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Original Article

Predictors of 5-Year Survival in Oral Cancer Patients in Mongolia: Age, Urban Residence, Stage, and Recurrence as Key Risk Factors

Franz K. Müller[1]*, Lucia F. Romano[1], Tesfaye M. Bekele[1]

[1]Department of Oral Surgery, Faculty of Medicine, University of Vienna, Vienna, Austria.

***E-mail** ✉ franz.mueller@outlook.com

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ABSTRACT

Oral cancers, especially those affecting the head and neck region, remain a major cause of mortality in developing nations such as Mongolia. This study employed a retrospective design to evaluate factors influencing 5-year survival outcomes among patients diagnosed with oral squamous cell carcinoma. We examined records from 173 patients with confirmed oral squamous cell carcinoma. Variables collected included demographic details (age, sex, residence, education), lifestyle factors (tobacco and alcohol use), oral health status, family cancer history, precancerous conditions, tumor characteristics, treatment regimens, rehabilitation data, recurrence, and survival status at five years. Survival estimates were generated using Kaplan–Meier analysis, and statistical procedures were conducted using STATA software. The overall 5-year survival rate across all oral cancer cases was 50.3%, while patients with tongue carcinoma demonstrated a lower survival rate of 38%. Key predictors for survival included age, place of residence, cancer stage, and recurrence. Patients older than 60 years exhibited a higher risk of death compared with those 60 or younger (HR = 1.52). Female patients experienced better survival outcomes (HR = 0.47, CI = 0.29–0.77). Urban residence was linked with worse survival (HR = 1.92, CI = 1.22–3.05). The presence of recurrent cancer nearly doubled the risk of mortality (HR = 1.99, CI = 1.15–3.04). Stage IV disease was associated with a fourfold increase in mortality risk compared to stage I patients (HR = 4.08, CI = 1.2–13.84).Findings indicate that advanced age, urban living, and tumor recurrence significantly decrease survival probabilities in oral cancer patients. Stage IV disease further amplifies mortality risk. These results highlight the importance of early diagnosis, timely intervention, and rigorous monitoring to detect oral cancers at earlier stages. Mongolia's survival rates remain lower than in developed countries, emphasizing the need for public education, preventive strategies, and comprehensive cancer awareness programs to improve outcomes.

Keywords: Oral cancer, Patient, Mongolia, Risk factors

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Introduction

The burden of oral cancer disproportionately affects low- and middle-income countries, with reported 5-year survival rates considerably lower than those in high-income settings. In 2020, approximately 476,125 new cases of oral or oropharyngeal cancer were documented globally [1]. Data from the SEER program (2013–2019) showed a 5-year relative survival rate of 68.5% for oral cavity and pharyngeal cancers [2]. The prevalence of oral cancers varies by geography and population demographics, with South and Southeast Asia exhibiting the highest incidence [3, 4].

Several risk factors are implicated in oral cancer etiology, including tobacco, alcohol, diet, oral hygiene, comorbidities, HPV infection, and betel nut chewing [1, 5–9]. Oral cancer can also develop in non-smokers [10]. Younger patients are increasingly affected, particularly with tongue cancer [6]. A systematic review in Saudi Arabia reported prevalence rates ranging from 21.6% to 68.2%, with male-to-female ratios between 36.6% and 65.4% [11]. Chinese studies demonstrated that patients with BMI <18.5 kg/m², younger than 55 years, advanced clinical stages (II–IV), and poor differentiation exhibited lower survival

[12]. Socioeconomic factors, including low education, farming occupation, and low household income, were linked to increased oral cancer risk in India [13].

Tumor-specific factors such as stage, location, histologic differentiation, treatment modality, and post-treatment care quality also affect survival [14–16]. For example, post-surgical 5-year survival differs by TNM stage: stage I patients achieved 90% survival, whereas stage IV patients had 45%, with cervical lymph node recurrence reducing survival rates further [17]. Another cohort found that 51.1% of patients had tongue cancer, 49.1% underwent postoperative radiotherapy, and node-negative patients had 79% 5-year survival versus 59% for node-positive patients [18]. Dutch data similarly revealed declining survival with increasing cancer stage [19].

The main aim of this study was to evaluate the 5-year survival rate of patients diagnosed with oral cancer, categorized according to histopathologic grading. Research examining factors that contribute to oral cancer recurrence is limited, highlighting a critical knowledge gap. Identifying these risk factors is crucial for enabling early detection, tailoring individualized treatment plans, and improving outcomes for patients in Mongolia.

This retrospective survival analysis was designed to provide a comprehensive assessment of multiple variables influencing oral cancer survival, including demographic characteristics, lifestyle habits, tumor features, treatment modalities, and other relevant clinical factors.

Materials and Methods

Study design

Medical records from 173 patients diagnosed with oral squamous cell carcinoma at the National Cancer Center of Mongolia, within the Department of Head and Neck Surgery, Radiation, and Chemotherapy between 2012 and 2017, were reviewed for this study.

Study setting, participants, and recruitment

Eligible participants were adults with histologically confirmed squamous cell carcinoma of the oral cavity, treated at the National Cancer Center between 2012 and 2017. Inclusion required a biopsy-confirmed oral cancer diagnosis to ensure accurate case selection. Patients with prior malignancies in other anatomical regions were excluded to isolate the impact of oral cancer on survival. Relevant data were periodically extracted from medical records, including survival outcomes and risk factors. Standardized medical history forms were used by healthcare providers to capture reliable and consistent information on variables such as age, sex, tumor location, histopathologic grade, TNM stage, tobacco and alcohol use, combined treatment approaches, and cervical lymph node metastasis.

Exclusion criteria

Patients were excluded if they:

- Died from causes unrelated to oral cancer, to ensure survival analysis reflected oral cancer-specific outcomes.
- Had a history of malignancy in regions other than the oral cavity, maintaining a homogeneous cohort focused on primary oral cancer.

Variables

The primary outcome was the 5-year survival rate for oral cancer patients. Secondary outcomes included tumor site (lips, tongue, gums, floor of the mouth, palate), histopathologic grade, and TNM stage according to the American Joint Committee on Cancer guidelines [20]. Oral cancer subsite classifications were based on ICD-10 codes: lips (C00), tongue (C02), gums (C03), floor of the mouth (C04), and palate (C05) [21]. Predictor variables included demographics (age, sex, residence), lifestyle behaviors (smoking, alcohol consumption), and clinical indicators (tumor size, stage, treatment modality). Tumor differentiation was categorized as G1 (well-differentiated), G2 (moderately differentiated), G3 (poorly differentiated), and G4 (undifferentiated) [22, 23]. Tumor recurrence during follow-up was recorded as a binary variable (“Yes” or “No”), with tobacco and alcohol consumption similarly coded due to limitations in the hospital registration system.

Sample size

The study analyzed 173 individuals with squamous cell carcinoma of the oral cavity. Participants were selected based on medical record availability and eligibility criteria.

Statistical analysis

All statistical analyses were conducted using Stata 15. Continuous variables such as age, tumor size, and lymph node involvement were categorized for clarity. Age was grouped into ranges (21–30, 31–40, 41–50, etc.). Tumor size was classified as T1, T2, T3, or T4, while lymph node status was recorded as N0, N >1, or NX. Cancer stage was grouped into I, II, III, or IV. Categorical variables were described using frequencies and percentages.

Survival outcomes were analyzed using the Kaplan–Meier method, with the log-rank test comparing survival distributions across factors. Hazard ratios

were determined via Cox proportional-hazards regression. Univariate and multivariate Cox models were applied to identify predictors of oral cancer survival, while logistic regression was used to evaluate independent risk factors for cancer recurrence, calculating odds ratios. All statistical tests were two-sided with a significance threshold of $P < 0.05$. Hazard ratios are reported with 95% confidence intervals. Missing data were handled using complete case analysis, excluding cases with incomplete variables from analysis.

Ethical considerations

The study adhered to strict ethical protocols to protect participants' safety and confidentiality. The research protocol was approved by the Research Ethics Committee of the Mongolian National University of Medical Sciences. Ethical approval was formally granted on June 8, 2021 (Approval No. 2021/3-07). All patient information was anonymized to maintain privacy, and data were handled according to stringent confidentiality standards. Retrospective data were managed carefully, following established guidelines for secondary research and ensuring compliance with data protection regulations.

Results and Discussion

Cohort selection

The retrospective cohort study initially identified 500 potential participants. Upon evaluating 143 individuals against inclusion criteria, these were excluded due to missing data or failure to meet eligibility, leaving 357 eligible participants. During data collection, additional exclusions occurred for incomplete or inconsistent records, reducing the cohort to 300. One hundred participants were lost to follow-up, resulting in a final group of 200 participants who completed the entire study period. After further data cleaning, the final analyzed sample consisted of 173 individuals, as illustrated in **Figure 1**.

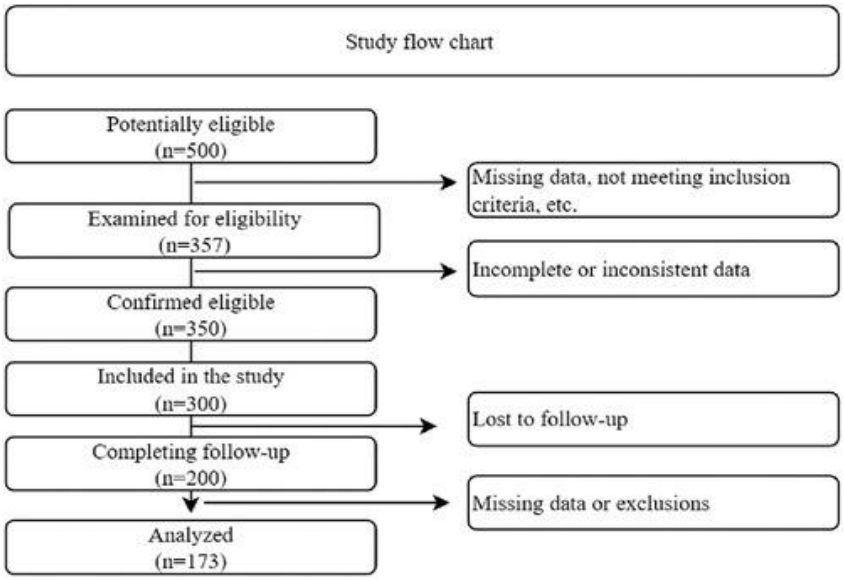

Figure 1. Study flow chart of cohort selection.

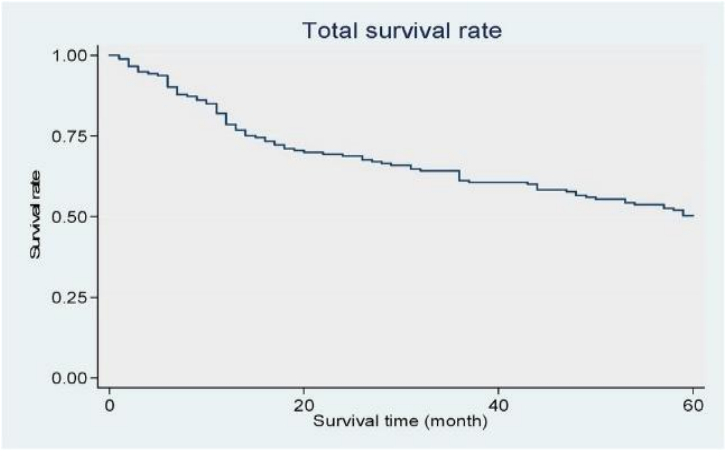

Figure 2. Kaplan–Meier survival curve showing declining overall survival of oral cancer patients over time.

Patient characteristics

During the study period, 173 oral cancer cases were recorded. Of these, 109 cases (63.0%) were male and 64 cases (37.0%) were female. The age group 61–70 years included 49 patients (28.3%), representing a substantial portion of the cohort. Most patients had intermediate education levels, and 56% resided in urban areas. Regarding lifestyle factors, 97 patients (56.1%) used tobacco, 131 (75.7%) consumed alcohol, and 156 (90.2%) reported no family history of cancer. Ten patients (5.8%) had precancerous lesions such as leucoplakia. The most common tumor site was the tongue (79 patients, 45.7%), followed by lips (23 patients, 13.3%) and the hard or soft palate (16 patients, 9.2%). At diagnosis, 73 patients (42.2%) were classified as stage III, and 132 (76.3%) had well-differentiated tumors. Regarding treatment, 110 patients (64%) underwent surgery alone, 15 (8.7%) had surgery with chemotherapy, and 14 (8.1%) received surgery combined with radiotherapy. Cancer recurrence was observed in 26 patients (15%), as summarized in **Table 1**.

Table 1. Socio-demographic, clinical, and treatment characteristics of oral cancer patients (N = 173)

Variables	Percent (%)	Count (N)
Age		
21–30	5.2	9
31–40	10.4	18
41–50	10.4	18
51–60	22.5	39
61–70	28.3	49
71–80	18.5	32
Over 81	4.6	8
Gender		
Male	63.0	109
Female	37.0	64
Residence		
Urban	43.9	76
Rural	56.1	97
Education		
None	2.9	5
Basic	15.0	26
Intermediate	46.8	81
Short-cycle tertiary	9.8	17
Advanced	25.4	44
Tobacco consumption		
No	56.1	97
Yes	43.9	76
Alcohol consumption		
No	75.7	131
Yes	24.3	42
Tobacco and alcohol use		
No	78.0	135
Yes	22.0	38
Chipped teeth		
No	91.3	158
Yes	8.7	15
Denture sores		
No	86.7	150
Yes	13.3	23
Family history		
No	90.2	156
Yes	9.8	17
Precancerous conditions		
No	87.9	152
Leukoplakia	5.8	10

Others	6.3	11
Cancer location		
Tongue	45.7	79
Lip	13.3	23
Cheek lining	5.8	10
Gums	8.7	15
Floor of the mouth	9.2	16
Hard palate	5.2	9
Soft palate	9.2	16
Retromolar space	2.9	5
Tumor size		
T1	12.1	21
T2	31.8	55
T3	32.4	56
T4	23.7	41
Lymph node		
N0	20.8	36
N > 1	66.5	115
NX	12.7	22
Metastasis		
M0	79.2	137
M1	2.3	4
MX	18.5	32
Stage		
I	6.4	11
II	14.5	25
III	42.2	73
IVA	27.2	47
IVB	7.5	13
IVC	2.3	4
Pathological grading		
G1 well-differentiated	76.3	132
G2 moderately differentiated	2.9	5
G3 poorly differentiated	17.9	31
G4 undifferentiated	2.9	5
Treatment		
Surgery	64.0	110
CT	2.9	5
RT	1.2	2
Surgery + CT	8.7	15
Surgery + RT	8.1	14
CT+RT	4.7	8
Surgery + CT + RT	10.5	18
Rehabilitation		
Yes	43.4	75
No	56.6	98
Cancer recurrence		
No	85.0	147
Yes	15.0	26
Survival in 5 years		
Alive	50.3	87
Passed away	49.7	86

CT = chemotherapy; RT = radiotherapy.

Univariate analysis of 5-year survival

The 5-year survival rate and prognostic factors for the 173 participants were evaluated **(Table 2).** Age significantly influenced survival outcomes. The

youngest group (21–30 years) had the highest 5-year survival (77.8%) and lowest hazard ratios, whereas survival decreased with age; patients older than 81 years had the lowest survival (37.5%). Gender also affected survival, with females showing higher 5-year survival (67.2%) compared to males (40.4%). Residence had a minor effect: rural participants had slightly better survival (56.7%) than urban participants (42.1%). Tobacco use, alcohol consumption, and the presence of chipped teeth were associated with lower survival, while education level, denture sores, family history, and precancerous conditions did not significantly affect outcomes.

Table 2. 5-year survival rates and univariate analysis of prognostic factors for oral cancer patients (N = 173)

Category	Total survivors at 5 years		P-value	Min–max		Log-rank P	Hazard ratio (95% CI)	
Age group	**N**	**%**						
21–30	7	77.8	0.082	60	(3–60)	0.051		
31–40	14	77.8	—	60	(7–60)	—		
41–50	10	55.6	—	60	(1–60)	—		1
51–60	19	48.7	—	59	(4–60)	—	0.86	(0.15–4.69)
61–70	20	40.8	—	31	(1–60)	—	2.02	(0.43–9.52)
71–80	14	43.8	—	53	(9–60)	—	2.38	(0.24–0.56)
Over 81	3	37.5	—	22	(2–60)	—	3.51 (0.84–14.74)	
Gender							2.71 (0.63–11.69)	
Male	44	40.4	0.001	44	(1–60)	0.002	4.12 (0.79–21.25)	
Female	43	67.2	—	60	(1–60)	—		
Residence								1
Rural	55	56.7	0.057	60	(2–60)	0.042	0.47	(0.29–0.77)
Urban	32	42.1	—	48	(1–60)	—		
Education level								1
Advanced	22	50.0	0.830	59.5	(1–60)	0.841	1.54	(1.01–2.35)
None	2	40.0	—	49	(6–60)	—		
Basic	12	46.2	—	47.5	(10–60)	—		1
Intermediate	44	54.3	—	60	(1–60)	—	1.18	(0.35–3.95)
Short-cycle tertiary	7	41.2	—	59.5	(1–60)	—	1.10	(0.56–2.15)
Tobacco use							0.88	(0.52–1.50)
No	56	57.7	0.027	60	(1–60)	0.071	1.28	(0.61–2.72)
Yes	31	40.8	—	46	(2–60)	—		
Alcohol intake								1
No	71	54.2	0.069	60	(1–60)	0.087	1.47	(0.96–2.24)
Yes	16	38.1	—	44	(3–60)	—		
Chipped teeth								1
No	83	52.5	0.056	60	(1–60)	0.087	1.49	(0.94–2.36)
Yes	4	26.7	—	37	(6–60)	—		
Denture sores								1
No	77	51.3	0.483	60	(1–60)	0.431	1.72	(0.91–3.24)
Yes	10	43.5	—	47	(5–60)	—		
Family history								1

No	80	51.3	0.429	60	(1–60)	0.286	1.26	(0.70–2.28)
Yes	7	41.2	—	47	(5–60)	—		
Precancerous conditions								1
None	76	50.0	0.393	59.5	(1–60)	0.650	1.42	(0.74–2.75)
Leukoplakia	4	40.0	—	50	(3–60)	—		
Other types	7	70.0	—	60	(1–60)	—		1
							1.23	(0.53–2.82)
							0.54	(0.17–1.72)

Univariate analysis of 5-year survival

Table 3 presents a detailed assessment of 5-year survival outcomes and univariate prognostic factors among 173 Mongolian oral cancer patients. Tumor location within the oral cavity significantly influenced survival. Tongue cancer patients exhibited a notably reduced 5-year survival rate of 38.0%, with a corresponding hazard ratio (HR) of 3.81 (95% CI: 0.71–15.71), indicating elevated mortality risk. Larger tumors (T3 and T4) were linked to lower survival and higher HRs when compared to smaller tumors (T1). Lymph node involvement (N stage) and metastatic spread (M stage) substantially affected survival, with HRs reflecting increased risk in both situations. Advanced cancer stages (III and IV) were associated with diminished survival and higher HRs. The analysis also considered treatment type, cancer recurrence, and histopathologic tumor grade. Notably, recurrence demonstrated a strong negative effect on survival, with an HR of 2.78 (95% CI: 1.69–4.75).

Table 3. Five-year survival and univariate analysis of prognostic factors (N = 173)

	Total survival and in 5 years		P-value[a]	Total survival (months) in 5 years	Log-rank P &	Hazard ratio[b] (95% CI)
	Count (N)	Percent (%)		Median (min–max)		
Cancer location						
Hard palate	7	77.8	0.155	60(2–60)	0.130	1
Tongue	30	38.0		36 (2–60)		3.81 (0.93–15.71)
Lip	15	65.2		60 (4–60)		1.67 (0.35–7.88)
Cheek lining	6	60.0		60 (14–60)		1.84 (0.34–10.08)
Gums	8	53.3		60(1–60)		2.78 (0.58–13.41)
Floor of the mouth	9	56.3		60(1–60)		2.32 (0.48–11.18)
Soft palate	9	56.3		60(5–60)		2.25 (0.47–10.83)
Retromolar space	3	60.0		60 (26–60)		1.82 (0.26–12.95)
Tumor size						
T1	13	61.9	0.001	60(2–60)	<0.001	1
T2	37	67.3		60(3–60)		0.89 (0.39–2.05)
T3	25	44.6		52.5 (2–60)		1.77 (0.81–3.85)
T4	12	29.3		26(1–60)		2.88 (1.31–6.31)
Lymph node						
N0	28	77.8	<0.001	60 (6–60)	<0.001	1
N > 1	46	40.0		7.5 (2–18)		3.64 (1.74–7.57)
NX	13	59.1		60(6–60)		2.01 (0.78–5.22)
Metastasis						
M0	73	53.3		60 (1–60)	<0.001	1
M1	0	0.0	0.079	7.5 (2–18)		7.29 (2.59–20.52)
MX	14	43.8		49(3–60)		1.27 (0.75–2.14)
Stage						

I	8	72.7	<0.001	60(8–60)	<0.001	1
II	20	80.0		60 (12–60)		0.74 (0.18–3.09)
III	41	56.2		60(2–60)		1.83 (0.56–5.97)
IV	18	28.1		20.5 (1–60)		4.41 (1.37–14.23)
Pathological grading						
Well	64	48.5	0.848	58.5 (1–60)	0.943	1
Moderate	3	60.0		60(7–60)		0.78 (0.19–3.19)
Poor	17	54.8		60(6–60)		0.87 (0.49–1.55)
Undifferentiated	3	60.0		60(4–60)		0.81 (0.19–3.30)
Treatment						
Surgery	63	57.3	0.074	60(1–60)	<0.001	1
CT	1	20.0		16(7–60)		3.16 (1.13–8.82)
RT	0	0.0		7.5 (6–9)		11.45 (2.64–49.68)
Surgery + CT	8	53.3		60(2–60)		1.02 (0.46–2.27)
Surgery + RT	3	21.4		13(2–60)		(1.64–6.19)
CT+RT	3	37.5		39.5 (6–60)		1.79 (0.71–4.51)
Surgery + CT + RT	8	44.4		40.5 (1–60)		1.59 (0.81–3.16)
Rehabilitation						
Yes	39	52.0	0.694	60(1–60)	0.706	1
No	48	49.0		59(1–60)		1.08 (0.71–1.66)
Cancer recurrence						
No	82	55.8	0.001	60 (1–60)	<0.001	1
Yes	5	19.2		16.5 (1–60)		2.78 (1.69–4.75)
Total	87	50.3		60(1–60)		

aChi-square test & log-rank Mantel–Cox test (mean ± standard error), bCox regression.

Multivariate analysis of 5-year survival

Table 4 summarizes both unadjusted and adjusted survival estimates for factors influencing oral cancer survival. Hazard ratios indicate relative mortality risks, and 95% confidence intervals (CI) reflect estimate precision. Adjustments were made for residence, cancer stage, surgery, and recurrence, as these variables are known or hypothesized to impact survival outcomes. Multivariate Cox proportional hazards regression included all prognostic factors that were significant in univariate analysis.

Patients residing in urban areas had poorer outcomes (HR = 1.92, 95% CI: 1.21–3.05) compared to those in rural areas. Cancer recurrence was also a strong predictor of decreased survival (HR = 1.99, 95% CI: 1.15–3.44). Stage IV cancer patients had a fourfold increase in mortality risk (HR = 4.08, 95% CI: 1.2–13.84) relative to stage I patients. Age, tumor differentiation, and surgical intervention were not significantly associated with overall survival.

Table 4. Multivariate analysis of prognostic factors for oral cancer survival (N = 173)

Variable	Category	Hazard Ratio (HR)	95% Confidence Interval	P-value
Age	≤60 years	1 (reference)	—	
	>60 years	1.52	0.96–2.39	0.070
Residence	Rural	1 (reference)	—	
	Urban	1.92	1.21–3.05	0.006
Overall Stage	Stage I	1 (reference)	—	
	Stage II	0.86	0.20–3.65	0.839
	Stage III	1.76	0.52–5.91	0.363
	Stage IV	4.08	1.20–13.84	0.024
Pathological Grade	Well to moderately differentiated	1 (reference)	—	
	Poorly to undifferentiated	1.10	0.62–1.96	0.743

Surgery Performed	Yes	1 (reference)	—	
	No	0.83	0.49–1.39	0.486
Cancer Recurrence	No	1 (reference)	—	
	Yes	1.99	1.15–3.44	0.014

Yes: HR = 1.99; 95% CI = 1.15–3.44; P = 0.014.
aChi-square test, bCox proportional hazards logistic regression, adjusted for all variables.

The findings indicate that age, urban residence, cancer stage, and recurrence are critical predictors of survival in oral cancer. Older age, living in urban areas, advanced stage (IV), and recurrence were associated with increased mortality risk. The negative impact of advanced age aligns with prior studies [24–26]. Urban residence also emerged as a significant risk factor, which may reflect higher urban population density in Ulaanbaatar and differential access to screening services.

Using Kaplan–Meier analysis, the overall 5-year survival rate for oral cancer in this cohort was 50.3%. By comparison, SEER data from 2013–2019 reported a relative 5-year survival rate of 68.5%, slightly higher than observed in this study [2]. The lower survival rate may be explained by population-specific differences in healthcare availability, diagnostic screening, and treatment practices.

Zanoni *et al.* [27] analyzed 2,085 newly diagnosed oral cancer patients between 1985 and 2015 and reported a 5-year survival rate of 64.4%, higher than the 50.3% observed in our cohort. Stage-specific survival rates in our study were 72.7% (stage I), 80% (stage II), 56.2% (stage III), and 28.1% (stage IV), demonstrating significantly higher mortality in advanced stages ($P < 0.001$), consistent with other studies [28, 29]. In the United States, T4 oral cancer patients had a 1.8-fold higher mortality risk versus T1, with a 39.1% survival rate. Our study found a 2.88-fold increased risk and a 29.3% survival rate for the same comparison [27].

Even with conventional interventions like surgery, radiotherapy, and chemotherapy, the prognosis and overall survival of patients with oral squamous cell carcinoma remain poor [16, 30]. Nevertheless, the past three decades have seen notable progress in early cancer detection, management of cervical lymph node metastases, postoperative chemotherapy, radiation therapy, and surgical techniques, all of which have contributed to improved survival outcomes [31–33].

In Brazil, a study reported that 77.4% of 703 oral cancer patients treated between 2007 and 2009 were male. In our cohort, males accounted for 63% of cases, which is lower than the Brazilian findings. Similar to our data (79.2%), 73.4% of patients in the Brazilian study presented with advanced-stage disease (III or IV). The 5-year survival rate reported in Brazil was 27.9%, markedly lower than the 50.3% observed in our research. The lower survival there may be explained by the comparatively small proportion of patients receiving either surgery alone or combined treatments (43.7%) versus surgery alone (91.3%) in our cohort. In contrast to our findings, the Brazilian study indicated that non-surgical therapy (HR 3.11; 95% CI 2.24–4.29; $p < 0.001$) and age over 60 (HR 1.37; 95% CI 1.01–1.50; $p < 0.001$) were strongly linked to mortality. In our cohort, neither non-surgical treatment (HR 0.83; 95% CI 0.49–1.39; $p = 0.486$) nor age above 60 (HR 1.52; 95% CI 0.96–2.42; $p = 0.07$) significantly influenced survival. Advanced tumor stage remained a consistent risk factor, with stage IV cancer in our study showing HR = 4.08 (95% CI 1.2–13.4; $p = 0.024$), similar to the Brazilian results (HR 2.14; 95% CI 1.68–2.74; $p < 0.001$) [9].

Geum *et al*. [17] investigated oral cancer patients undergoing radical surgery between 1998 and 2008, reporting a 5-year survival rate of 75.7%, higher than our 50.3%. Stage-specific survival in Geum's study was 90% (I), 80% (II), 100% (III), and 45.5% (IV), while our corresponding results were 72.7%, 80.0%, 56.3%, and 28.5%. Lymph node metastasis survival rates in Geum's cohort ranged from 92.6% (N0) to 30% (N1) and 92.6% (M0) to 0% (M1), compared to 72.8% (N0) to 40% (N1) and 53.3% (M0) to 0% (M1) in our study. These findings highlight that metastatic spread to lymph nodes and distant organs significantly reduces survival, which aligns with our results. While other populations show higher overall survival, late-stage diagnoses and metastasis substantially decrease survival probabilities, reflecting the heightened mortality risk associated with advanced disease.

A Taiwanese retrospective cohort of 3,010 oral squamous cell carcinoma patients who underwent surgery, radiotherapy, and chemotherapy showed that 34.9% (1,050) of tumors were located in the buccal mucosa and 16% (482) in the alveolar ridge. In contrast, alveolar tumors comprised 61.2% (295) of cases, and retromolar lesions 58.2% (92) were diagnosed at stages III–IV, while most other tumors were detected early (I–II). In our study, 45.7% (79) of malignancies were on the tongue and 13.3% (23) on the lips, with late-stage disease common outside the hard palate. Geographic differences in tumor site may reflect regional risk factors: in Taiwan, oral tobacco use predominates, whereas in Mongolia, alcohol, cigarette

use, sharp teeth, and denture irritation contribute to tongue and lip cancers. This demonstrates that tumor localization varies internationally based on local etiologic factors [34].

A Dutch study (2006–2010) indicated that tumor site significantly impacted survival: tongue cancer had a 65% survival rate, higher than our 38%; gum and alveolar cancers 53% versus our 53.3%; floor-of-mouth tumors 57% versus our 56.3%; palatal cancers 67% versus our 77.8%; and lip (65.2%), buccal mucosa (60%), soft palate (56.3%), and retromolar space (60%) all exceeded our observed rates [35]. SEER data for 6,791 early-stage (I–II) oral cancers diagnosed 1998–2004 showed survival rates comparable to ours (45.7%), with tongue cancer survival at 60.4% versus our 38%, and other oral sites 64.7% versus our 61.27% [36]. This underscores that tongue malignancies have poorer outcomes due to biological and epidemiological differences, as well as higher recurrence risk. Tumor invasion into muscles, bones, nerves, vessels, lymph nodes, or distant sites further influences survival.

Several limitations should be acknowledged. Bias and imprecision may affect the study's estimates. Selection bias could arise from relying on hospital records, potentially excluding patients treated elsewhere or with incomplete records, which may limit generalizability and produce an inaccurate representation of the population.

The investigation used a retrospective approach, meaning data were collected after patient outcomes were already known. This methodology increases the chance of recall and misclassification biases. Variations in the quality and completeness of medical records could have led to inaccuracies or bias in estimating prognostic factors and their impact on survival. Even though adjustments were made for potential confounders such as age and residential location, other unmeasured or residual confounders might still have influenced results. Factors like socioeconomic status, lifestyle habits, comorbidities, or access to healthcare could affect both exposures (prognostic indicators) and outcomes (survival), and the absence of these variables may have introduced bias in estimating associations.

Continuous variables, for instance age, were grouped into categories, which may have reduced the precision of estimates and led to some information loss. The selection of category thresholds could affect interpretation and potentially create artificial relationships or mask true associations. The relatively small sample size (N = 173) may have limited the study's statistical power, increasing the possibility of random variation and reducing the reliability of the observed associations. Consequently, the effect sizes reported should be interpreted with caution.

Since the analysis focused on patients with oral squamous cell carcinoma in a specific geographic region, the results may not be generalizable to other cancer types or populations. Additionally, the study was conducted in a particular healthcare setting, so caution is needed when applying these findings to regions with different healthcare resources or patient demographics. Despite these limitations, the study provides useful insights into survival predictors for oral cancer, but potential biases and imprecision must be taken into account to avoid overgeneralization and to inform future research directions.

Conclusion

In this cohort, the overall 5-year survival for oral cancer was 50.3%, with tongue cancer patients showing the lowest survival at 38%. Increased mortality risk was observed among older patients, urban residents, individuals with stage IV cancer, and those experiencing cancer recurrence. Compared with survival rates reported in more developed nations, Mongolia shows comparatively poorer outcomes, largely due to late-stage presentation. These findings highlight the need for strategies that emphasize early oral cancer detection, public education on cancer prevention, and proactive surveillance programs.

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