RESEARCH ARTICLE

Editorial Process: Submission:09/23/2024 Acceptance:06/04/2025

Incidence, Trends and Survival of Oral Cavity Squamous Cell Carcinoma in Aotearoa New Zealand over 15 Years (2006–2020)

Thu Thu Win Myint[1,2]*, Nick McIvor[3], Richard Douglas[2,3], Alana Cavadino[1], Mark Elwood[1]

Abstract

Background: Over recent decades, there have been changes in the incidence of squamous cell carcinoma of the oral cavity (OCSCC) in many countries. However, recent data on OCSCC in New Zealand has not been examined. This study examines the current incidence, trends and survival of OCSCC in New Zealand and identifies demographic differences by age, sex and ethnicity. **Method:** Patients with a primary diagnosis of OCSCC between 2006 and 2020 were retrieved from the National Cancer Registry. Age-standardised incidence rates (ASRs) were calculated and compared using age-standardised incidence rate ratios (ASRRs). Time trends were assessed by joinpoint regression with annual percentage changes, and overall and relative survival rates were estimated. **Results:** Over 15 years, 2094 cases of OCSCC were identified, and the average annual incidence was 2.1 per 100,000. The rates were higher in males (ASRR= 1.4 compared to females), older age groups (ASRR=11.3 in 50-69 years; ASRR=25.4 in 70+ years compared to <50 years), and Pasifika (ASRR=1.4, compared to European). OCSCC incidence increased significantly between 2009 and 2017 and decreased between 2017 and 2020. Females followed the same pattern of trends as overall OCSCC, while trends in males showed no significant changes. The survival outcome of OCSCC at five years was 57% and 66% for absolute and relative survival, respectively. Survival outcomes were poorer in males (HR = 1.20 compared to females), older age groups (HR=1.77 in 50-69 years; HR=4.21 in 70+ years compared to <50 years), Māori (HR=1.37 compared to European) and tumours originated from the floor of mouth (HR=1.40), palate (HR=1.47) and buccal (HR=1.54) compared to tongue. **Conclusion:** This study shows that the incidence of OCSCC overall and in females increased from 2009 to 2017, but declined significantly after 2017 in New Zealand. Incidence and survival rates are influenced by sex, age, ethnicity and subsite.

Keywords: Oral cancer- mouth neoplasms- incidence- survival

Asian Pac J Cancer Prev, **26 (6)**, 2015-2023

Introduction

Oral cavity cancer (OCC) develops from mucosa in a region extending from the mucosal surface of the lip to the junction of the hard and soft palate postero-superiorly and to the circumvallate papillae of the tongue postero-inferiorly [1]. Over 90% of oral cavity tumours are squamous cell carcinoma (SCC) [2]. In 2020, 377,713 new cases and 177,757 deaths related to OCC were reported worldwide, making this the sixteenth most common cancer [3].

Tobacco smoking and excess alcohol consumption are the two widely recognised risk factors for OCC [4-6]. Betel chewing is also a common risk factor but is more prevalent in Southeast Asian countries [7]. Human papillomavirus (HPV) has emerged as an additional risk factor, although the role of HPV in OCC is smaller compared to oropharyngeal cancer [8-10]. Poor diet and oral hygiene are also considered to contribute to OCC, but the evidence supporting this remains limited [4, 5].

Globally, the incidence of OCC has been declining [5]. However, the time trends depend on the prevalence of risk factors among the geographical locations where the incidences were reported [11]. The trends were also influenced by the age and sex of the patients [5, 12]. The overall survival outcome of OCC was reported to be just above 50% at five years, and the rates of survival differ according to subsite [13]. A recent study in Australia found that the survival of OCC can differ by ethnicity [14].

In a worldwide survey of OCC incidence, New Zealand and Australia ranked in third place out of 21 world regions for the highest OCC incidence, after Melanesia and South-Central Asia [3]. Previous studies performed in New Zealand found no changes in the incidence of OCC

*[1]Department of Epidemiology and Biostatistics, School of Population Health, The University of Auckland, Auckland, New Zealand. [2]Department of Surgery, School of Medicine, The University of Auckland, Auckland, New Zealand. [3]Department of Otorhinolaryngology Head and Neck Surgery, Te Toka Tumai, Auckland, Te Whatu Ora, Health New Zealand. *For Correspondence: thuthu.winmyint@auckland.ac.nz*

between 1982 and 2010 [15, 16]. OCC incidence after 2010 has not yet been studied in New Zealand. Therefore, this study was designed to determine the incidence of OCSCC in New Zealand over a 15-year period between 2006 and 2020. Additionally, the survival rates were evaluated. The study also assessed how the incidence, time trends, and survival differed by demographic characteristics such as age, sex and ethnicity.

Materials and Methods

Data source and management

This study included de-identified data of patients with a primary diagnosis of OCSCC retrieved from the New Zealand Cancer Registry (NZCR) from 1 January 2006 to 31 December 2020. The NZCR is a legislatively mandated population-based national registry that stores the pathology reports of all malignant tumours (excluding non-melanoma skin cancers) [17].

The key variables extracted from the NZCR included in this study were demographic characteristics (age at diagnosis, sex and ethnicity) and tumour characteristics (site and histology). The NZCR coded histology and anatomic sites of malignancies according to the ICD-O-3 (the WHO Classification of Tumours and the International Classification of Disease for Oncology, 3rd edition) [18].

ICD codes (C02-06), retrieved for OCSCC, were classified into their anatomic subsites according to the AJCC Cancer Staging Manual (8th edition) [19]. Patients were included (n = 2102) if the tumours were arising from the tongue (anterior two-thirds; C02), alveolar/gum (C03), floor of mouth (C04), palate/cheek (C05), buccal cavity (C060-2) and undefined sites (C068, C069). The cohort is limited to those who are NZ residents (n = 2094), and non-NZ residents (n = 8) were excluded from the study.

The variables of interest in this study include age at diagnosis, sex and ethnicity. Population data required to estimate the rates were provided by Te Whatu Ora - Health New Zealand and were stratified by year, sex, ethnicity and five-year age group. Age and ethnicity were grouped to be consistent with the population data. Accordingly, age was categorised into five-year age groups, and ethnicity was grouped into Māori, Pasifika, Asian and Other as per prioritised ethnicity [20]. This study used a single ethnic group in order of priority when a patient was identified with more than one ethnicity. The 'Other' ethnic group primarily includes European/Pākehā (99%), Middle Eastern/Latin American/African (MELAA) (0.5%), and unstated (0.5%). This group was called European/Pākehā, as Europeans constituted the majority of it. Importantly, there was no missing data in the key variables: age, sex and ethnicity, ensuring the completeness and accuracy of the database.

Data analysis

Age-specific incidence rates were the annual cases of OCSCC per 100,000 population by five-year age group for each sex and by ethnicity. Age-standardised incidence rates (ASR) were calculated by directly adjusting to the World Health Organisation's world standard population, with a 95% confidence interval (95% CI) [21]. Age-standardised incidence rate ratio (ASRR) compared the ASRs within each group: age group, sex and ethnicity [22]. Annual percentage change (APC) estimated the changes in trends over time resulting from joinpoint regression. The joinpoint regression program used in data analysis produces a minimum number of estimated points that can fit the data and identify when there is a major change in the direction or magnitude of trends [23]. Trends from joinpoint regression were described as outlined by Kawakita et al. [24]. To understand the age distribution for OCSCC, we performed log-incidence age and age-period cohort analyses. The analyses were performed using the incidences of five-year age groups (restricted to age groups between 30-34 years and 85-89 years). Log-incidence age analysis examined the changes in age-specific incidence rate by age group, ethnicity and sex. We applied log transformation to address the considerable variation in incidence rates across different age groups. Age-period cohort analysis was performed using the age-specific incidence rate by age groups for five-year calendar periods (2006-10, 2011-15, 2016-20) by ethnicity and sex.

We calculated survival rates from the date of diagnosis until either the date of death or the end of the study period (31 October 2021). The date of death is recorded in the NZCR through death certificates and autopsy reports [17]. Overall absolute survival (all deaths, any cause, non-specific to OCSCC) was estimated by the Kaplan-Meier method, and differences between demographic characteristics were assessed using log-rank tests [25]. Overall relative survival rates were calculated as a ratio of observed survival (from Kaplan-Meier) to mean expected survival [26]. We estimated each patient's expected survival from the NZ cohort life tables, indicative of their birth year, age at diagnosis, sex and ethnicity [27]. Univariate and multivariable Cox proportional hazard models were used to identify survival differences by demographic characteristics: year of diagnosis, age at diagnosis, sex, ethnicity and subsite [28]. The proportionality assumption was tested using the global Schoenfeld test [29]. Undefined sites were excluded from the model due to their small numbers. Yet, the proportional assumption showed some evidence of violation for some covariates: year of diagnosis (p=0.03) and age 70 and above (p=0.03). Since age was the co-variate that gives the most violation of the proportional hazard assumption (Supplementary Graph 1), a different model was tested with age groups as strata. Nonetheless, the Hazard ratio (HR) of the covariates showed a minimal difference between the model with age groups as strata and the selected model. Besides, the violation in the selected model was relatively negligible (Supplementary Graph 2).

We performed data analyses using R software, R version 4.3.0 and joinpoint trend analysis software from the Surveillance Research Program of the National Cancer Institute, version 4.9.1.0.

Results

Incidence

Between 2006 and 2020, 2094 patients with OCSCC

as their primary diagnosis were identified in the cancer registry. The mean and median age of OCSCC patients was 66 years (SD = 14.7 years) and 67 years (IQR, 56 to 77 years), respectively. The age-standardised incidence of OCSCC was 2.2 per 100,000 in 2006 and 2.0 per 100,000 in 2020, with an average annual incidence of 2.1 per 100,000 (95% CI 2.0 to 2.2) over 15 years.

Males comprised the larger proportion (n = 1130, 54%) of cases and had a significantly higher incidence rate than females (ASRR = 1.4, 95% CI 1.3 to 1.5). Incidences tended to remain higher in males in further analysis by age and ethnicity, particularly in older age groups (Supplementary Table 1).

Among ethnic groups, Pasifika had the highest annual incidence rate at 2.9 per 100,000. The rate was 40% higher in Pasifika compared to European (ASRR = 1.4, 95% CI 1.2 to 1.6). Māori and Asian have a similar average annual incidence of 1.9 per 100,000, which was marginally lower compared to European, although the difference was not statistically significant.

In terms of age groups, the oldest age groups (aged above 70 years) had the highest annual incidence rate of 13.2 per 100,000. Log-incidence age analysis demonstrated an approximately log-linear relationship between age group and log of age-specific rate with incidence increasing with age in both sexes (Figure 1 A&B). The age-period cohort analysis also indicated a pronounced age effect for each sex (Figure 2 A&B), but with only small birth cohort effects.

Among subsites, half of the OCSCC originated from the anterior two-thirds of tongue (n=1085, 52%), with an average incidence of 1.2 per 100,000. The incidence rates for floor of mouth, alveolar and buccal were quite similar, 0.2 to 0.3 per 100,000, where the rates were lowest in palate and undefined sites (Table 1). In further analysis of subsites by ethnicity and sex, Pasifika was observed with higher incidence compared to European in both sexes for tongue (Table 2; statistical significance was confined to females, ASRR = 1.9, 95% CI 1.5 to 2.2), buccal (ASRR = 1.9, 95% CI 1.2 to 2.7 in males; ASRR = 2.0, 95% CI 1.2 to 2.8 in females) and palate for males (ASRR = 2.7, 95% CI 1.6 to 3.7). Asian males were also found with a higher incidence in buccal compared to European (ASRR = 2.1, 95% CI 1.6 to 2.6).

Trends

While the overall trend in OCSCC incidence showed a minimal change over the 15 years, analysis showed two joinpoints at 2009 and 2017, having a decline of 5.8% per year from 2006 to 2009, followed by an increase of 3.5% per year between 2009 and 2017 and then a further decline of 6.7% per year from 2017 to 2020, the last two trends being statistically significant (Figure 3). A similar pattern was observed in females, with joinpoints identified at 2009 and 2017, an initial decline of 11.6% per year between 2006 to 2009, followed by an increase of 6.2% per between 2009 to 2017, then a further decline after 2017 with 11.7% per year. However, no joinpoint was identified for males; the trends for males showed a minimal increase of 0.6% per year over 15 years (Table 3). No joinpoints were identified in subset analysis by age groups, ethnicities, and subsites; the smaller numbers of cases in subsites prevent detailed analysis. The overall trends leaned towards an increase in older age groups but declined in those aged less than 50 (Table 3).

Among ethnic groups, there was a notable increase in trends among Māori and Pasifika, with 3.7% and 1.9% per year, respectively, although these increases were not statistically significant (Table 3). In the more detailed analysis by ethnicity and sex, the increasing trends of incidences were consistent in both Māori and Pasifika males and females, while trends among European and Asian males and females tended towards stable or declined (Supplementary Table 2).

Trends by subsites showed a significant increase in alveolar/gum area, with 11.7% per year, while the changes for the rest of the subsites were not statistically significant (Table 3).

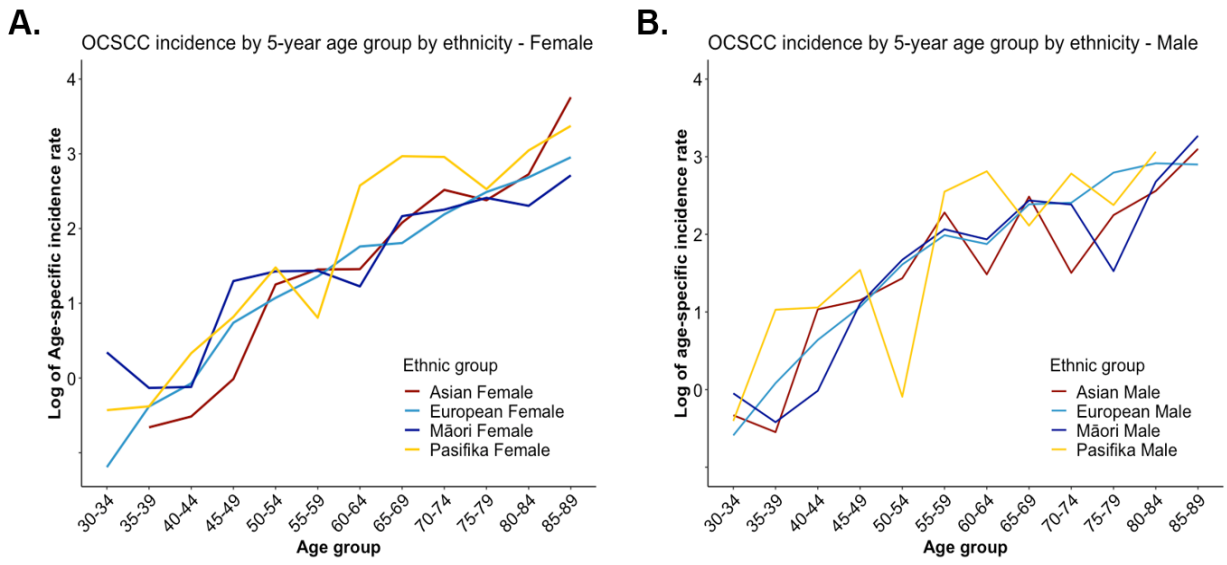

Figure 1. Log of Age-Specific Incidence Rate (per 100,000) by 5-Year Age Group and Ethnicity for Each Sex A. Female and B. Male.

Table 1. Number and Age-Standardised Incidence Rate by Demographic Characteristics, 2006-2020

Characteristics		Number	ASR (95% CI)	ASRR (95% CI)
Total OCSCC		2094	2.1 (2.0, 2.2)	-
Sex	Female	964	1.7 (1.6, 1.8)	Reference
	Male	1130	2.4 (2.3, 2.6)	1.4 (1.3, 1.5)
Age groups	< 50 years	282	0.5 (0.5, 0.6)	Reference
	50-69 years	918	5.8 (5.5, 6.2)	11.3 (11.1, 11.4)
	70+ years	894	13.2 (12.3, 14.1)	25.4 (25.2, 25.5)
Ethnicity	European	1674	2.0 (1.9, 2.1)	Reference
	Māori	173	1.9 (1.6, 2.2)	0.9 (0.8, 1.1)
	Pasifika	102	2.9 (2.3, 3.5)	1.4 (1.2, 1.6)
	Asian	145	1.9 (1.6, 2.3)	0.9 (0.7, 1.1)
Subsites	Anterior tongue (C020, C021, C022, C023, C028, C029)	1085	1.2 (1.1, 1.3)	14.9 (14.4, 15.3)
	Alveolar/Gum (C030, C031, C039)	325	0.3 (0.2, 0.3)	3.3 (2.8, 3.8)
	Floor of Mouth (C040, C041, C048, C049)	253	0.2 (0.2, 0.3)	2.7 (2.2, 3.2)
	Palate/Cheek (C050, C058, C059,	70	0.1 (0.0, 0.1)	Reference
	Buccal (C060, C061, C062)	292	0.3 (0.3, 0.4)	4.2 (3.7, 4.7)
	Undefined site/Not defined (C068, C069)	69	0.1 (0.0, 0.1)	0.9 (0.3, 1.6)

ASR, age-standardised incidence rate (per 100,000); ASRR, age-standardised incidence rate ratio; CI, 95% confidence interval

Survival

A total of 1,005 patients died over a follow-up of 15 years (including undefined sites, n = 40). The absolute and relative survival rates were 57% and 66% at 5 years and 45% and 60% at 10 years, respectively (Supplementary Table 3). In multivariable Cox regression, there was a significantly higher HR in males (HR=1.20), corresponding to lower survival compared to females (Table 4). Survival was also lower in Māori (HR=1.37) compared to Europeans, in older age groups (HR=1.77 in 50-69 years; HR=4.21 in 70 years and above) compared to those aged less than 50 years, and this is seen in relative survival also (Supplementary Table 3). Lower survival was identified in tumours from floor of mouth (HR=1.40), palate (HR=1.47) and buccal (HR=1.54) compared to anterior tongue (Table 4).

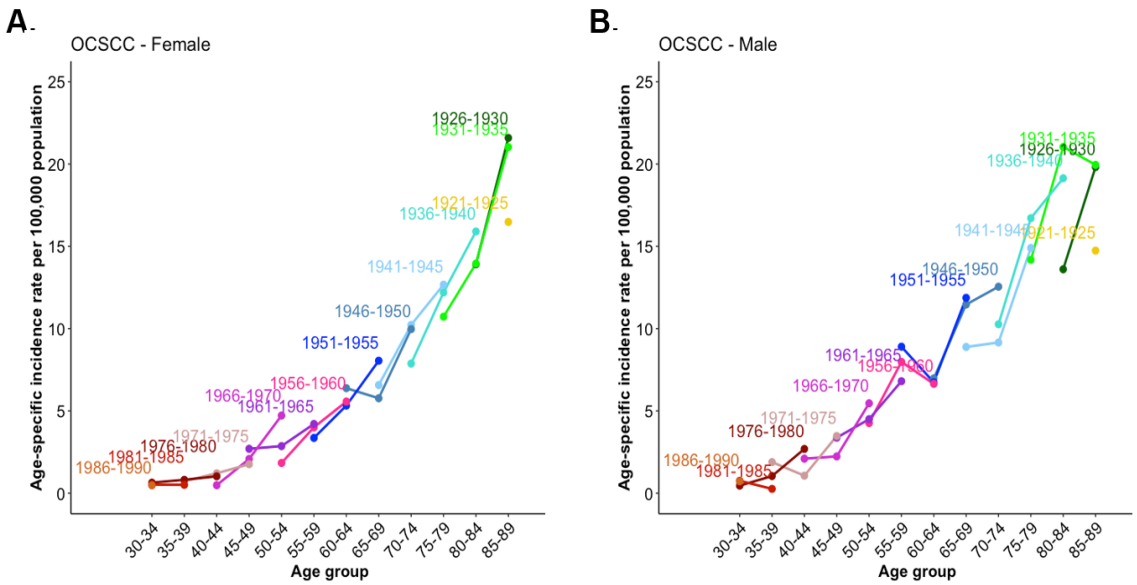

Figure 2. Age-Specific Incidence Rate (per 100,000) by Age and Birth Cohort for Each Sex A. Female and B. Male

Table 2. Age-Standardised Incidence of OCSCC by Subsites for Each Sex and Ethnic Group

Subsites	Sex	Ethnicity			
		Māori	Pasifika	Asian	European
Anterior tongue	Female	1.1 (0.8, 1.5)	1.8 (1.2, 2.5)	1.0 (0.7, 1.4)	0.9 (0.8, 1.0)
	Male	1.2 (0.9, 1.6)	1.6 (1.1, 2.3)	0.9 (0.6, 1.3)	1.3 (1.2, 1.4)
Alveolar/Gum	Female	0.1 (0.1, 0.3)	0.4 (0.1, 0.8)	0.4 (0.2, 0.7)	0.3 (0.2, 0.3)
	Male	0.2 (0.1, 0.4)	0.2 (0.1, 0.6)	0.3 (0.2, 0.6)	0.3 (0.3, 0.4)
Floor of mouth	Female	0.2 (0.1, 0.4)	0.1 (0.0, 0.4)	0.1 (0.0, 0.2)	0.2 (0.1, 0.2)
	Male	0.4 (0.2, 0.6)	0.2 (0.1, 0.6)	0.2 (0.1, 0.4)	0.3 (0.3, 0.4)
Palate/Cheek	Female	0.1 (0.0, 0.2)	–	0.03 (0.0, 0.2)	0.1 (0.0, 0.1)
	Male	0.1 (0.0, 0.2)	0.3 (0.1, 0.7)	0.1 (0.0, 0.3)	0.1 (0.1, 0.1)
Buccal	Female	0.2 (0.1, 0.4)	0.4 (0.2, 0.9)	0.2 (0.1, 0.4)	0.2 (0.2, 0.3)
	Male	0.2 (0.1, 0.4)	0.5 (0.2, 1.0)	0.6 (0.4, 0.9)	0.3 (0.2, 0.3)
Undefined site/Not defined	Female	0.04 (0.0, 0.2)	0.1 (0.0, 0.3)	–	0.1 (0.0, 0.1)
	Male	0.2 (0.1, 0.4)	0.1 (0.0, 0.4)	0.1 (0.0, 0.2)	0.1 (0.1, 0.1)

No cases were observed in the palate/cheek for Pasifika females and in the undefined site for Asian females.

Discussion

The average annual incidence of OCSCC was 2.1 per 100,000 in New Zealand between 2006 and 2020. For all subjects, incidence rates showed a decrease, although non-significant, from 2006 to 2009, followed by a significant increase from 2009 to 2017 and a significant decrease of 6.7% annually from 2017 to 2020, the latest year included. Tobacco smoking and alcohol consumption are recognised as the major risk factors for OCSCC [4, 6]. In New Zealand, the prevalence of tobacco smoking has been declining steadily, yet changes in alcohol consumption were minimal over the study period [30]. The declining incidence seen in the latter years of this study is recent and was not observed in the earlier study [15]. A European study conducted over a comparable timeline as this study also found decreasing OCSCC incidence when the smoking rates are reportedly declining [31, 32]. However, studies from Asian countries, particularly in Japan [24], South Korea [33], and Taiwan [34], found increasing OCSCC trends over an equivalent period to our study (during which smoking prevalence plateaued and there was little reduction in betel chewing) [35, 36].

Table 3. Average Annual Percentage Change (AAPC) of ASR by Demographic Characteristics.

Characteristics	Overall trend: 2006–2020 AAPC (95%CI) % per year
Total*	–0.8 (–2.3, +0.6)
Female*	–1.9 (–4.0, +0.1)
Male	+0.6 (–0.9, +2.2)
< 50 years	–0.9 (–3.8, +1.9)
50–69 years	+1.0 (–1.1, +3.4)
70+ years	+0.5 (–1.2, +2.8)
European	+0.1 (–1.4, +1.8)
Māori	+3.7 (–0.5, +9.6)
Pasifika	+1.9 (–3.9, +10.1)
Asian	+1.7 (–1.8, +6.8)
Anterior tongue	+1.0 (–0.7, +3.6)
Alveolar/Gum	+11.7 (+2.0,+23.5)
Floor of Mouth	+3.7 (–6.3, +14.7)
Palate/cheek	+2.5 (–19.4, +38.0)
Buccal	+2.9 (–6.7, +14.0)
Undefined site/Not defined	+2.3 (–17.8, +28.8)

AAPC, average annual percentage changes; CI, 95% confidence interval; (For total and for females, joinpoint analysis showed more complex trends: see Figure 3 for total trend)

Incidence in females followed a similar pattern as the overall OCSCC trends, with a greater significant decline of 11.7% per year after 2017, while those in males showed a higher average rate than in females but with no significant change over time. These findings are reasonably consistent with trends in the smoking prevalence in New Zealand, where the prevalence in males has remained higher compared to females, although the overall rate declined [37]. In addition, males have higher alcohol consumption than females [38]. Many other studies also witnessed a higher incidence in males [15, 24, 33, 39-41]. Trends in males were stable in earlier data in New Zealand at a time when those in Queensland had started to decline [15]. Therefore, males were observed to both have more OCSCC and have a higher prevalence of risk factors such as consumption of tobacco and alcohol.

The age effect on OCSCC incidence was clearly evident, with incidence increasing with age. Decreasing incidence rates of OCSCC at ages less than 50 may be attributable to the reduction in smoking rate, which is primarily driven by those younger than 35 years [37].

Among ethnic groups, the incidence rates were highest in Pasifika (40% higher than European). Pasifika had a higher (1.3 times) smoking prevalence compared to non-Māori/non-Pasifika people [42]. However, the reasons for the highest incidence of OCSCC are unclear, as Māori have a higher smoking prevalence but no higher rate of OCSCC. In other countries, variations by ethnic group

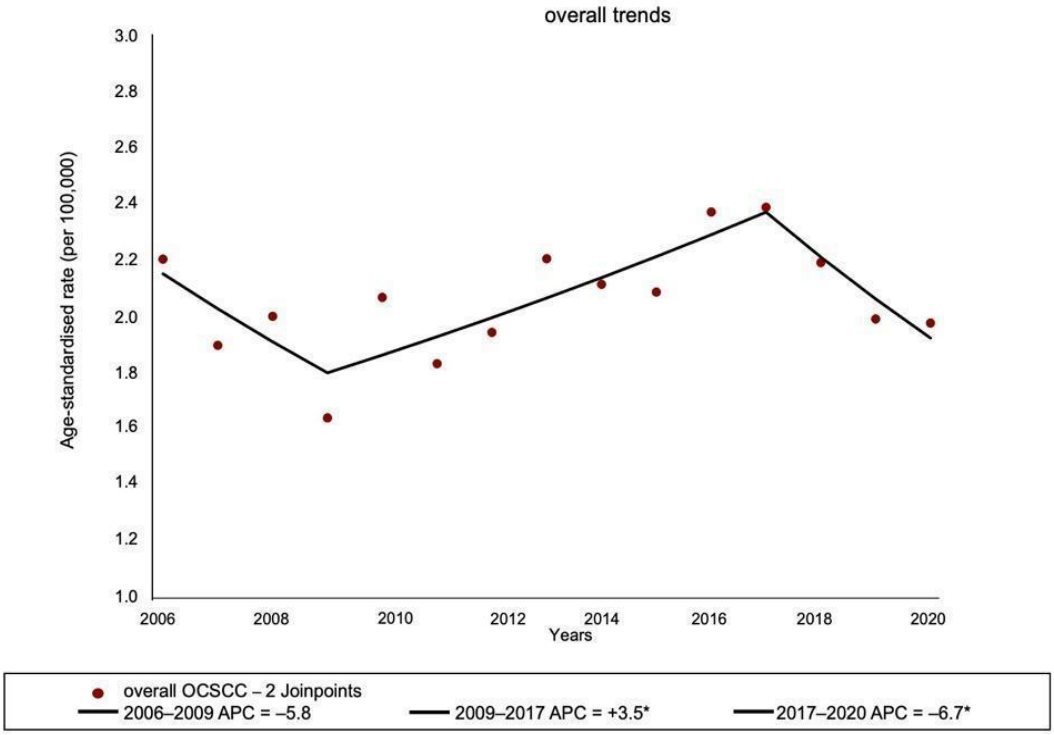

Figure 3. The Overall Trend of OCSCC

were widely diverse based on the geographical location of the study [43-46]. Further analysis of ethnicity by subsites offered some insight into an association between subsites and ethnicity, in particular Pasifika having higher incidences for subsites: tongue, palate and buccal.

Tongue was the subsite where most OCSCC tumours

Table 4. Univariable and Multivariable Analysis of Demographic Characteristics associated with Overall Survival Rate

Characteristics	Deaths/Total	Univariable		Multivariable	
		Hazard ratio, HR	95% CI	HR (Adjusted)	95% CI
Year of diagnosis					
2006-13	555/937	1	Reference	1	Reference
2014-20	410/1088	0.95	(0.83, 1.09)	0.94	(0.82, 1.08)
Sex					
Female	439/939	1	Reference	1	Reference
Male	526/1086	1.04	(0.91, 1,18)	1.2	(1.05, 1.36)
Age group					
< 50 years	67/275	1	Reference	1	Reference
50-69 years	336/884	1.82	(1.40, 2.37)	1.77	(1.36, 2.32)
70+ years	562/866	4.19	(3.24, 5.40)	4.21	(3.23, 5.49)
Ethnicity					
European/Pākehā	796/1618	1	Reference	1	Reference
Māori	72/165	0.93	(0.73, 1.18)	1.37	(1.07, 1.75)
Pasifika	43/99	0.91	(0.67, 1.24)	1.17	(0.86, 1.60)
Asian	54/143	0.78	(0.59, 1.03)	1.05	(0.80, 1.40)
Subsites					
Anterior tongue	435/1085	1	Reference	1	Reference
Alveolar/Gum	167/325	1.44	(1.21, 1.72)	1.11	(0.92, 1.33)
Floor of Mouth	148/253	1.59	(1.32, 1.92)	1.4	(1.16, 1.69)
Palate/cheek	39/70	1.65	(1.19, 2.30)	1.47	(1.06, 2.04)
Buccal	176/292	1.8	(1.51, 2.14)	1.54	(1.29, 1.84)

originated and had the highest incidence; however, the greatest increase in incidences was observed in the alveolar/gum, with 11.7% per year. Although subsites of OCSCC showed some variation with ethnicity, the underlying reasons for this are unknown. Subsites of the oral cavity are not highly associated with HPV, and the fraction is relatively small compared to oropharyngeal cancer (6% in Katirachi et al. study) [9]. The current study does not have HPV data. In New Zealand clinical practice, systematic screening for HPV status is limited to oropharyngeal cancers and those presenting with cervical nodes when the primary site is unknown. From further clinical information available for HPV status among patients with OCSCC from Northern New Zealand, between 2018 and 2022, of 241 patients with OCSCC, only 28 were tested for HPV, and 3 were positive (unpublished data).

The five-year survival of OCSCC was 57% absolute survival and 66% relative survival. Age, sex and ethnicity are key determinants of overall absolute survival for OCSCC in New Zealand. Males not only had higher incidences, but also poorer outcomes compared to females. A comparable poorer outcome was also observed in Māori patients and older age groups. Despite advances in imaging and treatment regimens, the outcome did not show a significant improvement in recent diagnoses over the last 15 years. Patients often experienced a poorer outcome if the tumour originated from the floor of mouth, palate and buccal. Stage of disease is also a major prognostic factor [47-49]; unfortunately, the cancer register data used in this study lacks detailed information on stage of tumour.

Tobacco smoking and alcohol consumption are major risk factors for OCSCC in New Zealand [6]. Lung cancers are also related to smoking, and incidences and mortality of lung cancer have declined in New Zealand despite having sex and ethnic disparity [50, 51]. Nonetheless, the trend patterns for oral cavity and lung cancer are not always similar [52]. Regardless, with the consistent declining rate of tobacco smoking over the last decades, it is expected that the OCSCC trends will keep declining. However, this decline has been noted recently and may be impacted by changes in diagnosis methods and accuracy of reporting. Further study is needed to confirm the changes in OCSCC incidences from 2021 onwards.

The results from this study show only a small improvement in survival outcomes in recent years. Health care policies to promote equity amongst ethnic groups, Māori and Pasifika, are important, given the higher incidence in Pasifika and lower survival in Māori. In most cases, dentists and general practitioners are the gatekeepers for the conventional oral examination and referral for a definitive diagnosis for those who present with suspicious oral lesions [53, 54]; but often, patients present with vague and undifferentiated symptoms initially which can lead to delayed diagnosis at an advanced stage, and hence require more extensive treatment and poorer outcomes [54, 55]. Thus, encouragement of screening for oral cancer and subsequent referral should be considered for those in a high-risk population, particularly in males and specific ethnic groups in New Zealand.

This study utilises the cancer registry data that is legislatively mandated, as well as pathological reports of all malignancies, with high levels of completeness and accuracy. The registry has information on key demographic characteristics (age, sex, ethnicity), subsites of OCSCC, and mortality data. However, the limitation of the routinely collected cancer registry data is not having further information related to incidence risk factor status such as smoking, alcohol consumption, HPV status, as well as stage of disease and cause of death. Another limitation of this study is that subsites were recorded mostly at the time of biopsy and may be inaccurate in large tumours arising from several subsites.

In conclusion, this study reports a declining incidence of OCSCC in New Zealand in the years after 2017. This decline is encouraging but based only on four years of data. Accordingly, further study in subsequent years will be important. The incidence was higher in the Pasifika population and this observation remains without an obvious explanation. Survival was reduced in males, older age groups and in Māori. Further research is needed to understand the potential reasons for lower survival in these groups.

Author Contribution Statement

ME – Conceptualisation, methodology, supervision, review and editing. AC – Software, validation, review and editing. RD – Supervision, review and editing, funding. NM – Review and editing, funding. TTWM – Data curation, formal analysis, software, visualisation, original draft, review and editing. All authors approved the final version.

Acknowledgements

We thank the New Zealand Cancer Registry (NZCR), Te Whatu Ora – Health New Zealand for providing the cancer registry data and population data.

Funding statement
A+ Trust Research Grant
Head and Neck Cancer Foundation Aotearoa

Approval of scientific body
The University of Auckland

Ethic approval
This study is approved by the Northern B Health and Disability Ethics Committee (HDEC) with reference number 2024 PR 11497.

Availability of data
Not applicable.

Conflict of interest
None.

References

1. Koch WM, Nance M. Classification, clinical features, and

molecular genetic models. InEpidemiology, Pathogenesis, and Prevention of Head and Neck Cancer. New York, NY: Springer New York;2010.p.1-21.1.
2. Montero PH, Patel SG. Cancer of the oral cavity. Surg Oncol Clin N Am. 2015;24(3):491-508. https://doi.org/10.1016/j.soc.2015.03.006.
3. Ferlay J, Ervik M, Lam F, Laversanne M, Colombet M, Mery L, Piñeros M, Znaor A, Soerjomataram I, Bray F. Global Cancer Observatory: Cancer Today [Internet]. Lyon, France: International Agency for Research on Cancer; 2024 [cited 2025 Mar 8]. Available from: https://gco.iarc.who.int/today.
4. Conway DI, Purkayastha M, Chestnutt IG. The changing epidemiology of oral cancer: Definitions, trends, and risk factors. Br Dent J. 2018;225(9):867-73. https://doi.org/10.1038/sj.bdj.2018.922.
5. Huang J, Chan SC, Ko S, Lok V, Zhang L, Lin X, et al. Disease burden, risk factors, and trends of lip, oral cavity, pharyngeal cancers: A global analysis. Cancer Med. 2023;12(17):18153-64. https://doi.org/10.1002/cam4.6391.
6. Yakin M, Gavidi RO, Cox B, Rich A. Oral cancer risk factors in new zealand. N Z Med J. 2017;130(1451):30-8.
7. Nokovitch L, Maquet C, Crampon F, Taihi I, Roussel LM, Obongo R, et al. Oral cavity squamous cell carcinoma risk factors: State of the art. J Clin Med. 2023;12(9). https://doi.org/10.3390/jcm12093264.
8. Boguñá N, Capdevila L, Jané-Salas E. Relationship of human papillomavirus with diseases of the oral cavity. Med Clin (Barc). 2019;153(4):157-64. https://doi.org/10.1016/j.medcli.2019.02.027.
9. Katirachi SK, Grønlund MP, Jakobsen KK, Grønhøj C, von Buchwald C. The prevalence of hpv in oral cavity squamous cell carcinoma. Viruses. 2023;15(2). https://doi.org/10.3390/v15020451.
10. Rahman R, Shaikh MH, Gopinath D, Idris A, Johnson NW. Human papillomavirus and epstein-barr virus co-infection in oral and oropharyngeal squamous cell carcinomas: A systematic review and meta-analysis. Mol Oral Microbiol. 2023;38(4):259-74. https://doi.org/10.1111/omi.12412.
11. Hernández-Morales A, González-López BS, Scougall-Vilchis RJ, Bermeo-Escalona JR, Velázquez-Enríquez U, Islas-Zarazúa R, et al. Lip and oral cavity cancer incidence and mortality rates associated with smoking and chewing tobacco use and the human development index in 172 countries worldwide: An ecological study 2019-2020. Healthcare (Basel). 2023;11(8). https://doi.org/10.3390/healthcare11081063.
12. Cunha ARD, Compton K, Xu R, Mishra R, Drangsholt MT, Antunes JLF, et al. The global, regional, and national burden of adult lip, oral, and pharyngeal cancer in 204 countries and territories: A systematic analysis for the global burden of disease study 2019. JAMA Oncol. 2023;9(10):1401-16. https://doi.org/10.1001/jamaoncol.2023.2960.
13. van Dijk BA, Brands MT, Geurts SM, Merkx MA, Roodenburg JL. Trends in oral cavity cancer incidence, mortality, survival and treatment in the netherlands. Int J Cancer. 2016;139(3):574-83. https://doi.org/10.1002/ijc.30107.
14. Alkandari AS, Ho JCY, Choi SW, Thomson P. Oral cavity and oropharyngeal carcinoma disparities in age and survival in indigenous and non-indigenous populations of queensland. BMC Cancer. 2023;23(1):503. https://doi.org/10.1186/s12885-023-11002-1.
15. Elwood JM, Youlden DR, Chelimo C, Ioannides SJ, Baade PD. Comparison of oropharyngeal and oral cavity squamous cell cancer incidence and trends in new zealand and queensland, australia. Cancer Epidemiol. 2014;38(1):16-21. https://doi.org/10.1016/j.canep.2013.12.004.
16. Chelimo C, Elwood JM. Sociodemographic differences in the incidence of oropharyngeal and oral cavity squamous cell cancers in new zealand. Aust N Z J Public Health. 2015;39(2):162-7. https://doi.org/10.1111/1753-6405.12352.
17. Ministry of Health. New Zealand Cancer Registry (NZCR) [Internet]. Wellington, New Zealand [cited 2025 5 Mar]. Available from: https://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/new-zealand-cancer-registry-nzcr.
18. Health New Zealand | Te Whatu Ora. New Zealand Cancer Registry - technical details [Internet]. Wellington, New Zealand [updated 10 January 2024]. Available from: https://www.tewhatuora.govt.nz/for-health-professionals/clinical-guidance/diseases-and-conditions/cancer/new-zealand-cancer-registry-nzcr/new-zealand-cancer-registry-technical-details.
19. Amin MB, Edge SB. American Joint Committee on Cancer. AJCC cancer staging manual: Part II Head and Neck. Eighth edition ed: Switzerland: Springer. 2017 ©2017; 2017. p. 55-171.
20. Health New Zealand | Te Whatu Ora. HISO 10001:2017 ethnicity data protocols [Internet]. Wellington: Ministry of Health [cited 2022 28 September]. Available from: https://www.tewhatuora.govt.nz/our-health-system/digital-health/health-information-standards/approved-standards/identity-standards/.
21. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJ, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. Geneva: World Health Organization. 2001;9(10):1-4.
22. Fay MP, Tiwari RC, Feuer EJ, Zou Z. Estimating average annual percent change for disease rates without assuming constant change. Biometrics. 2006;62(3):847-54. https://doi.org/10.1111/j.1541-0420.2006.00528.x.
23. Statistical Methodology and Applications Branch SRP, National Cancer Institute. Joinpoint regression program, version 4.9.1.0 [Internet] [cited 2022 April]. Available from: https://surveillance.cancer.gov/joinpoint/
24. Kawakita D, Oze I, Iwasaki S, Matsuda T, Matsuo K, Ito H. Trends in the incidence of head and neck cancer by subsite between 1993 and 2015 in japan. Cancer Med. 2022;11(6):1553-60. https://doi.org/10.1002/cam4.4539.
25. Clark TG, Bradburn MJ, Love SB, Altman DG. Survival analysis part i: Basic concepts and first analyses. Br J Cancer. 2003;89(2):232-8. https://doi.org/10.1038/sj.bjc.6601118.
26. Parkin DM, Hakulinen T. Cancer registration: Principles and methods. Analysis of survival. IARC Sci Publ. 1991(95):159-76.
27. Stats NZ. National and subnational period life tables: 2017–2019 [Internet]. New Zealand [cited 2023 1 May]. Available from: https://www.stats.govt.nz/information-releases/national-and-subnational-period-life-tables-2017-2019.
28. Bradburn mj, clark tg, love sb, altman dg. Survival analysis part ii: Multivariate data analysis – an introduction to concepts and methods. Br j cancer. 2003;89(3):431-6. Https://doi.Org/10.1038/sj.Bjc.6601119.
29. Bradburn MJ, Clark TG, Love SB, Altman DG. Survival analysis part iii: Multivariate data analysis -- choosing a model and assessing its adequacy and fit. Br J Cancer. 2003;89(4):605-11. https://doi.org/10.1038/sj.bjc.6601120.
30. Ministry of health. Annual update of key results 2022/23: New zealand health survey [internet]. Wellington, new zealand [updated 14 december 2023]. Available from: Https://www.Health.Govt.Nz/publications/annual-update-of-key-results-202223-new-zealand-health-survey.
31. O'Sullivan A, Kabir Z, Harding M. Lip, oral cavity and pharyngeal cancer burden in the european union from

1990-2019 using the 2019 global burden of disease study. Int J Environ Res Public Health. 2022;19(11). https://doi.org/10.3390/ijerph19116532.
32. OECD/European Union (2022). Health at a Glance: Europe 2022 [Internet]. State of Health in the EU Cycle, OECD Publishing, Paris [cited 2022]. Available from: https://www.oecd-ilibrary.org/content/publication/507433b0-en.
33. Jung YS, Seok J, Hong S, Ryu CH, Ryu J, Jung KW. The emergence of oral cavity cancer and the stabilization of oropharyngeal cancer: Recent contrasting epidemics in the south korean population. Cancer. 2021;127(10):1638-47. https://doi.org/10.1002/cncr.33434.
34. Tsai YS, Chen YC, Chen TI, Lee YK, Chiang CJ, You SL, et al. Incidence trends of oral cavity, oropharyngeal, hypopharyngeal and laryngeal cancers among males in taiwan, 1980-2019: A population-based cancer registry study. BMC Cancer. 2023;23(1):213. https://doi.org/10.1186/s12885-023-10651-6.
35. Arora S, Squier C. Areca nut trade, globalisation and its health impact: Perspectives from india and south-east asia. Perspect Public Health. 2019;139(1):44-8. https://doi.org/10.1177/1757913918785398.
36. Yang JJ, Yu D, Wen W, Shu XO, Saito E, Rahman S, et al. Tobacco smoking and mortality in asia: A pooled meta-analysis. JAMA Netw Open. 2019;2(3):e191474. https://doi.org/10.1001/jamanetworkopen.2019.1474.
37. Edwards R, Ball J, Hoek J, Waa A. Key findings for smoking and e-cigarette use prevalence and trends in the 2021/22 NZ Health Survey: continued rapid falls in smoking prevalence and increases in vaping. Public Health Expert. Wellington, New Zealand; 2022 Dec 13.
38. Alcohol Healthwatch. Drinking in the past year [Internet]. Auckland, New Zealand [cited 2024 26 March]. Available from: https://www.actionpoint.org.nz/drinking_in_the_past_year.
39. Ariyawardana A, Johnson NW. Trends of lip, oral cavity and oropharyngeal cancers in australia 1982-2008: Overall good news but with rising rates in the oropharynx. BMC Cancer. 2013;13:333. https://doi.org/10.1186/1471-2407-13-333.
40. Chan MH, Wang F, Mang WK, Tse LA. Sex differences in time trends on incidence rates of oropharyngeal and oral cavity cancers in hong kong. Ann Otol Rhinol Laryngol. 2018;127(12):895-902. https://doi.org/10.1177/0003489418802287.
41. Stepan KO, Mazul AL, Larson J, Shah P, Jackson RS, Pipkorn P, et al. Changing epidemiology of oral cavity cancer in the united states. Otolaryngol Head Neck Surg. 2023;168(4):761-8. https://doi.org/10.1177/01945998221098011.
42. Nip J, Edwards R, Ball J, Hoek J, Waa A. Smoking prevalence and trends: key findings in the 2022/23 NZ Health Survey [Internet]. Wellington, New Zealand [updated 14 December 2023]. Available from: https://www.phcc.org.nz/briefing/smoking-prevalence-and-trends-key-findings-202223-nz-health-survey.
43. Weatherspoon DJ, Chattopadhyay A, Boroumand S, Garcia I. Oral cavity and oropharyngeal cancer incidence trends and disparities in the united states: 2000-2010. Cancer Epidemiol. 2015;39(4):497-504. https://doi.org/10.1016/j.canep.2015.04.007.
44. Javadi P, Sharma A, Zahnd WE, Jenkins WD. Evolving disparities in the epidemiology of oral cavity and oropharyngeal cancers. Cancer Causes Control. 2017;28(6):635-45. https://doi.org/10.1007/s10552-017-0889-8.
45. Tataru D, Mak V, Simo R, Davies EA, Gallagher JE. Trends in the epidemiology of head and neck cancer in london. Clin Otolaryngol. 2017;42(1):104-14. https://doi.org/10.1111/coa.12673.
46. Mazul AL, Chidambaram S, Zevallos JP, Massa ST. Disparities in head and neck cancer incidence and trends by race/ethnicity and sex. Head Neck. 2023;45(1):75-84. https://doi.org/10.1002/hed.27209.
47. Listl S, Jansen L, Stenzinger A, Freier K, Emrich K, Holleczek B, et al. Survival of patients with oral cavity cancer in germany. PLoS One. 2013;8(1):e53415. https://doi.org/10.1371/journal.pone.0053415.
48. Chen SW, Zhang Q, Guo ZM, Chen WK, Liu WW, Chen YF, et al. Trends in clinical features and survival of oral cavity cancer: Fifty years of experience with 3,362 consecutive cases from a single institution. Cancer Manag Res. 2018;10:4523-35. https://doi.org/10.2147/cmar.S171251.
49. Zanoni DK, Montero PH, Migliacci JC, Shah JP, Wong RJ, Ganly I, et al. Survival outcomes after treatment of cancer of the oral cavity (1985-2015). Oral Oncol. 2019;90:115-21. https://doi.org/10.1016/j.oraloncology.2019.02.001.
50. Teng AM, Atkinson J, Disney G, Wilson N, Blakely T. Changing socioeconomic inequalities in cancer incidence and mortality: Cohort study with 54 million person-years follow-up 1981-2011. Int J Cancer. 2017;140(6):1306-16. https://doi.org/10.1002/ijc.30555.
51. Gurney JK, Robson B, Koea J, Scott N, Stanley J, Sarfati D. The most commonly diagnosed and most common causes of cancer death for māori new zealanders. N Z Med J. 2020;133(1521):77-96.
52. Chaturvedi AK, Anderson WF, Lortet-Tieulent J, Curado MP, Ferlay J, Franceschi S, et al. Worldwide trends in incidence rates for oral cavity and oropharyngeal cancers. J Clin Oncol. 2013;31(36):4550-9. https://doi.org/10.1200/jco.2013.50.3870.
53. Kennedy-Langley DT. The role of primary oral healthcare clinicians in the detection and diagnosis of oral and oropharyngeal cancer in New Zealand [Master thesis] Otago: University of Otago; 2017.
54. Owens D, Paleri V, Jones AV. Head and neck cancer explained: An overview of management pathways. Br Dent J. 2022;233(9):721-5. https://doi.org/10.1038/s41415-022-5199-1.
55. Collins R, Flynn A, Melville A, Richardson R, Eastwood A. Effective health care: Management of head and neck cancers. Qual Saf Health Care. 2005;14(2):144-8. https://doi.org/10.1136/qshc.2005.013961.