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Original article

Taste and smell are associated with dietary intake, eating behavior, nutritional status, and health-related quality of life in children with cancer

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SUMMARY

Background & aims: Smell and taste changes are frequently reported bothersome treatment symptoms during treatment for childhood cancer and assumed to influence outcomes such as food intake. Since nutritional status of children with cancer is already vulnerable, any detrimental effects on food intake should be prevented. Therefore, understanding the exact relationship between chemosensory changes and dietary intake, eating behavior, and other domains such as health-related quality of life (HRQoL), is important for improving outcomes.

Methods: In this longitudinal study, we followed 87 childhood cancer patients treated for hematological, solid, or brain malignancies. Smell (odor threshold and odor identification) and taste function (total taste score) were objectively investigated using commercial Sniffin' Sticks and Taste Strips respectively, and by self-report. Dietary intake was measured using a 3-day food dairy. For nutritional status, BMI expressed as standard deviation scores was derived from medical records. Eating behavior and HRQoL were assessed by the Behavioral Pediatrics Feeding Assessment Scale (BPFAS) and PedsQL 4.0 Generic Core Scales, respectively. Measurements were taken approximately 6 weeks (T0), 3 months (T1), 6 months after starting chemotherapy (T2), and 3 months after termination of chemotherapy or maintenance phase for children with acute lymphoblastic leukemia (ALL) (T3). Dietary intake, eating behavior, nutritional status, and HRQoL were modelled over time using mixed model analysis. Associations between smell and taste (objective and self-report), as well as patient characteries were studied.

Results: Energy intake significantly increased during the study period, with a higher age, BMI, and total taste scores associated to this increase. Boys had higher energy intake compared to girls. Eating behavior scores significantly declined, indicating less eating problems. Age, pre-diagnosis eating behavior, self-reported smell changes, and tube feeding were associated to eating behavior. BMI significantly increased, with a higher BMI at diagnosis to be related to a higher BMI during the study period. A lower BMI was found in children receiving tube feeding and self-reported taste changes. HRQoL improved during the study period, with lower HRQoL in children receiving tube feeding and self-reported taste changes.

Conclusion: Both objective and subjective measures of taste and smell influence dietary intake, eating behavior, nutritional status, and HRQoL. Individual dietary advice and coping strategies are warranted to prevent detrimental effects of chemosensory changes on food intake and clinical outcomes in children with cancer.

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1. Introduction

Childhood cancer is a rare disease, but it is the major cause of death among children in the Western world [1]. In recent decades, new therapies and more intensive treatment regimens have resulted in survival rates of approximately 80 % [2,3]. However, these intensive cancer treatments have severe side effects including pain, nausea, fatigue, weight loss, and changes in appetite [4,5]. Although frequently overlooked in clinical practice, taste changes are also reported being one of the most frequently and distressful side effects during treatment for childhood cancer [4,6]. All of these symptoms together can contribute to impaired nutritional status, which have been associated with more infections, worse survival, and poor quality of life in children with cancer [7,8].

Until a few years ago, little was known about chemosensory changes in children with cancer which includes both smell and taste perception. It is now known that changes in taste occur in up to 60 % of children with cancer, and that nausea caused by exposure to (food) smells is also common, consequently affecting health-related quality of life (HRQoL) [4,9,10]. In a previous study we showed that changes in smell and taste are rather heterogeneous within and between diagnoses. Despite this heterogeneity, smell sensitivity seemingly improved or sharpened during treatment for children with acute lymphoblastic leukemia (ALL) and taste loss was more present among children with lymphoma and solid tumors. Further, changes in taste (irrespective of its direction) tended to resolve after treatment or during maintenance phase [11,12].

Since nutritional status of children with cancer is already vulnerable, it is important to recognize smell and taste changes before they might have any detrimental effects. A handful of studies investigated a potential relationship between taste dysfunction and eating behavior, suggesting a negative impact [11,13,14]. In addition, taste and smell alterations seem to be associated with less appetite and weight loss in children undergoing chemotherapy [15]. Despite these results, the exact relationship between chemosensory function and nutrition-related outcomes in children with cancer remains largely unclear as almost all evidence comes from self-report. Therefore, we aimed to determine whether potential chemosensory changes (both objectively measured and self-reported), as well as other patient-related characteristics, have direct consequences for a broader scope of nutrition-related outcomes such as dietary intake, eating behavior, nutritional status, and HRQoL. Results from this study may be a useful starting point for developing new (dietary) interventions taking potential taste and smell changes into account, thereby improving food intake, nutritional status, and other clinical outcomes.

2. Methods

2.1. Participants

Participants were children diagnosed with cancer and treated with chemotherapy who were willing to participate in a prospective cohort study called SENSORY-2 between November 2020 and March 2023 at the Princess Máxima Center for Pediatric Oncology in Utrecht, the Netherlands [12]. Eligible patients had no prior diagnosis of cancer and associated anti-cancer treatment, were able to understand Dutch, and were 6–18 years old. Ethical approval was obtained from the Medical Ethics Review Committee of the University Medical Center Utrecht (METC N19.809). Written informed consent was obtained from the parents, and from children $\geq$12 years.

2.2. Procedure

Measurements were taken at four time points: within six weeks of diagnosis (T0), 3 months (T1) after starting chemotherapy, 6 months (T2) after starting chemotherapy, and 3 months (T3) after ending chemotherapy. For children with acute lymphoblastic leukemia (ALL), T3 was performed during the maintenance phase (approximately 12 months after diagnosis) when children receive a much gentler form of chemotherapy (typically comprising oral mercaptopurine and methotrexate, with additional vincristine and dexamethasone for some patients) that does not require hospital admissions.

2.3. Measurements

2.3.1. Smell function

Sniffin' Sticks (Burghart, Wedel, Germany) were used to determine smell function [16]. We investigated two parts of smell function: odor threshold (THR) and odor identification (ID). All odorants were presented in pen-like odor dispensing devices, which were positioned 2 cm in front of the patient's nostrils for approximately 3 s. Details regarding measuring THR and ID have been previously published [12]. Normative values were used to distinguish between normal and altered smell function (i.e., decreased (<10th percentile) or increased (>90th percentile) sensitivity/ability to identify smells) [17].

2.3.2. Taste function

Filter-paper strips (Taste Strips, Burghart, Wedel, Germany) were used to determine taste recognition thresholds for sweet, sour, salty, and bitter taste [18]. Details regarding this measurement have been previously published [12]. Normative values were used to distinguish between normal and altered taste function (i.e., decreased (<10th percentile) or increased perception (>90th percentile)) [19].

2.3.3. Subjective smell, taste, and appetite

Participants rated their smell, taste, and appetite on a 5-point Likert scale (1 “very bad” to 5 “very good”. In addition, participants were asked whether their smell, taste, and appetite had changed (yes/no) since chemotherapy. Regarding smell and taste, follow-up questions included specifying whether taste and smell changed in terms of intensity and/or quality.

2.3.4. Dietary intake

Dietary intake of each child was recorded using a 3-day food dairy filled in by parents. Total energy intake (calories/day), including macronutrients protein (g/day), fat (g/day), and carbohydrates (g/day) was calculated using food calculation software (Eetmeter 2002, Nutrition Center, the Netherlands). For studying the association between chemosensory function and dietary intake, total energy intake from oral foods was used and energy intake from tube feeding was excluded.

2.3.5. Eating behavior

Eating behavior was assessed at each time point using the Behavioral Pediatrics Feeding Assessment Scale (BPFAS) [20]. In addition, parents were asked to complete the questionnaire for the period before diagnosis (pre-diagnosis eating behavior). The BPFAS is a 35-item parent-report questionnaire that consists of 25 items that focus on child eating behavior and 10 items that focus on parents' feeding strategies. For each statement, parents reported how often the particular behavior occurred on a 5-point Likert scale (1 ‘never’ to 5 ‘always’). They were also asked to indicate whether they believed this behavior was problematic or not. Four scores are thus generated: Child Behavior-Frequency (CBF) and Parent Behavior-Frequency (PBF) (which refer to how often the specific child and parent behavior occur), and Child Behavior-Problems (CBP) and Parent Behavior-Problems (PBP) (which reflect the number of behaviors seen as problematic). Higher scores indicate more eating/feeding problems and the following cut-off values were used to determine the prevalence of eating and feeding disorders: CBF>61, CBP>6, PBF>20, PBP>2 [21]. For modelling eating behavior over time, CBF scores were used as these best reflect the child's eating behavior.

2.3.6. *Health-related quality of life*

Generic HRQoL was measured using the PedsQL 4.0 Generic Core Scales, consisting of 23 questions on four domains: physical functioning, emotional functioning, social functioning, and school functioning [22,23]. The domains can be combined into a psychosocial functioning scale (i.e., combined score of emotional, social, and school domains) and a total functioning scale (i.e., combined score of all domains). In addition, physical functioning scale was used in analysis. Items are rated by the parent or child on a 5-point Likert scale, ranging from 0 (never a problem) to 4 (almost always a problem) reflecting the child's experiences in the last week prior to the doctor's appointment in the outpatient clinic. Each answer is reversed scored and rescaled to a 0–100 scale. Higher scores indicate higher HRQoL.

2.3.7. *Related factors*

2.3.7.1. Patient characteristics. Patient characteristics were derived from medical records and included: age, sex, diagnosis, treatment protocol, length, weight, and BMI expressed as standard deviation scores (SDS; calculated from Dutch reference standards) and categorized as ‘Low BMI’ (<-2SDS), ‘Normal BMI’ (-2SDS to +2SDS) and ‘High BMI’ (>+2SDS) [24].

2.3.7.2. Treatment intensity. Treatment intensity was rated independently by Mirjam van den Brink and Wim Tissing using the Intensity of Treatment Rating scale (ITR-3), a psychometrically valid classification of pediatric cancer treatment, into one of four levels ranging from 1 ‘minimally invasive’ to 4 ‘most invasive’ [25]. Since only a few patients were rated either in the least intensive or most intensive categories, the ITR-scale was reduced to two categories: least/moderate intensive and very/most intensive.

2.4. *Statistical analysis*

Dietary intake, eating behavior, nutritional status, and HRQoL at each time point are were reported as mean and standard deviation were reported as mean and standard deviation. In addition, numbers and percentages (n, %) of overweight, normal, overweight as well as eating and feeding disorders were reported at each time point. Due to the presence of repeated measurements, six linear mixed models for longitudinal data were estimated to investigate the association of time (i.e., months), age, sex, BMI SDS (for model 1, 2, 4, 5 and 6), BMI SDS at diagnosis (for model 3), ITR, odor THR, odor ID, total taste score, self-reported smell changes (y/n), self-reported taste changes (y/n), corticosteroids (y/n), and tube feeding (y/n) with the following outcomes: 1) energy intake from oral dietary intake (i.e., daily caloric intake); 2) eating behavior (i.e., CBF score); 3) nutritional status (i.e., BMI SDS); and 4) HRQoL (i.e., physical, psychosocial, and total PedsQL score). An autoregressive order 1 (AR1) covariance structure was used. All statistical analyses were performed with IBM SPSS Statistics (version 29.0). A 5 % alpha level was used.

3. Results

3.1. *Patient characteristics*

A total of 87 patients diagnosed with a hematological (73.6 %), solid (21.8 %), or brain (4.6 %) malignancy were included in this study (Table 1). Median age was 11.5 years (range 6–17) and 52.9 % were girls.

3.2. *Dietary intake*

Table 2 shows oral dietary intake of the included children at each time point. Energy intake (kcal/day) significantly increased over time (B = 23.3, SE = 9.9, p = 0.020). Taste function was positively associated with energy intake (B = 33.9, SE = 15.9, p = 0.035), indicating that a single point increase on the Taste Strips test resulted in an increased energy intake of 33.9 kcal per day. Furthermore, age (B = 70.0, SE = 11.9, p < 0.001) and BMI (B = 92.5, SE = 32.9, p = 0.005) were associated to higher energy intake and boys had a higher energy intake compared to girls (B = 209.2, SE = 91.0, p = 0.023). Details concerning the estimation of all linear mixed models are presented in Supplementary Table 1.

3.3. *Eating behavior*

Table 3 shows scores on the BPFAS during the study period. During treatment, in approximately 10 % of the respondents the scores of CBF and PBF exceeded the cut-off value, but not at T3 (range 0–5.6 %). Prevalence rates of problem scores ranged between 0 and 6.0 % for child behavior (CBP) and between 0 and 5.7 % for parent behavior (PBP) at all time points.

CBF scores significantly changed over time (B = −0.4, SE = 0.1, p = 0.003), indicating less eating problems. Older children reported lower CBF scores (B = −0.9, SE = 0.2, p < 0.001), indicating less eating problems. Higher pre-diagnosis CBF scores (B = 0.5, SE = 0.1, p < 0.001) were associated to higher CBF scores during treatment, indicating more eating problems. In addition, children who self-reported that their smell had changed and received tube feeding, had higher CBF scores (i.e., more eating problems) compared to

Table 1
Patient characteristics (*n* = 87).

Sex, girl (n, %)	46 (52.9)
Age (median, range)	12 (6–17)
Diagnosis	
Hematological malignancy (n, %)	*64 (73.6)*
Acute lymphoblastic leukemia (ALL)	30 (34.5)
Myeloid malignancies	11 (12.6)
Malignant lymphoma	23 (26.4)
Solid tumors (n, %)	*19 (21.8)*
Bone tumor	10 (11.5)
Neuroblastoma	2 (2.3)
Soft tissue tumor	3 (3.4)
Other solid tumors	4 (4.6)
Brain tumors (n, %)	*4 (4.6)*
Intensity of Treatment Rating (n, %)	
Moderate intensive	41 (47.1)
Very intensive	38 (43.7)
Most intensive	8 (9.2)
BMI at diagnosis (n, %)	
Underweight	2 (2.3)
Normal weight	75 (86.2)
Overweight	10 (11.5)
Corticosteroids (n, %)	75 (86.2)
Tube feeding[a] (n, %)	16 (18.4)

[a] Number of patients receiving nasogastric tube feeding at any given time during the study.

Table 2
Oral dietary intake during the study period.

	T0 n = 64	**T1** n = 59	**T2** n = 37	**T3**[a] n = 19	**T3**[b] n = 32
Kcal (mean, sd)	1702.6 (795.9)	1628.4 (740.6)	1607.6 (692.1)	2099.8 (482.2)	1961.0 (355.9)
Protein (mean, sd)	60.2 (31.4)	55.8 (27.1)	56.1 (29.3)	71.1 (18.9)	65.5 (10.4)
Fat (mean, sd)	68.0 (36.0)	65.3 (35.5)	66.0 (30.0)	84.5 (21.7)	76.0 (17.4)
Carbohydrates (mean, sd)	203.9 (91.3)	197.7 (87.2)	188.0 (81.3)	253.8 (65.8)	243.7 (53.9)

[a] Maintenance phase (ALL), n = 24.
[b] Out of treatment, n = 39.

Table 3
Eating behavior characteristics during the study period.

	Pre-diagnosis n = 65	**T0** n = 70	**T1** n = 67	**T2** n = 48	**T3**[a] n = 22	**T3**[b] n = 36
CBF						
Mean (sd)	**42.0 (9.2)**	46.2 (10.9)	48.2 (13.6)	46.6 (12.8)	40.3 (6.6)	38.4 (6.9)
Disorder (n, %)	**2 (3.1)**	7 (10.0)	9 (13.4)	4 (8.3)	0 (0.0)	0 (0.0)
CBP						
Mean (sd)	**0.5 (1.9)**	1.1 (2.9)	1.0 (3.1)	0.6 (1.9)	0.3 (0.6)	0.4 (1.6)
Disorder (n, %)	**1 (1.5)**	4 (5.7)	4 (6.0)	1 (2.1)	0 (0.0)	1 (2.8)
PBF						
Mean (sd)	**15.3 (3.8)**	16.2 (3.9)	15.7 (4.4)	16.0 (4.5)	14.4 (2.8)	14.0 (3.4)
Disorder (n, %)	**4 (6.2)**	9 (12.9)	8 (11.9)	6 (12.5)	0 (0.0)	2 (5.6)
PBP						
Mean (sd)	**0.2 (0.7)**	0.3 (1.2)	0.4 (1.5)	0.4 (1.5)	0.1 (0.3)	0.2 (1.0)
Disorder (n, %)	**2 (3.1)**	4 (5.7)	2 (3.0)	2 (4.2)	0 (0.0)	1 (2.8)

CBF: Child Behavior-Frequency; CBP: Child Behavior-Problems; PBF: Parent Behavior-Frequency; PBP: Parent Behavior-Problems.
[a] Maintenance phase (ALL), n = 24.
[b] Out of treatment, n = 39.

those not reporting smell changes (B = 2.7, SE = 1.2, p = 0.028) or receiving tube feeding (B = 12.0, SE = 1.9, $p < 0.001$).

3.4. Nutritional status

Table 4 shows details regarding nutritional status during the study period. BMI SDS increased over time (B = 0.03, SE = 0.01, p = 0.043). A higher BMI at diagnosis was related to a higher BMI during the study period (B = 0.81, SE = 0.04, $p < 0.001$). Moreover, children who received tube feeding (B = −0.46, SE = 0.13, $p < 0.001$) or self-reported taste changes (B = −0.30, SE = 0.09, p = 0.002) had a lower BMI compared to those not receiving tube feeding or experiencing taste changes.

3.5. Health-related quality of life

Table 5 shows details regarding HRQoL during the study period. Physical (B = 1.8, SE = 0.4), psychosocial (B = 1.1, SE = 0.3), and total HRQoL (B = 1.4, SE = 0.3) increased over time (i.e., in months, all p-values <0.001). For all three domains, receiving tube feeding (physical: B = −13.8, SE = 5.3; psychosocial: B = −8.4, SE = 3.2; and total: B = −10.1, SE = 3.4; all p-values ≤0.01) and self-reported taste changes (physical: B = −13.2, SE = 3.5; psychosocial: B = −5.4, SE = 2.2; and total: B = −8.3, SE = 2.3; all p-values <0.02) were significantly associated to a lower HRQoL.

4. Discussion

The aim of the present study was to examine if taste and smell (both objective and self-report) in children receiving cancer treatment influence outcomes such as dietary intake, eating behavior, nutritional status, and HRQoL. We found taste function (as objectively measured with the Taste Strips test) being a predictor for energy intake (kcal/day). Self-reported taste changes were associated with a lower BMI and HRQoL in children with cancer, whereas self-reported smell changes were found to be a predictor for having more eating problems. Previous studies have already been shown that smell and taste changes are common in children with cancer, but the current study emphasizes the importance of early recognition and treatment of these complaints to prevent any detrimental effects on clinical outcomes such as nutritional status and HRQoL.

Previous qualitative studies among patients, parents, and nurses suggest that altered taste may be an important factor influencing food intake in children with cancer [26,27]. This is the first study showing a significant relationship between taste and dietary intake in children with cancer through objective measurements. Children

Table 4
Nutritional status characteristics during the study period.

	Diagnosis n = 86	**T0** n = 79	**T1** n = 72	**T2** n = 51	**T3**[a] n = 24	**T3**[b] n = 39
BMI SDS (mean, sd)	**0.19 (1.3)**	0.21 (1.2)	0.27 (1.3)	0.65 (1.3)	1.1 (1.0)	0.3 (1.5)
Weight change in kg since diagnosis (mean, range)	-	−0.1 (−16.5–9.9)	0.9 (−11.2–17.1)	3.1 (−9.8–24.3)	7.5 (−7.3–30.2)	4.5 (−5.3–18.2)
Underweight (n, %)	**2 (2.3)**	3 (3.8)	2 (2.9)	2 (4.0)	0 (0.0)	2 (5.1)
Normal weight (n, %)	**75 (87.2)**	69 (87.3)	62 (88.6)	43 (86.0)	22 (91.7)	34 (87.2)
Overweight (n, %)	**9 (10.5)**	7 (8.9)	6 (8.6)	5 (10.0)	2 (8.3)	3 (7.7)

[a] Maintenance phase (ALL), n = 24.
[b] Out of treatment, n = 39.

Table 5
HRQoL scores on the different domains during the study period.

	T0 n = 71	**T1** n = 65	**T2** n = 48	**T3**[a] n = 22	**T3**[b] n = 36
Physical HRQoL	46.1 (23.9)	52.7 (27.0)	55.0 (21.5)	72.9 (22.3)	72.5 (17.6)
Psychosocial HRQoL	62.4 (14.7)	66.0 (16.1)	69.0 (15.8)	77.4 (15.6)	77.3 (18.6)
Total HRQoL	56.7 (15.5)	61.4 (18.4)	64.1 (15.1)	75.8 (16.7)	75.6 (16.9)

[a] Maintenance phase (ALL), n = 24.
[b] Out of treatment, n = 39.

with a lower taste sensitivity consumed less calories. It is important to note that we excluded calories from tube feeding which is directly distributed into the stomach and therefore does not involve one's taste sensitivity. Furthermore, our findings are in line with a scoping review among adult cancer patients, showing that a reduced taste perception (particularly for sweet taste) is associated with lower calorie intake, as well as intake of proteins [28]. Nutritional and/or educational counselling in adult cancer patients have been shown to reduce the severity of taste problems and positively influences other outcomes such as nutritional intake, morbidity, quality of life, and self-care behavior [29–31]. Of course, children are very different from adults in this respect, but such interventions are nonetheless promising. Given the fact that both energy and protein intake may be compromised during treatment of childhood cancer, strategies to deal with taste changes in children with cancer specifically are warranted.

Previous research investigating Dutch children with cancer's eating behavior using the BPFAS showed somewhat higher prevalence rates of eating and feeding problems (CBF: range 13.5–17.8 %, PBF: range 17.0–27.7 %) compared to our study [32]. A possible explanation for an improvement here might be related to more attention to nutrition and feeding strategies since centralization of pediatric oncology care in 2018 in the Netherlands. Interestingly, children with self-reported changes in smell, but not taste, had more eating problems. Probably, smell changes in children with cancer are more associated with negative emotions and consequences for their eating behavior, for example eating alone upstairs because food odors are not tolerated, as we have previously described [14]. In addition, our feasibility study showed a correlation between objectively measured taste function and eating behavior [13]. Another study investigating self-reported eating behavior and taste alterations in children with cancer showed that food cravings and enjoyment of food decreased as taste alterations increased, as well as slow eating increased with increasing taste alterations [33]. In sum, current and previous evidence confirm the negative consequences of chemosensory changes for eating behavior in children with cancer.

Related to this are the consequences for nutritional status. One could argue that given the relatively low number of children with underweight in our study, the influence of smell and taste changes on this outcome is of limited relevance. It's true that the number of overweight children with cancer is nowadays higher than those with underweight – or will increase over the course of treatment [34,35]. However, it should be noted that cut-off values used to classify nutritional status can be arbitrary as many children's BMI will rarely fall below < -2 SDS, but may still experience periods of significant weight loss due to inadequate food intake. For that reason, it is of utmost importance that our study shows self-reported taste changes to be associated with a lower BMI, as this could indeed indicate which patients are particularly vulnerable to food-related problems and weight loss. However, we would then also expect an association between self-reported taste changes and energy intake, which have been previously found in breast cancer patients, but was not found in the current study [36]. In that respect, it is important to note that self-reported questions were focusing on whether chemosensory changes occurred (yes/no) since the start of treatment and did not distinguish between type of distortions. Our previous study showed that “food tasting different than before” (a qualitative taste disorder) was more often experienced in children with cancer than taste loss (a quantitative taste disorder) [12]. It could be that particularly taste loss, or a lower taste sensitivity, impacts energy intake which is evident from objective testing. Since we did not distinguish between types of self-reported taste changes, this could explain why, on average, we found no effect on energy intake.

In adult cancer patients, self-reported taste changes were also related to malnutrition risk [37]. In both adults and children, it seems that subjective data regarding smell and taste changes more accurately describe patients' experiences and predict changes in eating behavior or nutritional status than objective measures [15,38]. This also applies to HRQoL, where we did not find an association with objective but with self-reported taste changes. This is line with a previous study among breast cancer patients, showing a lower quality of life in patients with self-reported smell and taste changes [39].

This is the first prospective study investigating the influence of both objective and subjective measures of smell and taste on several outcomes in children with cancer during the course of treatment. However, some limitations should be reported. First of all, the sample size of children with particular malignancies, such as brain tumors, was small. Secondly, questionnaires investigating eating behavior and HRQoL, as well as food diaries, relied on parent-report. Of course, parent's thoughts on their child's eating behavior and HRQoL might be influenced by their own emotions and could be different from their child's experiences. When it comes to food diaries, this may be less of an issue because children were often hospitalized and accompanied by their parents around measurement days, meaning that children have fewer activities and there is usually a clear insight into their food intake. Nevertheless, future studies would benefit from questionnaires including child-report.

5. Conclusion

In conclusion, both objective and subjective measures of taste and smell influence dietary intake, eating behavior, nutritional status, and HRQoL. In a clinical setting, self-report might best reflect someone's experiences with chemosensory changes and predict clinical outcomes. Better characterization of changes in smell and taste during treatment, including individual dietary advice and coping strategies, is warranted to prevent any detrimental effects on food intake and clinical outcomes in children with cancer. Results from this study may be a useful starting point for new (dietary) recommendations and interventions, taking taste and smell changes into account, thereby improving dietary intake, nutritional status, and HRQoL in children with cancer.

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Authors' contribution

Mirjam van den Brink: conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing-original draft, writing-review and editing. Wim J.E. Tissing: conceptualization, methodology, supervision, writing-review and editing. Martha G. Grootenhuis: writing-review and editing, Marta Fiocco: formal analysis, methodology, writing-review and editing, Remco C. Havermans: conceptualization, methodology, supervision, writing-review and editing.

Conflict of interest

The authors have declared no relevant conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnu.2024.10.006.

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