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# Eating and speech problems in oral and pharyngeal cancer survivors – Associations with treatment-related side-effects and time since diagnosis

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**Abstract**

**Aims:** The aim of this cross-sectional study was to find factors associated with problems with the ability to eat and speak in oral and pharyngeal cancer (OPC) survivors and to evaluate if the panorama of oral problems varied with time since diagnosis.

**Methods and Results:** A questionnaire assessing cancer diagnosis and treatment, oral health-related quality of life, and presence of treatment-related side-effects was sent to members of the Norwegian Head and Neck Cancer Association. Three-quarters ($n = 117$) of the respondents experienced xerostomia, and 51% ($n = 79$) had dysphagia. Prevalence of dysphagia, trismus, and dysphonia was lowest among respondents diagnosed within the last 5–10 years prior to the study. Eating problems were reported by 75% ($n = 121$) of the OPC survivors and were associated with xerostomia, dysphagia, trismus, having removed part of the tongue, cancer diagnosis within 5 years prior to the study and having little problems with caries and tooth fracture. Speaking problems were experienced by 60% ($n = 93$) of the OPC survivors, and were associated with dysphonia, dysphagia, and trismus.

**Conclusion:** Our study shows a high prevalence of oral problems among OPC survivors and points to targets for interventions for eating and speech impairments that may improve oral health-related quality of life.

KEYWORDS
dental health, dysphagia, oral cancer, oral health-related quality of life, pharyngeal cancer, trismus, xerostomia

## 1 | INTRODUCTION

The number of long-term head and neck cancer (HNC) survivors is increasing in many European countries and in the US due to an increase in both the incidence and the survival rate of these cancer types.[1,2] HNC survivors often suffer from long-term side effects of the cancer treatment such as physical defects and scarring, tooth loss, impaired salivary gland function, trismus, osteoradionecrosis, dysphagia, and pain.[3,4] In turn, this may affect

oral functions and quality of life, and several studies report poor oral health-related quality of life (OHRQoL) in HNC survivors.[5–7]

Among the most reported problems in long-term HNC survivors are eating and speech disturbances.[7–9] Qualitative studies of HNC patients find that eating problems can disrupt daily life, where the meal situation may lose its value as a social occasion, and instead, feel stressed and cause embarrassment.[10] Eating challenges have also been associated with poor nutritional status and quality of life.[8,9] A prospective study of HNC patients treated with chemotherapy and radiation found that 77% reported speech problems 10 years post-treatment, but intensity-modulated radiotherapy was associated with less speech impairment compared with conventional radiation.[11] Reduced speech intelligibility and impaired articulation may affect daily life interactions and activities and cause severe functional and psychosocial problems.[12] A qualitative study also found that HNC survivors with speech problems may experience a more holistic feeling of being silenced.[13] To improve HNC survivors' ability to eat and express themselves clearly, it is important to understand the nature and underlying mechanisms of the problems. Both eating and speech are complex processes and problems may have various and multifaceted causes. During tumor resection, structures such as the jawbones, teeth, palate, or tongue can be resected, which can disturb both the ability to eat and to speak. Salivary dysfunction and xerostomia may cause problems forming a bolus when eating, disrupt taste and contribute to swallowing problems (dysphagia). It may also contribute to speech problems by increasing friction for tongue movements. Irradiated jaw- and tongue muscles may become fibrotic and cause trismus and loss of tongue mobility, respectively, which in turn may affect both the ability to eat and speak.[3,4] Surgical defects, scarring, as well as mucosal atrophy and poor mucosal lubrication, may increase pain sensitivity and affect oral functions.

In a recent cross-sectional study, we assessed OHRQoL by use of the Oral Impact on Daily Performances (OIDP) questionnaire and found that HNC survivors had more than four times the risk of having reduced OHRQoL compared to a general adult population in Norway. HNC survivors with a history of oral or pharyngeal cancer (OPC survivors) had poorer OHRQoL than those with a history of laryngeal cancer. Of the daily performances assessed by the OIDP questionnaire, eating and enjoying food as well as speaking and expressing oneself clearly were the most frequently affected.[7] The aims of the present study were to determine the frequency of common treatment-related side-effects such as trismus, xerostomia, dysphagia, surgical defects, and problems related to the teeth in the same group of OPC survivors, and whether the prevalence of such problems vary with time since cancer diagnosis. Furthermore, we wanted to assess the associations between such problems and eating and speech difficulties. Better knowledge of factors significantly associated with reduced ability to eat and enjoy food and to speak clearly may help identify meaningful approaches to alleviate the problems, thereby improving the OHRQoL in HNC survivors.

## 2 | MATERIALS AND METHODS

In this cross-sectional study, we sent a questionnaire by mail to the 577 members of the "Head and neck cancer association," an association that works for the interests of HNC patients in Norway. The association has members who have experienced HNC themselves, as well as next of kin and healthcare professionals working with HNC. The questionnaire was posted in May 2020, and after one reminder by SMS we had received 349 (59%) answers by the end of August 2020. We excluded respondents without a history of HNC ($n = 133$). In the present study, we also excluded the respondents who had a history of hypopharyngeal and laryngeal cancer ($n = 56$) as they had distinct characteristics from those with a history of OPC regarding OHRQoL, as previously described.[7] Figure 1 illustrates the flow of respondents in the study. The questionnaire assessed sociodemographic variables, general health, and oral health-related variables, as well as cancer diagnosis and treatment.

The study was conducted in accordance with the Declaration of Helsinki with informed consent from the participants, and the Regional Committee for Health Research approved it (REK79888). The study was conducted and reported in accordance with the STROBE checklist for observational studies.[14]

### 2.1 | Variables

The following variables were included in this study:

**Outcome variables**: We assessed eating and speech difficulties by two questions: During the last 6 months, have problems with your teeth or oral cavity caused problems with (1) your ability to eat and enjoy food; and (2) your ability to speak and express yourself clearly. These are the first two questions of the 8-question OIDP questionnaire, a tool to measure OHRQoL.[15] The respondents answered all the questions of the OIDP questionnaire, but the current study used only the first two that address eating and speech because these were the activities most frequently affected, as previously described.[7] The questions had five

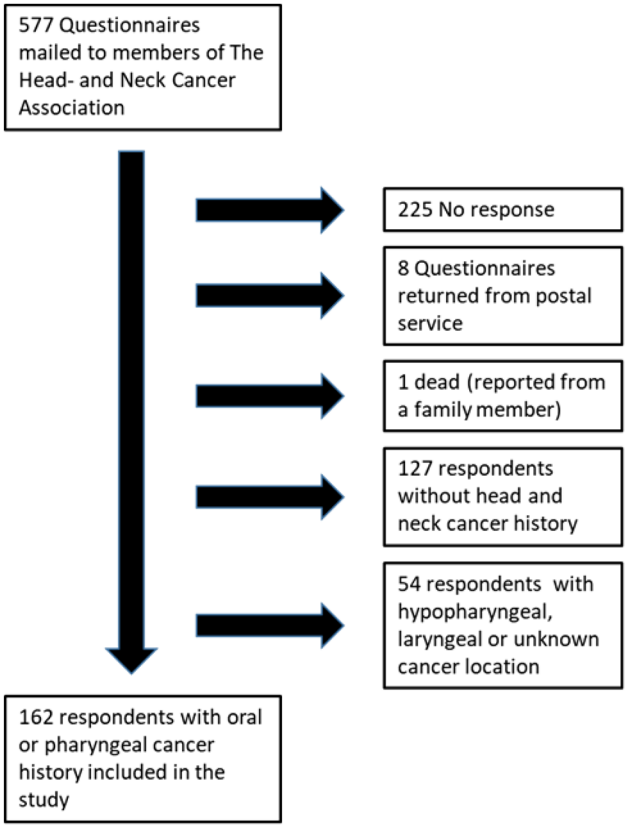


**FIGURE 1** Respondents who were included and excluded in the study with reason

response options: 0: never; 1: less than monthly; 2: once or twice a month; 3: once or twice a week; and 4: every or almost every day. For cross-tabulation and regression analyses, we dichotomized the responses to both of the questions into no or rare problems (options 0 and 1) versus frequent problems (options 2–4).

**Explanatory variables**: Gender was assessed with one question with the response options man or woman. Age was given in 10-year intervals and dichotomized into (1) <70 years and (2) 70 years or older. We assessed self-rated general health with one question that had five response options from 1 (very poor) to 5 (very good). In the cross-tabulation and regression analyses, we categorized the responses into (1) moderate-poor (options 1–3); and (2) good (options 4–5). In the questionnaire, we listed cancer locations in the head and neck region according to the WHO classification and instructed the respondents to check all relevant locations. In the current study, we excluded respondents with a history of cancer in the hypopharynx and larynx ($n = 52$) or with unknown origin ($n = 6$) and included all respondents with a history of cancer in the oral cavity ($n = 57$), oropharynx ($n = 96$), nasopharynx ($n = 4$), maxillary sinuses ($n = 1$), and salivary glands ($n = 3$). The time of the first cancer diagnosis was assessed with four options: (1) before 2000, (2) 2000–2009, (3) 2010–2014, and (4) 2015–2020. For cross-tabulation and regression analyses we trichotomized the options into (1) before 2010, (2) 2010–2014, and (3) 2015–2020. Cancer treatment was assessed with one question that had five options: (1) surgery; (2) radiation; (3) chemotherapy; (4) other (with free-text option), and (5) do not know. The respondents were instructed to check all relevant options. For analyses, we re-categorized the variable into (1) surgery without radiation, (2) radiation without surgery, and (3) radiation and surgery with or without adjuvant chemotherapy. No respondents had received chemotherapy without radiation or surgery or did not know what treatment they had received. We also assessed if the respondents had removed part of the tongue, upper or lower jaw during cancer treatment, with the response options yes or no. For analyses, those who had removed part of the upper jaw or part of the lower jaw were pooled. We assessed if the respondents had extracted teeth in association with the cancer treatment, with the response options: no teeth extracted; extracted 1–4 teeth; extracted 5–10 teeth; extracted more than 10 teeth; and extracted teeth, but do not remember how many. For analyses, the answers were dichotomized into no teeth extracted and teeth extracted. In the questionnaire, the respondents also rated to what extent they had problems with the following: Caries or tooth fracture; dead/necrotic jawbone; dry mouth (xerostomia); producing voice/sound (dysphonia); swallowing (dysphagia); and opening the mouth (trismus). For each variable, the response options were: (1) no or insignificant problems; (2) small problems; (3) substantial problems, and (4) great problems. For analyses, the responses to each problem were dichotomized into no or minor problems (options 1 and 2), and substantial or great problems (options 3 and 4). The respondents were also asked to rate the extent of pain they experienced today in the former tumor area on a Likert scale from 1 (no pain) to 10 (the worst pain imaginable). We dichotomized the responses into no or mild pain (1–4) and moderate to severe pain (5–10).

## 2.2 | Statistical analyses

We used the Statistical Package for Social Sciences (SPSS) for Windows version 26 (IBM corporation, Armonk, NY, USA) for statistical analyses. In addition to frequency analyses, we performed cross-tabulations between time of diagnosis and treatment and oral problems using Chi-square tests to assess the statistical difference between the groups. We also performed univariate and multivariate logistic regression analyses with the forced entry method. Problems eating or problems speaking were outcome variables, and no/rare problem was the reference value. The

other variables listed in Table 1 were used as explanatory variables, but cancer treatment was excluded from multivariate regression analyses due to the low number of respondents in the no-radiation group. We also excluded dysphonia from the regression analyses of eating problems, as we did not consider it a relevant variable. We present the results from regression analyses as odds ratios (OR) with 95% confidence intervals (95% CI). The significance level was set to $< 0.05$ for all analyses. Data were missing for less than 4% of the variables included in regression analyses, except for the data on the necrotic bone (8.6% missing data) and caries or tooth fracture (6.8% missing data).

## 3 | RESULTS

Table 1 summarizes the characteristics of the respondents and their panorama of oral problems. More than 90% ($n = 153$) of the respondents had received radiation therapy, almost 60% ($n = 94$) had extracted teeth in association with the cancer treatment and almost a quarter had tongue resections. More than 60% ($n = 98$) of the respondents reported problems with the ability to eat and enjoy food at least monthly, and almost half ($n = 72$) had problems with the ability to speak and express themselves clearly. Xerostomia, dysphagia, and trismus were all very commonly reported problems.

To assess how time since diagnosis affected treatment and panorama of problems, we performed cross-tabulations (Table 2). This showed that the proportion who had been treated with both surgery and radiation was lower among those diagnosed between 2015 and 2020 than those diagnosed at earlier time points. Dysphagia, trismus, and dysphonia were more common among those diagnosed before 2010 than those diagnosed within the past ten years prior to the study. Nevertheless, a higher proportion of those diagnosed in 2015 or later reported problems eating than those diagnosed earlier, although the difference was not statistically significant (Table 2).

To explore the associations between eating or speech problems and the various explanatory variables, we performed univariate and multivariate logistic regression analyses. In the adjusted model, reduced ability to eat and enjoy food was most strongly associated with being diagnosed with cancer within the past 5 years, experiencing xerostomia and/or dysphagia (Table 3). Experiencing trismus or having removed part of the tongue during cancer treatment was also significantly associated with eating problems. Reporting problems with caries and/or tooth fractures was significantly associated with lower odds of having eating problems. The fully adjusted model explained more than half of the variance in problems with the ability to eat and enjoy food (Table 3).

**TABLE 1** Cohort characteristics

| | *n* (%) |
|---|---|
| **Gender** | |
| Male | 85 (52.5) |
| Female | 77 (47.5) |
| **Age group** | |
| <70 years | 94 (58.0) |
| ≥70 years | 68 (42.0) |
| **General health** | |
| Very good | 16 (9.9) |
| Good | 58 (35.8) |
| Moderate | 65 (40.1) |
| Poor | 19 (11.7) |
| Very poor | 4 (2.5) |
| **Time of cancer diagnosis** | |
| Before 2000 | 20 (12.3) |
| 2000–2009 | 44 (27.2) |
| 2010–2014 | 54 (33.3) |
| 2015–2020 | 44 (27.2) |
| **Cancer treatment** | |
| Surgery no radiation | 9 (5.6) |
| Radiation | 46 (28.4) |
| Radiation+ | 107 (66.0) |
| **Additional treatment** | |
| Tooth extraction | 94 (58.0) |
| Tongue excisions | 36 (22.2) |
| Jaw excisions | 22 (13.6) |
| **Problem eat and enjoy food** | |
| Never | 36 (22.9) |
| Less than 1/month | 23 (14.6) |
| 1–2 /month | 11 (7.0) |
| 1–2 /week | 16 (10.2) |
| Every or almost every day | 71 (45.2) |
| **Problem speak and pronounce** | |
| Never | 63 (40.4) |
| Less than 1/month | 21 (13.5) |
| 1–2 /month | 10 (6.4) |
| 1–2 /week | 18 (11.5) |
| Every or almost every day | 44 (28.2) |
| **Oral problems**[a] | |
| Caries/tooth fracture | 45 (31.5) |
| Necrotic bone | 16 (11.9) |
| Xerostomia | 117 (74.1) |
| Dysphonia | 28 (18.2) |
| Dysphagia | 79 (51.0) |
| Trismus | 60 (38.2) |
| Pain[b] | 45 (28.1) |

[a]Number (%) reporting substantial or great problems.
[b]Number (%) reporting moderate or strong pain in the former tumor area.

**TABLE 2** Treatments and oral problems by time of diagnosis

| | Diagnosis | | | |
|---|---|---|---|---|
| | **Before 2010 *n* (%)** | **2010–2014 *n* (%)** | **2015–2020 *n* (%)** | ***p*** |
| **Age** | | | | |
| <60 | 12 (18.8) | 11 (20.4) | 11 (25.0) | |
| 60–69 | 23 (35.9) | 17 (31.5) | 20 (45.5) | .394 |
| ≥70 | 29 (45.3) | 26 (48.1) | 13 (29.5) | |
| **General health** | | | | |
| Good | 27 (42.2) | 28 (51.9) | 19 (43.2) | |
| Moderate | 25 (39.1) | 20 (37.0) | 20 (45.5) | .612 |
| Poor | 12 (18.8) | 6 (11.1) | 5 (11.4) | |
| **Treatment** | | | | |
| Surgery no radiation | 3 (4.7) | 2 (3.7) | 4 (9.1) | |
| Radiation | 13 (20.3) | 14 (25.9) | 19 (43.2) | **.049** |
| Radiation and surgery | 48 (75.0) | 38 (70.4) | 21 (47.7) | |
| **Tooth extraction** | | | | |
| No | 21 (33.9) | 26 (48.1) | 19 (43.2) | .284 |
| Yes | 41 (66.1) | 28 (51.9) | 25 (56.8) | |
| **Tongue excision** | | | | |
| No | 47 (73.4) | 44 (81.5) | 35 (79.5) | .547 |
| Yes | 17 (26.6) | 10 (18.5) | 9 (20.5) | |
| **Jaw excision** | | | | |
| No | 51 (79.7) | 48 (88.9) | 41 (93.2) | .085 |
| Yes | 13 (20.3) | 6 (11.1) | 3 (6.8) | |
| **Caries/tooth fracture** | | | | |
| No/minor problems | 35 (67.3) | 30 (57.7) | 33 (84.6) | **.023** |
| Substantial/great problems | 17 (32.7) | 22 (42.3) | 6 (15.4) | |
| **Necrotic bone** | | | | |
| No/minor problems | 40 (81.6) | 42 (91.3) | 36 (92.3) | .217 |
| Substantial/great problems | 9 (18.4) | 4 (8.7) | 3 (7.7) | |
| **Xerostomia** | | | | |
| No/minor problems | 18 (29.5) | 12 (22.2) | 11 (25.6) | .672 |
| Substantial/great problems | 43 (70.5) | 42 (77.8) | 32 (74.4) | |
| **Dysphagia** | | | | |
| No/minor problems | 19 (32.8) | 31 (57.4) | 26 (60.5) | **.007** |
| Substantial/great problems | 39 (67.2) | 23 (42.6) | 17 (39.5) | |
| **Trismus** | | | | |
| No/minor problems | 30 (49.2) | 39 (73.6) | 28 (65.1) | **.024** |
| Substantial/great problems | 31 (50.8) | 14 (26.4) | 15 (34.9) | |
| **Dysphonia** | | | | |
| No/minor problem | 40 (66.7) | 48 (92.3) | 38 (90.5) | **<.001** |
| Substantial/great problem | 20 (33.3) | 4 (7.7) | 4 (9.5) | |
| **Pain** | | | | |
| No or mild | 41 (65.1) | 45 (83.3) | 29 (67.4) | .068 |
| Moderate-severe | 22 (34.9) | 9 (16.7) | 14 (32.6) | |

(Continues)

TABLE 2 (Continued)

| | Diagnosis | | | |
|---|---|---|---|---|
| | Before 2010 *n* (%) | 2010–2014 *n* (%) | 2015–2020 *n* (%) | *p* |
| **Eat and enjoy food** | | | | |
| No/rare problem | 27 (43.5) | 22 (40.7) | 10 (24.4) | .122 |
| Frequent problem | 35 (56.5) | 32 (59.3) | 31 (75.6) | |
| **Speak and express clearly** | | | | |
| No/rare problem | 28 (45.2) | 33 (63.5) | 23 (54.8) | .147 |
| Frequent problem | 33 (63.5) | 19 (36.5) | 19 (45.2) | |

*p* = significance assessed by Chi-square test. Values in bold indicate statistically significant differences between groups ($p < 0.05$).

Problems with the ability to speak and express oneself were strongly associated with dysphonia, trismus, and dysphagia in multivariate analyses (Table 4). Having removed part of the tongue during cancer treatment was also significantly associated with reporting speech problems. The adjusted model explained a little more than half of the variance in oral impact on the ability to speak and express oneself clearly (Table 4).

## 4 | DISCUSSION

Reduced ability to eat and enjoy food and to speak and express oneself is common among long-term HNC survivors and may have a profound negative impact on their quality of life.[8] To eat and speak are both complex processes, therefore eating and speech disturbances are likely to have a multifactorial etiology. Identifying key elements of such problems may increase health care professionals' ability to intervene or guide patients towards practices or tools that can alleviate the problems. The main objective of the present study was to identify oral problems that were significantly associated with a reduced ability to eat and enjoy food or speak and express oneself clearly in a cohort of OPC survivors. We also wanted to assess how time since cancer diagnosis was associated with the panorama of problems.

Unlike many other cancer types where therapies targeting specific, tumor-driving pathways are in common use, head and neck cancer is usually treated with surgery, radiation, or chemotherapy, either as monotherapies or in combinations. These conventional cancer treatments affect normal cells and tissues in addition to the cancer cells, and may thereby cause side-effects, such as xerostomia, trismus, and dysphagia, which were all very common complaints in our study cohort. Due to the cross-sectional nature of our study, we cannot conclude that the oral problems we studied were directly caused by the cancer treatment or by the cancer treatment alone, but based on solid documentation in the literature,[3,4,8] it seems reasonable to suggest that the cancer treatment is a major cause of the problems studied.

We found that the proportion treated with surgery and radiation in combination was lowest among respondents diagnosed during the last 5 years preceding this study. Most of the respondents who were diagnosed after 2010 would have received radiation as intensity-modulated radiotherapy or volumetric-modulated arc therapy.[16] These refined radiation methods reduce the radiation dose to the healthy tissue surrounding the tumor.[17] This was reflected in our finding that trismus, dysphagia as well as dysphonia were more common problems among respondents diagnosed prior to compared after 2010. Although these problems were all associated with reporting speech impairment, time since diagnosis was not significantly associated with the prevalence of speech problems in adjusted regression analyses. For those suffering from dysphagia and trismus, exercises developed to improve strength and mobility of the tongue, swallowing exercises, and jaw opening exercises could help alleviate speech problems.[18,19]

Three-quarters of the OPC survivors included in the present study reported substantial to great problems with xerostomia, and the prevalence did not differ with time since cancer diagnosis. As intensity-modulated radiotherapy is reported to reduce the damage to the salivary glands, one could have expected a lower prevalence of xerostomia among respondents diagnosed after 2010. However, conflicting results on the benefits of intensity-modulated radiotherapy over conventional radiotherapy on xerostomia have been reported previouslys.[16] Our study included self-reported information on xerostomia, and clinical measures of salivary flow rate may not always reflect self-reported problems.[20] Furthermore, there may be other reasons than radiation for reduced salivation, such as medication. Xerostomia was strongly associated with reporting eating problems, which is in accordance with previous studies.[21,22] Along with xerostomia, dysphagia, and trismus were also significantly associated with reporting problems eating. Although the prevalence of these problems was either unaffected by the time of cancer diagnosis or was reduced with a shorter time since

**TABLE 3** Regression analyses for frequent problems with the ability to eat and enjoy food

| | Eat: no/rare problems versus frequent problems | |
|---|---|---|
| | **Unadjusted OR (95% CI)** | **Adjusted OR (95% CI)** |
| **Gender** | | |
| Male | 1 | 1 |
| Female | 1.70 (0.88–3.27) | 1.70 (0.55–5.26) |
| **Age** | | |
| < 70 | 1 | 1 |
| ≥70 | 1.22 (0.63–2.36) | 1.50 (0.52–4.32) |
| **General Health** | | |
| Good | 1 | 1 |
| Moderate–poor | **2.82 (1.45–5.49)** | 1.06 (0.34–3.28) |
| **Time of cancer diagnosis** | | |
| Before 2010 | **1** | 1 |
| 2010–2014 | 1.19 (0.63–2.66) | 3.32 (0.94-11-74) |
| 2015–2020 | 1.64 (0.83–3.23) | **9.45 (2.02–44.27)** |
| **Treatment** | | |
| Radiation− | 1 | |
| Radiation+ | 3.59 (0.86–14.92) | |
| **Caries/tooth fracture** | | |
| No/minor problems | 1 | **1** |
| Substantial/great problems | 0.84 (0.41–1.74) | **0.31 (0.10–0.95)** |
| **Necrotic bone** | | |
| Noinor problems | 1 | 1 |
| Substantial/great problems | 2.24 (0.68–7.36) | 0.35 (0.05–2.29) |
| **Xerostomia** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | **5.39 (2.48–11.72)** | **8.65 (2.23–33.56)** |
| **Dysphagia** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | **5.68 (2.72–11.88)** | **7.53 (2.27–25.02)** |
| **Trismus** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | **3.53 (1.66–7.47)** | **4.54 (1.25–16.53)** |
| **Pain** | | |
| No or mild | 1 | 1 |
| Moderate–severe | **2.10 (0.96–4.59)** | 3.02 (0.73–12.52) |
| **Tooth extraction** | | |
| No | 1 | 1 |
| Yes | **2.99 (1.53–5.86)** | 1.76 (0.58–5.30) |
| **Tongue excision** | | |
| No | 1 | 1 |
| Yes | 1.68 (0.74–3.80) | **5.71 (1.39–23.37)** |
| **Jaw excision** | | |
| No | 1 | 1 |
| Yes | 2.89 (0.92–9.04) | 3.15 (0.32–30.96) |
| Nagelkerke R2 | | 0.55 |
| Hosmer and Lemeshow | | 0.145 |
| Omnibus test | | <0.001 |

No/rare problems = no problems or problems less than monthly; Frequent problems = problems at least once to twice a month. Values in bold indicate statistically significant differences between groups ($p < 0.05$).

**TABLE 4** Regression analyses for frequent problems with the ability to speak and express oneself clearly

| | Speak: no/rare problems versus frequent problems | |
|---|---|---|
| | **Unadjusted OR (95% CI)** | **Adjusted OR (95% CI)** |
| **Gender** | | |
| Male | 1 | 1 |
| Female | 1.27 (0.68–2.39) | 1.11 (0.38–3.25) |
| **Age** | | |
| < 70 | 1 | 1 |
| ≥70 | 1.06 (0.56–2.00) | 1.08 (0.36–3.27) |
| **General health** | | |
| Good | 1 | 1 |
| Moderate–poor | **2.39 (1.25–4.57)** | 1.02 (0.33–3.13) |
| **Time of cancer diagnosis** | | |
| Before 2010 | 1 | 1 |
| 2010–2014 | 0.63 (0.32–1.23) | 1.61 (0.46–5.63) |
| 2015–2020 | 0.71 (0.36–1.41) | 2.05 (0.54–7.76) |
| **Treatment** | | |
| Radiation− | 1 | |
| Radiation + | 3.18 (0.64–15.83) | |
| **Caries/tooth fracture** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | 1.20 (0.59–2.44) | 0.47 (0.15–1.43) |
| **Necrotic bone** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | 4.10 (1.23–13.63) | 0.64 (0.12–3.27) |
| **Xerostomia** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | 2.08 (0.98–4.43) | 1.41 (0.35–5.69) |
| **Dysphonia** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | **13.57 (3.87–47.55)** | **6.83 (1.15–40.65)** |
| **Dysphagia** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | **7.55 (3.66–15.57)** | **6.12 (1.86–20.16)** |
| **Trismus** | | |
| No/minor problems | 1 | 1 |
| Substantial/great problems | **5.67 (2.78–11.55)** | **5.65 (1.79–17.83)** |
| **Pain** | | |
| No or mild | 1 | 1 |
| Moderate–severe | 1.56 (0.76–3.18) | 1.50 (0.43–5.25) |
| **Tooth extraction** | | |
| No | 1 | 1 |
| Yes | **2.23 (1.14–4.33)** | 1.11 (0.36–3.39) |
| **Tongue excision** | | |
| No | 1 | 1 |
| Yes | **2.40 (1.11–5.22)** | **3.84 (1.10–13.40)** |

(Continues)

**TABLE 4** (Continued)

| | Speak: no/rare problems versus frequent problems | |
|---|---|---|
| | **Unadjusted OR (95% CI)** | **Adjusted OR (95% CI)** |
| **Jaw excision** | | |
| No | 1 | 1 |
| Yes | **6.67 (2.14–20.78)** | 4.31 (0.55–33.90) |
| Nagelkerke R2 | | 0.53 |
| Hosmer and Lemeshow | | 0.289 |
| Omnibus test | | <0.001 |

No/rare problems = no problems or problems less than monthly; Frequent problems = problems at least once to twice a month. Values in bold indicate statistically significant differences between groups ($p < 0.05$).

diagnosis, being diagnosed 5 years or less prior to the study was strongly associated with reporting problems eating. This suggests that there are some important factors associated with eating problems that are not included in our regression model, which explained just above 50% of the variance in eating problems. This could include acute treatment-related side effects among those diagnosed and treated very recently. It could also reflect a gradual adaptation to the eating problems, for instance through modifications of the diet. Nevertheless, our finding that eating problems seem to be reduced with time since diagnosis may be of comfort to OPC survivors struggling with eating problems during the first period after treatment.

The teeth may affect our ability to eat without problems and to speak clearly,[23] and previous studies have found associations between poor dental status and impaired ability to eat in public, chew, swallow, and being able to eat ordinary food.[24] Xerostomia greatly increases the risk of caries and oral infections, furthermore, radiation have direct effects on the teeth, making them more fragile.[25,26] In the current study, almost a third of the respondents reported substantial problems with caries or tooth fractures. The prevalence of such problems was lower among those diagnosed within the past 5 year prior to the study. There are several possible explanations to this. It takes time to develop caries, there may be an increased focus on preventive measures, refined radiotherapy may cause less harm to the tooth structures, or it could reflect a general improvement in oral health in the population. Somewhat contra-intuitively, being bothered with tooth fracture or caries was significantly associated with a lower risk of reporting problems with the ability to eat and enjoy food. We can only speculate about this surprising finding, but those who report frequent problems with the teeth may be dentate to a greater extent than those who did not report such problems. Our study is based on a questionnaire, so we have very limited information about the dental status of the respondents. We have no information about the number of remaining teeth and the type and functionality of prosthetic replacements, which would be required to draw reliable conclusions on the association between dental health and OHRQoL.

The present study has some limitations. Many of the respondents had their cancer diagnosis and treatment many years prior to the study, thus, there is a risk of recollection bias for some of the measures. Also, self-reported measures, such as of the general health may not always correlate well with clinical measures, maybe reflecting subjective symptoms more than medical diagnoses. We considered it unlikely that the respondents had accurate knowledge about some relevant clinical parameters, such as tumor stage at diagnosis, and did not include questions to assess this in the questionnaire. We surveyed members of an organization working for HNC patients in Norway, therefore, the OPC cohort may not be representative of all persons with a history of OPC in Norway. We chose to survey members of this organization to avoid contacting persons with a HNC cancer history who did not want to be reminded of their illness, as that may be stressful.[27]

## 5 | CONCLUSIONS

Eating and speech problems were common among OPC survivors, and associated with dysphagia, trismus, and xerostomia. Therefore, interventions targeting these problems may also improve OPC survivors' ability to eat and enjoy food and speak and express themselves. Prevalence of several common treatment-related side-effects was lower among OPC survivors diagnosed during the last 5––10 years. Nevertheless, eating problems were most prevalent among those diagnosed within the last 5 years prior to the study, and speech problems were not significantly associated with time since diagnosis.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

## INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the North-Norwegian Regional Committee for Medical Research Ethics (REK 79888; 20.01.2020).

## INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study.

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