Status among Patients with Cancer: A Study Utilising the Mini Nutritional Assessment Short Form

Sachin Naik / Sajith Vellappally / Mohammed Alateek / Abdulaziz Abdullah Al Kheraif / Mohammed Alghamdi / Sukumaran Anil

Purpose: Oral health problems in patients with cancer can substantially affect their quality of life, treatment outcomes, and overall nutritional well-being. This study investigated the relationship between nutritional status and self-reported oral health complaints in patients with cancer.

Materials and Methods: A cross-sectional study was conducted among patients with cancer at the King Saud University Medical City Oncology Center in Riyadh, Saudi Arabia. Patients' nutritional status was assessed using the mini nutritional assessment short form (MNA-SF), and self-reported oral health problems were documented. Data were analysed using the Chi-square test and multinomial logistic regression.

Results: This study included 200 participants who completed both the MNA-SF assessment and self-reported their oral health complaints. Common oral health problems included xerostomia (81%), bleeding gums (60.5%), toothaches (35%), and mouth ulcers (24%). Malnourished individuals reported higher rates of all oral complaints, with 54% of them experiencing bleeding gums, 50% reporting toothaches, and 54% experiencing speech problems. Notably, 71% of malnourished patients reported mouth ulcers ($P < 0.05$). Regression analysis revealed a statistically significant association ($P < 0.05$) between xerostomia and the 'At risk of malnutrition' group, with an odds ratio of 1.004 (95% confidence interval [CI]: 0.411–2.449). In the 'Malnourished' category, mouth ulcers showed a statistically significant association ($P < 0.05$) with an odds ratio of 1.402 (95% CI: 0.409–4.800).

Conclusion: Our findings highlighted statistically significant correlations between nutritional status, as assessed using the MNA-SF, and oral health complaints in patients with cancer. Well-nourished individuals reported fewer oral complaints, whereas malnourished patients reported a higher prevalence of oral health issues.

Keywords: BMI, cancer, malnutrition, mini nutritional assessment, oral health

Oral health is critical for overall well-being, particularly in patients with cancer undergoing treatment. In Saudi Arabia, the prevalence of cancer is rising, with projections indicating a significant increase of 116.7% in new cases by 2040.[1] Concurrently, malnutrition poses a substantial health concern among patients with cancer, with studies showing that up to 26% of such patients may be malnourished.[3] Patients with cancer frequently experience a range of oral health problems, creating a complex relationship between cancer, nutrition, and oral health. These oral health challenges can significantly affect a patient's quality of life (QoL), treatment outcomes, and overall nutritional well-being.[21,40] The bidirectional nature of this relationship is increas-

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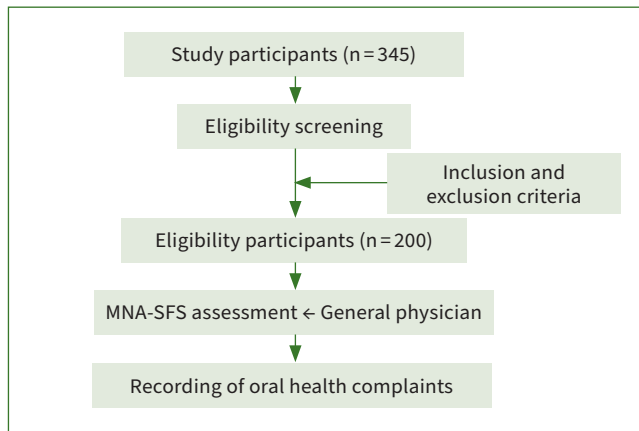
Fig 1 Flowchart of the study methodology.

ingly recognised; oral health issues can lead to malnutrition, whereas poor dietary status can exacerbate oral health problems.

Malnutrition in patients with cancer often results from a combination of disease-related factors and side effects of treatment. These include decreased nutrient consumption, loss of appetite, and changes in taste, often accompanied by psychological factors such as fear, depression, and anxiety.[16] Certain nutrients, particularly vitamins and proteins, are crucial in maintaining oral health by supporting tissue repair and enhancing the immune system's capacity to fight oral infections.[33] Conversely, nutritional deficiencies can worsen oral health problems and aggravate pre-existing conditions.[24]

Patients with cancer frequently experience debilitating symptoms such as fatigue, anorexia, and pain, along with oral health issues, including dry mouth (xerostomia), candidiasis, dysphagia, ulcers, and mucositis. These oral problems severely impact QoL by affecting essential functions such as eating and speaking and can exacerbate psychological distress.[15] Studies have shown strong associations between oral health, nutrition, and QoL in patients with cancer.[5,9,11,29,37]

Research indicates that integrating oral healthcare into cancer care can enhance the ability to eat, speak, and swallow and improve nutritional status. Optimising nutritional status before, during, and after cancer treatment is recommended to improve treatment tolerance.[5]

Cancer treatment further complicates the relationship between nutritional status and oral health in patients with cancer. Chemotherapy and radiation therapy can contribute to oral complications such as mucositis, xerostomia, alterations in salivary composition, and changes in taste perception.[24,28] These complications can significantly impact a patient's ability to eat, speak, and maintain oral hygiene.[34] For instance, mucositis and dysphagia can lead to reduced food intake, potentially resulting in malnutrition.[7] Consequently, malnutrition can weaken the immune system and impair wound healing, making patients more susceptible to oral infections and ulcers.[7] This creates a potential cycle where oral health issues lead to poor nutrition, which can worsen oral health.

**Table 1** Description of the study population (n = 200)

Characteristic	N	Percentage
Gender		
Male	113	56.5
Female	87	43.5
Age (year)		
18 to 24	4	2
25 to 44	40	20
45 to 64	96	48
≥65	60	30
Marriage		
Married	179	89.5
Unmarried	21	10.5
Type of cancer		
Breast cancer	64	32
Colon cancer	69	34.5
Lung cancer	10	5
Others	57	28.5
Treatment		
Chemotherapy (n = 200)	180	90
Radiotherapy (n = 200)	67	33.5
Surgery (n = 200)	78	39
Body mass index (kg/m2)		
Mean ± SD	28	(±17.06)

Table 2 Self-reported oral complaints

Oral health complaints	Yes	Percentage	No	Percentage
Bleeding gum	121	60.5	79	39.5
Toothache	70	35	130	65
Mouth ulcers	49	24	152	76
Bruxism	8	4	192	96
Xerostomia	162	81	38	19
Problems affecting speech	10	5	190	95
Satisfactory dietary intake	172	86	28	14

Although some interventional studies have shown promising results, such as the potential of nutritional supplements to reduce the severity of oral mucositis and accelerate healing, research in this area remains limited.[24,27,42] Further studies are required to develop effective interventions to address the complex relationships between nutrition, oral health, and cancer.

Fig 2 Nutritional status of the study participants according to mini nutritional assessment short-form scores.
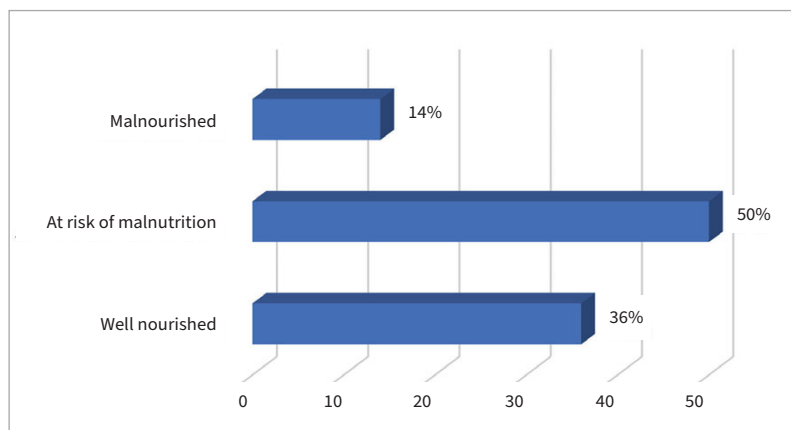
This study aimed to analyse the correlation between nutritional status and self-reported oral health complaints among patients with cancer, focusing on specific issues such as bleeding gums, toothaches, mouth ulcers, bruxism, xerostomia, and speech-related difficulties. By exploring these associations, we hope to contribute to the progress and development of integrated approaches to cancer care that concurrently address nutritional and oral health needs.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study focused on individuals diagnosed with cancer who were recruited from King Khalid University Hospital, King Saud University Medical City, Riyadh, Saudi Arabia. Data were collected between December 2023 and February 2024 (Fig 1). Potential participants were identified through their medical records and oncologist referrals. Eligible patients were contacted, provided with the study information, and invited to participate. Patients of interest underwent a screening process to confirm their eligibility.

The study included patients aged 18 years or older, with a cancer diagnosis or undergoing treatment, who provided informed consent either personally or through a caregiver. The exclusion criteria included patients with severe cognitive impairment, those with terminal illness, those who declined to provide informed consent, and pregnant women. The sample size for this study was calculated using G*Power software (version 3.1.9.7). We based our calculation on previous literature examining the prevalence of malnutrition in patients with cancer.[2] Assuming a moderate effect size (Cohen's w = 0.3), an alpha level of 0.05, and a desired power of 0.80; the minimum required sample size was estimated to be 196 participants. To account for potential dropouts or incomplete data, we recruited 200 participants.[10] This sample size was deemed adequate to detect clinically meaningful differences in oral health complaints between nutritional status groups, while also allowing for potential subgroup analyses.

Data were collected using a survey form comprising two main sections: demographic information and a self-reported oral health complaint questionnaire. Oral health complaints were selected based on insights from prior literature,[14,22,40] with patients personally recording their complaints to ensure that the data reflected their direct experiences.

Marital status data were collected to understand the role of social and emotional support in managing the side effects of treatment, including nutritional and oral health complaints.

Nutritional status was assessed using the mini nutritional assessment short form (MNA-SF), a validated tool comprising components across four key areas[18]: anthropometric measurements (height, weight, body mass index [BMI]), general health indicators (medical history, medication use, mobility), dietary habits and nutritional intake, and subjective health perceptions.

A pilot study was conducted over 2 weeks with 5% of the study sample to assess its feasibility and practicality. Data were collected using Google Forms, which allowed participants to complete the online survey. A team of experienced physicians and nursing staff assessed participants' nutritional status.

Ethical Considerations

This study was approved by the Ethics Committee of King Saud University (approval number: 23/0910/IRB).

Statistical Analysis

SPSS version 27.0 (Armonk, NY: IBM Corp) was used for all data analyses. Qualitative data were analysed using frequency distributions. The relationship between oral health complaints and MNA-SF scores was analysed using the Chi-squared test. Quantitative data, including BMI, were analysed using descriptive statistics.

MNA-SF scores were classified into three categories: well-nourished (≥ 24), at risk of malnutrition (17 to < 23.5), and malnourished (< 17).

Multinomial logistic regression was conducted to explore the relationship between independent variables (oral health complaints and cancer treatment type) and dependent variables (MNA-SF nutritional status). Statistical significance was set at a P value of less than 0.05.

Table 3 Descriptive statistics for mini nutritional assessment short-form variables

Variables	N	Percentage
BMI		
Under 19	17	8.5
19 to just under 21	11	5.5
21 to just under 23	25	12.5
Over 23	147	73.5
Mid-arm circumference (cm)		
Below 21 cm	7	3.5
21 to 22 cm	39	19.5
Above 22 cm	154	77
Calf circumference (cm)		
Under 31 cm	32	16
31 cm and above	168	84
Weight loss during last 3 months		
More than 3 kg	58	29
Uncertain	3	1.5
Between 1 and 3 kg	100	50
No weight loss	39	19.5
Lives independently		
Yes	190	95
No	10	5
More than 3 prescription drugs per day		
Yes	4	2
No	196	98
Psychological stress in the past 3 months		
Yes	182	91
No	18	9

Variables	N	Percentage
Mobility		
Confined to bed or chair	0	0
Can get out of bed/chair but does not leave the house	48	24
Rarely leaves home	152	76
Neuropsychological problems		
Severe dementia or depression	6	3
Mild dementia	107	53.5
No psychological issues	87	43.5
How many full meals do the patient eat daily?		
1 Meal	16	8
2 Meals	114	57
3 Meals	70	35
Markers for protein intake		
0	17	8.5
0.5	20	10
1.5	163	81.5
Servings of fruits or vegetables per day		
Yes	153	76.5
No	47	23.5
Food intake declined over the past three months		
Severe decline	17	8.5
Moderate decline	53	26.5
No decline	130	65
View themselves as having nutritional problems		
Major malnutrition	6	3
Uncertain or moderate malnutrition	44	22
No nutritional issues	150	75

RESULTS

Table 1 presents the participants' characteristics. Men comprised 56.5% of the sample, whereas women comprised 43.5%. The 45–64 years age group represented approximately 48% of the participants, with 30% aged 65 years or older. Colon cancer was the most prevalent type of cancer (34.5%), followed by breast cancer (32%). The remaining 28.5% of patients had other types of cancer. The cancer treatments included chemotherapy (90%), radiation (33.5%), and surgery (33.5%). The participants exhibited statistically significant variability in BMI, with an average of 28 (standard deviation: ±17.06).

Among the oral health complaints, 60.5% of study participants reported bleeding gums, 35% reported toothache, 24% had mouth ulcers, and 4% had bruxism (Table 2). Most of the respondents (81%) had xerostomia. Only 5% of the participants had problems affecting their speech. Approximately 86% of the participants reported satisfactory food intake, whereas 14% expressed concerns. Figure 2 indicates that 36% of participants were well-nourished, 50% were at risk of malnutrition, and 14% were malnourished.

Table 3 shows that over the past 3 months, 29% of people lost more than 3 kg of weight, raising weight loss concerns. Moreover, 95% of participants live independently without a bed or chair. Approximately 53.5% of patients had mild dementia. Regarding protein intake, 81.5% of participants scored 1.5, indicating satisfactory protein intake. A statistically significant proportion (76.5%) reported consuming fruits and vegetables daily. Furthermore, most participants (67%) perceived their health to be better than others, and 75% reported no nutritional difficulties. Notably, approximately 73.5% of the participants had BMIs exceeding 23, indicating a tendency towards higher body weight.

Figure 3 illustrates the relationship between oral health complaints and nutritional status based on MNA-SF scores.

Fig 3 Percentage of oral health complaints in patients with cancer, based on nutritional status.
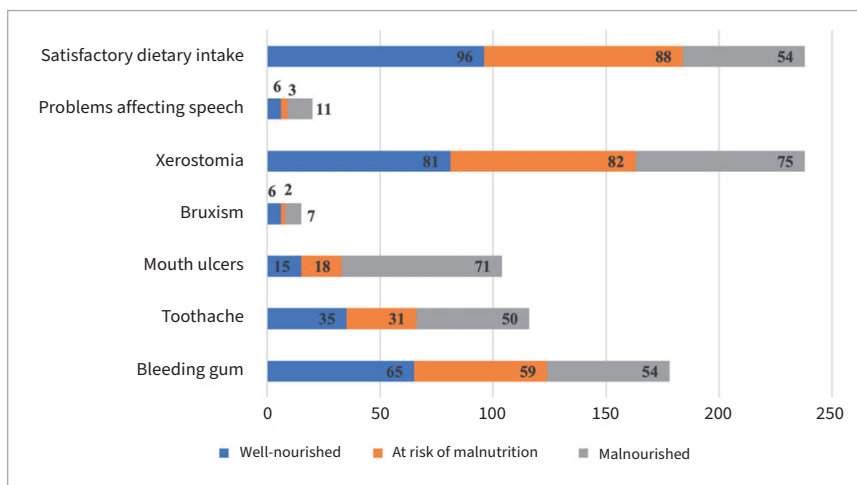
Well-nourished individuals exhibited lower rates of toothaches (35%), problems affecting speech (6%), and bleeding gums (65%), as determined by the MNA-SF assessment.

Table 4 shows statistically significant differences in satisfactory dietary intake among the different nutritional status groups (P <0.001). Malnourished participants reported higher rates of various oral complaints, including bleeding gums (59%), toothaches (31%), and speech problems (82%). Additionally, xerostomia was reported in 82% of the malnourished participants. Malnourished individuals also had significantly higher rates of mouth ulcers, with 71% affected (P <0.03).

Our findings indicate that chemotherapy may contribute to an increase in oral health complaints, specifically bleeding gums, toothaches, and speech-related problems. Among the observed complaints, 83% reported experiencing xerostomia, whereas 17% did not encounter such issues (P = 0.04). This suggests a statistically significant association between chemotherapy and xerostomia.

In the BMI category of 23 or greater, 60% of individuals reported bleeding gums, 40% reported toothache, and 28% reported problems affecting speech. The occurrence of oral complaints varied across BMI categories. Individuals who reported weight loss exceeding 3 kg exhibited a notable association with problems affecting speech, with a higher percentage (24%) reporting this issue compared with those without weight loss (13%) (P = 0.02). Additionally, these patients demonstrated higher rates of toothaches (40%) and bleeding gums (50%) than the general population. According to the MNA-SF, people who took more than three prescription medications daily reported a higher percentage of toothache (75%) compared with those in the 'No' category (65%) (P > 0.05).

Individuals with severe depression showed a statistically significant association with problems affecting speech, with a higher percentage (83%) than in those without severe depression (17%) (P = 0.02). Severe depression was also statistically significant associated with a higher prevalence of xerostomia, with 83% reporting xerostomia compared with 17% without severe depression (P = 0.03).

The results of the multinomial regression analysis for the malnutrition categories are presented in Table 5. In the 'At risk of malnutrition' category, chemotherapy revealed a marginally significant association (OR: 1.335; 95% confidence interval [CI]: 0.246–2.841; P = 0.07); xerostomia exhibited a statistically significant association (OR: 1.004; 95% CI: 0.411–2.449; P < 0.05); and a satisfactory diet was also statistically significantly associated (OR: 0.296; 95% CI: 0.076–1.150; P <0.05). In the 'Malnourished' category: chemotherapy was statistically significantly associated (OR: 1.517; 95% CI: 0.096–2.769; P < 0.05); mouth ulcers showed a statistically significant association (OR: 1.402; 95% CI: 0.409–4.800; P < 0.05); xerostomia showed a statistically significant association (OR: 1.819; 95% CI: 0.232–2.895; P < 0.05); and a satisfactory dietary intake showed a substantial association (OR: 0.05; 95% CI: 0.013–0.242; P < 0.05). These results indicate that the impact of xerostomia and mouth ulcers on nutrition may be influenced by oral health problems, leading to a connection between chemotherapy, oral health, and nutrition.

DISCUSSION

The nutritional status and oral health of patients with cancer are crucial for their overall well-being and treatment outcomes. This study explored the relationship between nutritional status and self-reported oral health complaints in patients with cancer and revealed statistically significant associations that underscore the complex interplay between cancer, nutrition, and oral health. Using the MNA-SF, we found that well-nourished patients had fewer oral health complaints, emphasising the link between oral health and nutrition. This aligns with previous studies that have highlighted the connection between nutrition, dental health, and cancer prognosis.[4,8,26,35] According to Polański et al, cancer and its treatments can decrease food intake, alter metabolism, and cause malnutrition. Our study corroborates these findings and demonstrates the prevalence of malnutrition in patients with cancer.[31]

A key finding of our study was the statistically significant higher prevalence of mouth ulcers among malnourished individ-

Table 4 Relationship between items of the mini nutritional assessment short form and self-reported oral complaints

	Bleeding gum	Toothache	Mouth ulcers	Bruxism	Xerostomia	Problems affecting speech	Satisfactory dietary intake
	(% Y/N)	(% Y/N)	(% Y/N)	(% Y/N)	(% Y/N)	(% Y/N)	(% Y/N)
Type of treatment							
Chemotherapy (n=180)	61/39	37/63	18/82	18/82	83/17	4/96	86/14
					P=0.04*		
Radiotherapy	69/31	45/55	18/82	5/96	76/24	6/94	81/19
Surgery	58/42	40/60	22/78	5/95	77/23	6/94	86/14
Malnutrition parameters							
Well-nourished	65/35	35/65	15/85	6/94	81/19	6/94	96/4
At risk of malnutrition	59/41	31/69	18/82	2/98	82/18	3/97	88/12
Malnourished	54/46	50/50	71/29	7/93	75/25	11/89	54/46
		P=0.03*			P=0.04*		P=0.001*
Y=Yes, N=No, *=Significant.							

uals identified using the MNA-SF. This aligns with previous research that established a connection between vitamin deficiencies, malnutrition, and problems with oral mucosal tissues.[12] Liu et al[25] emphasised the role of nutrition in improving the survival rates of individuals with oral cancer. Higher consumption of fruits, vegetables, and proteins benefits oral health.[28,34]

Patients with cancer often take high-sugar supplements to maintain their energy levels during treatment. However, these supplements, combined with reduced oral hygiene due to treatment-related pain, can increase the risk of oral diseases, such as mucositis, candidiasis, and dental caries. Hence, proper oral care is essential for mitigating these risks.[39]

Our study supports previous findings by Epstein et al, who identified common oral health problems in patients with cancer, including xerostomia, oral mucositis, altered taste, and difficulty swallowing.[13] Oral mucositis, affecting 40–70% of patients undergoing chemotherapy and radiotherapy, emerged as a critical factor in this relationship.[32] Mucositis-associated ulcers can cause intense pain and swallowing difficulties, potentially leading to malnutrition. Conversely, malnutrition can weaken the immune system, making patients more susceptible to severe mucositis and other oral infections.[32,34] Xerostomia, a common side effect of cancer therapy, was found to lead to dysphagia, reduced food intake, and potentially cause malnutrition and weight loss. It impairs chewing and swallowing, necessitating dietary modifications and saliva substitutes for management.[32]

Our study found that well-nourished individuals across all BMI categories had fewer oral health complaints, aligning with previous research.[23] Participants who experienced substantial weight loss showed a higher prevalence of bleeding gums and toothaches, highlighting the impact of weight loss on oral health deterioration. This suggests that achieving better overall health outcomes necessitates integrated healthcare approaches that address nutritional deficiencies and include weight management strategies.[30] In an earlier study, researchers extensively examined dietary status as a predictor of the length of stay (LOS) among patients with cancer, alongside dental health. A thorough review was conducted regarding nutritional status and its relationship with LOS in patients with cancer, highlighting the importance of using standardised measurements across patient demographics and study designs.[19] The study emphasised the high prevalence of malnutrition among patients with gastrointestinal cancer, and stressed the importance of timely nutrition education and professional care.[41]

The sstatistically significant findings of this study revealed that individuals who consumed more than three prescription drugs daily and experienced frequent malnutrition were more prone to bleeding gums and toothaches.

Our research also delved into psychological aspects, noting that severe depression demonstrated a notable association with problems affecting speech. This aligns with previous studies that emphasised the psychological impact of oral health problems on patients with cancer and the correlation between psychological symptoms and self-reported oral health.[20] These findings underscore the importance of adopting a holistic approach with comprehensive care integrating oral hygiene, nutrition, and emotional support for patients with cancer, in order to tackle medication-related nutritional challenges and their repercussions on oral hygiene.[27]

Table 5 Parameter estimates of multinomial logistic regression results

MNA-SF categories[a]		B	P value	OR	95% Confidence interval for OR	
					Lower bound	Upper bound
At risk of malnutrition	Intercept	1.69	0.08			
	Chemotherapy	0.18	0.07	1.335	0.246	2.841
	Surgery	0.21	0.51	1.240	0.651	2.363
	Radiotherapy	0.46	0.22	1.592	0.755	3.355
	Bleeding gum	−0.30	0.39	0.740	0.371	1.479
	Toothache	−0.22	0.52	0.796	0.391	1.621
	Mouth ulcers	0.23	0.60	1.259	0.525	3.018
	Bruxism	−1.1	0.20	0.309	0.050	1.923
	Xerostomia	2.00	0.03*	1.004	0.411	2.449
	Problem affecting speech	−0.95	0.25	0.387	0.076	1.957
	Satisfactory diet	1.21	0.01*	0.296	0.076	1.150
Malnourished	Intercept	2.06	0.08			
	Chemotherapy	0.66	0.02*	1.517	0.096	2.769
	Surgery	0.20	0.68	1.233	0.448	3.390
	Radiotherapy	0.41	0.47	1.511	0.490	4.659
	Bleeding gum	−0.53	0.31	0.585	0.204	1.675
	Toothache	0.21	0.69	1.239	0.419	3.662
	Mouth ulcers	0.33	0.04*	1.402	0.409	4.800
	Bruxism	0.17	0.86	1.195	0.156	9.144
	Xerostomia	−0.19	0.03*	1.819	0.232	2.895
	Problem affecting speech	−0.15	0.87	0.861	0.125	5.919
	Satisfactory diet	−2.87	0.01	0.056	0.013	0.242

[a] Difference category = well-nourished, OR = Odds ratio, B = coefficient, * Significant.

While our study did not capture data on radiotherapy, cancer staging, medications, and systemic diseases, previous research has suggested that these factors can significantly affect oral health and nutrition in patients with cancer. Radiotherapy, especially in the head and neck region, is known to cause severe mucositis and xerostomia.[38] Moreover, advanced cancer stages are often associated with higher rates of malnutrition.[17] Additionally, certain medications, such as some chemotherapy agents, can directly affect oral health and appetite.[6] Furthermore, comorbid systemic diseases such as diabetes can complicate both nutritional status and oral health.[36]

Limitations

This study had a few limitations. First, the cross-sectional design limited the establishment of causality between nutritional status and oral health complaints; hence, longitudinal studies are required to provide more robust evidence. Second, generalizability may be limited because the participants were enrolled from a single oncology centre. Third, there was a lack of detailed information on radiotherapy treatment, cancer staging, medication regimens, and comorbid systemic diseases, which could substantially affect nutrition and oral health and potentially confound our results. Fourth, although the Mini MNA-SF is commonly used, its primary focus on the elderly may limit its applicability to younger patients with cancer. The reliance on self-reported oral health complaints may introduce recall bias, and the study's emphasis on specific elements of oral health could make it challenging to obtain a comprehensive overview. Finally, this study did not account for potential differences in oral health complaints across various cancer types or stages. These limitations highlight the need for future research to address these gaps, particularly studies that include more detailed clinical information and employ objective oral health assessments.

CONCLUSION

This study demonstrated a statistically significant relationship between nutritional status, as measured by the MNA-SF, and oral health complaints in patients with cancer. Well-nourished individuals exhibited lower rates of oral health issues, whereas malnourished individuals and those at risk of malnutrition reported a higher prevalence of oral health complaints. These findings underscore the broad impact of nutritional status on oral health in patients with cancer. Moreover, they highlight the need for a comprehensive approach to cancer care that integrates nutritional counselling, oral health assessments, and preventive measures alongside traditional treatment modalities. Further research is required to study the association between nutrition and oral health in patients with cancer. Interventional studies are required to determine the effectiveness of nutritional and oral health interventions in this population. Such research could inform the development of more targeted and effective care protocols for patients with cancer, potentially improving their overall treatment outcomes and well-being.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Consent to Participate

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

REFERENCES

1. Alessy SA, Almotlak AA, Alattas M, Alshareef A, Alwosaibai K, Alghamdi MA, et al. Cancer research challenges and potential solutions in Saudi Arabia: a qualitative discussion group study. JCO Glob Oncol 2024;10:e2300189.

2. Alghofaili AA, Aladel AI, Alsoghier AM, Othman F, Shoqeair MM, Alqahtani SM, et al. Association of oral and general health with nutritional status of older adults attending two medical centers in Riyadh, Saudi Arabia: a cross-sectional study. Nutrients 2023;15:4032.

3. Alsaleh K, Almomen FA, Altaweel A, Barasain O, Alqublan A, Binsalamah A, et al. Malnutrition in cancer patients receiving chemotherapy in a single oncology center. J Nat Sci Med 2021;4:170–174.

4. Alshadwi A, Nadershah M, Carlson ER, Young LS, Burke PA, Daley BJ. Nutritional considerations for head and neck cancer patients: a review of the literature. J Oral Maxillofac Surg 2013;71:1853–1860.

5. Anand S, Visser A, Epstein JB, Jalovcic D. Necessity and influencing factors for integrating oral health in cancer care for older people: a narrative review. Support Care Cancer 2024;32:461.

6. Anand U, Dey A, Chandel AKS, Sanyal R, Mishra A, Pandey DK, et al. Cancer chemotherapy and beyond: Current status, drug candidates, associated risks and progress in targeted therapeutics. Genes Dis 2023;10:1367–1401.

7. Bao X, Liu F, Lin J, Chen Q, Chen L, Chen F, et al. Nutritional assessment and prognosis of oral cancer patients: a large-scale prospective study. BMC Cancer 2020;20:1–8.

8. Barrios R, Tsakos G, Gil-Montoya J, Montero J, Bravo M. Association between general and oral health-related quality of life in patients treated for oral cancer. Med Oral Patol Oral y Cir Bucal 2015;20:e678–e684.

9. Barrios R, Bravo M, Gil-Montoya J, Martínez-Lara I, García-Medina B, Tsakos G. Oral and general health-related quality of life in patients treated for oral cancer compared to control group. Health Qual Life Outcomes 2015;13:9.

10. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med 2013;35:121–126.

11. Chen N, Yu Y, Shen W, Xu X, Fan Y. Nutritional status as prognostic factor of advanced oesophageal cancer patients treated with immune checkpoint inhibitors. Clin Nutr 2024;43:142–153.

12. Dommisch H, Kuzmanova D, Jönsson D, Grant M, Chapple I. Effect of micronutrient malnutrition on periodontal disease and periodontal therapy. Periodontol 2000 2018;78:129–153.

13. Epstein JB, Villines D, Epstein GL, Smutzer G. Oral examination findings, taste and smell testing during and following head and neck cancer therapy. Support Care Cancer 2020;28:4305–4311.

14. Ezenwa MO, Fischer DJ, Epstein J, Johnson J, Yao Y, Wilkie DJ. Caregivers' perspectives on oral health problems of end-of-life cancer patients. Support Care Cancer 2016;24:4769–4777.

15. Furuya J, Suzuki H, Hidaka R, Koshitani N, Motomatsu Y, Kabasawa Y, et al. Factors affecting the oral health of inpatients with advanced cancer in palliative care. Support Care Cancer 2022;30:1463–1471.

16. Gebremedhin TK, Cherie A, Tolera BD, Atinafu BT, Demelew TM. Prevalence and risk factors of malnutrition among adult cancer patients receiving chemotherapy treatment in cancer center, Ethiopia: cross-sectional study. Heliyon 2021;7:e07362.

17. Ghias K, Jiang Y, Gupta A. The impact of treatment-induced dysgeusia on the nutritional status of cancer patients. Clin Nutr Open Sci 2023;50:57–76.

18. Guigoz Y, Vellas B, Garry PJ. Nutrition surveys in the elderly. Nutr Rev 1996; 54:s59.

19. Gupta D, Vashi PG, Lammersfeld CA, Braun DP. Role of nutritional status in predicting the length of stay in cancer: a systematic review of the epidemiological literature. Ann Nutr Metab 2011;59:96–106.

20. Hong S, Won YJ, Lee JJ, Jung KW, Kong HJ, Im JS, et al. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2018. Cancer Res Treat Off J Korean Cancer Assoc 2021;53:301–315.

21. Hunter M, Kellett J, Toohey K, D'Cunha NM, Isbel S, Naumovski N. Toxicities caused by head and neck cancer treatments and their influence on the development of malnutrition: review of the literature. Eur J Investig Heal Psychol Educ 2020;10:935–949.

22. Ingram SS, Seo PH, Sloane R, Francis T, Clipp EC, Doyle ME, et al. The association between oral health and general health and quality of life in older male cancer patients. J Am Geriatr Soc 2005;53:1504–1509.

23. Issrani R, Reddy J, Bader AK, Albalawi RFH, Alserhani EDM, Alruwaili DSR, et al. Exploring an association between body mass index and oral health – a scoping review. Diagnostics 2023;13:902.

24. Lalla R V, Saunders DP, Peterson DE. Chemotherapy or radiation-induced oral mucositis. Dent Clin 2014;58:341–349.

25. Liu S, Tsai W, Wong Y, Lin J, Poon C, Chao S, et al. Nutritional factors and survival of patients with oral cancer. Head Neck J Sci Spec Head Neck 2006;28:998–1007.

26. Marshall JR, Boyle P. Nutrition and oral cancer. Cancer Causes Control 1996;7: 101–111.

27. Melo A de S, de Lima Dantas JB, Medrado ARAP, Lima HR, Martins GB, Carrera M. Nutritional supplements in the management of oral mucositis in patients with head and neck cancer: narrative literary review. Clin Nutr ESPEN 2021; 43:31–38.

28. Miloro M, Kolokythas A. S415: Current diagnostic tools in the detection of oral cancer. J Oral Maxillofac Surg 2009;67:133–134.

29. Momokita M, Abe A, Shibata K, Hayashi H, Furuta H, Taniguchi S, et al. Prognostic nutritional index in patients with end-stage oral cancer. Am J Hosp Palliat Med 2023;40:396–400.

30. Nakamura M, Ojima T, Nakade M, Ohtsuka R, Yamamoto T, Suzuki K, et al. Poor oral health and diet in relation to weight loss, stable underweight, and obesity in community-dwelling older adults: a cross-sectional study from the JAGES 2010 project. J Epidemiol 2016;26:322–329.

31. Polański J, Jankowska-Polańska B, Mazur G. Relationship between nutritional status and quality of life in patients with lung cancer. Cancer Manag Res 2021; 13:1407–1416.

32. Pulito C, Cristaudo A, Porta C La, Zapperi S, Blandino G, Morrone A, et al. Oral mucositis: the hidden side of cancer therapy. J Exp Clin Cancer Res 2020;39:1–15.

33. Rahnama-Hezavah M, Mertowska P, Mertowski S, Skiba J, Krawiec K, Łobacz M, et al. How can imbalance in oral microbiota and immune response lead to dental implant problems? Int J Mol Sci 2023;24:17620.

34. Saito Y, Hayashi R, Iida Y, Mizumachi T, Fujii T, Matsumoto F, et al. Optimization of therapeutic strategy for p16-positive oropharyngeal squamous cell carcinoma: multi-institutional observational study based on the national Head and Neck Cancer Registry of Japan. Cancer 2020;126:4177–4187.

35. Sala A, Pencharz P, Barr RD. Children, cancer, and nutrition – a dynamic triangle in review. Cancer 2004;100:677–687.

36. Silvestris N, Franchina T, Gallo M, Argentiero A, Avogaro A, Cirino G, et al. Diabetes management in cancer patients. An Italian association of medical oncology, Italian association of medical Diabetologists, Italian Society of Diabetology, Italian Society of Endocrinology and Italian Society of Pharmacology multidisciplinary conse. ESMO Open 2023;8:102062.

37. Singh V, Singh AK, Dutta KD, Kumar N, Kumari A. Evaluation of quality of life and the nutritional status of oral cancer treated patients as compared with the control group in Varanasi district: a cross sectional study. Int J Community Med Public Heal 2019;6:4804.

38. de Souza Tolentino E, Centurion BS, Ferreira LHC, de Souza AP, Damante JH, Rubira-Bullen IRF. Oral adverse effects of head and neck radiotherapy: literature review and suggestion of a clinical oral care guideline for irradiated patients. J Appl Oral Sci 2011;19:448.

39. Sroussi HY, Epstein JB, Bensadoun R, Saunders DP, Lalla R V, Migliorati CA, et al. Common oral complications of head and neck cancer radiation therapy: mucositis, infections, saliva change, fibrosis, sensory dysfunctions, dental caries, periodontal disease, and osteoradionecrosis. Cancer Med 2017;6:2918–2931.

40. Yenugadhati N, Albalawi A, Qureshey AT, Qureshey ET, AL-Jahdali H, Jazieh AR, et al. Associated factors for oral health problems in a sample of Saudi cancer patients. Cancer Manag Res 2018;10:1285–1293.

41. Zhang L, Lu Y, Fang Y. Nutritional status and related factors of patients with advanced gastrointestinal cancer. Br J Nutr 2014;111:1239–1244.

42. Zheng Z, Zhao X, Zhao Q, Zhang Y, Liu S, Liu Z, et al. The effects of early nutritional intervention on oral mucositis and nutritional status of patients with head and neck cancer treated with radiotherapy. Front Oncol 2021;10:595632.