

Original Article

Chemosensory Dysfunction Is a Primary Factor in the Evolution of Declining Nutritional Status and Quality of Life in Patients With Advanced Cancer

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Abstract

Alterations in taste and smell functions have been reported in cancer patients. Although these senses are known to be particularly affected by chemotherapy, many features of chemosensory perception in cancer patients remain obscure. The relative importance of chemosensory changes in the etiology of malnutrition and wasting is not known. To assess this relationship, self-perceived taste and smell function were evaluated using a validated questionnaire in 66 patients with advanced cancer receiving palliative care (median survival 7.4 months). Participants also completed 3-day food records to assess dietary intake, and the Functional Assessment of Anorexia/Cachexia Therapy questionnaire to assess quality of life (QOL). Total chemosensory complaint scores ranged from 0 to 14 on a 16-point scale. Only 14% of the subjects reported no chemosensory complaints of any kind, whereas 86% reported some degree of chemosensory abnormality. The most common complaints were persistent bad taste in the mouth, taste distortion, and heightened sensitivity to odors. Subjects with severe chemosensory complaints showed substantially lower energy intakes (by 900–1,100 kcal/day), higher rates of weight loss, and lower QOL scores than subjects with mild or moderate chemosensory complaints. Severe chemosensory dysfunction is persistent well beyond the window of active therapy in patients with advanced cancer and represents a primary factor relating to malnutrition, wasting, and poor QOL. Further research is required to identify appropriate strategies to alleviate this important group of symptoms, to determine whether intervention will improve QOL, and to match foods and diet to the unique chemosensory profile of advanced cancer patients. J Pain Symptom Manage 2007;33:156–165. © 2007 U.S. Cancer Pain Relief Committee. Published by Elsevier Inc. All rights reserved.

Key Words

Taste and smell dysfunction, chemosensory changes, malnutrition, quality of life, advanced cancer, palliative care

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Introduction

Inadequate dietary intake is a significant factor involved in the weight loss and progressive functional decline associated with advanced cancer.¹ Our understanding of cancer-associated malnutrition is limited by a lack of understanding of the exact prevalence of the different nutritional impact symptoms, and more importantly perhaps, the magnitude of their contribution to the overall syndrome. In this study, we considered the potential role of altered taste and smell (chemosensory) perception in the decreased food intake associated with malignancy. The normal function of taste and smell sensation drives flavor perception and supports digestive function by initiating the release of digestive enzymes and stimulating gastric and intestinal motility.²⁻⁶ Chemosensory losses and distortions can affect appetite, food preference, and energy intake, and significantly affect food enjoyment and quality of life (QOL).⁷⁻¹²

It has been estimated that between one-quarter and one-half of all cancer patients experience changes in their taste and/or smell perception.^{13,14} Though the majority of research on chemosensory perception in cancer patients has examined the direct effects of anticancer therapies such as radiation and chemotherapy,^{9,12,14-17} this symptom is frequently cited among patients with advanced cancer for whom curative therapies have been discontinued in favor of palliative care.⁸ It is currently unknown what proportion of these patients with advanced cancer experience taste and smell defects, or how these changes affect nutrient intake, food preference, nutritional status, and QOL.

The objectives of this study were to (a) determine the prevalence of taste and smell alterations, (b) describe the taste and smell abnormalities affecting this population, and (c) test for a relationship between self-perceived taste and smell sensation and food and nutrient intake, nutritional status, and QOL in patients with advanced cancer.

Patients and Methods

The study was approved by the Institutional Health Research Ethics Board. Subjects with advanced cancer (defined as locally recurrent or metastatic, $n = 66$) were recruited either

from a regional palliative home care program ($n = 60$) or from the Pain and Symptom Clinic of the regional cancer treatment center ($n = 6$). In the home care setting, all patients currently admitted to the program were screened for eligibility and were approached to request their participation; approximately 80% of eligible subjects consented and completed the study. All participants spoke English and provided written informed consent. Patients suffering from oral, nasal, or esophageal cancer or currently (within the past two months) receiving radiation or chemotherapy were excluded due to the direct effects these cancers and cancer treatments can have on chemosensory perception and food intake. All subjects were resident in their homes, were physically able to consume foods, and were assumed to make food choices by personal preference.

Dietary records (detailing intake for three consecutive days, including one weekend day) were used to assess subjects' energy intakes, a method that has been shown to provide a valid and reliable estimate of current dietary intake.^{18,19} A dietitian instructed participants on completion of the food record and reviewed records with the study participant for accuracy and completeness.

Nutrient intakes were estimated from the three-day dietary records using the Canadian Nutrient File Database of the Food Processor II Nutrient Analysis Program™ (Esha Research, Salem, OR). Analysis focused on energy and protein intake and macronutrient composition of the diet (expressed as % kcal from fat, carbohydrate, and protein). Mean energy intakes were expressed in kcal/day and kcal/kg body weight (BW)/day. Mean protein intakes were expressed in g/day and g/kg BW/day. Food attitudes and changes to food appreciation were assessed by way of a targeted interview addressing favorite foods, changes to food enjoyment, and meal appreciation.

Each subject's height and weight were measured, and in any case where a participant was bedridden or unable to stand unsupported, the most recently recorded values were taken from the patient's medical chart. History of weight loss over the previous six months was self-reported and verified with the patient's medical chart.

Self-perceived taste and smell function were assessed by a questionnaire, which has been

used to evaluate chemosensory function in AIDS patients.⁷ As part of the questionnaire, participants were asked to rate their individual taste and smell abnormalities as “insignificant,” “mild,” “moderate,” “severe,” or “incapacitating.” The tool yields a taste complaint score (0–10) on the basis of subject responses to nine questions addressing changes to the sense of taste. One point is added for each reported taste complaint and two points for a rating of “severe” or “incapacitating” on the severity of the taste abnormality. Similarly, a smell complaint score (0–6) was generated by adding one point for a positive response to each of five questions addressing self-perceived changes to the sense of smell. Two points were assigned to a severity rating of “severe” or “incapacitating” for the smell abnormality. The total chemosensory complaint score (0–16) was calculated by adding the taste and smell complaint scores. A targeted interview was used to identify the presence of other factors that may influence taste and smell function.

QOL was assessed using the Functional Assessment of Anorexia/Cachexia Therapy (FAACT) instrument, which was developed and validated to reliably measure four primary domains of global QOL along with specific anorexia/cachexia-related QOL issues.²⁰ Physical well-being, functional well-being, social/family well-being, and emotional well-being subscales comprise the four core measures of QOL assessed; an additional 12-item subscale evaluates nutritional QOL. The global QOL score was calculated by summing the scores of the five individual QOL domains; higher scores indicate better QOL.²¹

The FAACT was also used to individually assess the self-perceived severity of five common symptoms that are likely to affect food intake,^{21,22} including poor appetite, nausea, early satiety, pain, and sadness.

Data Analyses

Descriptive statistics were used to determine the prevalence, quality, and intensity of chemosensory abnormalities; regression analysis was used to assess the relationship between chemosensory complaint score and energy intake. Individuals were stratified into four groups based on the quartile boundaries identified by the frequency distribution of the

chemosensory complaint score. The Wilcoxon rank-sum test procedure was used to validate the relationship between self-perceived severity of the taste and/or smell abnormality and the individual taste and smell complaint scores, ($P < 0.0001$ and $P < 0.0001$, respectively); given the significance of this relationship, the four chemosensory complaint groups were labeled using the same terminology.

One-way ANOVA was used to compare energy and protein intakes and macronutrient composition of the diet across the four chemosensory complaint groups and to assess the relationship between self-perceived severity of the taste and smell abnormalities and energy intake. The Wilcoxon rank-sum test procedure was used to compare weight loss, food enjoyment, and QOL scores among the four chemosensory complaint groups and among separate taste and smell complaint scores. The relationship between chemosensory complaint quartile and changes to favorite foods was assessed by Chi-square analysis.

Regression and correlation analyses were used to assess the relationships among the self-perceived severity of concurrent nutrition impact symptoms such as nausea, early satiety, poor appetite, pain and sadness versus chemosensory complaint score and energy intake. All statistical analyses were performed using the Statistical Analysis System (SAS for Windows, version 8.2., 1999, SAS Institute Inc, Cary NC).

Results

Sixty-six patients completed all of the assessments. Characteristics of the study population are shown in Table 1.

Chemosensory Complaints

Total chemosensory complaint scores ranged from 0 to 14. Fifty-seven subjects (86%; 95% CI, 78–94%) reported some type of chemosensory abnormality. Of those, 34 (52%; 95% CI, 40–64%) had both taste and smell complaints, 20 (30%; 95% CI, 19–41%) described only taste complaints, and three described only smell complaints (5%; 95% CI, 0–10%). The responses to

Table 1
**Characteristics of Chemosensory
 Study Population**

	Study Population <i>n</i> = 66, <i>n</i> (%)
Gender	
Male	30 (45)
Female	36 (55)
Age (years) (mean ± SD)	65.4 ± 12.4
Smoking status	
Current smoker	8 (12)
Former smoker	30 (45)
Wears dentures	32 (48)
Current hay fever	5 (8)
Current sinusitis	7 (11)
Previous diagnosis of taste or smell problem	1 (2)
Cancer diagnosis	
Lung	5 (8)
Gastrointestinal	14 (21)
Breast	19 (29)
Prostate	5 (8)
Other	19 (29)
Primary unknown	4 (6)

questions regarding specific taste and smell complaints are shown in Table 2.

Taste complaint scores ranged from 0 to 9 out of 10. Both decreases and increases in the various taste sensitivities were noted; however, the majority of subjects reporting altered sensitivity to bitter and/or sour stimulus noted an increased sensitivity to these basic tastes. Six of the 54 individuals reporting at least one taste complaint (11%; 95% CI, 3–19%) described their abnormal sense of taste as “severe” or “incapacitating.”

Smell complaint scores ranged from 0 to 6 out of 6. Three of the 37 individuals reporting at least one smell complaint (8%; 95% CI, 2–15%) rated their abnormal sense of smell as “severe” or “incapacitating.”

Chemosensory Complaints, Nutrient Intake, and Food Enjoyment

Regression analysis revealed a significant association between chemosensory complaint score and energy intake; individuals experiencing a greater number of chemosensory abnormalities ingested fewer calories ($P = 0.0070$, $R^2 = 0.1082$). When assessed individually, both taste and smell complaint scores were inversely related to energy intake ($P = 0.0180$ and $P = 0.0064$, respectively).

Patients were grouped by total chemosensory complaint score into four groups: Absent (0–1), Mild (2–4), Moderate (5–9), and Severe (10–16). Nutrient intakes by chemosensory complaint group are shown in Table 3. Individuals who rated their abnormal sense of taste as “severe” or “incapacitating” ate fewer calories than those who rated their problem as “insignificant,” “mild,” or “moderate,” both in terms of kcal/day ($P = 0.0021$) and kcal/kg BW/day ($P = 0.0017$). The magnitude of this difference was striking, with a difference in intake of 900–1,100 kcal/day, or 16.4 kcal/kg BW/day, between patients with severe chemosensory problems vs. patients with none.

Macronutrient composition of the diet was associated with chemosensory complaint score (Table 3), such that a significantly greater proportion of dietary energy was derived from carbohydrate and a lesser proportion from fat among individuals with moderate or severe chemosensory complaints. The observed differences in protein intake among chemosensory complaint groups were associated with energy intake; the fraction of dietary energy supplied by protein was not significantly different among chemosensory complaint groups. Weight loss in the previous six months was significantly greater among participants with mild, moderate, or severe complaints relative to those with insignificant chemosensory complaints. As might be expected for a factor with a significant association with low caloric intakes and large body weight losses, chemosensory score was significantly related to the time to death in regression analysis ($P = 0.0202$, $R^2 = 0.1112$). The average time to death of study participants was 31.6 ± 29.6 weeks.

Food enjoyment was lower among individuals with severe chemosensory complaints relative to those with insignificant, mild, or moderate chemosensory complaints ($P = 0.0010$); individuals with severe chemosensory complaints were also more likely to report a change in their favorite foods ($P = 0.0011$). Thirteen of the 17 individuals with insignificant chemosensory complaints (76%; 95% CI, 56–96%) and 20 of 33 individuals with mild to moderate chemosensory complaints (61%; 95% CI, 49–73%) reported no change to their favorite foods, whereas

Table 2
**Frequency of Responses to Questions
 Addressing Taste and Smell Complaints Relative
 to the Onset of Cancer ($n = 66$)**

	Yes	No
	n (%)	n (%)
Taste complaint		
I have noticed a change in my sense of taste	36 (55)	30 (45)
A food tastes different than it used to	31 (47)	35 (53)
I have a persistent bad taste in mouth	42 (64)	24 (36)
Drugs interfere with my sense of taste	16 (24)	50 (76)
I am experiencing an abnormal sensitivity to salt	27 (41)	39 (59)
Salt tastes [n (%)]:		
Stronger	16 (24)	
Weaker	11 (17)	
I am experiencing an abnormal sensitivity to sweet	26 (39)	40 (61)
Sweet tastes [n (%)]:		
Stronger	18 (27)	
Weaker	8 (12)	
I am experiencing an abnormal sensitivity to sour	21 (32)	46 (68)
Sour tastes [n (%)]:		
Stronger	18 (27)	
Weaker	2 (3)	
I am experiencing an abnormal sensitivity to bitter	15 (23)	51 (77)
Bitter tastes [n (%)]:		
Stronger	13 (20)	
Weaker	2 (3)	
I would rate my abnormal sense of taste as [n (%)]:		
Insignificant	32 (48)	
Mild to moderate	28 (42)	
Severe to incapacitating	6 (9)	
Smell complaint		
I have noticed a change in my sense of smell	21 (32)	45 (68)
A food smells different than it used to	18 (27)	48 (73)
Specific drugs interfere with my sense of smell	4 (6)	62 (94)
I have abnormal sensitivity to odors	27 (41)	39 (59)
Odors are:		
Stronger	18 (27)	
Weaker	9 (14)	
I would rate my abnormal sense of smell as [n (%)]:		
Insignificant	36 (55)	
Mild to moderate	27 (41)	
Severe to incapacitating	3 (5)	

only one of the 16 (6%; 95% CI, 0–12%) individuals with severe chemosensory complaints reported no change to their favorite foods. Four participants with severe chemosensory

complaints stated that they were no longer able to enjoy any foods.

Chemosensory Complaints and QOL

Chemosensory complaint score was negatively associated with global QOL ($R^2 = 0.2011$, $P = 0.0002$); in particular, the physical well-being ($R^2 = 0.3132$, $P < 0.0001$) and anorexia–cachexia-related nutritional well-being ($R^2 = 0.3119$, $P < 0.0001$) constructs were associated with chemosensory complaint score. Individually, taste and smell complaint scores both showed a significant relationship with the nutrition-related QOL domain ($R^2 = 0.2741$, $P < 0.0001$ and $R^2 = 0.2631$, $P < 0.0001$, respectively). A similar relationship was observed when individuals were stratified into chemosensory complaint groups on the basis of chemosensory complaint score (Table 4).

Chemosensory Complaints and Other Nutrition Impact Symptoms

Significant correlations among concurrent nutrition impact symptoms and chemosensory complaint score were observed. Individuals with high chemosensory complaint scores were more likely to report increased severity for poor appetite ($P = 0.0001$), nausea ($P = 0.0055$), and early satiety ($P = 0.0010$). Regression analysis showed negative associations between energy intake (kcal/kgBW/day) and lack of appetite ($P = 0.0037$, $R^2 = 0.1245$), nausea ($P = 0.0045$, $R^2 = 0.1192$) and early satiety ($P = 0.0283$, $R^2 = 0.0729$). When individual scores for poor appetite, nausea, early satiety, and chemosensory complaints were combined to create one nutrition impact variable, a significant association with energy intake was identified ($P = 0.0004$, $R^2 = 0.1798$). Pain and sadness were not significantly related to either chemosensory complaint score ($P = 0.3394$ and $P = 0.8523$, respectively) or energy intake ($P = 0.1602$ and $P = 0.5996$, respectively), and were, therefore, not included in the nutrition impact variable.

Discussion

We investigated the association of self-perceived chemosensory abnormalities with

Table 3
Nutrient Intake, Weight Loss, and BMI By Chemosensory Complaint Group

Nutritional Indices	Chemosensory Complaint Group								P-value	P-value ^a	
	Insignificant, n = 17		Mild, n = 15		Moderate, n = 18		Severe, n = 16				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Energy intake											
kcal/day	2,175	714	1,822	666	1,734	770	1,272	603	0.0050	1,2 > 4	—
kcal/kg BW/day	30.8	10.0	27.4	11.0	25.9	11.2	19.3	8.7	0.0192	1,2 > 4	—
Protein intake											
g/day	83	30	71	19	66	30	49	27	0.0051	1,2 > 4	0.8091 (NS)
g/kg BW/day	1.2	0.4	1.1	0.4	1.0	0.5	0.7	0.4	0.0294	1,2 > 4	0.8430 (NS)
Energy by macronutrient											
Carbohydrate (% kcal)	53.3	7.9	50.7	5.8	57.6	6.7	58.5	6.7	0.0059	3,4 > 1,2	—
Fat (% kcal)	32.6	5.9	33.6	6.5	28.8	5.9	27.2	5.7	0.0100	1,2 > 3,4	—
Protein (% kcal)	15.5	2.6	16.7	2.9	15.0	2.8	15.2	3.2	0.3408 (NS)	—	—
Age	67.9	11.3	67.5	13.5	67.1	12.3	58.4	10.9	0.1006 (NS)	—	—
Weight loss ^{a,b}	2.3	3.1	8.5	0.0	7.1	5.2	10.0	11.7	0.0372	—	—
BMI	25.8	7.4	24.7	5.9	24.1	3.5	24.4	5.1	0.8262 (NS)	—	—

SD = standard deviation; kcal = kilocalories; BW = body weight; NS = not significant at $\alpha = 0.05$.

Study participants stratified by self-assessed chemosensory complaint score, where insignificant = 0, mild = 2–4, moderate = 5–9, and severe = 10–16.

^aStatistical model adjusted for energy intake.

^bPercent weight loss over previous 6 months.

dietary intake, food enjoyment, and QOL among patients with advanced cancer. Our results suggest a high prevalence of chemosensory problems, which are clearly persistent well beyond the time of anticancer therapy. The majority (86%) of patients surveyed experienced chemosensory abnormalities; 52% reported the presence of both taste and smell

dysfunction. Where these chemosensory changes were severe, they were associated with very poor nutrient intakes, food enjoyment, and QOL. Chemosensory abnormalities clearly comprise an important unrecognized element of the symptom burden in this palliative population and where present in a severe form, appear to be a primary factor in the etiology

Table 4
Global and Subscale Measures of Quality of Life Generated Using the FAACT Instrument by Chemosensory Complaint Group

Quality-of-Life Subscale	Chemosensory Complaint Group								P-value
	Insignificant, n = 17		Mild, n = 15		Moderate, n = 18		Severe, n = 16		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Global quality of life	116	19	105	17	95	19	93	16	0.0022
Physical well-being	23	5	20	4	18	6	14	6	0.0015
Functional well-being	17	6	14	4	12	7	17	6	0.6249
Social/family well-being	21	4	21	4	20	5	22	5	0.2905
Emotional well-being	18	5	16	6	15	5	17	4	0.1229
Anorexia–cachexia-related	38	6	34	5	31	9	26	8	0.0004
Nutritional well-being									

FAACT = Functional Assessment of Anorexia/Cachexia Therapy.

Study participants stratified by self-assessed chemosensory complaint score, where insignificant = 0, mild = 2–4, moderate = 5–9, and severe = 10–16.

of cancer-associated malnutrition and wasting. Although our study size was conservative and the distribution of the severity of taste and smell problems may not be generalizable to other palliative care populations, taste and smell abnormalities are frequently cited as troubling symptoms in palliative care populations.^{13,14}

Malnutrition related to inadequate dietary intake is present in up to 90% of patients with advanced cancer, adversely affecting patient survival and QOL.^{23–25} Our results provide evidence that individuals reporting self-perceived chemosensory disturbances are at increased risk for malnutrition. The decrement in caloric intakes associated with severe chemosensory complaint was substantial (900–1,100 kcal/day), and average energy intake in this group (19 kcal/kg BW/day) was well below basal metabolic rates reported for patients with advanced malignant disease (22–24 kcal/kg/d).^{26–28} Not surprisingly, weight loss is a common finding among individuals suffering from altered taste and smell perception,^{22,29–32} as we found here.

It has been suggested that the decrease in dietary intake observed in cancer patients is related to abnormal chemosensation and its disruption of normal physiological responses to and hedonic value of food.³³ If this is the case, understanding and addressing the relationship between abnormal chemosensory function and dietary intake has the potential to improve food enjoyment, dietary intake, and nutritional status in patients with advanced cancer. This has been demonstrated in the elderly, for whom the sensory enhancement of foods resulted in increased dietary intake^{34,35} and improved functional status.³⁶ Recognizing that taste and smell abnormalities are also related to food preference,³⁷ dietary interventions catering to the unique preferences and chemosensory capacities of patients with advanced cancer may result in improved dietary intake and, therefore, warrant further investigation.³⁸

A considerable proportion of our subjects regard their chemosensory abnormalities as substantially disruptive and, therefore, clinically relevant; this was supported by the observed relationship between chemosensory complaint score and QOL. Interestingly, though depression has been shown to negatively affect chemosensory perception and food appreciation,³⁹ we

did not observe a significant relationship between chemosensory complaint group and the emotional well-being construct of QOL. Although it is unknown whether the chemosensory dysfunction reported by our subjects resulted in or merely reflected reduced QOL, individuals in various patient populations have consistently identified chemosensory abnormalities to be particularly distressing.^{7,8,12,40–42} Wickam et al.¹² correlated taste changes to decreased physical well-being, functional well-being, and total QOL among cancer patients receiving chemotherapy. As was observed in our sample, subjects related abnormal taste sensation to decreased food enjoyment. Heald et al.⁷ found that chemosensory distortion, assessed in 207 HIV-infected patients, was associated with decreased QOL in all measured domains. In light of these results, it can be argued that attempts to improve or normalize the chemosensory experience of terminal cancer patients have the potential to improve QOL. Future work can explore whether improved or normalized chemosensation has the ability to improve food intake and QOL in this population. Further qualitative studies may investigate the effect of taste and smell perception on food-related QOL and its role in food selection or avoidance in patients with advanced cancer.

It is possible to make objective clinical measures of detection and recognition of the four basic tastes, sweet, salty, sour, and bitter, and these have been used by others in various studies on cancer patients.^{29,37,43–48} We did not opt to use the clinical tests because the complex interaction of taste stimuli and volatile flavor compounds experienced with food consumption cannot be assessed through basic threshold testing. We argue that subjective (self-perceived) changes to chemosensory function are likely to provide sufficient stimulus to alter food-related behavior regardless of whether a measurable objective abnormality exists. This contention is supported by our results, in that individuals with severe chemosensory complaints were more likely to report a change to favorite foods than individuals with no complaints or those with mild to moderate chemosensory complaints.

The chemosensory abilities of patients seemed to be dominated by inappropriately increased sensitivity to odors as well as to bitter

and sour tastes. An analogy may be made to some of the instruments in an orchestra playing both too loud and “off-key.” Pattison et al.⁴⁷ provided empirical evidence that patients with advanced cancer experience enhanced olfactory sensation relative to age-matched controls. Although specific chemosensory complaints relating to sensitivity to the basic tastes were variable in our sample, there was a relatively consistent finding of increased perception of bitter or sour which could be expected to result in perceived “off flavors” during eating. The use of masking agents to neutralize these taste stimuli may prove to be an important strategy for improving dietary intake. These observations of chemosensory distortions and increased sensitivities to taste and smell are particularly interesting given the mean age of our sample (65.4 ± 12.4); in elderly populations (>65 years), a decline in chemosensory acuity is generally observed.⁴⁹

The overall variability in subject responses reflects the variation observed in clinical taste threshold studies performed in cancer patients in the 1970s and 1980s.^{29,37,43–45,48} The lack of agreement in the literature as to the quality and severity of chemosensory abnormalities faced by cancer patients highlights the individuality of abnormal chemosensory perception.

Associations among age,⁴⁹ gender,⁵⁰ oral health and dentition,⁵¹ smoking status,⁵² number and type of medications taken,^{7,53} depression,⁵⁴ various cancer treatments,^{15–17} chemosensory function, and food appreciation have been identified in healthy populations. In our sample, age and depression did not appear to be a factor affecting abnormal chemosensation and food intake/enjoyment. Because our goal was to ascertain the prevalence of self-perceived chemosensory abnormalities and nature of the relationship between chemosensory function and food intake and QOL among patients with advanced cancer, we did not seek in this case to identify the origins of reported abnormalities. However, we recognize that these potential causes of the reported chemosensory dysfunction need also to be evaluated in representative populations. The number and type of medications taken and the type and duration of cancer treatments are of particular relevance and should be explored in depth in future studies incorporating clinical evaluations

of chemosensory perception, nutritional status, and QOL among patients with advanced cancer.

Our study participants were similar to those in published studies of anorexia–cachexia therapies.⁵⁵ Given the prevalence of chemosensory disturbances in patients with advanced cancer, it may be speculated that where severe, these problems limit the efficacy of therapeutic food supplements, dietary interventions, and orexigenic agents. Chemosensory abnormalities may underlie failure to comply with study treatments, or their apparent lack of efficacy.

Patients with advanced cancer experience numerous symptoms that are likely to affect appetite and food intake and may be experiencing several of these at once.²² We found that poor appetite, nausea, early satiety, and chemosensory abnormalities tend to present concurrently. These symptoms are not likely to be entirely independent of one another, considering that nausea may be exacerbated by enhanced perception of odors and that these sensations may in turn influence the perceived interest in initiation and continuation of food intake. Individually and collectively, poor appetite, nausea, early satiety, and abnormal chemosensation were significantly related to decreased energy intakes. Here, we have been able to establish the relationship between the self-perceived chemosensory experience, energy intake, and QOL. We emphasize the importance of future work to evaluate the individual contributions and potential interactions among the various nutrition impact symptoms in contributing to poor nutritional status.

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