Head and neck cancer stage at diagnosis and survival outcomes among South Asian patients

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Short running title: South Asian head and neck cancer outcome

Conflict of interest / Financial disclosures: No competing financial interests exist.

Funding Source: California Tobacco-Related Diseases Research Program, Grant Number No. T32IR4677.

Manuscript Word Count: 3,299

Keywords: head and neck cancer, disparities, survival

Author Contributions:

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Presented as a poster at the Combined Otolaryngology Spring Meetings (COSM)/American Head and Neck Society (AHNS) Annual Meeting, 2025.

Abstract

Objective: To compare HNC stage at diagnosis and survival outcomes between South Asian, Other Asian, and Non-Hispanic White individuals in the US.

Study Design: Retrospective population-based cohort study.

Setting: Data from Surveillance, Epidemiology, and End Results Research Plus 17 database.

Methods: Patients diagnosed with squamous HNC from 2006-2020 were categorized as South Asian, Other Asian, and Non-Hispanic White. Logistic regression assessed the association between race/ethnicity and advanced stage disease (Stage III/IV vs I/II). Overall survival (OS) and disease-specific survival (DSS) outcomes were evaluated using Kaplan-Meier analysis and Cox proportional hazards regression models, respectively.

Results: Among 92,664 patients (1,066 South Asian, 3,260 Other Asian, and 88,338 Non-Hispanic White individuals), adjusted logistic regression showed South Asian individuals had higher risk of advanced stage at diagnosis (odds ratio [OR] 1.48, 95% CI 1.29 to 1.70) than Other Asian (OR 1.13, 95% CI 1.05 to 1.22) and Non-Hispanic White individuals. Adjusted Cox regression showed Other Asian (HR 0.89, 95% CI 0.84 to 0.94) individuals had improved OS, while South Asian individuals had similar OS (hazard ratio [HR] 1.09, 95% CI 0.99 to 1.21) as Non-Hispanic White individuals. South Asian individuals had worse DSS (HR 1.30, 95% CI 1.16 to 1.46) than Other Asian (HR 1.05, 95% CI 0.98 to 1.12), and Non-Hispanic White individuals.

Conclusion: South Asian individuals with HNC are more likely to present with advanced disease stage and have worse survival compared with Other Asian and Non-Hispanic White individuals, highlighting the importance of disaggregating Asian ethnic groups when assessing HNC outcome disparities.

Introduction

Head and neck cancer (HNC) poses a significant burden worldwide, ranking as the sixth most common malignancy.[1] Studies report that HNC remains high in the Asian subcontinent,[2,3] yet the aggregation of data across this diverse population often obscures critical disparities in risk factors and cancer outcomes specific to individual racial and ethnic groups.[4] South Asian individuals constitute a large proportion of the Asian population and have a high prevalence of oral cavity cancers (OCC).[5] While this association can be partly explained by cultural practices involving long-term use of smokeless tobacco products like betel quid,[6–8] the prevalence of regular tobacco smoking and alcohol consumption remains lower in South Asian individuals compared with Non-Hispanic White and other Asian racial and ethnic groups.[9–11]

In the United States (US), the South Asian population has become the largest Asian subgroup and continues to experience a rapid rate of growth.[12] Consequently, understanding disparities in health outcomes in this population is important. One previous study found that South Asian individuals with HNC had similar rates of advanced disease at diagnosis as Non-Hispanic White individuals.[13] However, the study was limited to male patients. Furthermore, the relationship between South Asian race/ethnicity and HNC survival remains unclear. The goal of this study was to perform a population-based analysis of HNC stage at diagnosis and survival outcomes of South Asian individuals in the US, compared with other Asian and Non-Hispanic White individuals.

Methods

Study Design and Population

This study was exempt from review by the Stanford University School of Medicine's Institutional Review Board, because it used de-identified data. This is a population-based retrospective cohort study utilizing data extracted from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Research Plus 17 database (2006-2020), which includes 17 population-based cancer registries in the US.[14] This represents approximately 26.5% of the entire U.S. population.[15] The study cohort included adults (age 18 and

older) diagnosed with head and neck cancer (HNC) from 2006 through 2020. HNC was identified using the International Classification of Disease for Oncology, Third Edition (ICD-O-3), topography codes for oropharynx (C01.9, C02.4, C05.1-05.2, C09.0-09.1, C09.8-09.9, C10.0, C10.2-10.4, C10.8-10.9), oral cavity (C02.0-02.3, C02.8-03.1, C03.9-04.1, C04.8-05.0, C06.0-06.2), larynx (C32.0-32.3, C32.8-32.9), and hypopharynx (C12.9-13.2, C13.8-13.9).[16] Squamous cell carcinoma (SCC) histology was determined according to ICD-O-3 morphology codes 8070/3, 8071/3, 8072/3, 8073/3, 8074/3, 8075/3, 8078/3.[16] Cancer staging for each patient was classified in accordance with the American Joint Committee on Cancer (AJCC) sixth edition (cases diagnosed 2006-2015), seventh edition (cases diagnosed 2016-2017), and eighth edition (cases diagnosed 2018-2020), classified as Stages I, II, III, and IV. Stage was also assessed for all cases using the SEER Program Combined Summary Stage variables: localized, regional, and distant stages of cancer. Patients with multiple primary tumors, and patients missing data on cancer stage, treatment status, cause of death, or race and ethnicity were excluded from this study.

The SEER database provides information on self-reported race and ethnicity extracted from medical and administrative records. We categorized race/ethnicity as South Asian, Other Asian, and Non-Hispanic White. The South Asian group was comprised the following SEER-derived ethnic categories: Asian Indian, Pakistani, and Asian Indian or Pakistani (NOS). The Other Asian group included individuals of Chinese, Filipino, Japanese, Korean, and Southeast Asian (Hmong, Kampuchean (including Khmer and Cambodian)), Thai, Laotian, and Vietnamese origin. Marital status was categorized as single (never married, divorced, separated, unmarried or domestic partner, or widowed), married, or unknown. Neighborhood socioeconomic status (SES) was assessed using the National Cancer Institute Yost Index, reported as SES quintile categories, with higher quintiles representing higher SES.

Data analysis

The association of race/ethnicity with advanced stage disease (Stage III/IV vs I/II) was assessed using unadjusted and adjusted logistic regression models. For the adjusted models, the following covariates were

included a priori in the model: age, sex, marital status, neighborhood-level SES, year of diagnosis, tumor site, and AJCC staging edition (6^{th}, 7^{th}, or 8th). In order to further account for staging differences between AJCC staging editions, sensitivity analyses were conducted assessing the association of race and ethnicity with SEER Program Combined Summary Stages (localized, regional, and distant cancer stage) using unadjusted and adjusted logistic regression models as described above. We compared: 1) regional and distant tumor stages versus localized; and 2) distant versus regional and localized tumor stages.

The association of race/ethnicity with survival was assessed using Kaplan-Meier (KM) analyses. The primary outcome measure was overall survival (OS). The secondary outcome measure was disease specific survival (DSS). OS and DSS were compared between racial and ethnicity groups using log-rank tests. We further assessed the association of race/ethnicity with survival using unadjusted and adjusted Cox proportional hazards regression model. For the adjusted models, the following covariates were included a priori in the model: demographic variables (age, sex, race, ethnicity, marital status, neighborhood-level SES) and clinical variables (tumor site, AJCC Stage, AJCC staging edition, year of diagnosis, radiotherapy (RT), chemotherapy, and surgery). Sensitivity analyses were performed including SEER Program Combined Summary Stage as a covariate in place of AJCC stage.

Data analyses were performed using R (Version 4.2.2; www.r-project.org) and associated library packages for descriptive statistics and data cleaning (dplyr, stringr, and broom), survival analysis (survival and survminer), regression analyses (broom), and data visualization (ggpubr). An estimate was considered statistically significant at α=0.05. Potential collinearity and multicollinearity among covariates were assessed with pairwise correlation and variance inflation factor analyses, respectively. Patients with missing data were excluded from analysis, except for marital status and surgery, which were coded as unknown.

Results

From 2006-2020, we identified 92,664, with 1,066 South Asian (mean [standard deviation (SD)] at age of presentation, 60.81 (13.68) years), 3,260 Other Asian (66.00 [13.21] years), and 88,338 Non-Hispanic White

individuals (64.08 [11.60] years). The patient characteristics are shown in Table 1. The majority of our patient cohort was male (75.87%) and Non-Hispanic White (95.33%). The South Asian patient cohort had a greater proportion of married individuals (76.27%) compared with the Other Asian (65.12%) and the Non-Hispanic White patient cohorts (54.47%). Additionally, the South Asian patient cohort had the greatest proportion of individuals in the highest socioeconomic group (5th Quintile Yost score, 46.44%) compared with Other Asian individuals (37.51%), and Non-Hispanic White individuals (26.94%). Lastly, the South Asian patient cohort disproportionately diagnosed with OCC (70.35%). Missingness across covariates was less than 3% and comparable across race/ethnicity groups. AJCC staging information was missing for South Asian (2.72%), Other Asian (2.06%), Non-Hispanic White (2.76%).

Advanced disease stage at diagnosis

Analyses of the association between race/ethnicity and advanced disease stage at diagnosis are reported in Table 2. In unadjusted analysis, South Asian (OR 0.87, 95% CI 0.77 to 0.99) and Other Asian individuals (OR 0.88, 95% CI 0.82 to 0.95) were less likely to present with advanced stage (Stage III/IV vs Stage I/II) compared with Non-Hispanic White individuals. However, this association was reversed after adjusting for age, sex, marital status, neighborhood-level SES, year of diagnosis, tumor site, and AJCC staging edition. South Asian individuals were more likely to present with advanced stage (OR 1.48, 95% CI 1.29 to 1.70) than Other Asian (OR 1.13, 95% CI 1.05 to 1.22) and Non-Hispanic White individuals. Sequential multivariable modeling (Supplemental Table 1) demonstrated that the reversal in direction between unadjusted and adjusted models was driven by differences in tumor characteristics. South Asian ethnicity remained associated with lower odds of advanced stage of disease in the age and sex adjusted model (OR 0.82, 95% CI 0.73 to 0.93). This association disappeared after including marital status and socioeconomic status (OR 0.90, 95% CI 0.79 to 1.02), and reversed after including tumor site, AJCC staging edition, and year of diagnosis (OR 1.48, 95% CI 1.30 to 1.70). Effect modification was assessed using likelihood ratio tests. We observed significant interactions between race/ethnicity and sex ($p = 0.002$) and primary tumor site ($p = 0.001$).

Sensitivity analyses were performed, utilizing SEER Program Combined Summary Stage in place of the AJCC cancer staging system. In the adjusted analysis, South Asian individuals (OR 1.18, 95% CI 1.04 to 1.35) were more likely to present with regional and distant disease (versus localized) than Other Asian (OR 1.00, 95% CI 0.93 to 1.09) and Non-Hispanic White individuals (Supplemental Table 2). South Asian (OR 1.65, 95% CI 1.40 to 1.95) and Other Asian (OR 1.32, 95% CI 1.21 to 1.45) individuals were more likely to present with distant disease (versus localized or regional) than Non-Hispanic White individuals (Supplemental Table 3).

Survival outcomes

KM analysis revealed similar OS for South Asian (5-year OS 58.4%, 95% CI, 54.7% to 58.6%; 10-year survival 46.5%, 95% CI, 41.8% to 51.6%), Other Asian (5-year survival 56.6%, 95% CI, 54.7% to 58.6%; 10-year survival 44.4%, 95% CI, 42.1% to 46.7%), and Non-Hispanic White individuals (5-year survival 56.2%, 95% CI, 55.8% to 56.5%; 10-year survival 40.8%, 95% CI, 40.4% to 41.3%; p = 0.05) (Figure 1). However, South Asian (5-year DSS 64.2%, 95% CI, 60.8% to 67.8%; 10-year survival 57.1%, 95% CI, 52.7% to 61.9%) and Other Asian (5-year survival 65.4%, 95% CI, 63.5% to 67.3%; 10-year survival 59.9%, 95% CI, 57.8% to 62.2%) individuals had worse DSS compared with Non-Hispanic White individuals (5-year survival 68.5%, 95% CI, 68.1% to 68.8%; 10-year survival 61.8%, 95% CI, 61.4% to 62.2%; p = 0.001) (Figure 2).

Unadjusted Cox regression analysis showed South Asian individuals (HR 0.92, 95% 0.83 to 1.02) had similar OS to Other Asian (HR 0.95, 95% 0.90 to 1.00) and non-Hispanic white individuals (Table 3). However, Other Asian (HR 0.89, 95% CI 0.84 to 0.94) individuals had improved OS, while South Asian individuals had similar OS (HR 1.09, 95% CI 0.99 to 1.21) as Non-Hispanic White individuals after adjusting for age, sex, marital status, Yost SES index, tumor site, AJCC Stage, year of diagnosis, AJCC staging edition, RT, chemotherapy, and surgery. Unadjusted Cox regression analysis showed that South Asian (HR 1.15, 95% 1.02 to 1.28) and Other Asian (HR 1.10, 95% 1.03 to 1.17) individuals had worse DSS compared with Non-Hispanic White individuals (Table 3). Adjusted analysis also showed that South Asian individuals had worse DSS (HR

1.30, 95% CI 1.16 to 1.46) than Other Asian (HR 1.05, 95% CI 0.98 to 1.12), and Non-Hispanic White individuals.

Similar outcomes were observed on sensitivity analyses, adjusting for SEER Program Combined Summary Stage instead of AJCC stage (Supplemental Table 4). Other Asian individuals (HR 0.89, 95% CI 0.85 to 0.94) had improved OS compared with South Asian (HR 1.09, 95% CI 0.98 to 1.21) and Non-Hispanic White individuals. South Asian individuals also had worse DSS (HR 1.28, 95% CI 1.14 to 1.44) compared with Other Asian individuals (HR 1.05, 95% CI 0.99 to 1.12) and Non-Hispanic White individuals.

Discussion

In this study, we examined disease stage at diagnosis and survival outcomes among South Asian patients with HNC in the US, comparing these findings with Other Asian and Non-Hispanic White patients. Our study found South Asian patients were more likely to present with advanced disease stage compared with both Other Asian and Non-Hispanic White patients. South Asian patients had similar OS to Non-Hispanic White patients, but worse OS than Other Asian patients, after adjusting for demographic and clinical variables. However, South Asian patients had worse DSS than Non-Hispanic White and Other Asian patients.

To our knowledge, this is the first study evaluating HNC disparities in disease stage at diagnosis and survival outcomes among the South Asian population compared with Other Asian and Non-Hispanic White populations in the US. One previous study by Khosla et al. used the National Cancer Database (NCDB) to assess disparities in HNC stage among South Asian, Chinese, Filipino male individuals, compared with Non-Hispanic White male individuals.[13] Contrary to our findings, they found no difference in the odds of presenting with late-stage disease between South Asian and Non-Hispanic White individuals. The discrepancy between our studies may have been due to differences in patient population. Khosla et al. assessed only male patients. Additionally, they included patients with nasopharyngeal cancer, which our study did not. Furthermore, they utilized the NCDB, a hospital-based database, whereas we employed the SEER database, which is a population-based database that is representative of the US population. Finally, unlike our study, the Khosla et al. study did not

assess differences in survival. Other studies on survival disparities among South Asian patients with HNC have either been conducted outside of the US or have been limited to OCC. Studies from Canada have shown that, similar to our findings, South Asian individuals have worse DSS for OCC compared with Chinese and Non-Asian individuals.[6,17] One study from England also found that South Asian individuals with OCC had lower OS and disease-free survival compared other Asian individuals.[18] A US-based NCDB study by Sozio et al. also found that South Asian individuals have better OS compared Non-Hispanic White individuals.[19] However, this study was limited to patients with buccal mucosa and gingiva SCC.

Our unadjusted analysis found that South Asian individuals were less likely to present with advanced disease compared with both Other Asian and Non-Hispanic White patients. However, this association was reversed in the adjusted analysis. Sequential modeling revealed that the reversal between unadjusted and adjusted estimates for odds of advanced disease was primarily driven by tumor site. South Asian individuals had higher proportion of OCC, which were associated with less advanced stage. Differences in marital status and neighborhood SES also contributed, likely obscuring within-stratum differences in unadjusted analyses. The higher likelihood of advanced disease among South Asian individuals is likely due to poor access to care. Inadequate health insurance may play a role. Lack of insurance and public insurance are associated with advanced stage disease presentation and worse survival.[20,21] While the Asian Indian population has the lowest uninsured rates across all Asian groups, coverage varies considerably between South Asian ethnicities, as Bhutanese, Nepalese, and Pakistani individuals experience higher uninsured rates.[22] Furthermore, previous studies have shown disparities in HNC outcomes by insurance type, even among insured patients.[23–25] Unfortunately, we could not assess differences in health insurance status because the SEER database currently does not provide that information. SES may also be another factor influencing access to care, as Asian Indian individuals are more likely to report an inability to afford medications and a lack of designated place to seek medical care when needed.[26] Our study found that the disparities persisted after adjusting for neighborhood-level SES. However, we could not adjust for individual-level SES. Other potential factors include cultural stigmas

associated with health perception of illnesses, preference for traditional remedies, and influence of family and community dynamics, which may affect healthcare-seeking behavior, potentially leading to advanced disease presentation.[27]

We identified significant effect modification by sex and primary tumor site, suggesting disparities in stage of diagnosis among South Asian patients may be more pronounced among specific demographic and anatomic subgroups. This heterogeneity may reflect differences in culture perception of disease, healthcare-seeking behavior, or biologic differences. Importantly, interpretation of these findings is constrained by SEER's South Asian ethnicity categorizations, which does not distinguish subgroups beyond Asian Indian and Pakistani. SEER also lacks individual-level immigration, nativity, insurance, comorbidity, language, and risk factor data, limiting our study's ability to evaluate mechanisms underlying disparities or distinguish between social and biological contributors for care.

Our study found that South Asian individuals had worse DSS compared with non-Hispanic White individuals, even after adjusting for disease stage and treatment variables. The reasons for this are unclear but may be attributed to access to care issues, as mentioned above. Differences in tumor mutations may also account for the worse DSS among the South Asian population. For example, previous studies have shown an association between betel nut use and TERT gene mutations in oral squamous cell carinoma.[28,29] Despite having worse DSS, South Asian individuals had similar OS to non-Hispanic White individuals, suggesting a higher risk of mortality from HNC but lower competing risk of mortality from other causes. The exact reasons for this are not clear, but may reflect lower rates of comorbidity due to the "healthy immigrant effect," where healthier individuals are more likely to immigrate, leading to better health outcomes in immigrant populations.[30–32] Unfortunately, SEER does not include comorbidity measures, or immigration status, which limits our ability to evaluate this mechanism. Alternatively, the discrepancy may be due to lower susceptibility to mortality from non-cancer comorbidities. Notably, South Asian individuals also have a higher prevalence of comorbidities such as diabetes

mellitus, obesity, stroke, and coronary artery disease,[33–37] yet paradoxically experience lower all-cause mortality from stroke and diabetes-related complications compared with White individuals.[38–41]

Our findings contribute to the growing body of evidence highlighting health disparities specific to the South Asian population. Many studies have aggregated South Asian individuals into broader categories, potentially obscuring differences in disease presentation and outcomes. Our study highlights the importance of disaggregating Asian subgroups when examining health disparities, as each subpopulation may have unique factors that affect their health outcome. For example, South Asian individuals report lower rates of smoking and alcohol consumption, which are known risk factors for HNC.[42] However, they have a high prevalence of OCC, often attributed to the use of smokeless tobacco products like betel quid.[7,43–46] A qualitative study found that South Asian patients have varied beliefs about the causes of HNC, with many expressing ambivalence or denial regarding its association with smokeless tobacco and misconceptions about its health benefits, highlighting an area for targeted patient education.[47] Our study supports the findings of recent studies emphasizing the importance of disaggregating racial groups to address cancer disparities that might be masked by aggregating racial and ethnic subgroups into larger groups. Moon et al. found that Native Hawaiian and Pacific Islander individuals, who are often grouped together in the Asian/Pacific Islander group, presented with more advanced disease stage and had worse DSS compared with Asian and Non-Hispanic White individuals.[48] Megwalu et al. found that Filipino individuals had higher incidence of thyroid cancer, higher rates of locoregionally advanced disease, and worse survival than Non-Filipino Asian and Non-Hispanic White individuals.[49,50]

A strength of this study is the use of population-based data, which provides a large sample size from a diverse population. By stratifying our findings by race/ethnicity, we gained nuanced insights into the disparities affecting South Asian that have been previously overlooked. Given the low missingness and non-differential distribution of our dataset, complete-case analyses were used. Limitations include the retrospective design precluding causal inference. In addition, SEER database categorizes South Asians into only three subgroups (Asian Indian, Pakistani, and Asian Indian or Pakistani (NOS)). Consequently, it is unclear if individuals

originating from other South Asian countries such as Bangladesh and Sri Lanka are included. Furthermore, the aggregation of these populations into one group may have masked potential heterogeneity in disease presentation, risk factors, and clinical outcomes between each distinct subgroup. SEER also lacks information detailing nativity, immigration, insurance, comorbidities, tumor genomic data, tobacco subtype, language proficiency. This limits direct assessment of social and biological mechanisms underlying disparities and precludes evaluation of immigration-related selection effects, such as the healthy immigrant phenomenon. Although sequential modeling suggests demographic, socioeconomic, and clinical characteristics contribute to the reversal of odds for advanced disease, confounding from unmeasured immigration-associated and care-seeking factors cannot be excluded. As a result, heterogeneity in exposures, cultural practices, and health outcomes within the broader South Asian patient population may be obscured.

In conclusion, our study shows significant disparities in HNC outcomes for South Asian individuals in the US. South Asian patients are more likely to present with advanced disease compared with both Other Asian and Non-Hispanic White patients. South Asian patients also have worse DSS than Other Asian and Non-Hispanic White patients. Given the differences in findings between Asian subgroups, these findings highlight the need to disaggregate monolithic racial groupings when assessing racial and ethnic disparities. Future research is needed to understand the factors that contribute to worse HNC outcomes among South Asian populations. Understanding these factors may help identify potential targets for interventions aimed at improving outcomes for these populations.

Acknowledgements

Declaration of Conflicting Interests: The authors declare that there is no conflict of interest.

Financial disclosures: No competing financial interests exist.

Funding Source: California Tobacco-Related Diseases Research Program, Grant Number No. T32IR4677.

This project and/or conference was partially supported by funds provided by The Regents of the University of California, Research Grants Program Office, Tobacco-Related Diseases Research Program, Grant Number No. T32IR4677. The opinions, findings, and conclusions herein are those of the author and do not necessarily represent those The Regents of the University of California, or any of its programs.

Presented as a poster at the Combined Otolaryngology Spring Meetings (COSM)/American Head and Neck Society (AHNS) Annual Meeting, 2025.

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Figure Legends

Figure 1: Overall survival by race/ethnicity.

p = 0.05 by Log-Rank Test

Figure 2: Disease-specific survival by race/ethnicity.

p = 0.001 by Log-Rank Test

Supplemental Materials

Supplemental Table 1. Association of race/ethnicity with advanced cancer stage at diagnosis (Regional/Distant vs. Localized).

Supplemental Table 2. Association of race/ethnicity with advanced cancer stage at diagnosis (Distant vs. Localized/Regional).

Supplemental Table 3. Association of race/ethnicity with survival (adjusting for SEER Program Combined Summary Stage instead of AJCC Stage).

Supplemental Table 4. Sequential multivariable logistic regression models for advanced stage at diagnosis by race/ethnicity (AJCC Stage III/IV vs I/II)

507 **Table 1. Patient characteristics.**

	Other Asian	South Asian	Non-Hispanic White
Age (mean (SD))	66.00 (13.21)	60.81 (13.68)	64.08 (11.60)
Sex			
F	1010 (0.31)	260 (0.24)	21086 (0.24)
M	2250 (0.69)	806 (0.76)	67252 (0.76)
Marital			
Married	2123 (0.65)	813 (0.76)	48115 (0.54)
Single	987 (0.3)	197 (0.18)	35660 (0.40)
Unknown	150 (0.05)	56 (0.05)	4563 (0.05)
Yost			
1st Quartile	238 (0.07)	71 (0.07)	12318 (0.14)
2nd Quartile	350 (0.11)	91 (0.09)	14774 (0.17)
3rd Quartile	537 (0.16)	149 (0.14)	16432 (0.19)
4th Quartile	849 (0.26)	234 (0.22)	19744 (0.23)
5th Quartile	1223 (0.38)	495 (0.46)	23794 (0.27)
Radiotherapy			
No	1223 (0.38)	424 (0.40)	25449 (0.29)
Yes	2037 (0.62)	642 (0.60)	62889 (0.71)
Chemotherapy			
No	2001 (0.61)	688. (0.65)	47064 (0.53)
Yes	1259 (0.39)	378. (0.35)	41274 (0.47)
Surgical Intervention			
No	1354 (0.42)	293 (0.27)	47715 (0.54)
Yes	1906 (0.58)	773 (0.73)	40623 (0.46)
AJCC Stage[a]			
I	956 (0.28)	300 (0.28)	23293 (0.26)
II	487 (0.14)	167 (0.15)	11828 (0.13)
III	482 (0.14)	155 (0.14)	13803 (0.16)
IV	1456 (0.43)	456 (0.42)	39972 (0.45)
Summary Stage			
Distant	577 (0.18)	187 (0.18)	14173 (0.16)
Localized	1319 (0.40)	434 (0.41)	29644 (0.34)
Regional	1364 (0.42)	445 (0.42)	44521 (0.50)
Staging Edition			
2006 - 2015	2000 (0.61)	506 (0.47)	55538 (0.63)
2016 - 2017	510 (0.16)	189 (0.18)	12952 (0.15)
2018	750 (0.23)	371 (0.35)	19848 (0.22)
Primary Site			
Oral cavity	1424 (0.44)	750 (0.70)	22361 (0.25)
Oropharynx	854 (0.26)	136 (0.13)	37831 (0.43)
Hypopharynx	240 (0.07)	62 (0.06)	3934 (0.04)

Larynx	742 (0.23)	118 (0.11)	24212 (0.27)

[a]Per the cancer staging system of the American Joint Committee on Cancer.

Table 2: Association of race/ethnicity with advanced cancer stage at diagnosis (AJCC Stage III/IV vs Stage I/II).

Variable	Odds ratio	Lower 95% CI	Upper 95% CI
Unadjusted			
Race			
South Asian	0.87	0.77	0.99
Other Asian	0.88	0.82	0.95
Non-Hispanic White	1 [reference]		
Adjusted			
Race			
South Asian	1.48	1.29	1.70
Other Asian	1.13	1.05	1.22
Non-Hispanic White	1 [reference]		
Age, y (continuous)	0.99	0.99	0.99
Sex			
Male	1 [reference]		
Female	0.90	0.87	0.94
Marital Status			
Married	1 [reference]		
Single/Unmarried	1.45	1.40	1.49
Unknown	0.91	0.85	0.97
Socioeconomic status (Yost Score)			
1st Quartile	1 [reference]		
2nd Quartile	0.93	0.88	0.98
3rd Quartile	0.86	0.82	0.91
4th Quartile	0.81	0.77	0.85
5th Quartile	0.72	0.69	0.76
Staging Edition			
2006 - 2015	1 [reference]		
2016 - 2017	1.00	0.95	1.06
2018	0.30	0.28	0.32
Year of diagnosis	1.04	1.03	1.04
Tumor site			
Oral Cavity	1 [reference]		
Oropharynx	3.63	3.50	3.77
Hypopharynx	6.51	5.92	7.16
Larynx	0.84	0.81	0.88

[a]Per the cancer staging system of the American Joint Committee on Cancer.

530 **Table 3: Association of race/ethnicity with survival.**

Variable	Hazard Ratio	Lower 95% CI	Upper 95% CI
Overall survival (OS), unadjusted			
Race			
South Asian	0.92	0.83	1.02
Other Asian	0.95	0.90	1.00
Non-Hispanic White	1 [reference]		
Overall survival (OS), adjusted			
Race			
South Asian	1.09	0.99	1.21
Other Asian	0.89	0.84	0.94
Non-Hispanic White	1 [reference]		
Age, y (continuous)	1.04	1.04	1.04
Sex			
Male	1 [reference]		
Female	0.91	0.88	0.93
Marital Status			
Married	1 [reference]		
Single/Unmarried	1.44	1.41	1.47
Unknown	1.11	1.06	1.16
Socioeconomic status (Yost Score)			
1st Quartile	1 [reference]		
2nd Quartile	0.87	0.84	0.90
3rd Quartile	0.81	0.78	0.83
4th Quartile	0.74	0.72	0.76
5th Quartile	0.64	0.62	0.66
Year of diagnosis	0.97	0.97	0.98
Radiotherapy			
No	1 [reference]		
Yes	0.55	0.54	0.57
Chemotherapy			
No	1 [reference]		
Yes	0.84	0.81	0.86
Surgical Intervention			
No	1 [reference]		
Yes	0.50	0.49	0.51
Tumor site			
Oral Cavity	1 [reference]		
Oropharynx	0.49	0.48	0.51
Hypopharynx	1.03	0.98	1.07

Larynx	0.87	0.84	0.89
AJCC Stage[a]			
I	1 [reference]		
II	1.70	1.64	1.76
III	2.47	2.38	2.56
IV	3.62	3.51	3.73
Staging Edition			
2006 - 2015			
2016 - 2017	0.94	0.91	0.98
2018	1.08	1.03	1.14
Disease specific survival (DSS), unadjusted			
Race			
South Asian	1.15	1.02	1.28
Other Asian	1.10	1.03	1.17
Non-Hispanic White	1 [reference]		
Disease specific survival (DSS), adjusted			
Race			
South Asian	1.30	1.16	1.46
Other Asian	1.05	0.98	1.12
Non-Hispanic White	1 [reference]		
Age, y (continuous)	1.03	1.03	1.03
Sex			
Male	1 [reference]		
Female	0.96	0.93	0.99
Marital Status			
Married	1 [reference]		
Single/Unmarried	1.43	1.39	1.47
Unknown	1.10	1.04	1.17
Socioeconomic status (Yost Score)			
1st Quartile	1 [reference]		
2nd Quartile	0.88	0.85	0.92
3rd Quartile	0.81	0.78	0.85
4th Quartile	0.75	0.72	0.78
5th Quartile	0.66	0.63	0.68
Year of diagnosis	0.97	0.96	0.97
Radiotherapy			
No	1 [reference]		
Yes	0.50	0.48	0.51
Chemotherapy			
No	1 [reference]		
Yes	0.84	0.82	0.87
Surgical Intervention			

No	1 [reference]		
Yes	0.44	0.43	0.46
Tumor site			
Oral Cavity	1 [reference]		
Oropharynx	0.42	0.40	0.43
Hypopharynx	0.92	0.87	0.97
Larynx	0.75	0.72	0.78
AJCC Stage[a]			
I	1 [reference]		
II	2.22	2.11	2.34
III	3.68	3.51	3.87
IV	6.31	6.03	6.59
Staging Edition			
2006 - 2015	1 [reference]		
2016 - 2017	0.92	0.88	0.96
2018	1.09	1.03	1.16

[a]Per the cancer staging system of the American Joint Committee on Cancer.