Taste Dysfunction in Head and Neck Cancer Survivors

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The brain uses the primary sense of taste, along with vision, hearing, touch, and smell, to interpret the physical world. Taste sensations help determine the nutritional qualities of food and prompt the secretion of enzymes and insulin for digestion (Breslin & Huang, 2006; Brisbois, Hutton, Baracos, & Wismer, 2006). Cravings and eating behaviors are driven by the desire for pleasant-tasting foods and beverages. When taste is impaired, digestion and appetite are disrupted (Breslin & Huang, 2006).

Taste receptor cells are found in the back of the throat and in the upper one-third of the esophagus, but most are located on the tongue. The anterior surface of the tongue is covered with dome-shaped projections called papillae. The sides of the papillae contain the taste buds, which are lined with taste receptor cells. Taste receptor cells are the only epithelial cells in the body that generate action potentials and use neurotransmitters, which directly transmit taste sensations to nerve fibers (Scott, 2005; Vandenbeuch & Kinnamon, 2009). Taste receptor cell proliferation is directly related to nerve supply; without adequate nerve supply, taste receptor cells die (Heckmann & Lang, 2006; Just, Pau, Witt, & Hummel, 2006).

Taste sensations begin when solid or liquid food is taken into the mouth. Every taste receptor cell is capable of recognizing all of the basic tastes: sweet, sour, salty, and bitter. When food comes in contact with receptor cells, taste sensation is transmitted to the brain and the perception of that taste sensation is directly related to the concentration of the stimuli and the number of receptor cells an individual possesses (Bartoshuk, 1989; Breslin & Huang, 2006; Smith & Margolskee, 2001).

Therapies for head and neck cancer often produce significant changes in taste, which consequently predispose patients to poor nutrition (Breslin & Huang, 2006; Hayward & Shea, 2009; Maes et al., 2002). Patients with cancer frequently report taste changes and dysgeusia, which is a persistent bitter or metallic taste sensation (Brisbois et al., 2006; Goldberg, Shea, Deems, & Doty, 2005; Hayward & Shea, 2009; Logan, Bartoshuk, Fillingim, Tomar, & Mendenhall, 2008). Alterations in

Purpose/Objectives: To describe the prevalence of issues with taste function in survivors of head and neck cancer.

Design: Exploratory, cross-sectional.

Setting: Outpatients from Saint Louis University Cancer Center in Missouri.

Sample: 92 adult head and neck cancer survivors, heterogeneous in cancer site, treatment type, and time post-treatment, ranging from three months to more than 28 years after completion of therapy.

Methods: Taste discrimination was assessed using high, medium, and low concentrations of sweet, salty, sour, and bitter tasting solutions.

Main Research Variables: Taste, percentage of weight change, tumor site and stage, treatment type, and time since completion of therapy.

Findings: Eighty-five of 92 participants had some measurable taste dysfunction. Confusion between bitter and sour and the inability to discriminate among the different concentrations of the sweet solutions were common. Statistically significant weight loss was associated with dysgeusia.

Conclusions: Taste dysfunction was a persistent problem across all categories of head and neck cancer treatments, sites, and stages. Participants who reported the loss of one or more specific taste modality performed poorly on the taste test. However, participants could not accurately predict which taste was most severely impaired.

Implications for Nursing: Taste dysfunction is a long-term treatment-related side effect for head and neck cancer survivors. Assessing for taste changes and dysgeusia are important nursing considerations, as taste loss is distressing and associated with decreased appetite. Future studies are needed to identify interventions to help patients better manage and adapt to this long-term complication of cancer therapy.

Knowledge Translation: Flavors are recognized by taste, texture, aroma, thermal quality, and visual cues. A disruption of one or more of those sensory experiences alters flavor recognition. Having intact taste sense but impaired flavor recognition is possible. Finally, taste is not accurately self-reported because it is commonly confused with flavor recognition.

taste are associated with changes in food selection, food aversions, diminished appetite, and poor quality of life among head and neck cancer survivors (Breslin &

Huang, 2006; Brisbois et al., 2006; Chasen & Bhargava, 2009; Connor et al., 2006; Hutton, Baracos, & Wismer, 2007; Larsson, Hedelin, Johansson, & Athlin, 2005; Roing, Hirsch, Holmstrom, & Schuster, 2009).

Head and neck cancer survivors are at risk for taste dysfunction because treatment to the head and neck region may reduce the concentration of taste receptor cells in a number of ways. Head and neck cancers may be treated with surgery or radiation alone, chemotherapy combined with radiation, or surgery combined with radiation and chemotherapy. Surgical treatment (e.g., glossectomy, laryngectomy) may remove or alter those normal anatomic structures of eating and swallowing. Surgery and radiation to the base of the tongue or face may disrupt the nerve supply to the taste receptor cells, impairing their proliferative capacity (Breslin & Spector, 2008; Just et al., 2006). In addition, both chemotherapy and radiation therapy cause deepithelialization of the oral mucosa and, therefore, reduce the number of functioning taste receptor cells (Just et al., 2005).

Patients with head and neck cancer who undergo radiation therapy are at particular risk for xerostomia (i.e., dry mouth). Saliva flow rates affect taste because saliva and tongue motility are necessary to maintain contact between the taste stimuli and the taste receptor cells inside the taste pores on the surface of the tongue (Bartoshuk, 1989). Normally, saliva flow adapts to keep taste stimuli moving across the tongue; if saliva flow is disrupted, taste sensitivity is decreased (Vissink, Burlage, Spijkervet, Jansma, & Coppes, 2003). The purpose of this study was to describe the prevalence of taste dysfunction in survivors of head and neck cancer.

Literature Review

A review of the literature was conducted using the search terms *taste dysfunction* and *head and neck cancer*. Literature sources included MEDLINE® and Scopus search engines (1996–2012) and the archival method (1982–2012). Survey and qualitative studies of taste function were not included in the literature review because taste impairment is not reliably self-reported (Gent, Goodspeed, Zagraniski, & Catalanotto, 1987; Goodspeed, Gent, & Catalanotto, 1987; Pribitkin, Rosenthal, & Cowart, 2003). Taste is not accurately self-reported because taste and flavor are commonly confused. Flavor recognition is the combination of taste sensation, thermal quality, texture, and aroma. Taste is only one dimension of flavor recognition (Smith & Margolskee, 2001). Patients with intact tactile, olfactory, and vision sensations would be able to recognize most flavors unless taste is severely impaired.

The literature search yielded only 12 published report measurements of taste acuity in head and neck

cancer survivors (Fernando et al., 1995; Just et al., 2005; Kamprad, Ranft, Weber, & Hildebrandt, 2008; Loewen, Boliek, Harris, Seikaly, & Rieger, 2010; Maes et al., 2002; Mirza et al., 2008; Mossman, Shatzman, & Chencharick, 1982; Sandow, Hejrat-Yazdi, & Heft, 2006; Schwartz, Weiffenbach, Valdez, & Fox, 1993; Yamashita, Nakagawa, Nakamura, et al., 2006; Yamashita, Nakagawa, Tago, et al., 2006; Zheng, Inokuchi, Yamamoto, & Komiyama, 2002) (see Table 1). However, the generalizability of the results of the prospective studies was limited by small sample sizes and taste testing methods (Fernando et al., 1995; Just et al., 2005; Loewen et al., 2010; Mirza et al., 2008; Mossman et al., 1982; Sandow et al., 2006; Schwartz et al., 1993; Zheng et al., 2002).

The two largest identified studies used pretreatment assessment of taste function to establish a baseline to which taste scores were compared (Yamashita, Nakagawa, Nakamura, et al., 2006; Yamashita, Nakagawa, Tago, et al., 2006). That designed approach did not take into account that patients with head and neck cancer often present with taste dysfunction. Pretreatment taste scores are unlikely to yield a true baseline of tasting ability because many cancers are known to secrete inflammatory cytokines, which alter taste thresholds and cause taste dysfunction at the time of diagnosis, prior to the implementation of cancer therapy or surgery (Plata-Salaman, 1998; Porter, Fedele, & Habbab, 2010; Steen, Shi, He, & McCluskey, 2010).

Taste threshold evolves over time based on dietary habits, which have cultural and regional influences (Breslin & Huang, 2006; Breslin & Spector, 2008). The tastants, or taste stimulants, used in the studies by Yamashita, Nakagawa, Nakamura, et al. (2006); Yamashita, Nakagawa, Tago, et al. (2006); and Zheng et al. (2002) were more highly concentrated in bitter and sour when compared to the standard of leading experts in the field of taste science (Pribitkin et al., 2003). Two prospective studies presented participants with one taste modality at a time, in ascending order of intensity, and tested participants weekly for longer than 12 weeks (Yamashita, Nakagawa, Nakamura, et al., 2006; Yamashita, Nakagawa, Tago, et al., 2006). Participants may have learned the sample order from prior experience with the test, so the taste test many not have been an accurate measure of participants' taste function.

Only three published reports of taste function in long-term survivors of head and neck cancer were identified (Loewen et al., 2010; Mossman et al., 1982; Schwartz et al., 1993). Most studies only included measures of taste function in participants six months after the completion of therapy, but taste impairment commonly is present at diagnosis, gets worse during treatment, and improves to some degree after treatment (Fernando et al., 1995; Just et al., 2005; Kamprad et al., 2008; Mirza et al., 2008; Yamashita, Nakagawa, Tago, et

Table 1. Studies of Taste Dysfunction in Head and Neck Cancer Survivors

Study	N	Design	Taste Measurement	Time Post-Treatment	Results
Fernando et al., 1995	26	Prospective, descriptive; participants were tested before, at the end of, and one month post-RT.	Whole mouth; seven different concentrations of the four basic tastes	1 month post-RT	Objective (p = 0.0016) and subjective taste loss of all modalities were documented. Significant differences associated with the volume of tongue in the RT field were observed.
Just et al., 2005	12 with 12 controls	Cross sectional, experimental	Filter paper; four concentrations of the basic four tastes	4–5 weeks after RT plus CT	Patients exhibited a significant decrease in gustatory function for all taste qualities.
Kamprad et al., 2008	44 with 30 controls	Prospective, experimental; participants were tested before, during, 8 weeks after, and 6 months after RT.	Four highly concentrated solutions of the four basic tastes	6 months post-RT	Persistent loss of bitter taste in those who received treatment to the whole tongue
Loewen et al., 2010	8 with 8 controls	Cross sectional, descriptive	Pipette droplet; one concentration; used tonic water for bitter and lemon juice for sour	20–63 months after surgery or surgery plus RT	No difference from the control group was found. The sample was very small, and lemon juice and tonic water are composed of multiple taste stimuli.
Maes et al., 2002	73	Cross sectional, descriptive	Pipette droplet; three concentrations of the four basic tastes	As many as 2 years after RT	Taste loss for bitter (41%), salty (51%), sweet (27%), and sour (17%) was found one to two years post-treatment. Tastant concentrations were not reported.
Mirza et al., 2008	8 with 17 controls	Prospective, experimental; participants were tested before, during, and after RT.	Pipette droplet; one concentration of the four basic tastes	6 months after RT	At six months post-treatment, participants had poor recognition of bitter, sour, and salty compared to the control group. Tastant concentrations were not reported.
Mossman et al., 1982	13	Cross sectional, descriptive	Pipette droplet; one concentration of the four basic tastes	1–7 years post-RT	Measureable taste loss occurred in nine participants; bitter and salty tastes were most severely affected.
Sandow et al., 2006	13 with 5 controls	Prospective, experimental; participants were tested before and at 1, 6, and 12 months post-RT.	Whole mouth; 10 concentrations of the four basic tastes	1 year post-RT	All participants returned to baseline ability to detect a difference between the tasting solution and rinse water at one year post-RT.
Schwartz et al., 1993	15 with 23 controls	Cross sectional, experimental	Whole mouth; eight concentrations of the four basic taste modalities	1–19 years post-RT	Sour taste loss; older patients reported dysgeusia.
Yamashita, Nakagawa, Nakamura, et al., 2006	118	Prospective, descriptive; participants were tested before, during, and after RT.	Filter paper; five concentrations of the four basic tastes	2 years after RT plus CT	All participants returned to baseline by four months post-RT.
Yamashita, Nakagawa, Tago, et al., 2006	51	Prospective, descriptive; participants were tested before, during, and after RT.	Filter paper; five concentration of the four basic tastes	11 weeks after RT	All participants returned to baseline by 11 weeks post-treatment.
Zheng et al., 2002	40	Prospective, descriptive; participants were tested before, during, and after RT.	Whole mouth; five concentration of the basic four tastes	6 months post-RT	All participants returned to baseline by six months post-RT.

CT—chemotherapy; RT—radiation therapy

al., 2006; Zheng et al., 2002). However, the time frame for taste function improvement is unknown because patients continue to report taste problems for years after the completion of therapy (Harrison et al., 1997; Logan et al., 2008; Martinez-Devesa, Barnes, Alcock, Kerr, & Milford, 2006; Schwartz et al., 1993). In addition, only one study (Loewen et al., 2010) included participants who were not treated with radiation therapy.

To understand the extent of the problem of taste dysfunction in head and neck cancer survivors, taste recognition must be measured objectively in long-term survivors (i.e., those who are two years or longer post-therapy), as well as those treated without radiation therapy. The inability to taste and enjoy food is associated with weight loss (Breslin & Spector, 2008; Chasen & Bhargava, 2009; Vissink et al., 2003). Little is known about the consequences of taste dysfunction for survivors of head and neck cancer; therefore, information on weight change and eating enjoyment was included in the data collection.

Methods

This cross-sectional, observational study was designed to describe the prevalence of taste dysfunction in a group of head and neck cancer survivors. Survivors were defined as having completed all therapy at least three months prior to recruitment, with no evidence of active disease at the time of data collection. The sample was heterogeous in terms of treatment type and disease site and included 50 long-term survivors (those longer than two years post-therapy).

Data Collection

Institutional review board approval was obtained from Saint Louis University in Missouri prior to recruitment and data collection. After giving informed consent, participants were asked to complete an eight-item paper-and-pencil questionnaire (see Figure 1). Charts were reviewed for tumor site and stage, treatment type, and age. Weight at first clinic visit was recorded to compare to weight on the day of taste testing. The date of treatment completion was recorded from the clinic chart, and time post-treatment was calculated based on the date of taste testing.

The taste test was a whole-mouth screening assessment. Solutions were prepared each day of taste testing by dissolving the powdered compounds in precisely measured volumes of distilled deionized water. Tastants were measured within 1/1,000 g of accuracy on a precision scale by a registered pharmacist and stored in brown glass apothecary bottles to prevent light degradation. Distilled deionized water used as tastant diluent was purchased each week and measured using precision graduated cylinders. Separate cylinders and funnels

Figure 1. Taste Questionnaire for Head and Neck Cancer Survivors

were maintained for each taste stimuli to ensure that no samples were contaminated with another taste modality. All tasting solutions were prepared on the day of taste testing, starting with lowest and ending with the highest concentration of solution. Unused solutions were discarded at the end of each day.

The purpose of the test was to detect gross abnormalities in tasting ability and measure perceived intensity and taste quality on the four basic taste modalities. High, medium, and low concentrations were used. The lowest level of each tastant compound exceeded the level at which it would be normally recognizable (Pribitkin et al., 2003). The taste stimuli were made from premeasured compounds dissolved in distilled deionized water. The taste stimuli used in the current study were as follows: sucrose for sweet, sodium chloride for salty, citric acid for sour, and quinine hydrochloride for bitter.

The sweet and salty tastants were prepared in the following molar (M) concentrations: 1 M, 0.32 M, and 0.1 M. Sour sample concentrations were 0.018 M, 0.0056 M, and 0.0018 M. The concentrations of bitter samples were 0.00018 M, 0.000056 M, and 0.000018 M. The tastant compounds were measured on a precision scale in quantities adequate to test as many as 10 participants on each data collection day. Those tastant concentrations are consistent with the accepted standard for suprathreshold taste testing (Bartoshuk, 1989; Pribitkin et al., 2003).

Each tastant sample consisted of 10 ml. Participants were informed that each sample contained a taste stimulant and that the tastants would be presented in random order. Three predetermined random orders were established by writing the 12 taste stimulant names on pieces of paper and pulling them from a hat. The process was repeated three times and the random orders were rotated each day of data collection, starting with random order 1 on data collection day 1. The perceived modality of each sample was

recorded, and the perceived intensity was indicated on a weighted visual analog scale. At least 30 ml of distilled deionized water was used to rinse the mouth between every sample.

Sample and Setting

From July 17 through December 18, 2009, 100 participants were recruited from an outpatient head and neck cancer clinic at Saint Louis University Cancer Center in Missouri and underwent taste testing. The current study was descriptive, so power analysis was not conducted. Ninety-two participants were included in the final data analysis. The clinic used paper charts at the time of the study, and participants were consented and taste tested prior to the investigators having access to the medical record. As a result, six patients were found to have overestimated their time since completion of therapy and were excluded. In addition, one woman was excluded because she was the only participant treated with chemotherapy alone, and data on weight change were not available for one participant.

Statistical Analysis

The current study was conducted in partial fulfillment of the requirements for the author's doctorate degree, so a statistician was consulted. Taste test scores usually are reported as mean minimum thresholds for recognition and analyzed as interval level data. In the current study, 27 participants could recognize one or more taste modality (sweet, sour, bitter, or salty) at low concentration but not at high concentration. That was grossly abnormal and also nullified the interpretation of minimum thresholds as a measure of taste function in this group. For example, if a participant could correctly identify the 0.1 M sucrose solution as sweet, but the 1 M sucrose sample tasted sour, the minimum recognition score of 0.1 M would not adequately reflect that participant's ability to taste sweet. As a result, the taste test scores were analyzed as categorical level data.

Taste test scores were tabulated by recording the number of tastants each participant correctly recognized, making the taste scores ordinal-level data. In addition, the sample was highly heterogeneous and histogram analysis revealed non-normal distribution of the data. For those reasons, a nonparametric approach was recommended for analyzing the taste scores. Descriptive statistics were used to present the taste scores and self-report of dysgeusia and tasting ability. Chi-square test was used to compare taste test scores and self-reported taste from the questionnaire, and the linear-by-linear association p value was used. The chi-square p value corresponding to Pearson's chi-square test was used, but Fisher's exact test was used when required by the sample size. One-way analysis of variance (ANOVA) was used to test for differences in time and percentage of weight loss related to taste. When comparing treatment types, tumor site, and tumor stage with taste as the outcome variable, the nonparametric equivalent Kruskal-Wallis ANOVA was used. T test was implemented to assess differences in time and percentage of weight loss related to dysgeusia, and the Mann-Whitney U test was used to analyze the relationship between dysgeusia and taste scores, treatment types, tumor site, and tumor stage. The level of significance was set at 0.05 for two-tailed tests, and data were analyzed with SPSS®, version 13.

Findings

Sample Characteristics

See Table 2 for sample characteristics. The mean age was 62.28 years, and most were men. The period

Table 2. Sample Characteristics (N = 92)	
Characteristic	**n**
Age (years)	
49 or younger	16
50–59	20
60–69	31
70 or older	25
Gender	
Male	65
Female	27
Years post-treatment	
Less than 1	23
1–2	19
2–3	15
3–4	15
4–5	12
More than 5	8
Tumor histology	
Squamous cell	73
Adenocarcinoma	3
Other	16
Disease stage	
I	13
II	12
III	17
IV	30
Unknown	20
Tumor site	
Paranasal cavity	8
Pharynx	28
Oral cavity	26
Larynx	21
Other	9
Treatment	
Surgery	21
Radiation therapy	5
Surgery and radiation therapy	31
Radiation therapy and chemotherapy	23
Surgery, radiation therapy, and chemotherapy	12

of time since completion of therapy ranged from 85 days to more than 28 years. Most participants received treatment for squamous cell carcinoma, and the majority presented with advanced disease. A variety of head and neck cancer sites were represented in the sample, and most patients were treated with combined modalities.

Performance on the Taste Test

Participants performed poorly on the taste tests (see Figure 2). Although they were able to recognize the highly concentrated solutions, even the lowest concentration should have been readily recognizable (Pribitkin et al., 2003). The highly concentrated sweet sample was composed of almost three tablespoons of sugar per 100 ml sample bottle, but four participants misidentified the solution as something other than sweet. Eighteen participants were not able to detect any taste modality in the low-concentration sucrose tasting solutions. Participants were most successful at recognizing salty taste samples, but 10 could not detect the salty sample at low concentration. Many confused sour for bitter, particularly at low concentration, where 28 participants reported that the citric acid solution tasted bitter. Participants performed poorest on their recognition of bitter. Even at high concentration, 9 participants could not taste anything, and 39 could not detect a difference from the rinse water at low concentration.

No significant linear relationship was found between self-rated taste scores and the objective taste test (see Figure 3). Participants could not accurately report taste dysfunction, which was measured by the taste test ($\chi^2 = 0.11$, $p = 0.74$). Four of the nine participants who rated their tasting ability as very good recognized less than 75% of the tasting solutions, and six of the 21 participants who rated their tasting as poor recognized more than 90% of the samples.
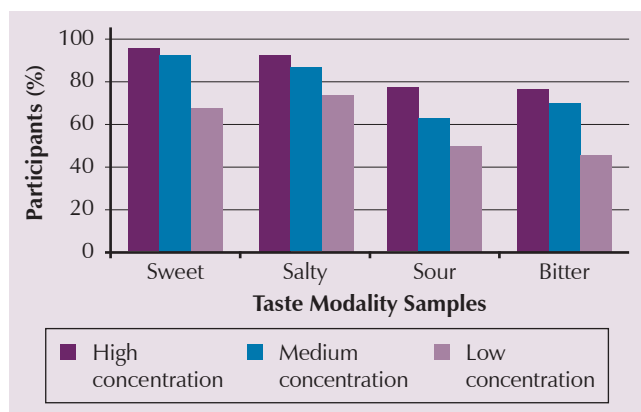

Figure 2. Correct Recognition of Taste Among Study Participants (N = 92)
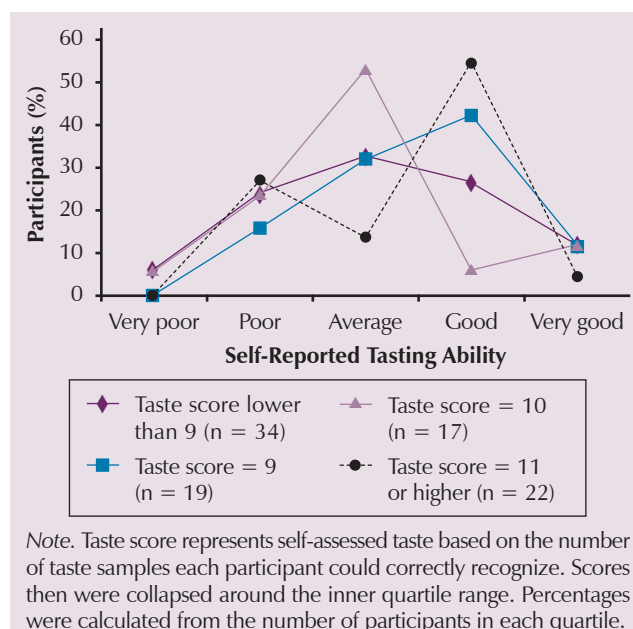

Note. Taste score represents self-assessed taste based on the number of taste samples each participant could correctly recognize. Scores then were collapsed around the inner quartile range. Percentages were calculated from the number of participants in each quartile.

Figure 3. Taste Test Scores Compared With Self-Reported Tasting Ability (N = 92)

Weight Change

No significant difference in the percentage of weight changes were observed based on taste scores (F = –1.508; p = 0.218) (see Figure 4). The 19 participants who recognized 75% of the taste solutions gained an average of 4% body weight from the first recorded pretreatment weight in the clinic chart to the weight recorded in the clinic chart on the date of taste testing, whereas the 22 participants who scored higher than 90% on the taste test lost more than 4% body weight. Participants' self-rated taste scores did not predict significant weight loss (F = 1.48; p = 0.22). However, patients with dysgeusia lost more weight from pretreatment to the date of taste testing. The 23 participants with dysgeusia lost more than 7% of their body weight, and patients without dysgeusia gained weight (t = 2.123; p = 0.037) from pretreatment to the date of taste testing.

Taste Dysfunction

Treatment type: No significant difference in taste function was detected among participants based on the five categories of treatment: surgery; radiation; radiation and chemotherapy; radiation and surgery; and surgery, radiation, and chemotherapy ($\chi^2 = 1.99$; p = 0.757).

Site: No significant difference in taste scores was detected among participants based on treatment site. However, participants who were treated for pharyngeal tumors self-reported worse tasting ability than any other treatment site group ($\chi^2 = 11.055$; p = 0.026).
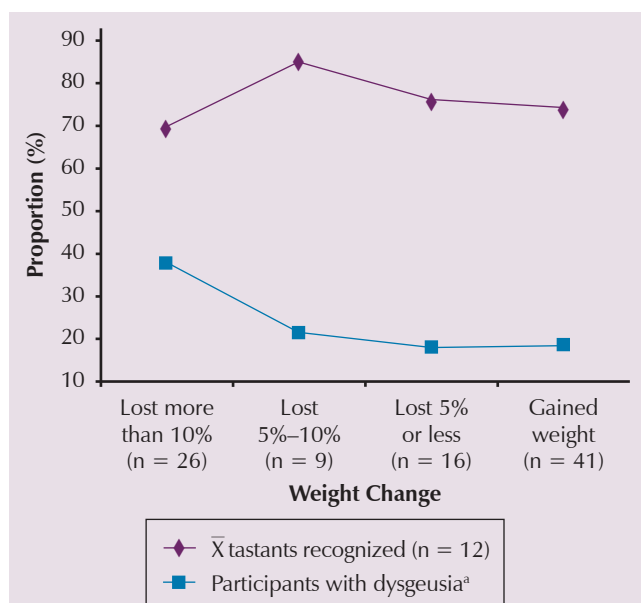
Stage: Seven of the 17 participants who were treated for stage III head and neck cancers were categorized as

having ageusia, which is the worst form of taste dysfunction and is demonstrated by a participant's inability to recognize one or more whole taste modalities at any concentration. Only 9 of 76 participants treated for all other stages had that severe taste dysfunction (χ^2 = 8.4; p = 0.009).

Time: No significant relationship was observed when comparing time post-treatment among the taste scores (F = 0.309; p = 0.906). However, reports of enjoyment with eating did appear to be associated with time (see Figure 5). Forty-two of 50 participants who were interviewed more than two years post-therapy reported deriving enjoyment from eating, whereas only 28 of 42 participants who were interviewed less than two years post-therapy said they enjoyed eating (χ^2 = 3.972, p = 0.046).

Discussion

Twenty-three participants in the current study reported dysgeusia. In addition, 14 anecdotally reported nontaste sensory experiences (i.e., sensations of puckering, dryness, tingling, and mild burning) during taste testing. Those oral sensory reports may have been physiologic manifestations of regional neuropathy (Granot & Nagler, 2005) and also may be related to the interruption of normal taste input. When normal taste sensation signals are interrupted, input from other nerves (i.e., those that sense texture, pungency, and

Figure 5. Taste Test Results by Years Post-Treatment (N = 92)
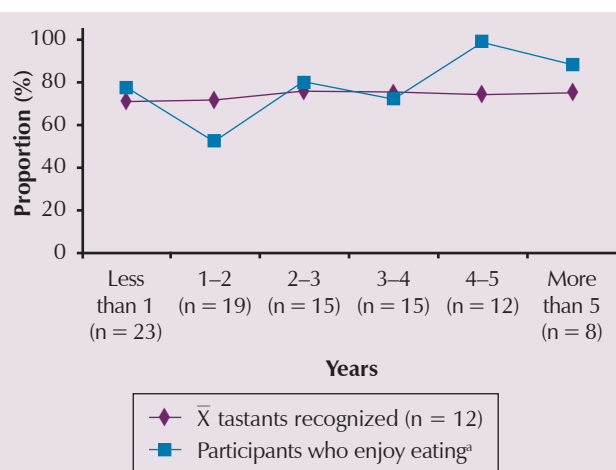
a Percentages were calculated based on the number of participants in each year interval.

pain) are intensified (Logan et al., 2008). Regardless of the cause, oral sensory issues were common among this group of head and neck cancer survivors and contributed to their weight loss.

Several studies have reported that taste changes resolved after the completion of therapy (Sandow et al., 2006; Yamashita, Nakagawa, Nakamura, et al., 2006; Yamashita, Nakagawa, Tago, et al., 2006; Zheng et al., 2002). That finding was not supported by the current study. Head and neck cancer survivors may have significant and enduring taste impairment. The inability to discriminate between the concentrations of sweet samples used in the current study is considered a grossly abnormal finding (Pribitkin et al., 2003). Taste dysfunction was not time dependent among participants in this study. The average number of tastants participants could recognize remained consistently around 9, regardless of the length of time post-treatment when testing occurred. That is an important finding because few studies of taste function among long-term survivors of head and neck cancer were found in the literature review. A major contribution of the current study is that it documented taste dysfunction among the 50 participants who were more than two years post-treatment.

Patients treated for tumors of the pharynx self-reported worse tasting ability than those in any other tumor site group. That may be related to the effects of treatment on the base of tongue, which may affect tongue mobility (Campbell et al., 2004).

The lack of agreement between self-reported tasting ability and taste test scores may be related to the great variability of time since completion of therapy, as some participants anecdotally reported that they did not miss the way food used to taste because they no longer

a Percentages were calculated based on the number of participants in each weight-change interval.

Note. Weight change trends were not associated with the percentage of tastants participants could recognize correctly.

Figure 4. Weight Change and Taste Dysfunction in Head and Neck Cancer Survivors (N = 92)

remember how it used to taste. Patients may adapt to their taste changes and lose awareness of their taste dysfunction over time.

Strengths and Limitations

The reliability of the current study was enhanced by the precision of the taste testing protocol. Great care was taken in the measurement of the taste testing compounds and diluent solutions. The taste testing solutions were prepared by a single person using the same method on every data collection day. A single investigator poured each sample and administered all taste tests. Samples were presented in random order for the purpose of allocation concealment, which prevented those enrolled from knowing the upcoming taste testing assignment.

The study results are limited by a number of procedural and design flaws. The sample size was small and highly heterogeneous relative to the number of variables examined. As a result, conservative estimations were required for a number of variables. Many categories could have been collapsed, but meaning may have been lost. The cross-sectional design and highly heterogeneous sample made drawing conclusions on the relationship between time and taste dysfunction difficult. A prospective study could help determine how taste impairment changes over time. The participants were drawn from a convenience sample. Controlling for potential mediator variables such as tobacco use, medications, or history of medical conditions associated with taste changes (e.g., Alzheimer disease, head injury) would have enhanced the generalizability of the study results. In addition, weight change was calculated based on the first weight recorded in the clinic chart. Head and neck cancer survivors often present with weight loss. Change in body mass index may have more accurately represented the relationship between weight change and taste impairment.

The methodology used to assess taste acuity in the current study was labor intensive and lacked the ability to discriminate more subtle taste changes in this group of patients. That methodology could never be used in clinical practice; however, the findings from the current study suggest that self-report is not necessarily an accurate indicator of taste acuity.

Implications for Nursing

Additional investigation of the relationship between dysgeusia and weight changes is important, particularly because that problem was identified by 23 participants in the sample. Investigation of the relationship between flavor recognition and weight change in patients with head and neck cancer would be helpful because flavor recognition may be more important than taste threshold in predicting weight change.

A prospective study with a control group would help clarify the relationship between taste dysfunction and time. In addition, a repeated measure may help determine why participants confused bitter, sour, and salty tastes in the current study. For example, if participants were tested on each taste modality twice during the sensory assessment and identified the low-concentration bitter sample as sour both times, it would help clarify whether participants were guessing to determine taste modality. Future research should focus on means to more accurately screen for taste dysfunction; more importantly, such tools should be simple to implement in the clinical setting.

The current study's findings imply that taste dysfunction is consistently present in patients with head and neck cancer, regardless of the time since treatment was completed. Taste function is impaired by head and neck cancer treatments, and taste test results were no better for participants who were more than two years post-treatment than for those tested earlier after completing therapy. However, participants reported greater enjoyment in eating two years after treatment. Participants appear to adapt their eating behaviors over time in ways that allow them to enjoy eating again. Instead of telling patients with head and neck cancer that their taste will return over time, informing them that they will adapt to their taste changes over time may be more accurate.

Participants had difficulty recognizing both weakly and highly concentrated tasting solutions. Therefore, head and neck cancer survivors may have difficulty tasting both strongly flavored and weakly flavored foods. Encouraging patients to try a variety of foods and experiment with food seasoning may enhance adaptation to taste changes.

Twenty-three participants in the current study reported persistent bitter or metallic taste in the mouth, and 15 participants continued to have pain with eating. Those symptoms affect the eating behaviors and comfort of patient with head and neck cancer. Recommending frequent oral care and smooth or soft foods are simple interventions for helping patients cope with those symptoms.

Conclusions

Head and neck cancer survivors experience taste dysfunction. Participants demonstrated impaired recognition of taste stimulant solutions at low and high concentrations, as well as persistent bitter or metallic phantom tastes. Taste dysfunction was prevalent among long-term survivors, including those who were longer than five years post-treatment. Recognition of taste dysfunction in patients with head and neck cancer

is important so that clinicians may help survivors cope with this distressing sensory loss.

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