HHS Public Access

Author manuscript

Oral Oncol. Author manuscript; available in PMC 2021 June 14.

Published in final edited form as:

Oral Oncol. 2017 February ; 65: 76–82. doi:10.1016/j.oraloncology.2016.12.014.

Depression and survival in head and neck cancer patients

Katherine Rieke[a], **Kendra K. Schmid**[b], **William Lydiatt**[c], **Julia Houfek**[d], **Eugene Boilesen**[e], **Shinobu Watanabe-Galloway**[a,*]

[a]Department of Epidemiology, College of Public Health, University of Nebraska Medical Center, Omaha, NE, United States

[b]Department of Biostatistics, College of Public Health, University of Nebraska Medical Center, Omaha, NE, United States

[c]Department of Otolaryngology-Head and Neck Surgery, University of Nebraska Medical Center and Nebraska Methodist Hospital, Omaha, NE, United States

[d]College of Nursing, University of Nebraska Medical Center, Omaha, NE, United States

[e]Center for Collaboration on Research Design and Analysis, University of Nebraska Medical Center, Omaha, NE, United States

Abstract

Objective: Though depression often afflicts head and neck cancer (HNC) patients, few studies have examined the association between depression and survival in this particular cancer population. The objective of this study is to investigate the five-year survival of HNC patients by depression status.

Materials and methods: This study used SEER-Medicare data from 2002–2010 and identified depression diagnosis two years before and one year after cancer diagnosis. HNC patients were identified using ICD-O3 codes and depression was identified using ICD-9-CM codes from Medicare claims.

Results: Of the 3466 patients included in the study, 642 (18.5%) were diagnosed with depression during the study period. Compared to those who received no depression diagnosis, those diagnosed with depression prior to cancer or after cancer diagnosis were more likely to die of cancer (HR = 1.49; 95% CI = 1.27, 1.76 and HR = 1.38; 95% CI = 1.16, 1.65, respectively). Similarly, when looking at death from any cause, those diagnosed with depression prior to cancer diagnosis and those who received a diagnosis of depression after cancer were more likely to die from any death compared to those without depression (HR= 1.55; 95% CI = 1.36, 1.76 and HR = 1.40; 95% CI = 1.21, 1.62, respectively).

Conclusions: The results emphasize the need for early identification and treatment of depression in HNC patients, as well as the establishment of policies to routinely screen these patients throughout the cancer treatment process.

*Corresponding author at: University of Nebraska Medical Center, Department of Epidemiology, 984395 Nebraska Medical Center, Omaha, NE 68198-4395, United States. swatanabe@unmc.edu (S. Watanabe-Galloway).

Conflict of interest

None.

Keywords

Depression; Head and neck cancer; Survival; SEER-Medicare; Cancer; Oncology; Epidemiology

Introduction

Lower survival and poorer outcomes have been demonstrated in cancer patients with depression [1–3]. Previous studies examining depression in cancer populations have found higher cancer recurrence and lower quality of life in cancer patients with clinical depression or depressive symptomology [1,4]. Depression has also been associated with increased mortality in patients with cancer, with mortality rates up to 25% higher in cancer patients who experience depression [5,6]. Though previous studies have examined the effect that depression may have on cancer mortality rates, there are few large-scale studies that have examined the association between depression and survival in patients with head and neck cancers (HNC).[1]

HNC patients face unique psychological challenges compared to many other cancer sites. HNCs and their treatments can cause severe physical and functional impairments, which have been associated with depression development in HNC patients [7–10]. Further, radiation therapy has been shown to be significantly associated with depression [11]. Moreover, patients with HNC may experience permanent facial disfigurement from treatments [10], and unlike other cancer sites, patients may be left with visible scars or deformities that cannot be concealed, which may cause issues with personal shame and self-consciousness, and ultimately lead to depression [12–14].

Because of the associations between HNC and depression, as well as the psychological impact that these cancers and their treatments may have on patients, we previously examined depression rates in HNC patients both before and after cancer diagnosis utilizing two linked national datasets [15]. The results of this study showed not only that depression diagnosis in HNC patients was moderately higher than estimates from other cancer sites, but also that depression was associated with advanced stage at diagnosis. However the question still remains as to the effect that depression has on the survival of HNC patients. Therefore, the objective of the present study is to investigate the five-year survival of HNC patients by depression status.

Materials and methods

We utilized the Surveillance Epidemiology and End Results (SEER)-Medicare[2] linked data from 2002–2010. We identified all individuals diagnosed with HNC from 2004–2005 based on International Classification of Disease for Oncology, Version 3 (ICD-O3)[3] codes who were linked to Medicare data. Individuals had to have HNC as their only cancer diagnosis and be 67 years of age or older at the time of diagnosis in order to ensure a minimum of two

[1]HNC: Head and neck cancer.
[2]SEER: Surveillance, Epidemiology, and End Results.
[3]ICD-O3: International Classification of Disease for Oncology.

years of Medicare enrolment prior to cancer diagnosis. Individuals had to be continuously enrolled in Medicare Parts A and B for 24 months prior to their HNC diagnosis until December of 2010 or their death, and could not be enrolled in a health maintenance organization (HMO)[4] during this same time period due to the possibility of incomplete claims records [2,15].

From this group, diagnosis of depression two years prior to cancer diagnosis was identified using ICD-9-CM codes from Medicare claims data. To be included in the preexisting depression group, subjects had to have at least one claim diagnosis of depression within the 24 months prior to HNC diagnosis. To be considered part of the post-HNC depression group, participants could not have been diagnosed with depression before cancer diagnosis and had to have at least one inpatient, outpatient, or carrier claim diagnosis of depression within one year after diagnosis of HNC. Individuals whose reporting source indicated they were diagnosed with HNC at the time of death or autopsy were excluded from all analyses for the present study [15].

Five-year survival of all patients was examined, with censoring time being December 2010 (the end of the study period). The survival of patients was identified using the number of years and months of survival provided in SEER data. For this variable, survival time was calculated using the date of diagnosis and either the date of death, date last known to be alive, or December of 2010 for the study data. Survival outcomes of interest included all-cause and cancer-specific death based on SEER data reporting. For all-cause mortality, vital status at the end of the study period (December 2010) was used. For cancer specific survival, deaths attributed to HNC were treated as events and deaths from other causes were treated as censored observation [16].

Statistical analysis

Kaplan-Meier curves were used to examine basic survival estimates by depression status of patients. Cox regression models were used to control for potential confounding variables. Covariates included in the models were determined using forward selection and clinical importance. Candidate covariates included sociodemographic information taken from SEER data, with education and income based on census tract. Because survival outcomes may differ by treatment received, radiation as part of the initial course of treatment (dichotomous variable) was included as a potential covariate. Additionally, because survival may differ by time of onset of depression, depression based on time of diagnosis was examined as a potential covariate in the model. Medical comorbidity was measured using an adaptation of the Charlson Comorbidity Index (CCI)[5] developed for Medicare data [17–19]. All analyses were performed using SAS 9.4, with the default method used to handle ties within the data (Breslow method). For the multivariable models, interaction terms were entered into the models to test the proportional hazard assumption of each variable, with those violating this assumption left in the model to control this violation [20].

[4]HMO: Health maintenance organization.
[5]Charlson Comorbidity Index.

Results

Bivariate analysis

Based on the inclusion and exclusion criteria listed above, there were 3533 individuals eligible for inclusion in the analyses. From these, an additional 67 individuals were excluded for being diagnosed with cancer at the time of death or autopsy, leaving a total of 3466 individuals in the study sample. Table 1 shows the demographic and clinical characteristics of the study sample by depression status over the course of cancer. Of the study sample, 361 individuals (10.4%) had a diagnosis of depression prior to HNC diagnosis, an additional 281 individuals (8.1%) developed depression after cancer diagnosis, and 2824 individuals (81.5%) were not diagnosed with depression at any point during the study period. As can be seen from Table 1, there were significant differences between the groups in terms of survival for both cancer-specific and all-cause mortality. For cancer-specific deaths, there were over 35% more deaths from cancer in those who were diagnosed with depression prior to cancer compared to those who were never diagnosed with depression (48.8% vs. 36.0%, respectively). Similarly, there were over 41% more deaths from cancer in those who were diagnosed with depression after their cancer diagnosis compared to those where never diagnosed with depression (50.9% vs. 36.0%, respectively). Other significant differences between groups included age, gender, ethnicity, marital status, stage, medical comorbidity, and receipt of radiation. When looking at all-cause mortality, there were over 35% more deaths in the group diagnosed with depression prior to cancer diagnosis compared to those who were never diagnosed with depression (77.6% vs. 57.4%, respectively). Similarly, when looking at those who developed depression after cancer diagnosis compared to those who were never diagnosed with depression, there were nearly 30% more deaths in the group that developed depression after cancer (74.4% compared to 57.4%, respectively).

Based on the Kaplan-Meier survival curves for cancer-specific mortality, those without a diagnosis of depression during the specific time period had better survival compared to those who received a depression diagnosis, either before or after cancer (Log Rank chi square = 63.03, p = <0.0001). Those who received a diagnosis of depression prior to cancer had a median survival time of 37 months, compared to 29 months for those who received a diagnosis of depression after cancer diagnosis. The median survival time could not be computed for those who received no diagnosis of depression as median survival exceeded the 60 month follow-up period.

Similarly, for all-cause mortality, individuals without a depression diagnosis had better survival outcomes compared to those who received a depression diagnosis, either before or after cancer diagnosis (Log Rank chi square = 99.56, p = <0.0001). Those who received a diagnosis of depression prior to cancer had a median survival time of 17 months, compared to 18 months for those who received a diagnosis of depression after cancer diagnosis, and 46 months for those who received no diagnosis of depression.

Multivariable analysis

Table 2 shows the multivariable analysis results for the outcome of cancer-specific death. For this model, the interaction term of radiation by time was included to account for

violations of the proportional hazards assumption. As can be seen from the table, depression diagnosis was significantly associated with cancer death in the multivariable model after controlling for all other covariates. Compared to those who received no depression diagnosis, those who were diagnosed with depression prior to cancer diagnosis had nearly 1.5 times the hazard of cancer death, while those who were diagnosed with depression after cancer diagnosis had nearly 1.4 times the hazard of cancer death. Other significant variables associated with cancer death included age, marital status, income, specific cancer site, stage at diagnosis, medical comorbidity, and receipt of radiation. Receipt of radiation was shown to be protective against cancer death (HR = 0.48; 95%CI = 0.4, 0.57).

The multivariable results for all-cause mortality are show in Table 3. For this model, the interaction terms of radiation, age, marital status, and race of the patients by time were included to account for violations of the proportional hazards assumption. Again, depression was found to be significantly associated with the outcome after controlling for demographic and clinical variables. Those who were diagnosed with depression prior to cancer diagnosis had 1.55 times the hazard of any death compared to those who received no depression diagnosis. Similarly, those who received a diagnosis of depression after had 1.40 times the hazard of any death. Other variables that were found to be significantly associated with all-cause mortality included age, marital status, gender, race, income, specific cancer site, stage at diagnosis, medical comorbidity, and receipt of radiation. Receipt of radiation was shown to be associated with all-cause mortality (HR = 1.64; 95% CI = 1.44 1.88).

Discussion

This study showed that HNC patients with a diagnosis of depression had significantly greater risk for death from cancer and death from any cause. Even after controlling for potential confounding variables, including stage of cancer at the time of diagnosis, individuals with a diagnosis of depression had 38% and 49% greater hazard of cancer-specific mortality and 40% and 55% greater hazard of all-cause mortality compared to those patients who never received a depression diagnosis.

The results of our study support those of several previous studies which have examined the association of depression on the survival of various types of cancer. Patients with cancers such as those of the breast [3,21,22], prostate [2], and lung [23] who also struggle with depression or depressive symptoms have been shown to have decreased survival compared to their non-depressed counterparts. Several previous studies of smaller scale have also examined the association of depression on survival of individuals with cancers of the head and neck. In a prospective study of 241 patients, Kim et al. found that HNC patients with pre-treatment depression had decreased 3-year survival compared to their non-depressed counterparts [24]. In a clinical trial of prophylactic depression treatment of HNC patients, Lazure et al. found that patients with depression had significantly greater mortality and disease recurrence compared to those who were not depressed [25]. Similarly, Shinn et al. found that, of 130 patients with oropharynx cancer, self-reported depression was associated with a 3.6 greater hazard of death and 3.8 greater hazard of disease recurrence [1]. Further, Kam et al. found that individuals with HNC have 3 times greater incidence of suicide compared the general population in the United States [26]. They also found an association

with radiation and depression which is again confirmed in this study. Previous work by our group has also shown a higher risk of emergent depression in patients that undergo radiation as part of their primary treatment for HNC [27]. Together with the present study, these studies underline the importance of patient psychological health during the diagnostic and treatment process of HNC, as well as the need for the recognition of past and current depressive symptoms by clinicians especially in those undergoing radiation as part of their treatment.

The present study adds to the existing literature of the effects of depression on survival of HNC in several ways. By utilizing a large, population-based sample, this study provides information on the relationship between depression and survival which may be more representative of the elderly HNC population than previous smaller-scale studies. Further, by examining the diagnoses of depression both before and after cancer diagnosis, the results offer a unique look at the influence that pre-existing depression may have on cancer outcomes, in addition to incident depression after cancer diagnosis. Based on our findings, future studies examining outcomes of HNC and other cancer patients should consider both current and historical psychological health of patients.

In terms of study limitations, we identified depression based on ICD-9-CM codes, thereby limiting our findings to only those individuals with diagnosed depression. Because of this, we are not able to capture the influence that sub-clinical or underdiagnosed depression may have on survival outcomes of this population. Additionally, our study did not include information on depression treatments received, which may have additional influence on survival. Further, Medicare only includes data in individual 65 and older, and the present study included only individuals 67 years of age and older in order to be able to examine depression diagnosis prior to cancer. The age limitation of both the data and our selection criteria do not allow for the examination of the effect of depression on younger patients. We also limited the analyses to those individuals not diagnosed with HNC at the time of death or at autopsy. While this may help more accurately depict cancer specific death, it may underestimate all-cause mortality in this sample. Another limitation of the present study is the lack of information on human papillomavirus (HPV)[6] status of the study subjects. Previous research on oropharyngeal cancer has shown that HPV-positive patients may have better survival than those without the virus [28]. Unfortunately, because there is no information on HPV status within SEER-Medicare files, we were unable to examine or control for this relationship in our study. However, this may only affect survival of patients with specific forms of HNC, and the current study can still be used to estimate the effect of depression on survival of HNCs as a group. Previous research has also shown that depression may compromise the immune system and may affect natural killer cells important to apoptosis, which may leave individuals at risk for cancer development. These associations could help explain the relationship between depression and HNC seen in this study. However, SEER-Medicare data does not contain this information and therefore could not be examined [29]. Strengths of the present study include a large sample size as well as diagnostically confirmed cancer and depression in the selected sample.

[6]HPV: Human papillomavirus.

Conclusion

In our study, depression diagnosis was associated with decreased survival in HNC patients. These results emphasize the need for strategies designed to prevent depression, early identification and treatment of depression in HNC patients, as well as the establishment of policies to routinely screen these patients throughout the cancer treatment process.

Acknowledgements

Katherine Rieke was supported by the Cancer Epidemiology Education in Special Populations (CEESP) Program of the University of Nebraska (R25 CA112383). The content is solely the responsibility of the authors and does not necessarily represent the official views of NCI or NIH.

This study used the linked SEER-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors. The authors acknowledge the efforts of the National Cancer Institute; the Office of Research, Development and Information, CMS; Information Management Services (IMS), Inc.; and the Surveillance, Epidemiology, and End Results (SEER) Program tumor registries in the creation of the SEER-Medicare database.

The collection of cancer incidence data used in this study was supported by the California Department of Public Health as part of the statewide cancer reporting program mandated by California Health and Safety Code Section 103885; the National Cancer Institute's Surveillance, Epidemiology and End Results Program under contract HHSN261201000140C awarded to the Cancer Prevention Institute of California, contract HHSN261201000035C awarded to the University of Southern California, and contract HHSN261201000034C awarded to the Public Health Institute; and the Centers for Disease Control and Prevention's National Program of Cancer Registries, under agreement # U58DP003862-01 awarded to the California Department of Public Health. The ideas and opinions expressed herein are those of the author(s) and endorsement by the State of California Department of Public Health, the National Cancer Institute, and the Centers for Disease Control and Prevention or their Contractors and Subcontractors is not intended nor should be inferred. The authors acknowledge the efforts of the National Cancer Institute; the Office of Research, Development and Information, CMS; Information Management Services (IMS), Inc.; and the Surveillance, Epidemiology, and End Results (SEER) Program tumor registries in the creation of the SEER-Medicare database.

Role of the funding source

Katherine Rieke was supported by the Cancer Epidemiology Education in Special Populations (CEESP) Program of the University of Nebraska (R25 CA112383). The funding source had no involvement in the design, analysis, or interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

Funding

Cancer Epidemiology Education in Special Populations (CEESP) Program of the University of Nebraska (R25 CA112383).

References

[1]. Shinn EH, Valentine A, Jethanandani A, Basen-Engquist K, Fellman B, Urbauer D, et al. Depression and oropharynx cancer outcome. Psychosom Med 2016;78:38–48. [PubMed: 26632757]

[2]. Prasad SM, Eggener SE, Lipsitz SR, Irwin MR, Ganz PA, Hu JC. Effect of depression on diagnosis, treatment, and mortality of men with clinically localized prostate cancer. J Clin Oncol 2014:JCO-2013.

[3]. Vodermaier A, Linden W, Rnic K, Young SN, Ng A, Ditsch N, et al. Prospective associations of depression with survival: a population-based cohort study in patients with newly diagnosed breast cancer. Breast Cancer Res Treat 2014;143:373–84. [PubMed: 24337537]

[4]. Burgess C, Cornelius V, Love S, Graham J, Richards M, Ramirez A. Depression and anxiety in women with early breast cancer: five year observational cohort study. BMJ 2005;330:702. [PubMed: 15695497]

[5]. Pinquart M, Duberstein PR. Depression and cancer mortality: a meta-analysis. Psychol Med 2010;40:1797–810. [PubMed: 20085667]

[6]. Satin JR, Linden W, Phillips MJ. Depression as a predictor of disease progression and mortality in cancer patients. Cancer 2009;115:5349–61. [PubMed: 19753617]

[7]. Haisfield-Wolfe M, McGuire D, Soeken K, Geiger-Brown J, De Forge B. Prevalence and correlates of depression among patients with head and neck cancer: a systematic review of implications for research. Oncol Nurs Forum 2009;36:E107–25. [PubMed: 19403439]

[8]. Massie M, Lloyd-Williams M, Irving G, Miller K. The prevalence of depression in people with cancer. In: Maj M, Sartorius N Kissane DW, editors. Depression and cancer. John Wiley & Sons Ltd.; 2011. p. 1–36.

[9]. Katz M, Irish J, Devins G, Rodin G, Gullane P. Psychosocial adjustment in head and neck cancer: the impact of disfigurement, gender and social support. Head Neck 2003;25:103–12. [PubMed: 12509792]

[10]. Hassanein K, Musgrove B, Bradbury E. Psychological outcome of patients following treatment of oral cancer and its relation with functional status and coping mechanisms. J Cranio-Maxillo-Facial Surgery: Off Publ Eur Assoc Cranio-Maxillo-Facial Surgery 2005;33:404–9.

[11]. Chen A, Jennelle R, Vijayakumar S, et al. Prospective study of psychosocial distress among patients undergoing radiotherapy for head and neck cancer. Int J Radiat Oncol Biol Phys 2009;73:187–93. [PubMed: 18513884]

[12]. Lydiatt W, Moran J, Burke W. A review of depression in the head and neck cancer patient. Clin Adv Hematol Oncol: H&O 2009;7:397–403. [PubMed: 19606075]

[13]. Howren M, Christensen A, Karnell L, Funk G. Psychological factors associated with head and neck cancer treatment and survivorship: evidence and opportunities for behavioral medicine. J Consult Clin Psychol 2013;81:299–317. [PubMed: 22963591]

[14]. Kissane D, Patel S, Shah J, et al. Preliminary evaluation of the reliability and validity of the Shame and Stigma Scale in head and neck cancer. Head Neck 2013;35:172–83. [PubMed: 22368160]

[15]. Baillargeon J, Kuo Y, Lin Y, Raji M, Singh A, Goodwin J. Effect of mental disorders on diagnosis, treatment, and survival of older adults with colon cancer. J Am Geriatr Soc 2011;59:1268–73. [PubMed: 21732924]

[16]. National Cancer Institute (NCI). SEER-Medicare: SEER Program & Data; 2015. <http://healthcaredelivery.cancer.gov/seermedicare/>.

[17]. Klabunde C, Potosky A, Legler J, Warren J. Development of a comorbidity index using physician claims data. J Clin Epidemiol 2000;53:1258–67. [PubMed: 11146273]

[18]. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Diseases 1987;40(5):373–83. [PubMed: 3558716]

[19]. Deyo R, Cherkin D, Ciol M. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613–9. [PubMed: 1607900]

[20]. Allison PD. Survival analysis using SAS. A practical guide. Cary; 1995.

[21]. Giese-Davis J, Collie K, Rancourt K, Neri E, Kraemer H, Spiegel D. Decrease in depression symptoms is associated with longer survival in patients with metastatic breast cancer: a secondary analysis. J Clin Oncol: Off J Am Soc Clin Oncol 2011;29:413–20.

[22]. Goodwin J, Zhang D, Ostir G. Effect of depression on diagnosis, treatment, and survival of older women with breast cancer. J Am Geriatr Soc 2004;52:106–11. [PubMed: 14687323]

[23]. Arrieta O, Angulo L, Oñate-Ocaña L, et al. Association of depression and anxiety on quality of life, treatment adherence, and prognosis in patients with advanced non-small cell lung cancer. Ann Surg Oncol 2013;20:1941–8. [PubMed: 23263699]

[24]. Kim S, Roh J, Kim S, et al. Pretreatment depression as a prognostic indicator of survival and nutritional status in patients with head and neck cancer. Cancer 2016;122:131–40. [PubMed: 26371775]

[25]. Lazure K, Lydiatt W, Denman D, Burke W. Association between depression and survival or disease recurrence in patients with head and neck cancer enrolled in a depression prevention trial. Head Neck 2009;31:888–92. [PubMed: 19309726]

[26]. Kam D, Salib A, Park R, et al. Incidence of suicide in patients with head and neck cancer. JAMA Otolaryngol – Head Neck Surgery 2015;141: 1075–81.

[27]. Lydiatt W, Bessette D, Schmid K, Sayles H, Burke W. Prevention of depression with escitalopram in patients undergoing treatment for head and neck cancer: randomized, double-blind, placebo-controlled clinical trial. JAMA Otolaryngol – Head Neck Surgery 2013;139:678–86.

[28]. Marur S, D'Souza G, Westra WH, Forastiere AA. HPV-associated head and neck cancer: a virus-related cancer epidemic. Lancet Oncol 2010;11:781–9. [PubMed: 20451455]

[29]. Gross A, Gallo J, Eaton W. Depression and cancer risk: 24 years of follow-up of the Baltimore Epidemiologic Catchment Area sample. Cancer Causes Control: CCC 2010;21(2):191–9. [PubMed: 19885645]

Table 1

Profile of the study sample by depression status.

Variable	Pre-cancer depression (N = 361)		Post-cancer depression (N = 281)		No depression (N = 2824)		p-Value
	N	%	N	%	N	%	
Age							0.0061
67–69	60	16.6%	52	18.5%	615	21.8%	
70–74	106	29.4%	99	35.2%	788	27.9%	
75–79	73	20.2%	52	18.5%	635	22.5%	
80–84	68	18.8%	52	18.5%	418	14.8%	
85+	54	15.0%	26	9.3%	368	13.0%	
Gender							<0.0001
Male	196	54.3%	167	59.4%	1931	68.4%	
Female	165	45.7%	114	40.6%	893	31.6%	
Ethnicity							0.0059
Non-hispanic white	324	89.8%	240	85.4%	2353	83.3%	
Other	37	10.2%	41	14.6%	471	16.7%	
Percent of census tract with a 4-year college degree							0.3212
0–33%	245	67.9%	197	70.1%	2025	71.7%	
34+%	90	24.9%	72	25.6%	644	22.8%	
Missing	26	7.2%	12	4.3%	155	5.5%	
Marital status							0.0002
Married/living as married	148	41.0%	131	46.6%	1499	53.1%	
Separated/divorced	39	10.8%	23	8.2%	249	8.8%	
Single	31	8.6%	29	10.3%	239	8.5%	
Widowed	124	34.3%	83	29.5%	671	23.8%	
Unknown	19	5.3%	15	5.3%	166	5.9%	
Median income census tract							0.9547
<$35,000 or Missing	118	32.7%	84	29.9%	897	31.8%	
$35,000–$44,999	86	23.8%	63	22.4%	649	23.0%	
$45,000–$59,999	75	20.8%	69	24.6%	633	22.4%	
$60,000+	82	22.7%	65	23.1%	645	22.8%	

Variable	Pre-cancer depression (N = 361)		Post-cancer depression (N = 281)		No depression (N = 2824)		p-Value
	N	%	N	%	N	%	
Cancer site							0.3433
Lip	26	7.2%	18	6.4%	228	8.1%	
Oral cavity	103	28.5%	66	23.5%	654	23.2%	
Oropharynx	96	26.6%	80	28.5%	736	26.1%	
Nasopharynx/hypopharynx	35	9.7%	24	8.5%	255	9.0%	
Larynx	101	28.0%	93	33.1%	951	33.7%	
SEER region							0.0572
Pacific/west	155	42.9%	98	34.9%	1085	38.4%	
Northeast	57	15.8%	73	26.0%	558	19.8%	
Midwest	47	13.0%	40	14.2%	391	13.8%	
South	102	28.3%	70	24.9%	790	28.0%	
Stage							0.0021
Unstaged	37	10.2%	27	9.6%	285	10.1%	
In situ/localized	149	41.3%	98	34.9%	1278	45.3%	
Regional	107	29.6%	102	36.3%	881	31.2%	
Distant	68	18.8%	54	19.2%	380	13.5%	
Charlson comorbidity							<0.0001
0	290	80.3%	263	93.6%	2650	93.8%	
1+	71	19.7%	18	6.4%	174	6.2%	
Radiation received							<0.0001
No	186	51.5%	85	30.2%	1261	44.7%	
Yes	175	48.5%	196	69.8%	1563	55.3%	
Any death							<0.0001
No	81	22.4%	72	25.6%	1204	42.6%	
Yes	280	77.6%	209	74.4%	1620	57.4%	
Cancer death							<0.0001
No	185	51.2%	138	49.1%	1808	64.0%	
Yes	176	48.8%	143	50.9%	1016	36.0%	

Table 2

Multivariable results for cancer-specific mortality.[a]

Variable	HR	95%	CI	p-Value	Type 3 p-value
Depression status					<0.001
No depression diagnosis	REF	–	–		
Pre-HNC depression	1.49	1.27	1.76	<0.001	
Post-HNC depression	1.38	1.16	1.65	<0.001	
Age					<0.001
67–69	REF	–	–		
70–74	1.15	0.98	1.36	0.098	
75–79	1.55	1.30	1.84	<0.001	
80–84	1.83	1.52	2.20	<0.001	
85+	2.32	1.90	2.82	<0.001	
Marital status					<0.001
Married/living as married	REF	–	–		
Single	1.30	1.07	1.57	0.008	
Widowed	1.41	1.24	1.60	<0.001	
Divorced/separated	1.44	1.19	1.74	<0.001	
Unknown	1.06	0.80	1.39	0.702	
Median income census tract					<0.001
<$35,000 or Missing	REF	–	–		
$35,000–$44,999	0.77	0.66	0.89	<0.001	
$45,000–$59,999	0.72	0.61	0.84	<0.001	
$60,000+	0.71	0.61	0.82	<0.001	
Cancer site					<0.001
Lip	REF	–	–		
Larynx	3.54	2.38	5.24	<0.001	
Nasopharynx/hypopharynx	5.52	3.64	8.35	<0.001	
Oral cavity	3.47	2.34	5.15	<0.001	
Oropharynx	3.71	2.49	5.52	<0.001	
Stage					<0.001

Variable	HR	95%	CI	p-Value	Type 3 p-value
In situ/localized	REF	–	–		
Regional	3.30	2.83	3.86	<0.001	
Distant	4.93	4.17	5.83	<0.001	
Unstaged	2.68	2.20	3.28	<0.001	
Charlson comorbidity					<0.001
0	REF	–	–		
1+	1.47	1.21	1.80	<0.001	
Radiation received					<0.001
No	REF	–	–		
Yes	0.48	0.41	0.57	<0.001	

[a]Adjusting for the interaction of radiation * time.

Table 3

Multivariable results for all-cause mortality.[a]

Variable	HR	95%	CI	p-Value	Type 3 p-value
Depression status					<0.001
No depression diagnosis	REF	–	–		
Pre-HNC depression	1.55	1.36	1.76	<0.001	
Post-HNC depression	1.40	1.21	1.62	<0.001	
Age					<0.001
67–69	REF	–	–		
70–74	1.15	1.00	1.33	0.052	
75–79	1.47	1.26	1.73	<0.001	
80–84	1.67	1.39	2.02	<0.001	
85+	2.40	1.96	2.95	<0.001	
Marital status					<0.001
Married/living as married	REF	–	–		
Single	1.38	1.16	1.63	<0.001	
Widowed	1.62	1.40	1.88	<0.001	
Divorced/separated	1.52	1.29	1.78	<0.001	
Unknown	1.31	1.03	1.67	0.028	
Gender					<0.001
Male	REF	–	–		
Female	0.84	0.76	0.93	<0.001	
Race					0.003
Non-hispanic white	REF	–	–		
Other	1.28	1.09	1.51	0.003	
Median income census tract					<0.001
<$35,000 or Missing	REF	–	–		
$35,000–$44,999	0.82	0.73	0.92	<0.001	
$45,000–$59,999	0.75	0.66	0.84	<0.001	
$60,000+	0.73	0.64	0.82	<0.001	
Cancer site					<0.001

Variable	HR	95%	CI	p-Value	Type 3 p-value
Lip	REF	–	–		
Larynx	1.66	1.35	2.05	<0.001	
Nasopharynx/hypopharynx	2.46	1.93	3.13	<0.001	
Oral cavity	1.61	1.30	1.99	<0.001	
Oropharynx	1.74	1.40	2.16	<0.001	
Stage					<0.001
In situ/localized	REF	–	–		
Regional	2.34	2.08	2.63	<0.001	
Distant	3.27	2.86	3.73	<0.001	
Unstaged	2.08	1.79	2.43	<0.001	
Charlson comorbidity					<0.001
0	REF	–	–		
1+	1.86	1.61	2.15	<0.001	
Radiation received					<0.001
No	REF	–	–		
Yes	1.64	1.44	1.88	<0.001	

[a] Adjusting for the interactions of age * time, marital status * time, race * time, and radiation * time.