Taste and Smell Abnormalities in Advanced Cancer: Negative Impact on Subjective Food Intake

Aidan O'Donoghue
Trinity College Dublin, Ireland

Michelle Barrett
Health Service Executive, Ireland

Pauline Uí Dhuibhir Pauline Uí Dhuibhir
Our Lady's Hospice & Care Services, Ireland

See next page for additional authors

Funder: Open access funding provided by IReL.

Authors
Aidan O'Donoghue, Michelle Barrett, Pauline Uí Dhuibhir Pauline Uí Dhuibhir, Aileen Kennedy, Norma O'Leary, and Declan Walshe

DOI: 10.1002/ncp.10943

CLINICAL RESEARCH

Taste and smell abnormalities in advanced cancer: Negative impact on subjective food intake

Aidan O'Donoghue BSc[1,2] | Michelle Barrett MSc[2] | Pauline Ui Dhuibhir MSc[2] | Aileen Kennedy PhD[3] | Norma O'Leary MD[4,5] | Declan Walsh MD[6]

[1]School of Medicine, Trinity College Dublin, Dublin, Ireland

[2]Academic Department of Palliative Medicine, Our Lady's Hospice & Care Services, Dublin, Ireland

[3]School of Biological and Health Sciences, Technological University Dublin, Dublin, Ireland

[4]Department of Palliative Medicine, St James's Hospital, Dublin, Ireland

[5]Department of Palliative Medicine, Our Lady's Hospice & Care Services, Dublin, Ireland

[6]Department of Supportive Oncology, Levine Cancer Institute, Charlotte, North Carolina, USA

Correspondence
Declan Walsh, MD, Department of Supportive Oncology, Levine Cancer Institute, 711 Morehead St, Charlotte, NC 28202, USA.
Email: declan.walsh@atriumhealth.org

Abstract

Background: Taste and smell abnormalities (TSAs) are present in all cancer stages and may contribute to malnutrition. Despite this, they are rarely screened for. This study examined the prevalence and characteristics of TSAs and their influence on subjective food intake in advanced cancer.

Methods: Consecutive patients with advanced cancer were recruited. A modified Taste and Smell Survey assessed subjective TSAs. Objective TSAs were assessed with validated taste strips and "Sniffin Sticks." A six-item food intake questionnaire identified any effect TSAs had on food preferences/aversions. Nutrition status was evaluated with the abridged Patient-Generated Subjective Global Assessment.

Results: All 30 participants had either subjective or objective TSAs. The prevalence of TSAs varied based on the assessment tool used. Participants were more aware of taste changes (TCs) than smell changes (SCs). TCs caused reduced food intake in 13 participants. Six reported SCs affected food intake. Food choices caused by TSAs were inconsistent. Some foods preferred because of TSAs were avoided by other participants. None received nutrition counseling on TSA management. Almost all were at malnutrition risk (97%). Almost half (47%) felt TSAs reduced quality of life (QoL). Participants reported "not looking forward to meals" and "can't sit down and eat anything" because of TSAs.

Conclusion: TSAs were highly prevalent and impactful on food intake. Both TCs and SCs were complex and varied on an individual basis. Despite the effect on health and QoL, no patients received any nutrition counseling on TSA management. Individualized screening and advice are needed for TSAs in advanced cancer.

KEYWORDS
cancer, eating, food intake, malnutrition, smell, taste

BACKGROUND

Cancer is a common debilitating disease and is the third leading cause of death in Ireland.[1] Nutrition impact symptoms (NISs) are common throughout the cancer trajectory. NISs are defined as symptoms that negatively affect nutrition status and increase malnutrition risk.[2] Examples of NISs include anorexia, early satiety, and taste and smell abnormalities (TSAs). TSAs are present at all stages of cancer, including the treatment naïve,[3] during chemotherapy and radiotherapy,[4,5] in advanced disease,[6] and into survivorship.[7] Prevalence estimates in advanced cancer range from 60% to 93%.[6,8]

TSAs comprise a spectrum that includes increased, decreased, or absent taste and smell perception but also distortions in sensation. There is conflicting research about whether there is[9,10] or is not[11] a direct link between the sensations of smell and taste. The language used to describe TSAs may be inconsistent; for example, it is often flavor referred to rather than taste.[12] Flavor is a multisensory response that includes both taste and smell along with other senses and systems.[13]

With no recommended assessment and minimal focus on these common cancer symptoms, TSAs are not routinely assessed in oncology practice. This is of concern given their high prevalence, clinical importance, and effect on quality of life (QoL).[14,15] With the focus of specialist palliative medicine on maximizing QoL, research into TSAs in this cohort is essential. Management of TSAs in advanced cancer has been recommended to enhance QoL and to reinstate eating pleasure.[16] Although there is no "gold standard" for TSA assessment,[7] both subjective and objective methods are available. Subjective measures record patient experience, whereas objective measures assess the ability to detect and distinguish certain tastes and smells.

We know TSAs are prevalent and burdensome in patients with cancer, but little is known about whether/how they might also influence nutrition status. Appropriate clinical interventions could be devised in response. Accordingly, we examined the impact of TSAs on subjective food intake in advanced cancer in acute care palliative medicine. Specialist palliative care in Ireland includes the care of patients without cancer, however, for the purpose of this study, only patients with cancer were included because of established TSA prevalence. The objectives were to identify TSA prevalence, characteristics, severity, and relationships to food aversions. We explored any associated changes in food preference or choice.

METHODS

A prospective cross-sectional study was conducted in a specialist palliative medicine inpatient unit. Consecutive patients with a cancer diagnosis and Eastern Cooperative Oncology Group (ECOG) score ≤3 were identified at a daily multidisciplinary team meeting and invited to participate.[17] Those who agreed provided informed consent after both verbal and written explanations of the study. Ethical approval was provided by St Vincent's University Hospital ethics committee (reference number: RS19-001). Demographic data were obtained via routine medical records. A single interview occurred, in which each participant completed the assessments described below. All questionnaires were researcher administered, as self-administration was deemed too burdensome by the ethics committee for this cohort given their likely poor performance status. Nutrition assessment was not routine clinical practice.

Subjective TSAs

A modified Taste and Smell Survey (TSS) evaluated subjective TSAs (Appendix S1).[18] Four original TSS questions about medications were omitted, as they were irrelevant in cancer. Although not validated, no assessment of taste changes (TCs) and smell changes (SCs) in mixed cancers is, and the TSS has been used previously in oncology,[19] including in advanced cancer.[6,15] The TSS also evaluated QoL.

Objective TSAs

Taste

Taste was objectively assessed by taste strips (Burghart Messtechnik GmbH, Wedel, Germany). These validated strips assessed the ability to identify four modalities: bitter, salt, sour, and sweet.[20] The order of presentation was by a random selection generator function in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Each taste was assigned a number, except bitter, which was always presented last because of the prolonged taste. After each strip, the participant took a small sip of water to cleanse the palate. Those who did not identify all four strips correctly were deemed to have "impaired taste perception" (ITP). This process took ~3 min to complete.

Smell

Validated “Sniffin' Sticks” (Burghart Messtechnik GmbH, Wedel, Germany) assessed smell.[21] Twelve odor-filled pens were used. While the pen was held 2 cm from either nostril, the patient was shown a card with four smell descriptors. They were asked to identify which description matched the pen odor. If unsure, they were advised to pick the best match or guess. A score of 1 was given for each pen correctly identified. Scores were categorized as normal smell, 10–12; hyposmia (reduced), 6–9; and anosmia (absence), ≤5. All scores <10 were deemed to have impaired smell perception (ISP). This process took ~6 min to complete.

Food intake questionnaire

A six-item research department–designed food intake questionnaire (Appendix S2) identified any effect TSAs might have on food preferences and aversions. This was administered only to those with any subjective TSAs and divided into separate taste and smell sections. Objective measurements of food intake were not done.

Nutrition screening

An abridged version of the Patient-Generated Subjective Global Assessment[22] (abPG-SGA) evaluated nutrition status (Appendix S3). This has been validated in oncology.[23] A score of ≥6 identifies malnutrition risk (range, 0–36).

It has four domains:

1. self-reported height, weight, weight history (1 month; 6 months prior)
2. dietary intake in the past month
3. fourteen NISs, including taste and smell
4. current physical activity levels and daily function

Body mass index was calculated based on participant-reported weight and height. A BMI < 23.0 was considered underweight for those ≥60 years old.[24]

RESULTS

Patient characteristics

A total of 30 participants were recruited. The median age was 75 years (range, 46–93), with a male majority ($n = 19$). Most had a solid tumor diagnosis ($n = 29/30$). One had lymphoma. Population characteristics are in Table 1.

TABLE 1 Patient demographics and clinical data

Characteristic	*n* (%)
Sex	
Male	19 (63)
Female	11 (27)
Age	
<60 years	6 (20)
≥60 years	24 (80)
Primary diagnosis	
Upper gastrointestinal	10 (33)
Lung	9 (30)
Lower gastrointestinal	3 (10)
Urological	3 (10)
Breast	2 (7)
Gynecological	2 (7)
Lymphoma	1 (3)
Previous treatments	
Radiotherapy	15 (50)
Chemotherapy	10 (33)
Surgery	9 (30)
Other	5 (17)
Reason for admission	
Symptom control	20 (67)
End-of-life care	6 (20)
Rehabilitation	4 (13)
BMI category	
Normal	11 (37)
Obese	5 (17)
Underweight	13 (43)
Smoking status	
Previous	12 (40)
Current	10 (33)
Never	8 (27)
ECOG	
3	16 (54)
2	10 (33)
1	4 (13)

Abbreviations: BMI, body mass index; ECOG, Eastern Cooperative Oncology Group.

abPG-SGA

Almost all were at malnutrition risk ($n = 29/30$). The median total score of the abPG-SGA was 17 (range, 5–25). Seven did not know their weight history, so this section was incomplete. Even without this, they were all still identified as at malnutrition risk by the abPG-SGA.

NISs from the abPG-SGA are in Figure 1. The median NIS number was 7 (range, 2–10). Fifteen stated that they ate less than normal, but seven reported eating more than normal. The mean 6 months' percentage weight loss ($n = 15$) was 16% (SD, 13.6). The median BMI on study day was 22.5 kg/m^2 (range, 15–43); 13 participants were underweight (all ≥ 60 years old). Further data on BMI can be found in Table 1.

TSA prevalence

All participants had either subjective or objective TSAs. The prevalence and identification varied based on the tool (Figure 2).

Subjective

All participants ($n = 30$) had TCs. In 18 participants, these were identified by both subjective and objective measures. Twenty-five had SCs. Only seven reported SCs in the abPG-SGA, the rest were through the TSS.

Objective

Seven participants had objective ITP without subjective changes; five had TCs but no ITP. Fifteen had ISP without subjective SCs. Seven had SCs and objective ISP; three had SCs without ISP. Five had neither subjective nor objective SCs.

TSA characteristics

TSAs in subjective and objective assessments are in Figure 3.

Taste

In objective tests, only five correctly identified all four taste sensations. Four participants identified three; 12 identified two; and seven identified one. Sweet taste was identified correctly most often (80%) and sour least (37%). Of the 20

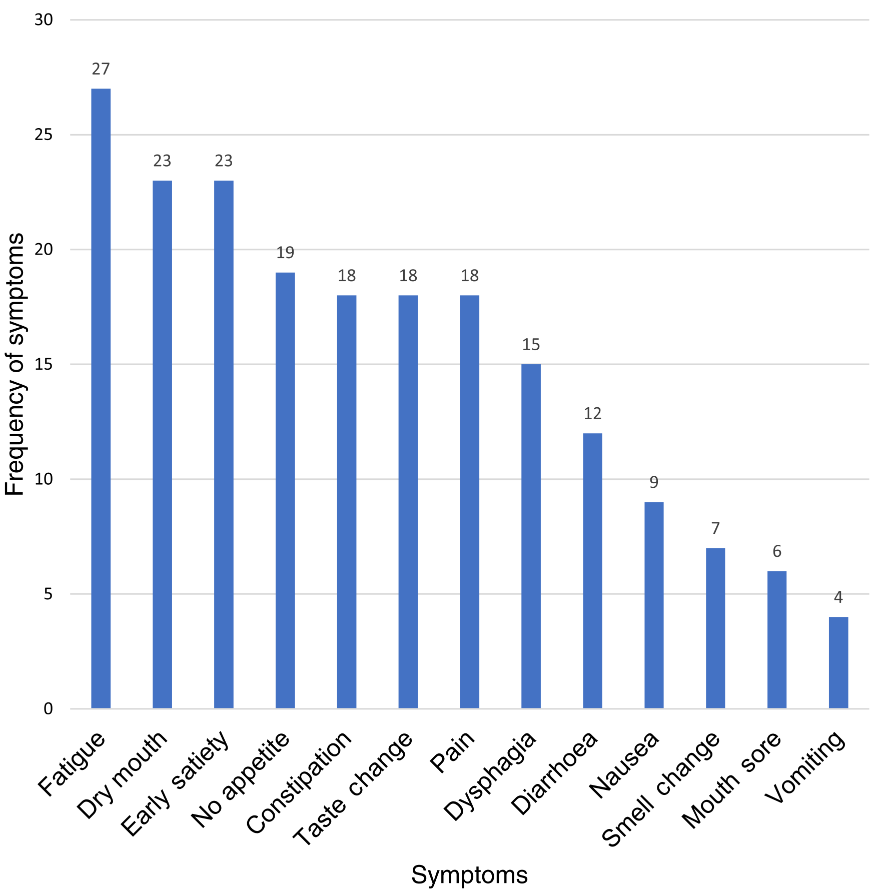

FIGURE 1 Abridged Patient-Generated Subjective Global Assessment nutrition impact symptoms ($n = 30$)

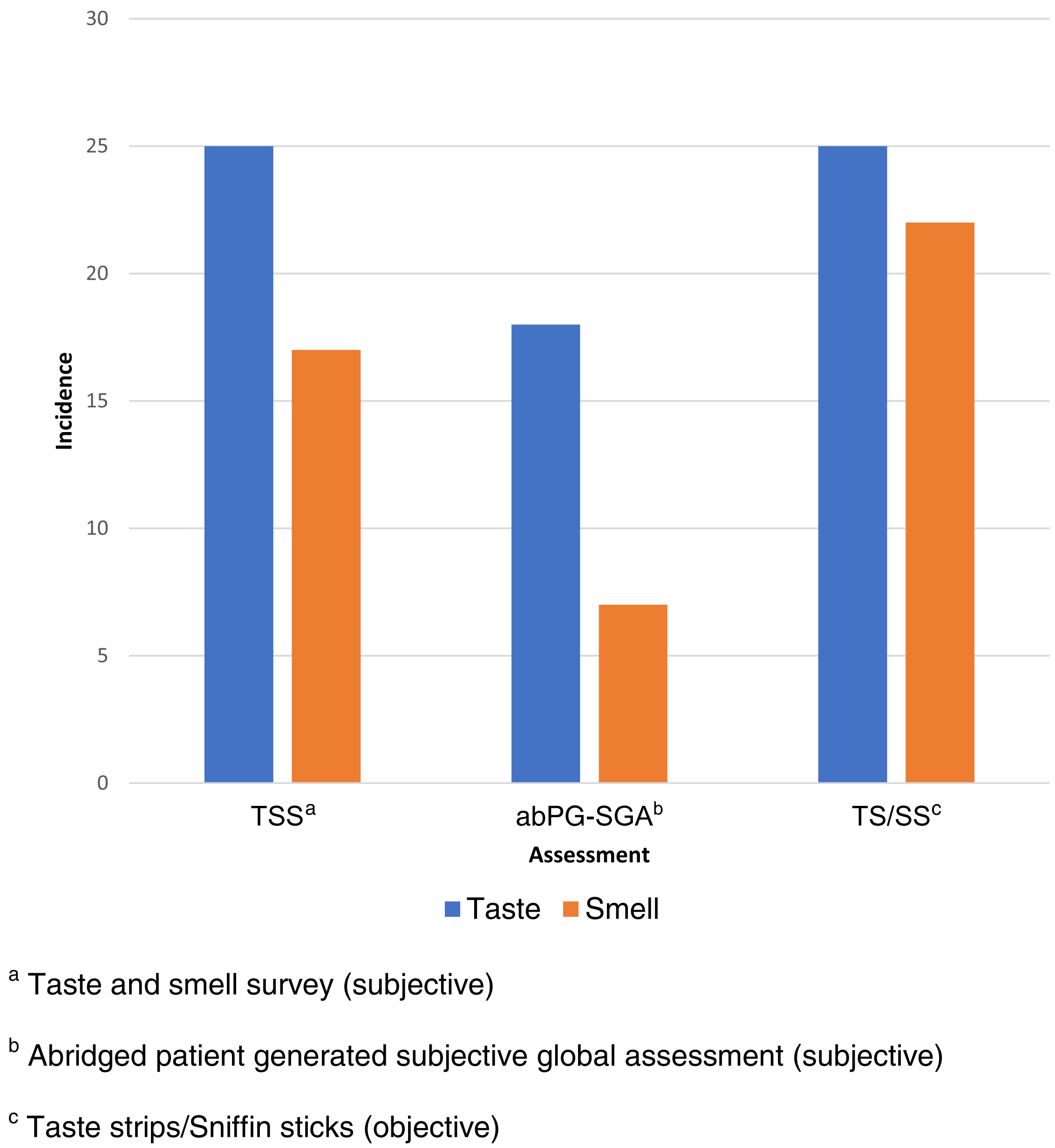

FIGURE 2 Taste and smell abnormality prevalence by assessment tool ($n = 30$). abPG-SGA, abridged Patient-Generated Subjective Global Assessment; SS, Sniffin Sticks; TS, taste strips; TSS, Taste and Smell Survey

who reported unchanged sour sensitivity, only five correctly identified it in objective assessment. Two participants did not identify any taste correctly. In no case did subjective TCs match objective results. Persistent bad taste was more common in previous/current smokers than in those who had never smoked (55% vs 29%, respectively). Participants' verbatim reports of TCs are in Table 2.

Smell

The TSS and abPG-SGA both identified seven participants with SCs. When compared, five reported SCs in both, so the abPG-SGA and TSS identified two participants each with SCs based on their different descriptors. Six reported that foods smelled different in the TSS, but only three had noted SCs before. Interestingly, six who had ISP had no subjective SCs. Both of those with subjective anosmia also had objective anosmia. Verbatim descriptions of SCs are in Table 2.

TSAs and QoL

Almost half (47%) reported that TCs affected QoL. In the five participants without objective TCs, four

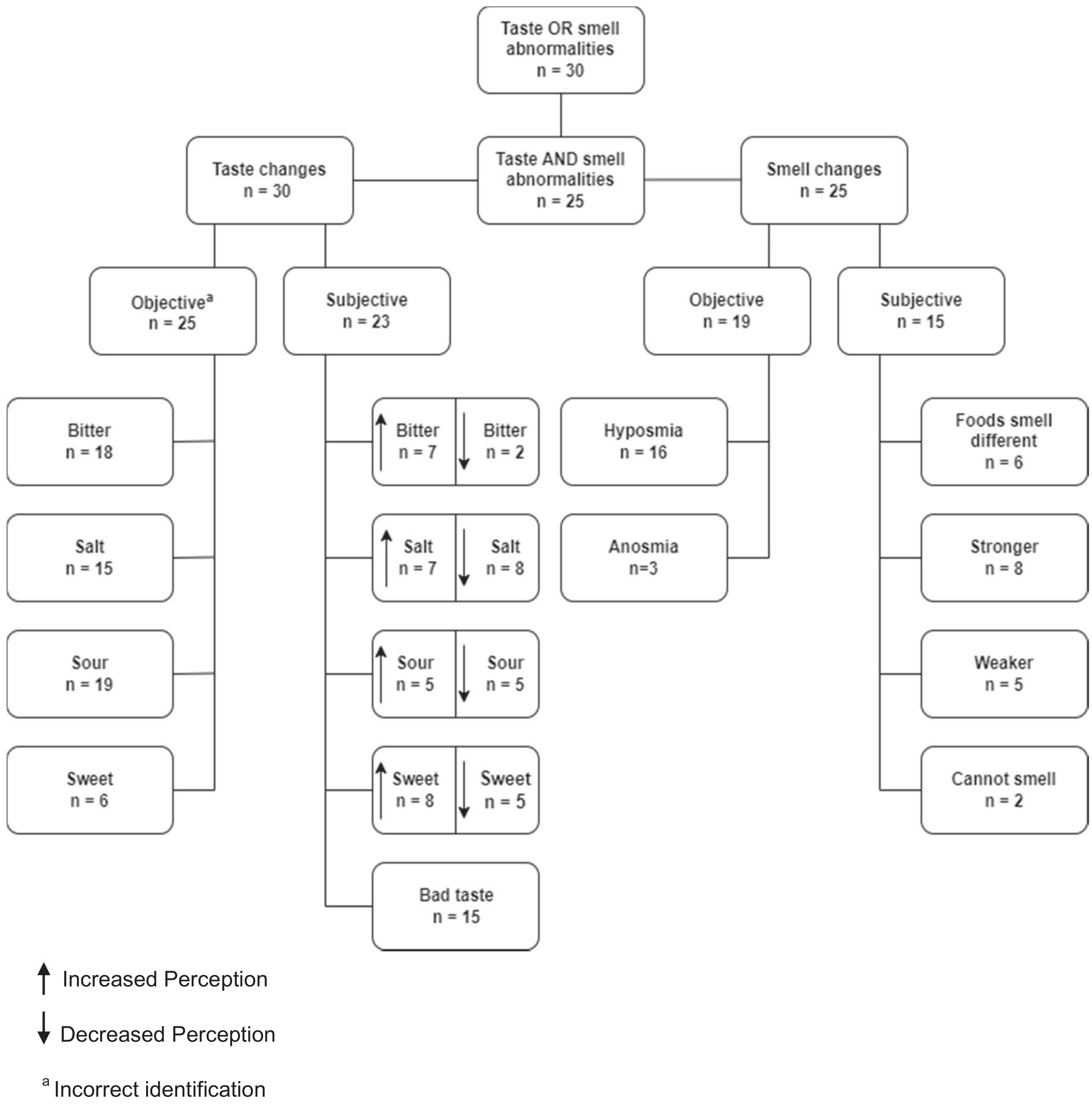

FIGURE 3 Characteristics of taste and smell.

reported that subjective TCs affected QoL. Nine reported that SCs had a negative impact on QoL. Of these, three had severe objective SCs whereas two had none. Reasons for the negative impact for both TCs and SCs are in Table 2.

TSAs and food intake

There was no apparent pattern to any food preferences and aversions. Despite universal TSAs in this cohort, no one had received any specific clinical advice about TSAs. Thirteen of the 25 with subjective TCs stated that it reduced food intake. Six reported that SCs affected food intake.

Foods avoided because of TSAs varied but included vegetables (13%) and meat (13%). Spicy foods were among the commonest to avoid (10%) from both the TC and SC perspectives. Dairy, sweet foods, and cereals were also avoided by those with TSAs. The reasons these foods were avoided most was that "they don't taste the same" or the smell caused the onset of symptoms, such as nausea and reflux.

Sweet foods were preferred because of TCs by three, as they "*taste better*"or "*enjoy more*." Bland foods were preferred by two others as they are "*easier to eat*." One participant avoided "*nearly everything*." Interestingly, dairy, meats, and cereals were also preferred by some with TSAs as well as savory foods. Some did not reference enjoyment as the reason for preferring these

TABLE 2 Taste and smell verbatim quotes and qualitative data

Changes	Description
Taste changes	
TSA03	Not the same satisfaction
TSA04	Undesirable
TSA05	Disgusting
TSA06	Horrible
TSA08	Crazy, changes from day to day
TSA20	Not looking forward to meals
TSA22	Food tastes bland
TSA27	Cannot stand eating dinner
TSA30	Tastes like cardboard
Smell changes	
TSA03	The smell of foods makes me nauseated
TSA17	More interested in smells
TSA19	Connected with rejecting food
TSA22	Foods smell like a hospital
TSA and QoL	
TSA01	A major effect on me
TSA02	Spoilt, cannot sit down and eat anything
TSA08	Do not enjoy my food like I used to
TSA10	Want to vomit at certain smells
TSA13	Less inclined to eat out
TSA22	Destroyed it
TSA26	Cannot be near food

Note: "TSAXX" represents participant study numbers.

Abbreviations: QoL, quality of life; TSA, taste and smell abnormality.

foods but instead focused on the need for nutrition intake with, "I can eat more," and "I can get it down."

DISCUSSION

All participants had TSAs. The prevalence varied based on the assessment tool. Participants were more aware of TCs than SCs. Food choice caused by TSAs varied greatly with no consistency or trends in preferred foods across the sample group. Despite its apparent influence on nutrition intake and QoL, no patient had received any clinical advice on TSA management. Almost all were at malnutrition risk with a high NIS burden. This was despite a predominantly normal or obese BMI, which further highlights that BMI alone is an inappropriate measure of nutrition status.

This study evaluated the effect of TSAs on food intake in patients with cancer in an acute specialist palliative medicine setting. The population was representative of advanced cancer, being polysymptomatic and frail, with ECOG performance status scores of 2–3. This cohort was older than other studies of a similar cohort.[6] This may have had some influence on the prevalence of TSAs, given that TCs and SCs are both more common with increasing age.[25,26]

TSAs were highly prevalent in all participants by both subjective and objective measures in this clinical setting. The prevalence in this study is higher than that found in a systematic literature analysis that estimated prevalence between 60% and 86% in palliative care.[8] This is likely because of the multiple TSA assessments we used compared with other publications, in which fewer assessments were employed.

Although subjective measures reflect the lived patient experience, some evidence suggests such reports of both taste and smell are inaccurate.[27–29] Similarly, most of our participants were unaware of SCs, but these were instead identified through objective tests. Most did not report SCs either in the abPG-SGA or the TSS. However, when asked if their sense of smell was weaker/stronger or unchanged in the TSS, most reported SCs.

There were also discrepancies between subjective and objective taste scores. Some were unaware of their TSAs based on the higher number of objective TSAs found. This may also explain the low reporting of how SCs affected food intake, given that most were unaware of their SCs. This discrepancy between subjective and objective assessment might be more pronounced if assessed by an open question about symptoms, in which participants might be more likely to report TCs if asked directly.[30]

It is noteworthy that objective assessment only measures decreased perception, unlike the questionnaires in which the abPG-SGA asks about the prior 2 weeks and the TSS about specific changes (increased or decreased perception, persistent bad taste, food tastes different, etc). The TSS has a longer timeframe (since becoming ill) and so may identify more potential TSAs than the other two. Given that there is no gold standard, it is difficult to recommend a single TSA screening tool. No one tool adequately identified all TSAs, so the determination of tool sensitivity and specificity is impractical and requires further research.

There is also a debate as to whether objective measurement alone is appropriate. If participants are unaware of either TCs or SCs, should they be drawn to their attention? Nevertheless, it can be argued that TCs or SCs might still affect unconscious choices of volume or type of food and are still nutritionally important irrespective of the level of awareness.

We found that TSAs had a direct impact on food choice and nutrition intake in our study, unlike another study.[31] This may be due to different dietary and cultural habits between an Asian and a Western diet. Our results support previous work by others that showed an effect on food preference.[5] Taste is known to be the most important influencer on food choice.[32] We saw that TCs had a greater effect on both food preferences and aversions than SCs. This may have been secondary to participants being more aware of their TCs than SCs. A preference for sweeter foods with SCs has been noted before.[33]

There was no discernible pattern in food preferences and TSAs. The influences varied, and participants changed diets in multiple ways. Consequently, a "one size fits all approach" for TSA management is impractical. Instead, specialized patient-specific advice is required to address any impact of TSAs on food intake.

Despite the universal impact of TSAs, none of our participants had received any professional nutrition counseling. When asked, participants named foods they avoided or preferred and provided justifications. However, before this, they had not had this opportunity, perhaps because of the lack of clinical awareness. TSAs are not routinely evaluated, and patients do not report them without specific enquiry.[30] This represents a missed therapeutic opportunity and highlights the need for dietetic input in routine cancer care. This is further compounded by participant quotes on TSAs (Table 2), such as "can't stand eating dinner," "can't be near food," and "can't sit down and eat anything," which highlight the increased malnutrition risk when TSAs are present. Evaluation of all patients with cancer should include nutrition assessment for TSAs. The benefit of a weekly assessment of subjective symptoms, including TSAs, should be investigated in this cohort. This should include some context as to what is meant by TSAs, especially with SCs, given that most were unaware of their SCs and most were identified using detailed assessment in the TSS rather than the abPG-SGA. With increased awareness of TSAs because of their association with coronavirus disease 2019,[34] we hope that TSAs will become more of a focus in other conditions in which they are prevalent.

Most participants were at malnutrition risk. This is not uncommon throughout the cancer trajectory, particularly so in advanced disease. Food intake in advanced cancer is often low and may be further reduced by TSAs.[35] Severe TSAs have been associated with significantly reduced food intake (by 900–1100 kcal/daily).[15]

We investigated an under-researched area with a simple questionnaire to assess the impact on food intake. This concise tool allowed for a reduction in patient burden in this often-fatigued population. More invasive methods of assessment may have been unsuitable. The study had some weaknesses. First, the number of participants in this study was small. Further time for recruitment, or screening as part of an admission proforma, would allow for greater numbers. We did not objectively measure nutrition intake. Quantitative assessment would provide greater understanding of TSA influence on food preference and intake. In addition, the modified TSS used is unvalidated. Validation of this tool, determining the most appropriate scoring system, and a comparison between it and other forms of assessment would be beneficial to finalize what the "gold standard" TSA assessment should be. Finally, further qualitative investigation into the effect of TSAs on food intake would be beneficial.

CONCLUSIONS

TSAs were present in all participants and had a major subjective impact on food intake. Prevalence varied based on the tool used. TCs were more common than SCs irrespective of measure. SCs were identified with objective assessment more than subjective. Many participants reported that TSAs had both emotional and physical consequences. Half felt that they reduced QoL. Both TCs and SCs were complex and varied on an individual basis. Despite the negative effect, nobody received professional management advice on TSAs. This highlights the need for individualized dietetic support and that all patients with cancer should be screened for TSAs. In no case did subjective TCs match the objective results. TCs had a greater influence on food preference than SCs. Sweet taste was correctly identified most and sour least. Almost all participants were at malnutrition risk. With TSAs prevalent in all and being an impactful symptom regarding QoL, patients with advanced cancer should be routinely screened for TSAs. Given the lack of consistency in preferred foods and how characteristics of TSAs differed between participants, individualized nutrition counseling is recommended for all.

AUTHOR CONTRIBUTIONS

Aidan O'Donoghue, Michelle Barrett, Pauline Ui Dhuibhir, and Declan Walsh equally contributed to the conception and design of the research; Aileen Kennedy and Norma O'Leary contributed to the design of the research; Aidan O'Donoghue, Michelle Barrett, Pauline Ui Dhuibhir, and Norma O'Leary contributed to the acquisition of the data; Aidan O'Donoghue, Michelle Barrett, Pauline Ui Dhuibhir, and Declan

Walsh contributed to the interpretation of the data; and Aidan O'Donoghue and Declan Walsh drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

ACKNOWLEDGMENT

Open access funding provided by IReL.

CONFLICT OF INTEREST

None declared.

ORCID

Aidan O'Donoghue http://orcid.org/0000-0002-7757-3865
Michelle Barrett https://orcid.org/0000-0002-8233-9184
Pauline Ui Dhuibhir https://orcid.org/0000-0002-5030-7639
Aileen Kennedy https://orcid.org/0000-0001-8921-9006
Norma O'Leary https://orcid.org/0000-0002-2310-1248
Declan Walsh https://orcid.org/0000-0002-9310-1729

REFERENCES

1. National Cancer Registry Ireland. *Cancer in Ireland 1994-2017 with Estimates for 2017-2019: Annual Report of the National Cancer Registry*. NCRI; 2019.
2. Tong H, Isenring E, Yates P. The prevalence of nutrition impact symptoms and their relationship to quality of life and clinical outcomes in medical oncology patients. *Supp Care Cancer*. 2009;17(1):83-90. doi:10.1007/s00520-008-0472-7
3. Spotten L, Corish C, Lorton C, et al. Subjective taste and smell changes in treatment-naive people with solid tumours. *Supp Care Cancer*. 2016;24(7):3201-3208. doi:10.1007/s00520-016-3133-2
4. Amézaga J, Alfaro B, Ríos Y, et al. Assessing taste and smell alterations in cancer patients undergoing chemotherapy according to treatment. *Supp Care Cancer*. 2018;26(12):4077-4086. doi:10.1007/s00520-018-4277-z
5. de Vries YC, Helmich E, Karsten MDA, Boesveldt S, Winkels RM, van Laarhoven HWM. The impact of chemosensory and food-related changes in patients with advanced oesophagogastric cancer treated with capecitabine and oxaliplatin: a qualitative study. *Supp Care Cancer*. 2016;24(7):3119-3126. doi:10.1007/s00520-016-3128-z
6. McGettigan N, Dhuibhir PU, Barrett M, et al. Subjective and objective assessment of taste and smell sensation in advanced cancer. *Am J Hosp Palliat Care*. 2019;36(8):688-696. doi:10.1177/1049909119832836
7. Spotten LE, Corish CA, Lorton CM, et al. Subjective and objective taste and smell changes in cancer. *Ann Oncol*. 2017;28(5):969-984. doi:10.1093/annonc/mdx018
8. Heckel M, Stiel S, Ostgathe C. Smell and taste in palliative care: a systematic analysis of literature. *Eur Arch Otrhinolaryngol*. 2015;272(2):279-288. doi:10.1007/s00405-014-3016-4
9. Wrobel BB, Leopold DA. Clinical assessment of patients with smell and taste disorders. *Otolaryngol Clin North Am*. 2004;37(6):1127-1142. doi:10.1016/j.otc.2004.06.010
10. Wrobel BB, Leopold DA. Smell and taste disorders. *Facial Plast Surg Clin North Am*. 2004;12(4):459-468. doi:10.1016/j.fsc.2004.04.006
11. Stinton N, Atif MA, Barkat N, Doty RL. Influence of smell loss on taste function. *Behav Neurosci*. 2010;124(2):256-264. doi:10.1037/a0018766
12. Speed LJ, Majid A. Grounding language in the neglected senses of touch, taste, and smell. *Cogn Neuropsychol*. 2019;37(5-6):363-392. doi:10.1080/02643294.2019.1623188
13. Auvray M, Spence C. The multisensory perception of flavor. *Conscious Cogn*. 2008;17(3):1016-1031. doi:10.1016/j.concog.2007.06.005
14. Hovan AJ, Williams PM, Stevenson-Moore P, et al. A systematic review of dysgeusia induced by cancer therapies. *Supp Care Cancer*. 2010;18(8):1081-1087. doi:10.1007/s00520-010-0902-1
15. Hutton JL, Baracos VE, Wismer WV. Chemosensory dysfunction is a primary factor in the evolution of declining nutritional status and quality of life in patients with advanced cancer. *J Pain Symptom Manage*. 2007;33(2):156-165. doi:10.1016/j.jpainsymman.2006.07.017
16. Brisbois TD, Hutton JL, Baracos VE, Wismer WV. Taste and smell abnormalities as an independent cause of failure of food intake in patients with advanced cancer--an argument for the application of sensory science. *J Palliat Care*. 2006;22(2):111-114.
17. Oken MM, Creech RH, Tormey DC, et al. Toxicity and response criteria of the Eastern Cooperative Oncology Group. *Am J Clin Oncol*. 1982;5(6):649-655.
18. Heald AE, Pieper CF, Schiffman SS. Taste and smell complaints in HIV-infected patients. *AIDS*. 1998;12(13):1667-1674.
19. Belqaid K, Orrevall Y, McGreevy J, et al. Self-reported taste and smell alterations in patients under investigation for lung cancer. *Acta Oncol*. 2014;53(10):1405-1412. doi:10.3109/0284186x.2014.895035
20. Mueller C, Kallert S, Renner B, et al. Quantitative assessment of gustatory function in a clinical context using impregnated "taste strips". *Rhinology*. 2003;41(1):2-6.
21. Hummel T, Sekinger B, Wolf SR, Pauli E, Kobal G. Sniffin' Sticks': olfactory performance assessed by the combined testing of odour identification, odor discrimination and olfactory threshold. *Chem Senses*. 1997;22(1):39-52. doi:10.1093/chemse/22.1.39.
22. Ottery FD. Definition of standardized nutritional assessment and interventional pathways in oncology. *Nutrition*. 1996;12(1 Suppl):S15-S19. doi:10.1016/0899-9007(96)90011-8
23. Gabrielson DK, Scaffidi D, Leung E, et al. Use of an abridged scored Patient-Generated Subjective Global Assessment (abPG-SGA) as a nutritional screening tool for cancer patients in an outpatient setting. *Nutr Cancer*. 2013;65(2):234-239. doi:10.1080/01635581.2013.755554
24. Porter Starr KN, Bales CW. Excessive body weight in older adults. *Clin Geriatr Med*. 2015;31(3):311-326. doi:10.1016/j.cger.2015.04.001
25. Methven L, Allen VJ, Withers CA, Gosney MA. Ageing and taste. *Proc Nutr Soc*. 2012;71(4):556-565. doi:10.1017/s0029665112000742

26. Doty RL, Kamath V. The influences of age on olfaction: a review. *Front Psychol*. 2014;5:20. doi:10.3389/fpsyg.2014.00020
27. Landis BN. Ratings of overall olfactory function. *Chem Senses*. 2003;28(8):691-694. doi:10.1093/chemse/bjg061
28. Soter A, Kim J, Jackman A, Tourbier I, Kaul A, Doty RL. Accuracy of self-report in detecting taste dysfunction. *Laryngoscope*. 2008;118(4):611-617. doi:10.1097/MLG.0b013e318161e53a
29. Mahmoud FA, Aktas A, Walsh D, Hullihen B. A pilot study of taste changes among hospice inpatients with advanced cancer. *Am J Hosp Palliat Care*. 2011;28(7):487-492. doi:10.1177/1049909111402187
30. Homsi J, Walsh D, Rivera N, et al. Symptom evaluation in palliative medicine: patient report vs systematic assessment. *Supp Care Cancer*. 2006;14(5):444-453. doi:10.1007/s00520-005-0009-2
31. Yoshimoto N, Inagaki M, Sekiguchi Y, Tomishima Y, Masuko K. Chemotherapy alters subjective senses of taste and smell but not dietary patterns in Japanese lung cancer patients. *Supp Care Cancer*. 2020;28(4):1667-1674. doi:10.1007/s00520-019-04958-z.
32. Glanz K, Basil M, Maibach E, Goldberg J, Snyder D. Why Americans eat what they do. *J Am Diet Assoc*. 1998;98(10):1118-1126. doi:10.1016/s0002-8223(98)00260-0.
33. Duffy VB, Backstrand JR, Ferris AM. Olfactory dysfunction and related nutritional risk in free-living, elderly women. *J Am Diet Assoc*. 1995;95(8):879-884. doi:10.1016/s0002-8223(95)00244-8
34. Pierron D, Pereda-Loth V, Mantel M, et al. Smell and taste changes are early indicators of the COVID-19 pandemic and political decision effectiveness. *Nat Commun*. 2020;11(1):5152. doi:10.1038/s41467-020-18963-y
35. Brisbois TD, de Kock IH, Watanabe SM, Baracos VE, Wismer WV. Characterization of chemosensory alterations in advanced cancer reveals specific chemosensory phenotypes impacting dietary intake and quality of life. *J Pain Symptom Manage*. 2011;41(4):673-683. doi:10.1016/j.jpainsymman.2010.06.022

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: O'Donoghue A, Barrett M, Dhuibhir PU, Kennedy A, O'Leary N, Walsh D. Taste and smell abnormalities in advanced cancer: Negative impact on subjective food intake. *Nutr Clin Pract*. 2023;1-10. doi:10.1002/ncp.10943