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Fatigue, Stress, and Functional Status Are Associated with Taste Changes in Oncology Patients Receiving Chemotherapy

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Abstract

Context: A common complaint among oncology patients receiving chemotherapy is altered taste perception. The purpose of this study was to evaluate for differences in common symptoms and stress levels in patients who reported taste changes.

Methods: Patients were receiving chemotherapy for breast, gastrointestinal, gynecological, or lung cancer. Change in the way food tastes (CFT) was assessed using the Memorial Symptom Assessment Scale prior to the patients' second or third cycle of chemotherapy. Valid and reliable instruments were used to assess for depressive symptoms, state and trait anxiety, cognitive impairment, diurnal variations in fatigue and energy, sleep disturbance, and pain. Stress was assessed using the Perceived Stress Scale and the Impact of Events Scale-Revised. Multiple logistic regression was used to evaluate for risk factors associated with CFT.

Results: Of the 1329 patients, 49.4% reported CFT. Patients in the CFT group reported higher levels of depression, anxiety, fatigue, and sleep disturbance as well as higher levels of general and

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disease specific stress. Factors associated with CFT group included: being non-White; receiving an antiemetic regimen that contained a neurokinin-1 receptor antagonist with two other antiemetics, having a lower functional status, higher levels of morning fatigue, and reporting higher scores on the hyperarousal subscale of the Impact of Event Scale-Revised.

Conclusions: This study provides new evidence on associations between taste changes and common co-occurring symptoms and stress in oncology patients receiving chemotherapy. Clinicians need to evaluate for taste changes in these patients because this symptom can effect patients' nutritional intake and quality of life.

Keywords

taste changes; chemotherapy; stress; depression; anxiety; sleep disturbance; fatigue

Introduction

Approximately 650,000 oncology patients in the United States will receive chemotherapy in 2020.[1] Prevalence rates for self-reported taste changes associated with chemotherapy range from 12% to 84%.[2] Despite its common occurrence and the importance of taste perception to maintain adequate nutritional status, research on the associations between taste changes and other common co-occurring symptoms associated with the administration of chemotherapy is limited.

The etiology of taste changes associated with chemotherapy is multifactorial. Preclinical evidence suggests that chemotherapy induces apoptosis of taste receptor cells and inhibits taste progenitor/stem cell proliferation.[3,4] In addition, chemotherapy disrupts the rapidly dividing cells in the basal layer of the taste epithelium that are responsible for taste cell renewal.[4,5] Of note, in a study of patients with head and neck cancer who received radiation therapy with (n=21) and without (n=5) cisplatin and 5-fluorouracil,[6] changes in expression of taste receptor genes occurred particularly in patients with mild/moderate stomatitis. These changes were associated with dysgeusia for umani and sweet tastes and phantoguesia.

While not studied in oncology patients, recent evidence suggests that taste changes are associated with the occurrence and severity of common neuropsychological symptoms (e.g., depression, anxiety, fatigue, sleep disturbance, changes in cognitive function) and several studies in the general population provide insights on these relationships. For example, in two studies of patients with major depression,[7,8] compared to healthy controls, depressed patients required significantly higher concentrations to perceive all of the basic taste modalities (i.e., sweet, salty, sour, bitter). In another study, that used data from the National Health and Nutrition Examination Survey,[9] the prevalence rates for alterations in taste were 19.3% and 23.7% in individuals with depressive symptoms or a major depressive disorder, respectively. In another study that evaluated for associations between alterations in taste perceptions and depressive symptoms and anxiety,[10] individuals with mild subclinical depression were not able to rate changes in fat taste intensities. Individuals with a normal anxiety score had decreased perceptions of both sweet and salty tastes.[11] Finally, in a study that examined the relationship between taste perception and mood states in female students, [12] higher fatigue scores and low anger scores were associated with decreased sour taste

perception. Findings regarding associations between changes in taste and sleep disturbance are inconsistent.[13–16] While in one study, no changes were found,[13] in two studies of healthy individuals,[14,16] preferences for sweet taste increased. In another study,[15] individuals with increased sleepiness rated taste for umami and sour taste significantly higher. Given the increasing evidence on the deleterious effects of multiple co-occurring symptoms in oncology patients,[17] and emerging evidence from other populations, an evaluation of the associations between taste changes and common neuropsychological symptoms in oncology patients is warranted.

Similar to neuropsychological symptoms, taste changes can occur during situations of increased stress. While no studies of oncology patients were found, two studies have evaluated for associations between taste changes and laboratory induced-stress in healthy individuals.[18,19] In one study,[19] following the administration of a mental stressor, taste perceptions for sweet, bitter, and sour decreased. In another study,[18] higher levels of acute stress were associated with decreases in sweet taste perceptions. Again, given the high levels of stress associated with a cancer diagnosis and its treatments,[20,21] this relationship warrants evaluation in oncology patients.

Changes in patients' ability to taste can have a negative effect on their quality of life (QOL).[22] Across several studies of oncology patients receiving chemotherapy,[23–26] decreased taste was associated with significant decrements in QOL. In addition, findings from several qualitative studies suggest that taste changes during chemotherapy have a negative impact on patient's social activities,[27,28] as well as on their overall QOL.[25,26,29]

In this study, we extended our prior analysis on associations between taste changes and gastrointestinal symptoms,[2] in a sample of oncology patients (n=1329) receiving chemotherapy and based on the lack of available evidence evaluate for associations between taste changes and common neuropsychological symptoms (i.e., depression, anxiety, fatigue, sleep disturbance, changes in cognitive function, decrements in energy, and pain) and stress. The purposes of this study were to evaluate for differences in the severity of common neuropsychological symptoms, perceived stress, and QOL outcomes between patients who did and did not report change in the way food tastes (CFT) in the week prior to their second or third cycle of chemotherapy. In addition, we determined which of these characteristics were associated with the occurrence of CFT.

METHODS

Study design and participants

Data for this analysis are from a larger longitudinal study that evaluated the symptom experience of oncology outpatients receiving chemotherapy. Details on the methods used in this study are published elsewhere.[30,31] In brief, patients were ≥18 years of age; had a diagnosis of breast, gastrointestinal, gynecological, or lung cancer; had received chemotherapy within the preceding four weeks; were scheduled to receive at least two additional cycles of chemotherapy, were able to read, write, and understand English; and provided written informed consent. Patients were recruited from two Comprehensive Cancer Centers, one Veteran's Affairs hospital, and four community-based oncology programs. The

study was approved by the Committee on Human Research at the University of California at San Francisco and by the Institutional Review Board at each of the study sites. Of the 1343 patients who consented to participate, 1329 patients with data on CFT are included in this analysis.

Study procedures

A research staff member approached eligible patients in the infusion unit during their first or second cycle of chemotherapy and discussed participation in the study. Written informed consent was obtained from all of the patients. Data from the enrollment assessment that was completed during the week prior to the patients' second or third cycle of chemotherapy were used in this analysis. Medical records were reviewed for disease and treatment information.

Instruments

Demographic and clinical characteristics -—Patients completed a demographic questionnaire, the Karnofsky Performance Status scale,[32] and the Self-Administered Comorbidity Questionnaire (SCQ).[33] The total SCQ score ranges from 0 to 39. In addition, they completed the Alcohol Use Disorders Identification Test[34] and a smoking history questionnaire.[35]

Assessment of change in the way food tastes (CFT) -—CFT was measured using the Memorial Symptom Assessment Scale.[36] Patients were asked to indicate whether or not they had experienced CFT in the past week (i.e., symptom occurrence). If they experienced CFT, they rated its frequency, severity, and distress. Patients' assessment of CFT in the week prior to their second or third cycle of chemotherapy (i.e., enrollment assessment) was used to dichotomize the sample. Patients who provided a rating for occurrence, frequency, severity, and/or distress for the CFT were coded as having CFT. Patients who indicated "no" to the occurrence item were coded as not having CFT.

Assessment of common neuropsychological symptoms -—Associations between the occurrence of CFT and common neuropsychological symptoms were evaluated using a number of valid and reliable instruments. Diurnal variations in fatigue and decrements in energy were evaluated using the Lee Fatigue Scale.[37] State and trait anxiety were evaluated using the Spielberger State-Trait Anxiety Inventories.[38] Depressive symptoms were assessed using the Center for Epidemiological Studies-Depression scale.[39] The quality of sleep was evaluated using the General Sleep Disturbance Scale.[40] Difficulties with executive function were assessed using the Attentional Function Index.[41] Occurrence of pain was evaluated using the Brief Pain Inventory.[42]

Assessment of stress -—Stress was assessed using general (i.e., Perceived Stress Scale[43] and disease-specific (i.e., Impact of Event Scale-Revised (IES-R)[44]) measures. Three subscales of the IES-R evaluate the level of intrusion, avoidance, and hyperarousal associated with cancer and its treatment. The Perceived Stress Scale evaluates stress due to life circumstances. For both instruments, a higher score indicates greater stress.

Assessment of QOL -—QOL was evaluated using disease-specific (i.e., QOL-Patient Version (QOL-PV)[45]) and generic (i.e., Medical Outcomes Study-Short Form-12 (SF-12)[46]) measures. The QOL-PV assesses four domains of QOL (i.e., physical, psychological, social, and spiritual well-being) as well as a total QOL score. Higher scores indicate a better QOL. The SF-12 consists of 12 questions about physical and mental health as well as overall health status. The SF-12 is scored into physical component summary (PCS) and mental component summary (MCS) scores. Higher summary scores indicate a better QOL.

Coding of the emetogenicity of the chemotherapy regimens

Using the Multinational Association of Supportive Care in Cancer guidelines,[47] each chemotherapy drug in the regimen was classified as having minimal, low, moderate, or high emetogenic potential. The emetogenicity of the regimen was categorized into one of three groups (i.e., low/minimal, moderate, high) based on the chemotherapy drug with highest emetogenic potential. An exception was made if a patient received doxorubicin and cyclophosphamide. When administered separately, doxorubicin and cyclophosphamide are listed as having moderate emetogenic potential. When given together, the combination has high emetogenic potential.

Coding of the antiemetic regimens

Each antiemetic was coded as either a neurokinin-1 receptor antagonist, a serotonin receptor antagonist, a dopamine receptor antagonist, prochlorperazine, lorazepam, or a steroid. The antiemetic regimens were coded into one of four groups: none (i.e., no antiemetics administered); steroid alone or serotonin receptor antagonist alone; serotonin receptor antagonist and steroid; or neurokinin-1 receptor antagonist and two other antiemetics.

Statistical analyses

Data were analyzed using SPSS Version 26 (IBM, Armonk, NY). Descriptive statistics and frequency distributions were calculated for demographic and clinical characteristics. For categorical variables, nonparametric tests were used to evaluate for differences in demographic and clinical characteristics between patients who did and did not report CFT. For continuous variables, Independent Student’s t-tests were done to evaluate for differences in demographic and clinical characteristics, as well as symptom severity, perceived stress, and QOL scores between patients who did and did not report CFT. To evaluate for clinically meaningful between group differences, effect sizes were determined using Cohen’s d statistic.

To evaluate for associations between select demographic, clinical, neuropsychological symptom, and stress characteristics and CFT group membership, a backwards, stepwise logistic regression analysis was performed. The initial logistic regression model included all the characteristics that differed between the two CFT groups (i.e., demographic and clinical characteristics (see Supplemental Table 1), symptom severity scores (Table 1) and stress scores Table 2)). A backwards stepwise approach was used to create a parsimonious model. Only variables with a p-value of <0.05 were retained in the final model.

RESULTS

Sample characteristics

Description of this sample was previously reported[2] and details are provided in Supplementary Table 1. In brief, of the 1329 patients in this study, 49.4% (n=656) reported CFT in the week prior to their second or third cycle of chemotherapy.

Differences in demographic and clinical characteristics

As noted in our previous analysis,[2] compared with the no CTF group, patients who reported CFT had fewer years of education; were more likely to be Black or Hispanic, mixed race, or other; and had a lower annual household income. Patients in the CFT group were less likely to be employed and less likely to exercise on a regular basis. In addition, patients in the CFT group had a higher body mass index, lower Karnofsky Performance Status scores, fewer years since their cancer diagnosis, fewer prior cancer treatments, and fewer metastatic sites. Compared to the no CFT group, patients in the CFT group were more likely to have breast cancer, received chemotherapy on a 14-day cycle, had a higher MAX2 score, received highly emetogenic chemotherapy, and were more likely to receive an antiemetic regimen that contained a neurokinin-1 receptor antagonist and two other antiemetics (Supplementary Table 1).

Differences in symptom severity

Compared to the no CFT group, patients in the CFT group had significantly higher depression, trait anxiety, state anxiety, sleep disturbance, as well as morning and evening fatigue scores, and lower attentional function and morning energy scores (Table 1).

Differences in stress scores

Compared to the no CFT group, patients in the CFT group reported a significantly higher Perceived Stress Scale score. Patients in the CFT group reported significantly higher IES-R subscale (i.e., intrusion, avoidance, and hyperarousal) and total scores (Table 2).

Differences in QOL outcomes

Compared to the no CFT group, patients in the CFT group reported significantly lower physical, psychological, and social well-being, as well as total QOL-PV scores. For the SF-12, compared to the no CFT group, patients in the CFT group had significantly lower PCS and MCS scores (Table 3).

Logistic regression analysis of factors associated with CFT group membership

As shown in Table 4, the overall logistic regression model was significant (X^2=107.72, p<0.001). Six variables were retained in the final model, namely self-reported ethnicity, Karnofsky Performance Status score, cancer diagnosis, antiemetic regimen, morning fatigue score, and the IES-R hyperarousal subscale score. In terms of functional status, patients with higher Karnofsky Performance Status scores had a decrease in the odds of being in CFT group (OR=0.98; p=0.004). With regards to ethnicity, compared to Whites, Blacks (OR=1.89; p=0.014) had an increased odds of being in CFT group and patients of Hispanic,

mixed race, or other (OR=1.62; p=0.018) had increased odds of being in CFT group. In terms of cancer diagnosis, compared to patients with breast cancer, patients with lung (OR=0.60; p=0.016) and gynecological (OR=0.64; p=0.014) cancers had a decrease in the odds of being in CFT group. In terms of the antiemetic regimen, compared to patients who did not receive any antiemetic, patients who received a neurokinin-1 receptor antagonist and two other antiemetics had an increased odds of being in the CFT group (OR=2.39; p=0.001). Higher morning fatigue (OR=1.10; p=0.003) and higher hyperarousal (OR=1.26; p=0.034) scores were associated with an increase in the odds of being in the CFT group.

DISCUSSION

To our knowledge, this study is the first to evaluate for associations between demographic and clinical characteristics, as well as common neuropsychological symptoms (i.e., depression, anxiety, fatigue, sleep disturbance, changes in cognitive function, decrements in energy, pain) and stress and the occurrence of CFT in oncology patients undergoing chemotherapy. In addition, this study is the first to evaluate for differences in both generic and disease-specific measures of QOL in patients who did and did not report CFT. The results of the logistic regression analysis provide new insights into risk factors associated with CFT.

The only demographic characteristic that remained significant in the multivarible model was ethnicity. Consistent with a previous report from the general United States population that found that a higher percentage of African Americans reported taste changes,[48] patients who were Black, Hispanic, or of a mixed ethnic background were more likely report CFT. As noted in the previous study, reasons for these differences are not readily apparent.

Several clinical characteristics were associated with the occurrence of CFT. While no studies have documented an association between poorer functional status and taste changes, previous studies of oncology patients found that lower functional status scores were associated with a higher symptom burden,[49] reduced tolerance to chemotherapy,[50] and higher levels of distress.[51] Consistent with our previous report,[2] compared to the patients with lung and gynecological cancers, patients with breast cancer had an increased risk of being in the CFT group. While previous studies described taste changes in patients with breast,[23,26,52,53] lung,[54,55] and gynecological[26,56] cancers, no studies have evaluated for differences across diagnoses. Given that the various chemotherapy regimens may have differential inflammatory effects on the gastrointestinal tract, future studies are warranted that evaluate for differences in taste changes and other gastrointestinal symptoms (e.g., mucositis) within and across cancer diagnoses and chemotherapy regimens.

The type of antiemetic regimen is another characteristic that was retained in the final regression model in our previous[2] and current report. In the current study, being prescribed a neurokinin-1 receptor antagonist with two other antiemetics was associated with a 2.39-fold increased risk of being in the CFT group (the OR in the previous study was 2.51). As noted previously,[2] both the neurokinin-1 and serotonin receptor antagonists have direct effects on gastrointestinal motility and taste perceptions.[57–62]

For patients in the taste change group, all of the symptom severity scores were near or above the clinically meaningful cut-off scores, which suggests a relatively high symptom burden. In the univariate analyses, except for evening energy, all of the other symptom severity scores were significantly higher in the patients who reported taste changes. These between group differences represent clinically meaningful differences in the severity of depressive symptoms (d=0.32), cognitive impairment (d=0.33), and morning fatigue (d=0.39).[63] However, morning fatigue was the only symptom that remained significant on the multivariable model with each one unit increase on the fatigue scale being associated with a 1.10 increase in the odds of being in the CFT group. Our finding is consistent with a previous report that identified taste changes as part of a fatigues/anorexia-cachexia symptom cluster in patients with advanced cancer.[64] The relationship between fatigue and taste changes warrants additional investigation given that athletes experience changes in taste sensitivity associated with profound physical fatigue following vigorous exercise.[65]

Another new and emerging hypothesis for chemotherapy-induced taste changes, as well as for associations between taste changes and common neuropsychological symptoms in oncology patients is the activation of the microbiota-brain-gut axis (MBGA).[66,67] The MBGA is a bi-directional biochemical signaling pathway between the central nervous system and the gastrointestinal system that includes the gut microbiota.[68] Like the tongue, the gastrointestinal system is capable of sensing nutrients and toxins through similar taste receptors and signaling mechanisms.[69,70] For example, while sweet taste begins at the tongue, sugar molecules can activate sensors in the gut that send direct signals to the brain that create a preference for sugar.[70] In addition, nutrients in the intestinal lumen are detected by specific taste sensors that respond to sweet, umami, and bitter compounds, as well as both long- and short-chain fatty acids.[71,72] Likewise, the gut microbiota plays a role in shaping neural development, brain biochemistry, and behavior.[73] Disruptions in these communication pathways contribute to the development of obesity,[74] psychiatric disorders, and cancer.[75]

Oncology patients undergoing chemotherapy experience a significant amount of stress.[20] In this study, the mean Perceived Stress Scale score for the taste change group was above the clinically meaningful cut-off score of ≥14[76] and the mean IES-R total score approached the clinically meaningful cut-off score of ≥24.[77,78] While all of the general and disease specific stress scores were higher in the patients with CFT, only the IES-R-hyperarousal subscale score remained significant in the logistic regression analysis. Patients who reported higher levels of hyperarousal had an increased risk of being in the CFT group. This subscale of the IES-R evaluates difficulty concentrating, anger and irritability, psychophysiologic vigilance arousal on exposure to reminders, and hypervigilance and is often used as a proxy measure for post-traumatic stress. While no studies were found that evaluated for associations between taste changes and stress in oncology patients, one of the physiologic responses to acute stress is altered food and energy intake including weight loss and weight gain.[79,80] These stress-induced changes are modulated by the release of neurotransmitters from the hypothalamic-pituitary-adrenal axis. Of note, both noradrenaline and serotonin are involved in taste signaling.[81] Serotonin and noradrenaline can effect taste cell excitability by altering the function of ion channels.[82,83] As noted in one study,[84] taste changes are often reported by patients with chronic conditions that are characterized by changes in the release of

serotonin and noradrenaline (e.g., depression, anxiety disorder). Given that high levels of stress, depressive symptoms, and anxiety are common in oncology patients, our findings suggest that these co-occurring symptoms may contribute to the taste changes associated with the administration of chemotherapy.

Consistent with previous reports that found that alterations in taste perceptions were associated with decrements in oncology patients' QOL,[85,86] patients in our study who reported taste changes had statistically significant and clinically meaningful decrements in all of the QOL-PV subscale (except spiritual well-being) and total scores (d=0.25 to 0.44).[63] In addition, these patients had PCS and MCS scores that were below the normative score of 50 for the United States population.[87]

Several limitations warrant consideration. Given that an evaluation of taste changes was not done prior to the administration of chemotherapy, future studies need to perform this evaluation and track changes in taste over time. Because a change in taste was measured using a single item on the Memorial Symptom Assessment Scale (i.e., "change in the way food tastes") and may be interpreted by patients in a variety of ways (e.g., change in the flavor of food), future studies need to assess changes in both taste and smell using subjective and objective measures. Given the complex interactions among common neuropsychological and gastrointestinal symptoms, as well as stress, longitudinal studies are needed to assess for causal mechanisms. In addition, an evaluation of genetic and epigenetic markers may help to identify potential biological mechanisms.

Despite these limitations, findings from this study and our previous study,[2] suggest that the co-occurrence of gastrointestinal symptoms and common neuropsychological symptoms are associated chemotherapy-induced CFT. Clinicians need to assess for all of these symptoms and evaluate their impact on patients' nutritional intake, functional status, and QOL. Depending on the severity of their impact, patients may warrant referrals for symptom management, psychological services, dietary counseling, and/or physical therapy. These findings provide guidance for future studies that need to explore the associations among and mechanisms that underlie these multiple co-occurring symptoms in patients undergoing chemotherapy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Disclosures:

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Table 1.

Differences in Symptom Severity Scores Between Patients With and Without Change in the Way Food Tastes

Symptom	Clinically Meaningful Cut-off Scores	No Taste Changes 50.6% (n = 673)	With Taste Changes 49.4% (n = 656)	Statistics
		Mean (SD)	Mean (SD)	
CES-D score	≥16.0	11.3 (9.1)	14.4 (10.0)	t = −5.95, p < 0.001
Trait Anxiety Inventory score	≥32.2	34.0 (10.2)	36.3 (10.7)	t = −4.01, p < 0.001
State Anxiety Inventory score	≥31.8	32.6 (11.6)	35.1 (13.0)	t = −3.64, p < 0.001
Attentional Function Index score	<5 Low 5 – 7.5 Moderate >7.5 High	6.7 (1.7)	6.1 (1.8)	t = 5.56, p < 0.001
General Sleep Disturbance Scale	≥43.0	50.1 (20.4)	55.0 (19.7)	t = −4.37, p < 0.001
Morning fatigue score (LFS)	≥3.2	2.7 (2.1)	3.6 (2.3)	t = −7.28, p < 0.001
Evening fatigue score (LFS)	≥5.6	5.1 (2.1)	5.6 (2.1)	t = −4.43, p < 0.001
Morning energy score (LFS)	≤6.2	4.6 (2.2)	4.2 (2.2)	t = 3.03, p = .003
Evening energy score (LFS)	≤3.5	3.6 (2.0)	3.5 (2.1)	t = 1.74, p = 0.082
Percentage of patients with pain (%, n)		70.6 (471)	75.1 (488)	FE, p = 0.073

Abbreviations: CES-D = Center for Epidemiological Studies-Depression Scale, FE = Fisher's Exact, LFS = Lee Fatigue Scale, SD = standard deviation

Table 2.

Differences in Stress Scores Between Patients With and Without Change in the Way Food Tastes

Instrument	No Taste Changes 50.6% (n = 673)	With Taste Changes 49.4% (n = 656)	Statistics
	Mean (SD)	Mean (SD)	
Perceived Stress Scale score	17.67 (8.06)	19.30 (8.23)	t = −3.60, p < 0.001
IES-R subscale scores			
Intrusion	0.83 (0.68)	0.98 (0.74)	t = −3.78, p < 0.001
Avoidance	0.88 (0.63)	1.01 (0.71)	t = −3.22, p < 0.001
Hyperarousal	0.56 (0.61)	0.75 (0.70)	t = −5.09, p < 0.001
IES-R total score	17.15 (12.01)	20.47 (13.95)	t = −4.54, p < 0.001

Abbreviations: IES-R = Impact of Event Scale-Revised, SD = standard deviation

Table 3.

Differences in Quality of Life Scores Between Patients With and Without Change in the Way Food Tastes

Instrument	No Taste Changes 50.6% (n = 673)	With Taste Changes 49.4% (n = 656)	Statistics
	Mean (SD)	Mean (SD)	
Quality of Life – Patient Version			
Physical well-being	7.0 (1.7)	6.2 (1.8)	t = 8.91, p < 0.001
Psychological well-being	5.7 (1.8)	5.2 (1.8)	t = 5.26, p < 0.001
Social well-being	6.0 (2.0)	5.5 (2.0)	t = 4.75, p < 0.001
Spiritual well-being	5.4 (2.1)	5.5 (2.0)	t = −1.58, p = 0.114
Total QOL score	6.0 (1.4)	5.5 (1.4)	t = 5.89, p < 0.001
Short Form 12 Health Survey			
PCS score	42.4 (10.7)	40.0 (10.3)	t = 4.12, p < 0.001
MCS score	50.4 (9.9)	47.5 (10.8)	t = 4.86, p < 0.001

Abbreviations: MCS = Mental Component Summary, PCS = physical component summary, QOL = quality of life, SD = standard deviation

Table 4.

Multiple Logistic Regression Analysis Predicting Change in the Way Food Tastes Group Membership

Predictor	Odds Ratio (95% CI)	p-value
Karnofsky Performance Status score	0.98 (0.97, 0.99)	0.004
Ethnicity		
Asian or Pacific Islander vs. White	1.43 (0.98, 2.08)	0.065
Black vs. White	1.89 (1.14, 3.15)	0.014
Hispanic, Mixed Race, or Other vs White	1.62 (1.09, 2.41)	0.018
Cancer diagnosis		
Gastrointestinal vs. breast	0.99 (0.74, 1.34)	0.971
Gynecological vs. breast	0.64 (0.45, 0.92)	0.014
Lung vs. breast	0.60 (0.39, 0.91)	0.016
Antiemetic regimen		
Steroid alone or serotonin receptor antagonist alone vs. none	1.24 (0.73, 2.10)	0.425
Serotonin receptor antagonist and steroid vs. none	1.34 (0.82, 2.20)	0.247
NK-1 receptor antagonist and two other antiemetics vs. none	2.39 (1.41, 4.05)	0.001
Morning fatigue score	1.10 (1.03, 1.18)	0.003
Impact of Event Scale-Revised - Hyperarousal subscale score	1.26 (1.02, 1.57)	0.034
Overall model fit: degrees of freedom = 12; $X^2 = 107.72$, $p < 0.001$		