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ORIGINAL ARTICLE

Malnutrition in patients treated for oral or oropharyngeal cancer—prevalence and relationship with oral symptoms: an explorative study

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Abstract
Purpose This study aimed to assess prevalence of malnutrition after treatment for oral/oropharyngeal cancer and to explore how oral symptoms relate to malnutrition after treatment.
Methods In this cross-sectional study, malnutrition (weight loss ≥10% in 6 months or ≥5% in 1 month), oral symptoms (EORTC QLQ-H&N35 questionnaire and additional questions to assess chewing problems), dental status, trismus and dietary intake were assessed in 116 adult patients treated for oral/oropharyngeal cancer.
Results Prevalence of malnutrition was 16% (95%CI: 10% to 23%). Prevalence of malnutrition in the period 0–3 months after treatment was significantly higher (25%) than in the periods >3–12 months (13%) and >12–36 months after treatment (3%, $p=0.008$). Logistic multivariate regression analysis revealed that swallowing problems ($p=0.021$) and insufficient protein intake were significantly related to malnutrition ($p=0.016$).
Conclusions In conclusion, malnutrition is a considerable problem in patients treated for oral/oropharyngeal cancer, shortly after treatment. Of all oral symptoms, only swallowing problems were significantly related to malnutrition in the period after treatment for oral/oropharyngeal cancer.

Keywords Malnutrition · Weight loss · Mouth neoplasms · Oropharyngeal neoplasms · Oral symptoms

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Introduction

Malnutrition has been defined as a subacute or chronic state of nutrition, in which a combination of undernutrition (insufficient food intake) and inflammation has led to a decrease in muscle mass, fat mass, and diminished function, i.e., immune function, cognitive function and muscle strength [33]. In the period before head and neck cancer (HNC) treatment, prevalence of severe weight loss, an indicator of subacute malnutrition, varies from 19% to 45% [17, 23, 39, 40].

Malnutrition in HNC patients may have multiple causes. In the period before treatment, a major cause of malnutrition is insufficient food intake, related to mechanical obstruction of food or pain caused by the tumor. In this period, cachexia, a complex metabolic syndrome associated with underlying illness and characterized by loss of muscle with or without loss of fat mass may contribute to malnutrition as well [13]. During and after treatment,

malnutrition may develop or aggravate as a result of oral symptoms related to treatment, such as chewing and swallowing problems, pain, dry mouth, sticky saliva, and taste disturbances [42]. In this period, increased inflammatory activity may also contribute to malnutrition, for example due to radiation-induced mucositis [19].

Although malnutrition in the period before HNC treatment is often reported [17, 21, 39], few data are available on prevalence of malnutrition after treatment for oral/oropharyngeal cancer. Previous studies in HNC patients treated with radiotherapy reported that prevalence of malnutrition is highest during radiotherapy and declines during the first 3 months after radiotherapy [16, 26]. These studies were heterogeneous regarding tumor localization and follow-up was limited to the first 6 months after treatment. Consequently, prevalence of malnutrition in the long-term period after treatment for oral/oropharyngeal cancer is unclear.

It is well known that oral symptoms are risk factors for malnutrition [42]. In the period before treatment, swallowing problems and pain in the mouth are identified as main risk factors for malnutrition in HNC patients [17, 20]. Besides swallowing problems, patients treated for oral/oropharyngeal cancer may also suffer from chewing problems, either due to poor dental status or trismus. Edentulous patients often cannot wear their prosthesis for about 3 months after surgery and not uncommonly even up to 6 months after radiotherapy or chemoradiation, due to either radiation-induced mucositis, oral edema, tender oral mucosal surfaces, surgically induced changes in anatomy, or time needed to manufacture a new prosthesis. Additionally, trismus may result from scar tissue formation, as a result of surgery and from radiotherapy [15, 43]. The relationship between poor dental status and trismus and malnutrition in patients treated for oral/oropharyngeal cancer has not been studied before. Thus, it is unclear which oral symptom(s) are risk factors for malnutrition in the period after treatment for oral/oropharyngeal cancer.

The primary aim of this cross-sectional study was to test the hypothesis that prevalence of subacute malnutrition, as indicated by severe involuntary weight loss, in patients treated for oral/oropharyngeal cancer declines in the period after treatment. The secondary aim of the study was to test the hypothesis that swallowing problems, poor dental status and trismus are risk factors for malnutrition in the period after treatment for oral/oropharyngeal cancer.

Patients and methods

A convenience sample of 185 consecutive adult patients was asked to participate in this cross-sectional study between October 2004 and February 2006. These patients had been treated for oral or oropharyngeal cancer at the University Medical Center Groningen (UMCG), the Netherlands. Patients willing to participate underwent assessment after their visit to the physician. Diagnosis and treatment information were retrieved from medical records (Table 1). The study was approved by the Ethics Committee of the UMCG. Informed consent was obtained from all participants.

Inclusion criteria were: age ≥18 years and completed treatment for oral/oropharyngeal cancer ≤3 years before study measurement. Treatment modalities were: surgery (local tumor excision and/or neck dissection); surgery and radiotherapy; radiotherapy (conventional or accelerated scheme); or radiotherapy with concomitant chemotherapy (carboplatin and 5-FU). Exclusion criteria were: a recurrent, residual or newly diagnosed tumor within 3 months after study measurement; edema due to liver, kidney or cardiac disease, to eliminate confounding by edema on body weight; uncontrolled diabetes mellitus to eliminate possible confounding in risk factors for weight loss.

Patients received dietary counseling from a dietitian working at the UMCG at time of diagnosis, during admission for surgery and weekly during radiotherapy. Duration of dietary counseling was generally limited to the first half year after treatment.

Assessment of malnutrition

Actual body weight (kilogram) was measured on a calibrated Seca 701 scale (Medical scales & Measuring Systems Seca Ltd., UK). Patients were measured in indoor clothing without shoes, after voiding the bladder. Weight for clothing (1.0–1.5 kg) was deducted from measured weight and this corrected weight was used for further analysis. Patients were asked for their body weight 1 and 6 months before study measurement. Pre-treatment body weight was retrieved from the medical records. Height was measured by a stadiometer (Seca 222, Medical scales and Measuring Systems Seca ltd., UK).

Percentage weight loss was calculated as: [(normal body weight − actual body weight)/normal body weight]× 100. Normal body weight was defined as body weight 1 month, or 6 months ago, or prior to treatment. Malnutrition was defined as involuntary weight loss ≥10% in 6 months or ≥5% in 1 month [1, 3, 25, 30, 34, 39]. BMI (kg/m^2) was calculated as [actual body weight/(body height^2)].

Assessment of oral symptoms

The EORTC QLQ-H&N35 questionnaire was used to assess pain in mouth or throat, swallowing problems, senses problems, dry mouth, and sticky saliva [2]. Scale

Table 1 Patient characteristics (n=116)

Age (years), mean (SD)	59.7 (11.7)%[a]
Gender	
Male	62
Female	38
Number of treated head and neck tumors	
1	77
2	21
3	2
Last treated tumor	
Squamous cell carcinoma	89
Salivary gland tumor	9
Other	3
Size of last treated tumor	
T1	46
T2	29
T3	3
T4	11
Unknown	11
Site of last treated tumor	
Oral cavity	71
Oropharynx	26
Other[b]	3
Treatment of last tumor	
Surgery	53
Surgery+radiotherapy	30
Radiotherapy	10
Chemoradiation	6
Interval between end of treatment and assessment (months), median (IQR[c])	4.3 (1.4, 12.6)

[a] Sum of percentages may be dissimilar to 100%, due to rounding

[b] Neck metastasis, maxillary sinus, unknown primary

[c] *IQR* Interquartile range

scores were calculated according to the manual and range from 0 to 100 [12]. In addition, three questions regarding chewing problems were asked: (1) How much difficulty did you experience while chewing solid food (like meat/solid bread)?; (2) How much difficulty did you experience while chewing dry food (like cookies)?; (3) How much difficulty did you experience while chewing soft food (like soft bread)? Possible answers to the additional questions were: (1) no difficulty; (2) little difficulty; (3) much difficulty; and (4) so much difficulty that eating was impossible. Answers (3) and (4) were dichotomized to 'chewing problems' and answers (1) and (2) to 'no chewing problems'. Time frame for all questions was the week prior to assessment.

Dental status was assessed by number of natural teeth and/or presence or absence of a dental prosthesis. Dental status was considered poor if: edentate without prosthesis, edentate plus prosthesis in upper/lower jaw, or one edentulous jaw without prosthesis and 1–16 elements in the other jaw, otherwise dental status was considered acceptable.

Maximal mouth opening was measured three times using two calibrated calipers, one for edentates or partially dentate patients wearing their prosthesis and one for edentates not wearing their prosthesis. Trismus was defined as mean mouth opening ≤35 mm [10, 18].

Dietary intake and requirements

Dietary intake of the last week before measurement was assessed by means of dietary history, by a registered dietitian (HJ) [4]. Energy and protein intake were calculated using food calculation software (JOULE v.02r80 by iSOFT, The Netherlands). Nutritional requirements were estimated conform practical guidelines used in the UMCG: 30 or 35 kcal and 1.0 or 1.5 g protein per kg actual body weight for well-nourished and malnourished patients respectively [29]. For patients with a BMI>27, body weight equivalent to BMI=27 was calculated and used in the calculations, to correct for the relatively lower metabolic active muscle mass [9]. Energy or protein intake <90% of requirements was considered insufficient.

Patients were asked if they (partly) mashed or grinded their food. Patients not using oral food were able to answer with 'not applicable'.

Statistical analysis

Statistical analyses were performed using SPSS 16.0 for Windows software (SPSS Inc., Chicago, IL, USA). Interval after treatment (months) was categorized into 0–3 months after treatment, >3–12 months after treatment and >12–36 months after treatment. An independent samples Student's *t* test was used to test differences in continuous variables between two groups. A paired sample Student's *t* test was used to test differences in the mean of a continuous variable between two related groups. The Mann–Whitney *U* test was used to test differences in continuous variables between two groups if not distributed normally and in ordinal variables. The chi-square test was used to test differences between categorical variables. The Fisher's exact test was used for categorical variables if ≥20% of the cells had an expected count less than 5, in 2×2 tables.

The relationship between oral symptoms and malnutrition was analyzed in a multivariate logistic regression analysis. Malnutrition (yes/no) was entered as outcome variable. Age (years), gender (male versus female), tumor size (T1/T2 versus T3/T4), treatment with or without radiotherapy (surgery alone versus radiotherapy, surgery and radiotherapy or chemoradiation), single or combined treatment modality (surgery alone or radiotherapy alone versus surgery and radiotherapy or chemoradiation), interval after treatment (continuous variable (months)), dental status (poor versus acceptable), chewing problems (yes versus no), trismus (yes versus no), energy intake (sufficient versus insufficient), protein intake (sufficient versus insufficient), EORTC QLQ-H&N35 scale scores (continuous variables) on swallowing problems, sticky saliva, senses problems, dry mouth, and pain in mouth or throat were entered in the logistic regression analysis (method stepwise backward), entry criterion $p \leq 0.05$, removal criterion $p > 0.10$.

The relationship between percentual decline in pre-treatment body weight and interval after treatment (categorical variable) was analyzed by one-way analysis of variance.

In all analyses, statistical significance was set at $p < 0.05$.

Results

Patients

Of the 185 eligible patients, 63 patients declined participation. Reasons to decline participation were: not interested in the study (36%, 23/63), fatigue (14%, 9/63), time investment too long (17%, 11/63) and unknown reasons (32%, 20/63). One-hundred and 21 patients were included in the study. Six patients had to be excluded because of either still being under treatment ($n=1$), tumor recurrence shortly after inclusion ($n=1$), or not being able to undergo nutritional assessment ($n=4$). Data of the remaining 116 patients (Table 1) were used in the various analyses on malnutrition, unless stated otherwise. Data on pre-treatment body weight were complete in 112 patients. Data on energy and protein intake were complete in 109 patients.

Nutritional assessment

Overall prevalence of malnutrition was 16% (18/116, 95% CI: 10% to 23%). Prevalence of malnutrition in the period 0–3 months after treatment was significantly higher (25%, 13/53) than in the periods >3–12 months after treatment (13%, 4/32) and >12–36 months after treatment (3%, 1/31; $p=0.008$). Mean pre-treatment body weight significantly declined from 78.7±13.4 kg to 75.9±14.0 kg post-treatment ($p<0.001$; mean decline 2.8±5.9 kg). Mean percentual decline in pre-treatment body weight was 3.4±7.3% and no significant differences in percentual decline in pre-treatment body weight between the three intervals after treatment were found ($p=0.220$). Mean pre-treatment BMI declined from 26.3±4.0 to 25.4±4.0 kg/m^2 post-treatment ($p<0.001$; mean decline 1.0±2.0 kg). Five percent (6/114) of all patients had a BMI<18.5 kg/m^2.

Prevalence of malnutrition per treatment modality is presented in Table 2. Analyzed univariately, no differences in age (years), gender, tumor size (T1/T2 versus T3/T4), number of treated head and neck tumors and localization of last tumor (oral cavity versus oropharynx) were found between malnourished and well-nourished patients.

Oral symptoms

Analyzed univariately, malnourished patients scored worse on swallowing problems ($p=0.005$), dry mouth ($p=0.032$) and sticky saliva ($p=0.011$) compared to well-nourished patients (Table 3).

Table 2 Prevalence of malnutrition related to last type of HNC treatment

Type of treatment (*n*)	Malnutrition	
	n	%[a]
Surgery (62)	5	8
Treatment including radiotherapy (54)	13	24[b]
Radiotherapy (12)	3	25
Surgery and radiotherapy (before or after surgery) (35)	9	26
Chemoradiation (7)	1	14

[a] Percentages are row percentages

[b] Prevalence of malnutrition in patients treated with radiotherapy, surgery and radiotherapy, or chemoradiation is significantly higher than in patients treated with surgery alone ($p=0.034$), analyzed by chi-square test

Table 3 Univariate analysis on malnutrition and oral symptoms

Oral symptoms (n)[a]	Malnutrition		No malnutrition		*p*	Malnutrition		No malnutrition	
	n	%[c]	*n*	%[c]		Median	IQR[b]	Median	IQR
Chewing problems (31/116)	7	23	24	77	0.248[d]				
Trismus (30/116)	7	23	23	77	0.239[d]				
Poor dental status (37/116)	9	24	28	76	0.129[e]				
Pain in mouth/throat (113)					0.092[f]	25.0	14.6, 37.5	16.7	0.0, 25.0
Swallowing problems (113)					0.005[f]	29.2	0.0, 52.1	0.0	0.0, 25.0
Senses problems (113)					0.211[f]	16.7	0.0, 37.5	0.0	0.0, 16.7
Dry mouth (113)					0.032[f]	66.7	33.3, 100.0	33.3	0.0, 66.7
Sticky saliva (113)					0.011[f]	66.7	0.0, 100.0	0.0	0.0, 66.7

[a] Number of valid observations (patients with this symptom/total number of patients)

[b] Interquartile range

[c] Percentages are row percentages

[d] Analyzed by Fisher's exact test

[e] Analyzed by chi-square analysis, with continuity correction

[f] Analyzed by Mann–Whitney *U* test

Dietary intake

Ninety-six percent of all patients (111/115) used an oral diet, either with (3%, 3/115) or without tube feeding (94%, 108/115; Table 1). Four patients used tube feeding only (3%, 4/115). Of the patients using oral food (with or without tube feeding), 87% (97/111) used a solid diet and 13% (14/111) a liquid/mashed diet. Patients using a liquid/mashed diet were significantly more often malnourished (36%, 5/14) than patients able to use a solid diet (11%, 11/97, $p=0.003$).

Mean actual intake was 2185±699 kcal and 83±24 g protein. No significant differences were found in intake between malnourished and well-nourished patients. Frequency of insufficient protein intake, related to requirements, was significantly higher in malnourished patients (65%, 11/17) than in well-nourished patients (29%, 27/92 $p=0.011$).

Multivariate logistic regression analysis

Swallowing problems and insufficient protein intake were significantly related to malnutrition in the logistic multivariate regression analysis (Table 4).

Discussion

The results of our study demonstrate that one out of six patients is malnourished after treatment for oral/oropharyngeal cancer, with the highest prevalence of malnutrition shortly after treatment (one out of four patients). The decline in prevalence of malnutrition within the first year after treatment in our study is in accordance with results of other studies [16, 26, 36].

Very limited data are available on prevalence of malnutrition after treatment for oral/oropharyngeal cancer. In a randomized controlled trial 48% of the patients was malnourished 3 months after start of radiotherapy. If patients received dietary counseling during and shortly after radiotherapy this percentage was 24% [16]. In HNC patients, in which malnourished patients received tube feeding during and after radiotherapy, prevalence of malnutrition was 27% and 6% in the third and sixth month after start of radiotherapy, respectively [36]. Other studies on malnutrition in HNC patients focused on changes in nutritional status during and after treatment. In a randomized controlled trial, performed in HNC patients treated with radiotherapy, nutritional status was deteriorated 3 months after treatment in all patients not receiving dietary counseling nor dietary supplements, but if patients received dietary counseling during radiotherapy this frequency was limited to 12% [26]. In HNC patients not receiving dietary counseling during and after treatment, mean body weight significantly declined with 2.3±4.0 kg during treatment and 2.2±5.5 kg in the period after treatment [40]. In all of these studies prevalence of malnutrition declined in the first 6 months after treatment in patients receiving dietary intervention [16, 26, 36].

Of all oral symptoms, swallowing problems was the only one related to malnutrition in the logistic multivariate regression analysis. Although swallowing problems may be present in the long-term period after treatment for oral or oropharyngeal cancer [28], swallowing problems are most

Table 4 Results of multivariate logistic regression analysis on malnutrition and oral symptoms (n=109)

Variable	*β*	SE *β*	OR	95% CI of OR	*p*
Swallowing problems[a]	0.03	0.01	1.03	1.01 to 1.06	0.021
Insufficient protein intake[b]	1.60	0.66	4.93	1.35 to 18.06	0.016
Interval after treatment (months)	−0.13	0.06	0.89	0.79 to 1.00	0.057
Constant	−2.37	0.64	0.09		<0.001

B regression coefficient, *SE β* standard error of *β*, *OR* odds ratio=e^{β}, *95% CI of OR* 95% confidence interval of odds ratio

[a] Scale score, as assessed by EORTC QLQ-H&N35. A difference of, for instance, 20 points in swallowing problems between two patients results in an OR for malnutrition of 1.82 ($20 \times \beta = 20 \times 0.03 = 0.06 \rightarrow e^{0.06} = 1.82$)

[b] *0* absent, *1* present

severe during and shortly after treatment, due to radiation-induced mucositis and reduced mobility of the tongue due to surgery [35, 42]. Probably swallowing problems will cause malnutrition predominantly during treatment, and to a lesser extent in the period after treatment. To reduce post-treatment malnutrition risk due to swallowing problems, we recommend routine screening for both presence of swallowing problems and malnutrition in patients after treatment for oral or oropharyngeal cancer. Future research should investigate whether the prevalence of post-treatment malnutrition can be reduced or even prevented by strategies to overcome the swallowing problems. For example, the assumed efficacy of multidisciplinary treatment of treatment-related swallowing problems by both the dietitian and speech therapist needs to be investigated. Furthermore, the role of early tube feeding, e.g., by prophylactic gastrostomy placement, should be more thoroughly investigated, because large randomized controlled trials on this topic are still lacking.

The multiple regression analysis corrected for confounders like energy and protein intake and other oral symptoms. Poor dental status, trismus, and chewing problems were no risk factors for malnutrition in the multivariate regression analysis. Patients having chewing problems often change their diet into a soft, mashed or liquid diet. As nutritional density of a mashed or liquid diet is lower than that of a solid diet, these patients also are advised to use energy- and protein-enriched liquid dietary supplements. Use of these supplements increases energy and protein intake and in turn decreases the risk for malnutrition. Only one other study assessed the relationship between dental status and malnutrition, but this study was performed in the period before treatment [20]. In the latter study also, no significant relationship between these variables was found [20].

No significant relationship was found between percentual decline in body weight and interval after treatment. Mean decline in pre-treatment body weight was limited to 3%. However, this 3% weight loss may be additional to weight loss that already may have developed before start of treatment. At time of diagnosis, 34% of patients with oral/oropharyngeal cancer have already lost ≥10% of body weight in 6 months or ≥5% in 1 month [17]. Additionally, in the current study difference between pre-treatment and actual body weight ranged widely, indicating that a subgroup of patients fails to regain body weight to pre-illness or even pre-treatment level.

Although patients treated with radiotherapy were significantly more frequently malnourished than patients treated with surgery alone in the univariate analysis, treatment with any type of radiotherapy was not significantly related to malnutrition in the multivariate logistic regression analysis. In a prospective study on weight loss in HNC patients not receiving dietary counseling, patients treated with any type of radiotherapy lost significantly more body weight than patients treated with surgery alone [40]. In the current study, swallowing problems and insufficient intake were more strongly related to malnutrition than type of treatment, in the period after treatment.

Averagely, both malnourished and well-nourished patients seemed to have a rather adequate intake of energy and protein. However, insufficient protein intake related to requirements was significantly related to malnutrition. Energy and protein intake of our patients were similar to intake reported in other studies in HNC patients [16, 26, 40]. On the other hand, mean body weight of our patients was higher than reported in two of these studies [26, 40], suggesting that dietary requirements of our patients were higher as well. As the 95% confidence interval of the odds ratio of insufficient protein intake was wide, the significant relationship found between insufficient protein intake and malnutrition should be interpreted with caution. This wide confidence interval may be the result of insufficient power due to the relatively low prevalence of malnutrition. On the other hand, the effect of protein intake on malnutrition may vary per patient. As malnutrition is the result of a combination of insufficient intake and inflammation activity [33], inflammation activity may have continued in the period after treatment.

Unfortunately, currently a gold standard for the assessment of malnutrition unfortunately does not exist [33]. Weight loss is one of the criteria commonly used for

assessment of malnutrition [34]. Weight loss of ≥10% in 6 months/≥5% in 1 month is a generally accepted cutoff for clinically relevant weight loss. Such a weight loss is associated with increased morbidity, such as impaired wound healing and reduced immune function [6, 37]. Besides that, weight loss of ≥10% in 6 months/≥5% in 1 month has shown to be of great prognostic value in the occurrence of major postoperative complications and has been associated with higher mortality and reduced quality of life [1, 6, 25, 30, 37–39, 41].

Whereas involuntary weight loss reflects (sub)acute malnutrition, underweight reflects chronic malnutrition [14, 31]. Cutoff values for BMI varying from 18.5 to 20.0 kg/m^2 have been used as an indicator of chronic malnutrition [34, 45]. If a BMI<18.5 kg/m^2 was added to our criteria for malnutrition, total prevalence of malnutrition would have risen to 19% (22/116). Prevalence of malnutrition in the period 0–3 months after treatment (28%, 15/53) also would have been significantly higher than in the periods >3–12 months and >12–36 months after treatment (16%, 5/32 and 7%, 2/31, p=0.012). If this cutoff for BMI is increased to BMI<20 kg/m^2, total prevalence of malnutrition would have increased further to 22% (25/116). Prevalence of malnutrition per interval after treatment would have been 32% (17/53), 16% (5/32) and 10% (3/32) respectively (p=0.012). These findings indicate that the choice of the cutoff values is of the utmost importance for assessment of malnutrition. Obviously, a gold standard for the assessment of malnutrition is required.

To test the hypothesis that prevalence of malnutrition declines after treatment, we classified patients into three groups: 0–3 months after treatment, >3–12 months after treatment and >12–36 months after treatment. We chose these cutoff values, to distinguish between acute and late side effects of HNC treatment. Radiation-induced acute side effects, such as mucositis, will diminish in the first 3 months after treatment [5, 42]. In the period between 3 months and 1 year after treatment, existing oral symptoms may recover or may become chronic, as oral symptoms present 1 year after treatment usually do not recover in the period after that [22, 35]. Furthermore, in the short-term period after treatment, inflammation activity related to treatment may still be present [11, 19, 32]. One year after treatment, it is expected that patients reach a 'steady state' with regard to their nutritional problems.

The current study has some limitations. The first one is the modest participation rate of 66%. In 14% of the patients not willing to participate fatigue has played a major role in the decision to refuse participation in the study. As it cannot be excluded that fatigue was the result of malnutrition, the modest participation rate may have resulted in underestimation of malnutrition.

The second study limitation is the use of a self reported body weight. Generally, men slightly overestimate body weight (0.3 kg), whereas women tend to underestimate their body weight (−1.4 kg) [24]. In our study population, the majority (62%) of patients was male. As a result, prevalence of malnutrition may have been slightly overestimated.

The third study limitation was the use of prediction equations to estimate nutritional requirements [8, 27, 44]. Indirect calorimetry is the gold standard to assess energy requirements [7]. However, for practical reasons it was not possible to perform indirect calorimetry in the current study. Therefore, energy requirements had to be estimated. We have chosen to compare energy intake to energy recommendations conform clinical practice in the UMCG. Use of equations to predict energy expenditure may lead to errors [8, 44] Such prediction errors may vary from 235 to 425 kcal, which is about 15–30% of resting energy expenditure as measured by indirect calorimetry [44]. Therefore, evaluation of dietary intake in relation to requirements requires further research.

In conclusion, malnutrition is a considerable problem in patients treated for oral/oropharyngeal cancer, shortly after treatment. Of all oral symptoms, only swallowing problems were significantly related to malnutrition in the period after treatment for oral/oropharyngeal cancer.

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