ORIGINAL ARTICLE

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8

https://doi.org/10.22037/ORLFPS.v5i2.28008

# Studying Malnutrition-Related Factors in Patients with Head and Neck Cancer Following Surgery

**Leila Vazifeh Mostaan[1], Sharifeh Haghjoo[2], Kazem Anvari[3]*, Mohammad Safarian[4], Kamran Khazaeni[5], Monavar Afzal Aghaei[6]**

1. Cancer research center, Mashhad University of Medical Sciences, Mashhad, Iran.
2. Department of ENT, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
3. Cancer research center, Mashhad University of Medical Sciences, Mashhad, Iran.
4. Department of Nutrition, Mashhad University of Medical Sciences, Mashhad, Iran.
5. Department of ENT, Ghaem Hospital, Mashhad University of Medical Sciences, Mashhad, Iran.
6. School of Public Health, Mashhad University of Medical Sciences, Mashhad, Iran.

**Article Info**

**Article note:**
Received: July, 2017
Accepted: March 2019
Publish Online: December 2019

**Corresponding Author**:
Dr. Kazem Anvari,
**Email:**
anvariK@mums.ac.ir

**Keyword:**
Head and Neck Cancer (HNC);
Malnutrition;
Malnutrition Universal Screening Tool, MUST;
Surgery;
Weight loss;

**Abstract**

**Background:** Nutritional dysfunction with or without aspiration is a common complication following head and neck cancer (HNC) surgery and patients frequently present with weight loss secondary to dysphagia and malnutrition.

**Aim:** The aim of this study was to investigate the incidence of weight loss and malnutrition in patients with HNC following surgery through the Malnutrition Universal Screening Tool (MUST) scale.

**Methods:** A total of 28 patients with a confirmed diagnosis of head and neck cancer mainly of the oral cavity referring for surgery for the first time were enrolled. A researcher-designed questionnaire was used for data collection. Further, a single nutritionist evaluated each patient's nutritional status before and 6-8 weeks' post-surgery according to MUST to measure the level of malnutrition. Significance level was set at $p<0.05$.

**Results:** Among the subjects**,** 57% were younger than 70 years; 61% were in stage II of cancer while the rest were in stage III. Weight, body mass index (BMI), serum hemoglobin, and albumin levels showed a significant reduction following surgery ($p<0.05$). Specifically, 18% had less than 5%, 36% had 5-10%, and 46% had >10% weight loss. According to MUST scale, 18% of Patients with HNC had low, 25% had moderate, and 57% had high risk of malnutrition. A significant relationship was found between severe malnutrition and patients older than 70 years of age.

**Conclusion:** In head and neck cancer patients, weight loss increases the morbidity and mortality, therefore nutritional interventions should be initiated before cancer treatment begins and these interventions need to be ongoing after completion of treatment to ensure optimal outcome.

**Conflict of Interest:** The authors declare no conflicts of interest.
**Please cite this article as:** Vazifeh Mostaan L, Haghjoo S, Anvari K, Safarian M, Khazaeni K, Afzal Aghaei M. Studying Malnutrition-Related Factors in Head and Neck Cancer Patients Following Surgery. J Otorhinolaryngol Facial Plast Surg. 2019;5(2):1-8. https://doi.org/10.22037/ORLFPS.v5i2.28008

## Introduction

Disease-related malnutrition is a common finding in patients with cancer leading to significant morbidity and mortality (1). It has an incidence of 40-80% with a prevalence ranging from 50% to 80% depending on tumor type, cancer stage, treatment modality, and the nutritional assessment method used (2,3).

Head and neck cancers (HNC) constitute the sixth most common malignancy worldwide (4). The prevalence of severe weight loss which can be an index for the extent of malnutrition varies from 19% to 45% in the period before HNC treatment (4, 5) and is

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8
https://doi.org/10.22037/ORLFPS.v5i2.28008

associated with undesired outcome, as well as impaired quality of life and performance status (6). The tumor itself, radiation-induced fibrosis, and surgical defects are reported to be followed with excessive weight loss and malnutrition (7, 8). Further, swallowing problems and pain in the mouth are considered as main risk factors for malnutrition in HNC (4, 9, 10).

Several studies have emphasized the early identification and treatment of poor nutritional status which can be highly beneficial in the management of cancer patients (11, 12). In this respect, regular measurement of body weight during and after treatment of head and neck cancer has been proposed as an important and an inexpensive means of surveillance (8). In addition, body mass index (BMI) has been suggested an important indicator, especially in patients receiving radiotherapy (13).

Considering oral symptoms in oral nutrition, the most common symptoms leading to malnutrition in head and neck cancer cases include swallowing disorders, chewing disorders, reduced saliva secretion, pain in the mouth or throat, and tasting disorders (14, 15).

The reduced immune function can also lead to different complications such as delayed healing of ulcers, along with reduced tolerance to surgery and radiotherapy. It also reduces the therapeutic response to cancer and has a negative impact on the quality of life (16).

Despite the many studies conducted on Patients with HNC, yet few data are available on the prevalence of malnutrition after treatment for oral/oropharyngeal cancers.

In the same vein, studies have been rarely performed in Iranian hospitals; we aimed at studying the factors leading to severe malnutrition among head and neck cancer patients following surgery, in order to better prevention of further complications.

## Methods

In this prospective descriptive study, 28 patients with the pathologic diagnosis of head and neck cancer, mainly of the oral cavity were enrolled. They were referred to the Otorhinolaryngology clinic of Omid University Hospital, Mashhad, Iran from March 2011 to April 2014 for undergoing surgery for the first time.

A designed questionnaire was used for data collection including demographic characteristics, type of cancer, complete blood test results, as well as height, weight and BMI of each patient. The questionnaire was filled in once before surgery and once again following the surgery.

In the initial analysis, in case the pathology exam had not been previously performed, a punch biopsy of the tumor margin was taken in the operating room which was then examined by a single well-experienced pathologist. On the other hand, if the biopsy sample had previously been examined in a different medical center, the histological sections were requested and re-examined by the same pathologist in our center.

After confirming the diagnosis of cancer and its staging, routine lab tests were performed. The patient was then referred to a nutritionist in order to examine his/her nutritional status. The second visit with the nutritionist was set 6 to 8 weeks after surgery.

In order to prevent any bias, the height, weight, and BMI were measured by the Body Composition Analyzer BC-418 device, both before and after surgery.

The nutritionist evaluated each patient's nutritional status according to Malnutrition Universal Screening Tool (MUST). In the first step, BMI was scored before initiating any treatment, after which weight loss during the six post-op weeks was measured and scored. In the third step and based on MUST, the level of malnutrition was calculated.

Patients with the following criteria were excluded from the study: a history of previous surgery due to the same type of cancer, cancer due to metastasis, cancer of the lower esophagus, neck esophagus, larynx or the

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8
https://doi.org/10.22037/ORLFPS.v5i2.28008

pharynx, having a history of malnutrition prior to cancer, a history of radiotherapy or chemotherapy.

The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences and an informed consent was obtained from each participant prior to study entrance.

**Statistical analysis**

The collected data were then analyzed by the SPSS software ver. 18. Chi-square test, Fisher's exact test, Paired and Independent sample t-test were applied wherever appropriate. A $p<0.05$ was considered as statistically significant.

## Results

In total, 28 patients were studied, 14 of each gender, whose age ranged from 37 to 87 years; 16 (57%) were younger than 70 years while 12 (43%) cases were over 70 years of age.

The most common cancer was squamous cell carcinoma of the tongue with a prevalence of 75% (21 cases), which was followed by buccal mucosal squamous cell carcinoma (25%). Further, 17 (61%) patients were of stage II while the other 11 (39%) were in stage III of oral cavity cancers.

In general, 13 patients (46%) had serum a hemoglobin (Hb) level below 12 g/dL, 7 (25%) had Hb level between 12 and 14, while in the other 8 (29%) this level was over 14.

The mean weight before and after surgery was 66.37±14.32 Kg and 62.12±14.58 Kg, showing a statistically significant reduction (P=0.00). The same result was obtained for BMI based on Paired-sample t-test (25.75±5.36 vs. 23.95±5.56; P=0.00).

Fisher's Exact test showed no significant difference in the risk level of malnutrition between the two genders, as reported in Table 1 (P=0.37). The same result was obtained for age (P=0.05) (Table 2).

Fisher's exact test showed no significant correlation either between BMI and risk level of malnutrition (P=0.05), or between the site of tumor and risk level of malnutrition (P=0.60).

In general, 42.85% of the females had severe malnutrition while 57.14% of the males suffered from this condition; showing no significant difference regarding gender (P=0.25). The same results were obtained when considering severe malnutrition in different age groups (<50, 51-60, 61-70 and>71 yr) (P=0.07). No correlation was found between BMI and severe malnutrition either (P=0.49).

Table 3 presents the indices of age, weight, height, and BMI in patients with and without severe malnutrition before surgery. Based on the table, no significant difference was detected in such indices between the two groups.

Based on paired-sample t-test, serum Hb and albumin levels showed no significant difference either between those with and without severe malnutrition before surgery. However, the Hb level before and after surgery was significantly different, showing a mean 0.8 mg/dL decrease following surgery (12.27±1.86 vs. 11.44±1.96; P=0.005). This was the same for the serum albumin level indicating 0.24 fall in comparison to the case before surgery (4.09±0.48 vs. 3.84±0.74; P=0.03).

In total, 21.4%, 42.9%, and 35.7% of the females had a body weight reduction of <5%, 5-10%, and >10%, respectively. The same figures were 14.3%, 28.6%, and 57.1% among the males.

Patients younger than and over 70 years of age constituted 37.5% and 62.5% of patients with severe malnutrition respectively, showing a significant difference (P=0.03). Table 4 presents the risk level of malnutrition in the two groups of patients over and under 70 years of age based on the MUST.

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8

https://doi.org/10.22037/ORLFPS.v5i2.28008

**Table 1.** The association between gender and risk level of malnutrition based on the Malnutrition Universal Screening Tool

| Risk Levels / Gender | No risk N(%) | Moderate N(%) | High N(%) | p-value |
|---|---|---|---|---|
| **Man** | 2 (40) | 2 (28.6) | 10 (62.5) | |
| **Woman** | 3 (60) | 5 (71.4) | 6 (37.5) | 0.37 |
| **Total** | 5(100) | 7 (100) | 16 (100) | |

**Table 2.** The association between different age groups and risk level of malnutrition based on the Malnutrition Universal Screening Tool

| Risk Levels / Age (years) | No risk N(%) | Moderate N(%) | High N(%) | p-value |
|---|---|---|---|---|
| **<49** | 2 (40) | 1 (14.3) | 3 (18.8) | |
| **50-59** | 0 | 2 (28.7) | 3 (18.8) | |
| **60-69** | 3 (60) | 2 (28.7) | 1 (6.3) | 0.05 |
| **>70** | 0 | 2 (28.7) | 9 (56.3) | |
| **Total** | 5 (100) | 7 (100) | 16 (100) | |

**Table 3.** Pre-surgical demographic data of the studied patients with and without severe malnutrition based on the Malnutrition Universal Screening Tool

| Risk Levels / Demographic Characteristics | Non-severe malnutrition (mean±SD) | Severe malnutrition (mean±SD) | p-value |
|---|---|---|---|
| **Age (year)** | 60.08±11.95 | 66.87±14.04 | 0.19 |
| **Height (Cm)** | 158.91±7.69 | 162.61±8.82 | 0.40 |
| **Weight (Kg)** | 69.70±15.56 | 63.88±13.26 | 0.29 |
| **BMI** | 27.50±4.83 | 24.43±5.51 | 0.13 |

**Table 4.** Comparing the risk levels of malnutrition in those younger and older than 70 years based on the Malnutrition Universal Screening Tool

| Risk Levels / Age (years) | No risk | Moderate | Severe | p-value |
|---|---|---|---|---|
| | No (%) | No (%) | No (%) | |
| **<70** | 5 (100) | 5 (71.4) | 6 (37.5) | |
| **>70** | 0 (0) | 2 (28.6) | 10 (62.5) | 0.3 |
| **Total** | 5 (100) | 7 (100) | 16 (100) | |

## Discussion

This prospective descriptive study was conducted in a 3-year period. The patients were cases of head and neck cancer who were simply enrolled in the study. Specifically, 57% were younger than 70 years of age which is in line with similar studies (17). Patients over 70 years of age had a greater risk of malnutrition based on MUST.

In the current study, a significant difference was observed in weight, BMI, serum Hb, and albumin levels before and after surgery. In general, 18%, 25% and 57% had a low, moderate, and high risk of malnutrition, respectively.

Approximately 35 to 60 percent of all patients with head and neck cancer are malnourished at the time of diagnosis because of tumor burden and obstruction of intake (18).

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8
https://doi.org/10.22037/ORLFPS.v5i2.28008

Pressoir and colleagues (6) reported malnutrition in 30.9% of patients, rated as severe in 12.2%. They introduced pre-existing obesity (BMI≥30) and head-and-neck or upper digestive tract cancers associated with increased risk of malnutrition.

In the present study, no significant association was found between gender, BMI, serum Hb, plus albumin levels and risk of severe post-operative malnutrition.

Note that the most common type of cancer was squamous cell carcinoma of the tongue (75%) and squamous cell carcinoma of the buccal mucosa (25%). In similar study, oral cavity cancers accounted for 24 to 48 percent of all head and neck carcinomas (17). In general, 18% of our patients had a weight reduction less than 5% while in 36% it was 5 to 10 percent and 46% experienced a weight loss over 10%.

Ehrsson and colleagues obtained a mean maximum weight loss of 13% for patients with enteral nutrition and 6% in oral feeding ($p < 0.001$). They also reported tumor stage as the only independent factor associated with maximum weight loss (8).

Wittenar and colleagues in 2011 studied 116 cases and demonstrated a malnourishment rate of one out of six patients following oral/oropharyngeal cancer treatment, while the highest prevalence of malnutrition was recorded shortly after the treatment. The mean rate of malnutrition was 16% which increased to 25% following 6 months of treatment initiation. Their mean weight indicated a significant difference following surgery. The malnourished group showed a significant difference with the well-nourished group in oral symptoms. They concluded that malnutrition is a serious issue in such cancer patients and among all oral symptoms, swallowing problems following treatment are significantly associated with malnutrition (4).

In the study by Datema and colleagues in 2011 on 383 head and neck cancer patients, 335 did not have malnutrition while 38 had severe malnutrition. They found no association between the tumor site and malnutrition despite a higher rate of this condition in those with oral cavity carcinoma (17).

Similarly, in our study no significant association was found between the site of tumor and risk level of malnutrition (P=0.60). Yet, malnutrition had a significantly higher prevalence among patients over 70 years of age in comparison to younger cases. We found no significant difference between albumin and Hb levels in those with and without severe malnutrition. However, both factors showed a significant drop following surgery.

In another study by Van den Bergand colleagues, the correlation between malnutrition and life style was studied in 47 patients with oral cavity, oropharyngeal, and hypopharyngeal SCC. A weight loss>10% during 6 months was regarded as malnutrition. Surprisingly, the patients who had undergone surgery regained their lost weight while those who were treated with radiotherapy or combination therapy did not gain weight during this period. In general, those undergoing surgery had a better quality of life in comparison to radiotherapy (19).

In another study by Wittenar and colleagues in 2007 on 407 cases, 19% of the patients with oral cavity and oropharynx cancer were diagnosed with critical weight loss. Loss of appetite, dysphagia, and loss of taste were significantly associated with critical weight loss. A larger tumor size was associated with greater weight loss (9).

In the current study, the post-operative weight and BMI were significantly lower than the pre-op values. In general, 25 (89%) had a BMI >20 while 2 (7%) had a BMI <18.5. Also, 17 (61%) patients were of stage II while the other 11 (39%) were in stage III of head and neck cancers.

In the study performed by Capuano and colleagues in 2010, 61 patients with stage III and IV head and neck cancers were studied. Their mean BMI was 24.4 and 36% suffered

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8
https://doi.org/10.22037/ORLFPS.v5i2.28008

from malnutrition. The mean weight loss was 10±5 (20).

In the study by Datema et al., the mean age of the 383 patients with SCC of the head and neck for 10-15 years was 62.9±11.8 yr. Severe malnutrition was diagnosed in 5.2% of them, who were mostly of stage IV cancer. They also emphasized the significant and independent role of severe malnutrition on the overall survival in such patients (17).

Lifestyle has also shown a negative correlation with the stage of cancer in most studies on HNC (21). Ottosson and colleagues in 2014 studied 101 HNC cases, in which dysphagia and aspiration had a higher prevalence among patients with severe malnutrition (22). Further, Pai and colleagues in a study on 1652 patients stated that pre-treatment BMI significantly affected the long-term survival rate; a greater BMI led to longer survival (23). These results were in contrast to the study by Gaudet and colleagues (24), while Pressoir and colleagues identified pre-existing obesity as a new risk factor for malnutrition probably due to the delay in nutritional support in such individuals; antibiotics use was also significantly higher in malnourished patients ($p<0.001$) (6).

Languis et al. in a study on 1340 patients with HNC in 2013 also stated a positive relationship between weight loss during radiotherapy and their 5-year survival (25) which was inconsistent to the findings of Ottosson and colleagues. (22).

In another study conducted in 2014 on 1903 patients with HNC, weight loss significantly correlated with malnutrition; it emphasized the need for sufficient nutritional support in such patients (26).

Taken together, nutritional consultation and routine screening of malnutrition before, during, and after treatment initiation in patients with head and neck cancer seems a necessity to prevent related complications and decrease the financial burden on the health system. Medical personnel must be aware that unintentional weight loss is an important predictor of malnutrition risks even if the patient's BMI is not suggestive of malnutrition (27).

The current study did not assess and discuss various factors affecting lifestyle and the role of different therapeutic methods in the rate of malnutrition in patients with HNC. Further, the follow-up period was not long enough. Nevertheless, it is recommended that alternative medical interventions such as immune-enhancing nutrients or anticytokine pharmaceutical agents could be taken into consideration as adjuvant therapies in such cases in future studies.

## Conclusion

In head and neck cancer patients, weight loss increases the morbidity and mortality, reduces treatment tolerance and quality of life. Nutritional interventions should be initiated before cancer treatment begins and these interventions need to be ongoing after completion of treatment to ensure better quality of life and better adaptation in coping with the undesired effects. Further, special attention should be paid to those on enteral nutrition or individuals with more advanced disease.

## Acknowledgments

Not declared.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Ethics

This study was approved by the "Ethics Committee of Mashhad University of Medical Sciences (Mashhad, Iran)"; Registration Code: 98/370895.

## Financial Support

Not declared.

## Authors' ORCIDs

**Leila Vazifeh Mostaan:**
https://orcid.org/0000-0001-8322-906

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8

https://doi.org/10.22037/ORLFPS.v5i2.28008

**Kazem Anvari:**
https://orcid.org/0000-0002-1080-1907
**Kamran Khazaeni:**
https://orcid.org/0000-0002-6275-2609
**Monavar Afzal Aghaei:**
https://orcid.org/0000-0003-2029-6577

## References

1. Van Cutsem E, Arends J. The causes and consequences of cancer associated malnutrition. Eur J Oncol Nurs. 2005, 9:S51–S63. Suppl 2:S51-63.

2. Lis CG, Gupta D, Lammersfeld CA, Markman M, Vashi PG. Role of nutritional status in predicting quality of life outcomes in cancer-a systematic review of the epidemiological literature. Nutr J. 2012;11:27.

3. 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. Support Care Cancer. 2009;17:83–90.

4. Jager-Wittenaar H, Dijkstra PU, Vissink A, van Oort RP. van der laan BF, Roodenburg JL. Malnutrition in patients treated for oral or oropharyngeal cancer–prevalence and relationship with oral symptoms: an explorative study. Support Care Cancer. 2010;16.

5. van den Berg MG. rasmussen-Conrad EL, Gwasara GM, Krabbe Pf, Naber AH, Merkx MA (2006) A prospective study on weight loss and energy intake in patients with head and neck cancer, during diagnosis, treatment and revalidation. Clin Nutr.;25:765-72.

6. Pressoir M, Desné S, Berchery D, Rossignol G, Poiree B, Meslier M, Traversier S, et al. Prevalence, risk factors and clinical implications of malnutrition in French Comprehensive Cancer Centres. Br J Cancer. 2010;102(6):966-71.

7. Chasen MR, Bhargava R. A descriptive review of the factors contributing to nutritional compromise in patients with head and neck cancer. Support Care Cancer. 2009;17:1345-51.

8. Ehrsson YT, Langius-Eklöf A, Laurell G. Nutritional surveillance and weight loss in head and neck cancer patients. Support Care Cancer. 2012;20(4):757-65.

9. Jager-Wittenaar H, Dijkstra PU, van der Laan BFAM, Vissink A, van Oort RP, Roodenburg JLN. Critical weight loss in head and neck cancer patients—prevalence and risk factors at diagnosis: an explorative study. Supp Care Cancer. 2007;15:1045–50.

10. Kubrak C, Olson K, Jha N, Jensen L, McCargar L, Seikaly H, Harris J, Scrimger R, Parliament M, Baracos VE. Nutrition impact symptoms: key determinants of reduced dietary intake, weight loss, and reduced functional capacity of patients with head and neck cancer before treatment. Head Neck. 2010;32(3):290–300.

11. Holder H. Nursing management of nutrition in cancer and palliative care. Br J Nurs. 2003;12:667–668, 670, 672–4.

12. Ouwens MM, Hermens RR, Hulscher MM, et al. The causes and consequences of cancer associated malnutrition. Eur J Oncol Nurs. 2009;31:902-10.

13. McRackan TR, Watkins JM, Herrin AE, et al. Effect of body mass index on chemoradiation outcomes in head and neck cancer. Laryngoscope. 2008;118:1180–5.

14. List MA, Bilir SP. Functional outcomes in head and neck cancer. Semin Radiat Oncol. 2004;14:178-89.

15. Vissink A, Jansma J, Spijkervet FK, Burlage FR, Coppes RP. Oral sequelae of head and neck radiotherapy. Crit Rev Oral Biol Med. 2003;14:199-212.

16. Arends J, Bodoky G, Bozzetti F, Fearon K, Muscaritoli M, Selga G, et al. ESPEN Guidelines on Enteral Nutrition: Nonsurgical oncology. Clin Nutr. 2006;25:245-59.

17. Datema FR, Ferrier MB, Baatenburg de Jong RJ. Impact of severe malnutrition on short-term mortality and overall survival in head and neck cancer. Oral Oncol. 2011;47(9):910-4.

18. Alshadwi A, Nadershah M, Carlson ER, Young LS, Burke PA, Daley BJ. Nutritional Considerations for Head and Neck Cancer Patients: A Review of the Literature. J Oral Maxillofacial Surg. 2013;71(11):1853-60.

19. van den Berg MG, Rasmussen-Conrad EL, van Nispen L, van Binsbergen JJ, Merkx MA. A prospective study on malnutrition and quality of life in patients with head and neck cancer. Oral Oncol. 2008;44(9):830-7.

20. Capuano G, Gentile PC, Bianciardi F, Tosti M, Palladino A, Di Palma M. Prevalence and influence of malnutrition on quality of life and performance status in patients with locally advanced head and neck cancer before treatment. Support Care Cancer. 2010;18(4):433-7.

Journal of Otorhinolaryngology and Facial Plastic Surgery. 2019;5(2):1-8

https://doi.org/10.22037/ORLFPS.v5i2.28008

21. De Graeff A, de Leeuw R, Ros W. Pre-treatment factors predicting quality of life after treatment for head and neck cancer. Head Neck. 2000;22:398.

22. Ottosson S, Zackrisson B, Kjellén E, Nilsson P, Laurell G. Weight loss in patients with head and neck cancer during and after conventional and accelerated radiotherapy. Acta Oncol. 2013;52(4):711-8.

23. Pai PC, Chuang CC, Tseng CK, Tsang NM, Chang KP, Yen TC, et al. Impact of pretreatment body mass index on patients with head-and-neck cancer treated with radiation. Int J Radiat Oncol Biol Phys. 2012;83(1):e93-e100.

24. Gaudet MM, Patel AV, Sun J, Hildebrand JS, McCullough ML, Chen AY, et al. Prospective studies of body mass index with head and neck cancer incidence and mortality. Cancer Epidemiol Biomarkers Prev. 2012; 21(3):497-503.

25. Langius JA, Bakker S, Rietveld DH, Kruizenga HM, Langendijk JA, Weijs PJ, et al. Critical weight loss is a major prognostic indicator for disease-specific survival in patients with head and neck cancer receiving radiotherapy. Br J Cancer. 2013;109(5):1093-9.

26. Hébuterne X, Lemarié E, Michallet M, de Montreuil CB, Schneider SM, Goldwasser F. Prevalence of malnutrition and current use of nutrition support in patients with cancer. JPEN J Parenter Enteral Nutr. 2014;38(2):196-204.

27. Loh KW, Vriens MR, Gerritsen A, Borel Rinkes IHM, Van Hillegersberg R, Schippers C, et al. Unintentional weight loss is the most important indicator of malnutrition among surgical cancer patients. Nithreland J Med. 2012; 335:365-9.