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Incidence of oral cavity and pharyngeal cancers by anatomical sites in population-based registries in Puerto Rico and the United States of America

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Abstract

Objective—Puerto Rico's (PR) epidemiological data on each oral cavity and pharynx cancer (OCPC) site is yet largely unexplored. Our aim was to compare OCPC incidence in PR, by anatomical site, with that of non-Hispanic whites (NHW), non-Hispanic blacks (NHB), and Hispanic (USH) individuals in the USA.

Methods—Data from the Surveillance Epidemiology and End Results program and the PR Central Cancer Registry were collected and analyzed. Age-standardized rates, percent changes, and standardized rate ratios were estimated with 95% confidence intervals.

Results—Although declining incidence rates were observed for most anatomical sites in most racial/ethnic groups and in both sexes, the incidence of oropharynx cancers, slightly increased for cancers in the oropharynx among PR women, both in the base of tongue and soft palate/other oropharynx ($p>0.05$). The incidence of soft palate/other oropharynx cancers in PR men was about 2.8 times higher than in USH men ($p<0.05$) and about 1.4 times higher than in NHW men but 21% lower than in NHB men ($p>0.05$). Significant interactions terms formed with racial/ethnic group

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and age were shown in various sites. The largest differences between sexes were consistently noted in PR.

Conclusion—Further research in PR should assess the effect of the HPV infection, as well as of other risk factors, in OCPC incidence by anatomical site in younger populations. These data could explain more precisely the reasons for the differences observed in this study, particularly among sexes in PR.

Indexing terms

Oral cavity and pharyngeal cancer; SEER; Puerto Rico; Incidence; Trends

INTRODUCTION

Oral cavity and pharyngeal cancer (OCPC), as a group, is the sixth most common cancer in the world.[1] Worldwide, the annual estimated incidence is approximately 275,000 for oral cavity cancers and 130,300 for pharyngeal cancers, excluding those of the nasopharynx.[2] However, OCPC incidence rates vary up to 20-fold according to geographic location.[1] Among all Caribbean islands, for example, Puerto Rico (PR) has the highest reported age-adjusted (World standard) OCPC incidence (8 per 100,000 inhabitants; excluding nasopharynx) even slightly higher than in the United States of America (USA) (7.2 per 100,000 inhabitants; excluding nasopharynx).[3]

According to the PR Central Cancer Registry (PRCCR), OCPC is the fourth and twelfth most common cancers among Puerto Rican men and women, respectively; approximately 357 cases (273 men and 84 women) are diagnosed each year.[4] From 1992 to 2002, the OCPC incidence among Puerto Rican women increased by 5.3% each year whereas among Puerto Rican men remained constant ($p > 0.05$).[5] In the USA, on the other hand, the OCPC incidence in women decreased by approximately 1% per year from 1992 to 2008, and the OCPC incidence in men decreased by approximately 1.4% per year from 1992 to 2006, although some differences have been observed according to race, sex, and anatomical site.[6]

Various known risk factors such as alcohol use, tobacco use, human papillomavirus (HPV) exposure, poor nutrition, and poor oral hygiene may influence the trends of OCPC incidence in PR and the USA. In fact, some of these factors (e.g., HPV exposure and tobacco use) have been more closely associated with OCPC incidence at certain anatomical sites.[7,8] Hence, determining the incidence of OCPC in PR by anatomical site and comparing it with that in non-Hispanic white (NHW), non-Hispanic black (NHB), and Hispanic (USH) Americans may help to determine where to focus our cancer prevention and control efforts to reduce the OCPC burden in PR. Thus, our aim was to assess the age-standardized OCPC incidence by anatomical site in PR and contrast these statistics with national data for USH, NHW, and NHB groups in the USA as reported by the Surveillance, Epidemiology, and End Results (SEER) program from 1992 to 2009.

MATERIALS AND METHODS

Data sources

Data from the SEER program and the PRCCR were collected and analyzed as previously described in various studies.[5,9,10] The PRCCR, part of the National Program of Cancer Registries, is administered by the Centers for Disease Control and Prevention (CDC) and uses the coding standards of the SEER program and the North American Association of Central Cancer Registries. Therefore, PRCCR data are fully comparable with SEER data. According to a CDC audit, in 2003, 95.3% of all cancer cases diagnosed or treated in hospital facilities in Puerto Rico were appropriately reported to the PRCCR, which is comparable to the proportion in the USA (95%).[11]

The criteria specified in the third revision of the International Classification of Diseases for Oncology (ICD-O-3) were used to select cases of OCPC from 2001 and later for this analysis.[12] Cases from 1992–2000 were initially reported using ICD-O-2 and later converted to ICD-O-3 by the SEER program.[13] This study was approved by the University of Puerto Rico Medical Sciences Campus Institutional Review Board.

Study population

Individuals older than 39 years and diagnosed with OCPC at three different primary sites: 1) oral cavity [oral tongue (C020–C023), floor of mouth (C040–C049), and gingivobuccal (C030–C039,C050, and C060–C069)], 2) oropharynx [base of tongue (C019 & C024), tonsil (C090–C099), and soft palate/other oropharynxC(051–C052,C100–C109)], and 3) hypopharynx (C129, C130–C139) were included in the analyses. Cases of lip, salivary gland, and nasopharynx cancer were not included given their different epidemiologic characteristics.[7] Moreover, patients with cancers in other ill-defined sites in the lip, oral cavity, and pharynx were excluded from this study because the number of these cases diagnosed in PR during the study period was rather small (1992–2009; 77 in women and 347 in men). This study did not account for ethnic differences within the USH population.

Statistical Analysis

Using the world standard population as a reference, we applied the direct method to compute the age-standardized rates [ASR (World)] for each OCPC anatomical site during 1992–2009.[15] The change in the ASR (World) for each OCPC anatomical sites from the earliest and the latest study period (1992–1998 and 2003–2009) was calculated as a percent change (PC) as follows:

$$PC = \frac{\mathrm{Rate}_{2003-2009} - \mathrm{Rate}_{1992-1998}}{\mathrm{Rate}_{1992-1998}} * 100$$

A Bonferroni test adjusted for multiple comparisons was performed using 99.4% confidence for eight comparisons (two sex categories and four racial/ethnic groups), for each site, in order to assess the significance change of the PCs. As a consequence, the overall significant type I error was approximately 5%. The confidence intervals (CIs) were calculated with the

formulas recommended by the U.S. Census Bureau.[16] Significant changes were declared with $p<0.05$ for each anatomical site if 0 was not included in the interval.

We also assessed racial/ethnic group differences in OCPC incidence by anatomical sites, during2005–2009, by estimating the ratio of two standardized rates $\left[\frac{ASR(\text{world})_i}{ASR(\text{world})_j}\right]$ between sexes (i = men and j = women) and any two groups (i = PR and j = other racial/ethnic group) with 95% CIs.[17] This ratio is referred to as the standardized rate ratio (SRR). A likelihood ratio test was used to formally assess the interaction terms between the predictor variables (sex and age-group) in the Poisson regression model in order to determine if the age-specific rates were different. The statistical analysis was performed using Stata/SE statistical software version 11.0 (Stata Corp., L.P., College Station, TX).

RESULTS

Age Standardized Rates (World)

The incidence of each OCPC anatomical site during 1992–2009 is shown in Table 1. Although declining incidence rates were observed for most anatomical sites in most racial/ethnic groups and in both sexes, the incidence of oropharynx cancers, mainly base of tongue (PC = 62.3) and tonsil (PC = 64.3), significantly increased in NHW men from 1992–1998 to 2003–2009 ($p<0.05$; Table 2). PR also showed a slight increase for cancers in the oropharynx among women, both in the base of tongue and soft palate/other oropharynx ($p>0.05$; Table 2). Among women, PR showed the larger increase for cases of oral tongue cancers (PC = 40.5; $p>0.05$) and the only group with increasing trends of floor of mouth cancers (PC = 9.2; $p>0.05$). Hispanic men, both Puerto Ricans (PC=18.7) and USH (PC = 7.8), were the only groups with increasing trends of gingivobucccal cancers ($p>0.05$). Cancers from all OCPC sites diminished among NHB (Table 2). Hypopharynx cancers declined in all racial/ethnic groups (Table 2).

Standardized Rates Ratios

During 2005–2009, the incidence of OCPC at any anatomical site was consistently lower in Puerto Rican women than in any other group (Table 3). Among men, however, the OCPC incidence in PR varied compared to that among USH and NHW. For example, the incidence of soft palate/other oropharynx cancers in Puerto Rican men was about 2.8 (95%CI = 2.08, 3.91) times higher than in USH men and about 1.4 (95%CI = 1.20, 1.71) times higher than in NHW men but 21% (SRR: 0.79; 95%CI = 0.62, 1.00) lower than in NHB men. Accordingly, the incidence of cancer in oropharyngeal sites in men was slightly higher in PR than in USH ($p>0.05$). Likewise, men in PR had about 28% (SRR: 1.28; 95%CI = 0.91, 1.82) higher incidence of floor of mouth cancer as compared to USH men. All OCPC sites showed lower SRR in PR than NHB (Table 3).

Despite these findings, significant interactions terms formed with racial/ethnic group and age were shown in various sites ($p<0.05$). For example, among men the oral cavity and oropharynx sites showed higher cancer incidence among those individuals between 40–49 years old and 50–59 years old in PR as compared to USH [data not shown]. The incidence of

cancers of the soft palate/other oropharynx among individuals older than 70 years of age was about 25% lower in PR than in USH and NHW ($p>0.05$; data not shown) whereas among younger individuals (40–69 years of age) the relative risks (RR) ranged from 1.39 to 5.21 ($p<0.05$; data not shown). Younger women (40–49 years old) in PR showed higher risks of oropharynx cancer than USH women of the same age group (RR: 2.39; 95%CI = 1.12, 5.07) [data not shown]. Likewise, the incidence of soft palate/other oropharynx cancers among women in PR between 40–49 years old (RR: 8.86; 95%CI = 0.99, 79.28) and 50–59 years old (RR: 1.03; 95%CI = 0.28, 3.85) was higher than in USH women. Most of the sites showed an inverse dose-response relationship among those racial/ethnic groups' comparisons with significant interactions terms in the Poisson model [data not shown].

In all racial/ethnic groups and at all anatomical sites, the incidence of OCPC was higher in men than in women; this excess was not significant ($p>0.05$) neither for oral tongue cancer in USH nor for gingivobuccal cancer in NHB (Table 4). The largest differences in OCPC incidence between sexes were consistently noted in Puerto Rican individuals except for base of tongue cancers (Table 4); it was manly observed for cancer of the hypopharynx (SRR: 29.6; 95% CI = 14.1, 86.3). For each racial/ethnic group, various sites showed significant interaction terms formed with sex and age ($p<0.05$). Those individuals between 60–69 years old in PR and 50–59 years old in NHW showed higher RR in men than in women [data not shown]. Also, the incidence floor of mouth cancer among USH men was much higher than in USH women for those between 60–69 years old (RR: 11.1; 95%CI = 2.6, 47.6) [data not shown]. NHB had the highest difference between sexes for tonsil cancer among individuals that were ≥ 70 years of age ($p<0.05$; data not shown).

DISCUSSION

The results of this study indicate that the incidence of OCPC by anatomical site in PR differs from that in other racial/ethnic groups in the continental USA. Differences in OCPC incidence between PR and continental USA by anatomical site could be the result of differences in the prevalence of OCPC risk factors in these populations, including smoking, alcohol drinking, poor oral hygiene, poor dietary habits, HPV infection, and risky sexual behaviors. Furthermore, we cannot discount genetic predisposition as a relevant factor; for example, a study conducted in PR[18] indicated that in persons with the GSTT1-present genotype, the risk of oral cancer increased as cigarette use increased. However, to our knowledge, no studies have shown that the frequency of genetic polymorphisms associated with oral cancers is different in Puerto Rican and American individuals.

In addition, the lower incidence of certain OCPC (i.e. soft palate/other oropharynx and floor of mouth) in USH men than in Puerto Rican men could be the result of what is known as the "healthy migrant effect," which suggests that people who migrate are healthier than those who remain in their countries of origin.[19] The fact that USH individuals may possess better health-enhancing behavioral profiles[19] may influence the incidence rates in this USA population. Nonetheless, given that in our study, we only observed such patterns among men; further research is warranted to determine whether this hypothesis in fact applies only to men and to elucidate the reasons for this sex-based disparity between Puerto Rican and USH individuals.

Despite the differences found, for all racial/ethnic groups the most common cancer was the tonsils followed by the soft palate/other oropharynx among men in PR and the base of tongue among men in the continental USA. On the other hand, in all racial/ethnic groups, women mainly had cancers in the gingivobuccal subsite followed by the tonsils in Puerto Rican and NHB women and the oral tongue in USH and NHW women. An increase in the incidence of cancers in the tonsils and oral tongue was previously observed in NHW individuals from 1975–1982 to 1992–1998[20] and, as seen in our study, the incidence of these cancers continues increasing in this group among men and women, respectively. Also, other researchers have found that the incidence of oral tongue, base of the tongue and tonsil squamous cell carcinomas has increased over time.[21] Squamous cell carcinoma of the tonsil and the base of tongue has previously been associated with HPV.[22–24] OCPC of the oropharynx has also been related to HPV, and our findings suggest the incidence of oropharyngeal cancers is slightly increasing among women older than 39 years old in PR but not in the continental USA. However, Puerto Rican women presented lower risks of oropharyngeal cancers than any other racial/ethnic group in the continental USA; only women between 40–49 years old in PR showed higher risks (RR: 2.39; 95%CI = 1.12–5.07) than USH women within the same age group. Higher risks were also found for oropharyngeal cancers among men in PR when compared to USH men between the 40–49 and 50–59 age groups. Soft palate/otheroropharynx cancers as well showed higher risks in younger groups when comparing PR to NHW and USH. These findings could suggest not only differences in HPV infection but also in sexual behaviors between the groups, because various studies have found that an increasing number of lifetime sex partners is associated with an increasing risk of oropharyngeal cancer; the risk of oropharyngeal cancer is increased by 34-fold in individuals with more than 9 lifetime sex partners.[25]

Population-based data on oral HPV infection are not available for PR, so we cannot make a direct comparison with the data of the USA, based on the National Health and Nutrition Examination Survey (NHANES).[26] Nonetheless, a population-based study performed in PR during 2005–2008 suggested that oral sex practices and higher numbers of sexual partners could be more prevalent in PR than in Mexican Americans in the USA.[27] Hence, monitoring the impact of HPV vaccines[28] on the trends in oropharyngeal cancer incidence in PR and the continental USA may be of interest. However, given the low uptake of the vaccine,[29,30] the impact of vaccination on disease trends may be delayed.

The decline in the incidence of cancers of the hypopharynx, floor of the mouth, and gingivobuccal in the mouth from 1992–1998 to 2003–2009 is consistent with the declines in smoking and alcohol consumption, which are the major risk factors for OCPC.[31] According to the Behavioral Risk Factor Surveillance System survey, from 1997 to 2010, tobacco consumption declined in PR (14.4% to 11.9%) and in the USA (23.2% to 17.3%).[32] Moreover, a small fluctuation in the prevalence of heavy alcohol drinking was observed in Puerto Rico (3.8% to 3.0%) and the USA (5.1% to 5.0%) from 2001 to 2010.[32] Nonetheless, caution must be taken when considering these prevalence estimations as a possible justification for declining trends in the incidence of cancer at these sites, since there could be a delay of several years between exposure and the development of these cancers. These lifestyles (smoking and alcohol drinking) could partly explain the observed sex-based differences in OCPC incidence, as the risk of OCPC that is attributed to these factors is

about 76% (95% CI = 65–87%) for men and 52% (95% CI = 28–75%) for women.[33] However, we cannot discount the existence of other differences between men and women regarding the prevalence of other factors that may influence disease trends, such as HPV infection, sexual behaviors, and preventive care use, that may have also influenced our results.

The preventive care use, specifically dental checkups, is lower in men than in women in the USA[34] so it could potentially explain sex-based differences in OCPC incidence at different anatomical sites. During the early 1990s, Marshall and colleagues[35] found that poor oral hygiene also increases the risk of OCPC but to a lesser degree than do smoking and alcohol drinking. Poor oral hygiene can result in periodontitis, which has been related to oral premalignant lesions and OCPC. According to Lissowska et al.,[36] the attributable risk of OCPC for low frequency of tooth brushing and dental checkups is about 56% and 47%, respectively. This chronic inflammatory disease (i.e., periodontitis) could affect tissues at distant sites through periodontal bacteria, via saliva and the bloodstream, and cause tissue injury through inflammatory reactions.[37–39] Furthermore, an oral inflammatory disease may lead to enhanced penetration of other carcinogens (e.g., tobacco, alcohol, and dietary metabolites)[40] as well as the acquisition and persistence of oral HPV infection.[41]

According to NHANES, during 2009–2010 the prevalence of oral infection with any of 37 HPV DNA types evaluated was significantly higher among men than women (10.1% vs. 3.6%; $p < 0.05$)[26], and this disparity may be related to the number of sexual partners. In fact, Ortiz and colleagues[27] reported that the prevalence of multiple sexual partners (≥7 lifetime partners) is higher in men than in women in PR (47.9% and 13.2%, respectively). Thus, this pattern may contribute to explain the largest sex-based differences in OCPC incidence among Puerto Ricans, particularly for anatomical sites related to HPV infection.

To our knowledge, this is the first study to describe OCPC incidence by anatomical site in PR and compare it with that of other racial/ethnic groups in the USA. Nonetheless, some limitations of this study should be acknowledged. First, we were unable to collect information regarding risk factors for OCPC for any of the racial/ethnic groups. Nevertheless, our findings suggest different behavior patterns in PR that could be affecting our OCPC incidence rates in each site. Second, our results may have been influenced by poor accuracy in the classification of Hispanic cancer cases in the SEER 13 program. However, this bias can be reduced by combining surname and medical record information.[42] Because this method is used by the SEER 13 program when classifying persons as USH individuals,[43] we do not expect our conclusions to be affected. Last, reduced cancer reporting by the Department of Veterans Affairs hospitals impacted the most recent USA and Puerto Rican cancer surveillance data (2005-present).[44] Even though incidence rates after 2004 may be underestimated, differences between Puerto Ricans and the other racial/ethnic groups in the USA are expected to remain the same, as both groups were affected by underreporting.

Conclusion and recommendations

The incidence of each OCPC anatomical site in PR differed from that in NHW, NHB, and USH in the USA. Our study showed that younger individuals in PR had higher risks of oropharyngeal cancers, particularly in the soft palate/other oropharynx, than USH (both sexes) and NHW (only women) of the same age group. Therefore, further research in PR should assess the effect of the HPV infection, as well as of other risk factors, in OCPC incidence by anatomical site in younger populations. Another important finding was the risks differences between sexes, particularly in PR which showed the most extreme ratios. Thus, future research should also consider assessing the interaction between sex and different risk factors on different OCPC sites. These data could explain more precisely the reasons for the differences observed in this study and could provide relevant data that would help to identify future recommendations aimed at reducing the burden of OCPC in PR.

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Table 1

Age-standardized rates (incidence per 100,000 individuals) for oral cavity and pharynx cancer by anatomical sites, sex, and racial/ethnic group, 1992–2009.

	ASR(World)							
	PR		USH		NHW		NHB	
Anatomical sites	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Oral cavity	4.5	1.3	4.9	2.8	8.5	4.9	9.2	3.8
Oral tongue	0.9	0.3	1.5	1.1	2.8	1.6	2.2	0.8
Floor of mouth	1.7	0.2	1.7	0.4	2.7	1.1	3.9	1.1
Gingivobuccal	1.8	0.7	1.8	1.3	3	2.2	3.2	1.9
Oropharynx	7.5	1.1	7.1	1.7	14	3.5	18.6	4.4
Base of tongue	2.2	0.4	2.4	0.6	5.7	1.3	6.2	1.5
Tonsil	2.8	0.5	3.3	0.7	6.1	1.4	7.5	1.7
Soft palate/other	2.5	0.2	1.3	0.4	2.1	0.8	4.9	1.3
Hypopharynx	2.4	0.2	2.4	0.3	2.8	0.7	6	1.2

ASR = Age-standardized rates; PR = Puerto Rico; USH = Hispanics in the US; NHW = non-Hispanic whites; NHB = non-Hispanic blacks

Table 2

Percent change (1992–1998 to 2003–2009) for oral cavity and pharynx cancer by anatomical site, sex, and racial/ethnic group.

	Percent change							
	PR		USH		NHW		NHB	
Anatomical sites	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Oral cavity	−5.2	5.2	−21.5*	−8.4	−18.9*	−18.0*	−44.4*	−22.3*
Oral tongue	1	40.5	−13.4	37.3	−0.8	7.4	−20.3	−11.4
Floor of mouth	−27.5*	9.2	−48.0*	−41.7*	−38.8*	−45.8*	−60.3*	−46.0*
Gingivobuccal	18.2	−7.5	7.8	−20.2	−13.0*	−17.5*	−35.4*	−8.8
Oropharynx	−3.9	2	−5.2	−14.2	47.6*	−5.9	−20.9*	−14.7
Base of tongue	−13.5	18.2	−1	−16.3	61.9*	−0.8	−15.1	−5.6
Tonsil	−2.1	−12.9	4.3	−7.1	65.3*	−0.5	−13.5	−26.4
Soft palate/other	3.8	10.8	−30.5*	−24.8	−15.3*	−21.1*	−37.4*	−6.4
Hypopharynx	−25.5*	−71.2*	−24.4*	−42.3	−35.2*	−37.8*	−40.8*	−46.2*

PR = Puerto Rico; USH = Hispanics in the US; NHW = non-Hispanic whites; NHB = non-Hispanic blacks

*$P < 0.05$

Table 3

Standardized rate ratio for oral cavity and pharynx cancer by anatomical sites and sex, 2005–2009.

	SRR PR vs. USH (95% CI)		SRR PR vs. NHW (95% CI)		SRR PR vs. NHB (95% CI)	
Anatomical site	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Oral Cavity	0.92 † (0.77, 1.11)	0.49 * (0.38, 0.64)	0.55 *† (0.47, 0.63)	0.31 *† (0.24, 0.38)	0.66 *† (0.55, 0.79)	0.42 * (0.32, 0.55)
Oral tongue	0.71 † (0.49, 1.02)	0.33 *† (0.20, 0.53)	0.33 *† (0.25, 0.44)	0.24 * (0.15, 0.36)	0.52 * (0.36, 0.76)	0.50 * (0.28, 0.84)
Floor of mouth	1.28 (0.91, 1.82)	0.58 (0.28, 1.14)	0.70 *† (0.55, 0.88)	0.25 * (0.13, 0.43)	0.64 * (0.47, 0.89)	0.30 * (0.15, 0.56)
Gingivobuccal	0.86 † (0.65, 1.14)	0.64 * (0.44, 0.91)	0.63 *† (0.51, 0.77)	0.38 * (0.28, 0.50)	0.78 (0.58, 1.04)	0.43 * (0.30, 0.61)
Oropharynx	1.08 † (0.94, 1.24)	0.71 *† (0.51, 0.98)	0.44 *† (0.40, 0.49)	0.35 *† (0.26, 0.45)	0.45 *† (0.40, 0.52)	0.28 *† (0.21, 0.38)
Base of tongue	0.82 † (0.63, 1.05)	0.8 (0.46, 1.35)	0.28 * (0.23, 0.34)	0.34 *† (0.21, 0.50)	0.35 * (0.27, 0.43)	0.32 *† (0.19, 0.50)
Tonsil	0.77 *† (0.62, 0.96)	0.57 *† (0.33, 0.93)	0.35 * (0.29, 0.41)	0.32 *† (0.19, 0.48)	0.38 *† (0.31, 0.46)	0.28 * (0.16, 0.45)
Soft palate/other	2.82 *† (2.08, 3.91)	0.89 † (0.45, 1.71)	1.44 *† (1.20, 1.71)	0.42 * (0.24, 0.67)	0.79 † (0.62, 1.00)	0.25 * (0.14, 0.42)
Hypopharynx	1.00 † (0.77, 1.31)	0.32 * (0.10, 0.84)	0.90 † (0.74, 1.09)	0.12 * (0.04, 0.24)	0.42 * (0.33, 0.53)	0.10 * (0.03, 0.22)

SRR = Standardized rate ratio; PR = Puerto Rico; USH = Hispanics in the US; NHW = non-Hispanic whites; NHB = non-Hispanic blacks; CI = Confidence Interval

* $P < 0.05$;

† Interaction between age and group was found ($P < 0.05$).

Table 4

Standardized rate ratios for oral cavity and pharynx cancer by anatomical sites and racial/ethnic group, 2005–2009.

	SRR Men vs. Women (95% CI)			
Anatomical site	**PR**	**USH**	**MHW**	**NWB**
Oral Cavity	3.06 *† (2.38, 3.98)	1.63 * (1.34, 2.00)	1.71 *† (1.59, 1.83)	1.95 * (1.58, 2.27)
Oral tongue	2.19 * (1.34, 3.75)	1.04 (0.74, 1.45)	1.59 * (1.42, 1.78)	2.08 * (1.39, 2.78)
Floor of mouth	7.26 * (4.15, 14.27)	3.27 *† (2.05, 5.45)	2.62 *† (2.26, 3.05)	3.35 * (2.25, 4.25)
Gingivobuccal	2.40 *† (1.72, 3.41)	1.77 * (1.32, 2.40)	1.44 *† (1.30, 1.60)	1.33 (0.98, 1.74)
Oropharynx	6.30 *† (4.84, 8.44)	4.16 * (3.35, 5.22)	4.93 *† (4.60, 5.28)	3.94 * (3.36, 4.31)
Base of tongue	4.48 * (2.92, 7.32)	4.37 * (3.04, 6.51)	5.36 * (4.82, 5.98)	4.11 * (3.14, 4.75)
Tonsil	6.31 * (4.09, 10.50)	4.62 * (3.39, 6.46)	5.78 *† (5.20, 6.45)	4.69 *† (3.62, 5.35)
Soft palate/Other	8.96 *† (5.58, 15.96)	2.83 * (1.73, 4.86)	2.61 *† (2.24, 3.06)	2.85 * (2.10, 3.45)
Hypopharynx	29.61 * (14.09, 86.27)	9.57 * (5.58, 18.43)	3.81 * (3.24, 4.52)	6.93 * (4.84, 8.10)

SRR = Standardized rate ratio; PR = Puerto Rico; USH = Hispanics in the US; NHW = non-Hispanic whites; NHB = non-Hispanic blacks; CI = Confidence Interval

* $P < 0.05$;

† Interaction between age and sex was found ($P < 0.05$)