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Board-certified facilities and survival in head and neck cancer in Japan: A hospital-based cancer registry study

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ABSTRACT

Objectives: Head and neck cancer (HNC) outcomes may vary with facility specialization. Japan operates a nationwide board certification system that accredits training facilities based on case volume, multidisciplinary capacity, and specialist staffing. We examined whether treatment at certified facilities is associated with survival and assessed geographic variation in access to such facilities.

Methods: In this nationwide retrospective cohort study using the hospital-based cancer registry, we included 75,196 patients with primary invasive HNC diagnosed between 2012 and 2015 who received first-course treatment at board-certified (n = 48,674; 119 facilities) or non-certified (n = 26,522; 386 facilities) facilities. The primary outcome was 5-year overall survival, analysed using multilevel survival models with facility-level random effects adjusted for age and sex, stratified by stage (I–II vs III–IV) and subsite.

Results: Board-certified facilities treated a higher proportion of patients with stage III–IV disease (55.2% vs 45.1%). For stage I–II disease, the 5-year survival was similar (76.7% vs 75.3%; adjusted hazard ratio [aHR], 0.99; 95% CI, 0.93–1.04). For stage III–IV disease, survival was higher at certified facilities (50.7% vs 44.9%; aHR, 0.86; 95% CI, 0.82–0.90). Stage-dependent associations were broadly consistent across subsites. The proportion of residents treated at certified facilities ranged from 9.7% to 91.9% across prefectures.

Conclusions: Treatment at board-certified facilities was associated with better survival for advanced but not early-stage HNC, suggesting specialization matters most for complex multimodality care. Substantial geographic variation in access represents a target for policy efforts aligning quality with equity.

Introduction

Head and neck cancers (HNCs) are a heterogeneous group of malignancies and remain a major global health burden. According to GLOBOCAN 2020, cancers of the oral cavity, pharynx, and larynx account for approximately 900,000 new cases and 500,000 deaths worldwide annually.[1] The optimal management of HNCs often requires coordinated multimodality care involving surgery, radiotherapy, and systemic therapy, with outcomes potentially influenced by institutional experience, case volume, multidisciplinary capacity, and access to specialized resources.[2–5]

To promote high-quality and standardized care, Japan introduced a nationwide board certification system for HNCs in 2009, under which training facilities are accredited based on predefined requirements for specialist staffing, multidisciplinary capability, and case volume.[6] In Japan, studies have reported differences in treatment patterns and survival between board-certified and non-certified facilities,[7] and a nationwide German study likewise demonstrated improved survival at certified HNC centres.[8] However, nationwide evidence from Japan remains limited regarding the survival implications of board-certified care, the patient groups most likely to benefit, and geographic variation in access to certified facilities. Ensuring equitable access to specialized care across regions remains an important policy challenge.[9]

In this study, we aimed to examine whether and where facility-related differences in outcomes for patients with HNCs persist. We

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used the nationwide hospital-based cancer registry (HBCR) to compare the 5-year overall survival (OS) of patients with HNCs treated at board-certified vs. non-certified facilities in Japan from 2012 to 2015, stratified by stage (I–II vs. III–IV) and tumour subsite. The secondary objective of the study was to elucidate prefecture-level variations in the proportion of patients receiving first-course treatment at board-certified facilities.

Materials and methods

Data source

Data from the nationwide HBCR in Japan, coordinated by the National Cancer Centre, were used. The HBCR collects standardized information on all newly diagnosed cancer cases at designated cancer care hospitals and related institutions, including demographic characteristics, tumour characteristics, and first-course treatment.[10] In 2017 the registry covered approximately 70% of all cancer cases in Japan.[10,11]

For survival analyses, the registry implements centralized procedures to ascertain vital status. For cases diagnosed until 2015, the National Cancer Centre verified the patients' vital status using municipal resident registration records and provided this information back to the participating hospitals for registry follow-up.

Study population

Patients diagnosed with primary HNC between January 1, 2012, and December 31, 2015, were identified. Eligible cases were those of invasive malignant neoplasms defined using the International Classification of Diseases, Oncology 3 (ICD-O-3) codes. Primary tumour sites were defined using ICD-O-3 topography codes and grouped as follows: oral cavity, C00.0–C06.9; nasopharynx, C11.0–C11.9; oropharynx, C01.9, C02.4, C05.1–C05.2, C09.0–C09.9, and C10.0/C10.2–C10.9; hypopharynx, C12.9 and C13.0–C13.9; larynx, C32.0–C32.9, plus C10.1; [12,13] major salivary glands, C07.9–C08.9; and nasal cavity and paranasal sinuses, C30.0 and C31.0–C31.9. Among tumours arising in the head and neck, those developing at ill-defined sites in the lip, oral cavity, and pharynx (C14.0, C14.2, and C14.8) and otologic sites (C30.1 and C44.2) were excluded. Patients with thyroid cancers, haematological malignancies (including malignant lymphomas and leukaemia), and tumours for which the primary site was not the head or neck were not included in the study population. To ensure the valid attribution of first-course treatment to the reporting facility, patients who did not receive first-course treatment at the registered hospital (e.g., did not receive treatment or received best supportive care only) were excluded. Patients with carcinoma in situ (stages 0 and cT0) and those with disease of an unknown stage were also excluded.

Exposure: Facility certification status

The primary exposure was the certification status of the treatment facility under the board certification system for head and neck surgeons in Japan. The key criteria that certified training facilities must meet are as follows: (1) accreditation as a training institution in otorhinolaryngology–head and neck surgery; (2) $\geq$ 100 newly diagnosed patients with HNC annually; (3) $\geq$ 1 full-time board-certified attending head and neck surgeon; (4) availability of multidisciplinary treatment infrastructure, including radiotherapy; and (5) participation in the national head and neck malignancy registry.[6] Using the publicly available list of certified training facilities for fiscal year 2020, hospitals were classified as board-certified or non-certified facilities.

Outcomes

The primary outcome was OS, defined as the time from diagnosis to death from any cause or the last confirmed follow-up. Patients who were alive at the last contact were censored at that date. The primary point of comparison was the OS between board-certified and non-certified facilities stratified by the integrated disease stage group (I–II vs. III–IV). Because HBCR records both clinical and pathological stages, the integrated stage was defined by prioritizing the pathological stage; the clinical stage was used when the pathological stage was unavailable owing to presurgical therapy or was otherwise unknown.[10]

Secondary outcomes included OS stratified by the subsite; the proportion of patients undergoing surgery as part of first-course treatment, stratified by subsite and stage group; and the prefecture-level proportion of patients treated at board-certified facilities, to assess geographic variation in access across Japan's 47 prefectures.

Covariates

Routinely collected patient- and tumour-level variables were extracted from the HBCR, including age at diagnosis (<40, 40–64, 65–74, and $\geq$ 75 years); sex; tumour subsite; clinical T, N, and M categories; and stage group (I–II vs III–IV). Clinical TNM categories and stages were coded according to the Union for International Cancer Control TNM Classification of Malignant Tumours, 7th edition, which was the standard used in the HBCR during the study period (2012–2015). Facility-level characteristics beyond certification status (e.g., academic status, bed volume, availability of advanced technologies, and multidisciplinary resources) were not available in the HBCR dataset.

Statistical analysis

Patient and tumour characteristics were summarized according to the facility certification status. OS was estimated using the Kaplan–Meier method and compared using the log-rank test. The 5-year OS was obtained from the Kaplan–Meier estimator. Kaplan–Meier curves and 5-year OS estimates for tumour subsites are reported in the Supplementary material.

To evaluate the association between facility certification status and mortality, three models were fitted. Model 1 was unadjusted. Model 2 was a Cox proportional-hazards model adjusted for age and sex. Model 3 (primary analysis) was a multilevel survival model with facility-level random effects, adjusted for age category and sex to account for the clustering of patients within facilities.[14] Hazard ratios (HRs) from Model 1 and adjusted HR (aHRs) from Models 2 and 3 were estimated for the overall cohort and for each tumour subsite, stratified by stage group (I–II vs. III–IV). The results from Model 3 are shown as a forest plot; the estimates from all three models are reported in the Supplementary material. For the sensitivity analysis, the primary analysis was repeated using clinical stage alone to define the stage groups. This approach was used because the integrated stage, which prioritizes pathological over clinical stage, may overrepresent pathological staging at facilities with higher surgical rates, potentially introducing differential staging accuracy between facility types.

To examine whether differences in treatment patterns underlie the observed survival benefit, the proportion of patients who underwent surgery as part of the first-course treatment between board-certified and non-certified facilities were compared, stratified by the tumour subsite and integrated stage group (I–II vs. III–IV). Nasopharyngeal cancer was excluded only from the surgical treatment-pattern analysis because radiotherapy, with or without chemotherapy, is an established primary treatment.

For each prefecture, the proportion of residents diagnosed with HNCs who received first-course treatment at board-certified facilities was calculated to assess geographic variation in access to certified care, and the results were visualized using a choropleth map. Prefectures were divided into equal-interval categories (80–100%, 60–80%, 40–60%, 20–40%, and 0–20%) and color-coded accordingly. Prefectural boundary data from the National Land Numerical Information were processed

using QGIS version 3.32.3. All analyses were performed using Stata SE version 19.0 (StataCorp LLC, College Station, TX, USA). Given the exploratory nature of this study, all P-values and HRs are reported descriptively; no formal significance threshold was applied. This study was reported in accordance with the STROBE guideline for observational studies.[15]

Ethics

This study was approved by the Data Utilization Review Committee for the Nationwide Collection of the HBCR data, National Cancer Centre, Japan (review no. 24–04), and by the Ethics Committee (approval details blinded for peer review). The requirement for individual informed consent was waived because this was a retrospective study that used de-identified registry data.

Results

Study population

Among the 117,299 patients with HNCs recorded in the HBCR between 2012 and 2015, 35,227 with no first-course treatment were excluded. The remaining 82,072 patients who received first-course treatment at either board-certified or non-certified facilities were further screened, and 6,876 patients with cT0, stage 0, or unknown disease stage were excluded. The final analytical cohort comprised 75,196 patients (Supplementary Fig. S1).

Patient characteristics

Of the 75,196 patients analysed, 26,522 (35.3%) and 48,674 (64.7%) received first-course treatment at non-certified facilities (386 facilities) and board-certified facilities (119 facilities), respectively (Table 1). Patients treated at board-certified facilities tended to be younger; the proportion of patients aged ≥ 75 years was lower among these patients (26.9% vs. 33.2%). The distribution of disease stage differed between the two facility types, with board-certified facilities treating a higher proportion of patients with stage III–IV disease than non-certified facilities (55.2% vs. 45.1%). Consistent with this finding, stages cT4 (25.1% vs. 18.6%) and cN2 (29.0% vs. 22.6%) were more frequent among patients treated at board-certified facilities, whereas the frequency of stage cM1 was similar between the facilities (2.9% vs. 3.1%). Across most subsites, stage III–IV disease was more common among patients treated at board-certified facilities.

Table 1
Patient and Tumour Characteristics by Facility Certification Status in the HBCR, 2012–2015.

	Non-certified facilities n = 26,522 (386 facilities)	Board-certified facilities n = 48,674 (119 facilities)
Age at diagnosis, n (%)		
<40 years	624 (2.4)	1538 (3.2)
40–64 years	8028 (30.3)	16,987 (34.9)
65–74 years	9056 (34.1)	17,042 (35.0)
≥75 years	8814 (33.2)	13,107 (26.9)
Sex, n (%)		
Male	19,801 (74.7)	36,882 (75.8)
Female	6721 (25.3)	11,792 (24.2)
Integrated stage, n (%)		
Stage I–II	14,557 (54.9)	21,826 (44.8)
Stage III–IV	11,965 (45.1)	26,848 (55.2)
Clinical T, n (%)		
T1	7732 (33.3)	11,103 (25.0)
T2	7881 (33.9)	14,886 (33.5)
T3	3301 (14.2)	7319 (16.5)
T4	4317 (18.6)	11,179 (25.1)
Clinical N, n (%)		
N0	15,396 (65.9)	26,162 (58.6)
N1	2329 (10.0)	4725 (10.6)
N2	5266 (22.6)	12,972 (29.0)
N3	354 (1.5)	810 (1.8)
Clinical M, n (%)		
M0	24,296 (96.9)	45,225 (97.1)
M1	784 (3.1)	1352 (2.9)
Oral cavity, n (%)		
Stage I–II	5112 (63.6)	8780 (54.7)
Stage III–IV	2921 (36.4)	7266 (45.3)
Nasopharynx, n (%)		
Stage I–II	301 (40.6)	562 (34.2)
Stage III–IV	441 (59.4)	1081 (65.8)
Oropharynx, n (%)		
Stage I–II	1537 (39.3)	2429 (31.7)
Stage III–IV	2376 (60.7)	5231 (68.3)
Hypopharynx, n (%)		
Stage I–II	1045 (30.0)	2521 (29.6)
Stage III–IV	2434 (70.0)	6007 (70.4)
Larynx, n (%)		
Stage I–II	4868 (71.2)	5493 (62.3)
Stage III–IV	1967 (28.8)	3322 (37.7)
Major salivary glands, n (%)		
Stage I–II	971 (53.0)	1097 (41.3)
Stage III–IV	861 (47.0)	1562 (58.7)
Nasal cavity and paranasal sinuses, n (%)		
Stage I–II	723 (42.8)	944 (28.4)
Stage III–IV	965 (57.2)	2379 (71.6)

Abbreviation: HBCR, Hospital-based Cancer Registry.

OS by facility certification status

In Kaplan–Meier analyses stratified by stage group, the survival curves for stage I–II disease largely overlapped between board-certified and non-certified facilities, with only a modest difference in the 5-year OS (76.7% [95% confidence interval [CI], 76.1%–77.2%] vs. 75.3% [95% CI, 74.6%–76.0%]). In contrast, the survival curves for stage III–IV disease were clearly separated, with higher survival among patients treated at board-certified facilities (5-year OS, 50.7% [95% CI, 50.1%–51.3%] vs. 44.9% [95% CI, 44.0%–45.8%], respectively) (Fig. 1; Supplementary Table S1).

In the primary multilevel parametric survival model (Model 3), the aHR for board-certified versus non-certified facilities was 0.99 (95% CI, 0.93–1.04) for stage I–II disease. In contrast, for stage III–IV disease, treatment at board-certified facilities was associated with lower mortality (aHR, 0.86; 95% CI, 0.82–0.90) (Fig. 2; Supplementary Table S2). These stage-dependent associations were consistent across all three models and in the sensitivity analysis using the clinical stage alone to define the stage groups (Supplementary Table S2 and S3).

Subsite-specific survival

Subsite-specific Kaplan–Meier curves showed patterns broadly consistent with those observed in the primary model. Differences between facility groups were generally more apparent among patients with stage III–IV disease than among those with stage I–II disease, although the magnitude of separation varied across subsites (Supplementary Fig. S2). The corresponding 5-year OS estimates by subsite and stage groups are shown in Supplementary Table S1.

In subsite-stratified analyses using the primary model (Model 3), among patients with stage III–IV disease, treatment at board-certified facilities was associated with lower mortality for several subsites, including the oral cavity (aHR, 0.81; 95% CI, 0.75–0.88), oropharynx (aHR, 0.89; 95% CI, 0.82–0.97), hypopharynx (aHR, 0.80; 95% CI, 0.74–0.87), larynx (aHR, 0.84; 95% CI, 0.77–0.92), and nasal cavity and paranasal sinuses (aHR, 0.80; 95% CI, 0.71–0.90) (Fig. 2; Supplementary Table S2). In contrast, the association was not clear for nasopharyngeal cancer (aHR, 0.91; 95% CI, 0.76–1.09) or major salivary gland

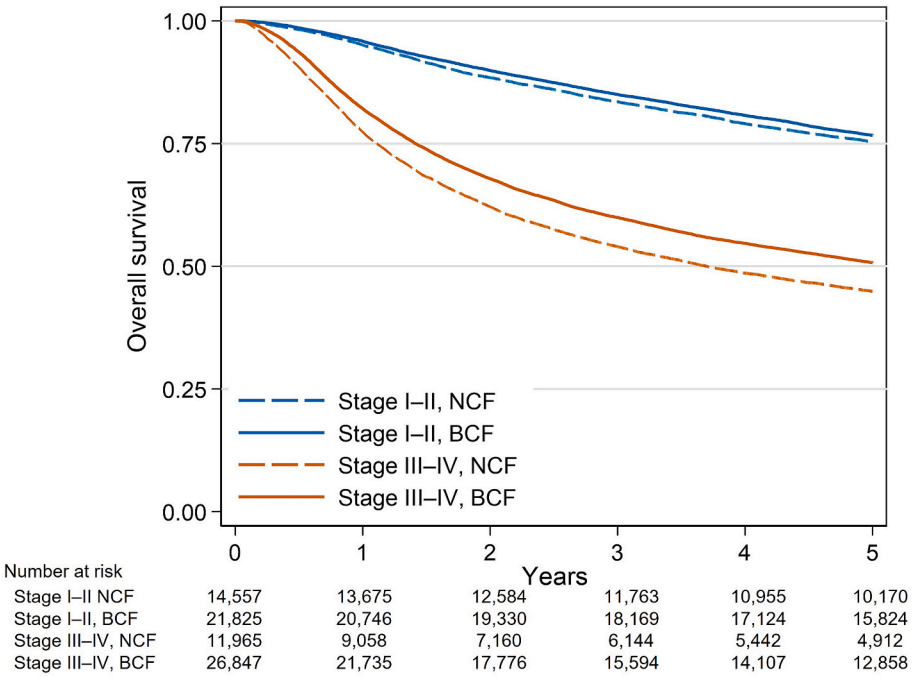

Fig. 1. Kaplan–Meier estimates of overall survival by stage group and facility certification status Curves are shown for stage I–II and stage III–IV disease treated at board-certified facilities (BCF) and non-certified facilities (NCF). Numbers at risk are shown on the x-axis.

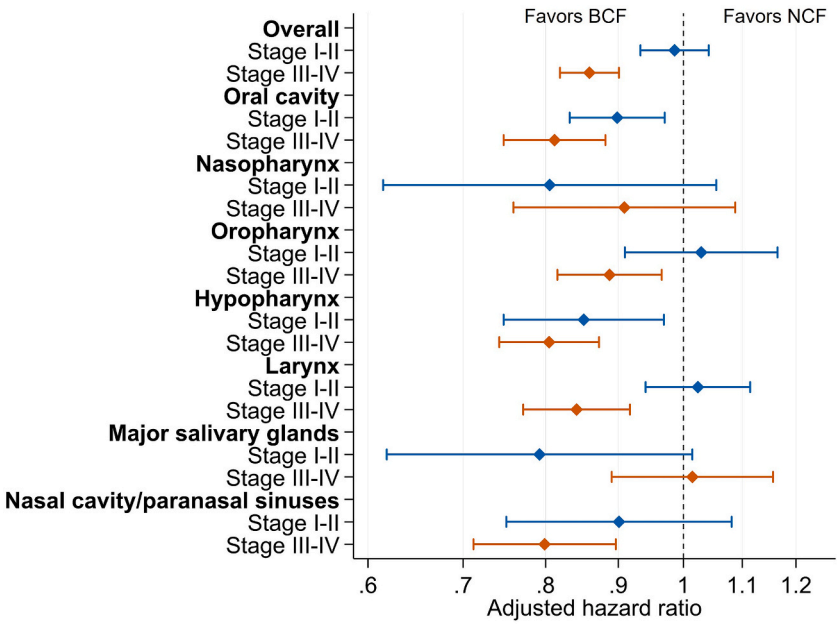

Fig. 2. Association between treatment at board-certified facilities and mortality overall and by subsite (stage group-based stratification) Hazard ratios (HRs) and 95% confidence intervals (CIs) were estimated using a multilevel parametric survival model with an exponential distribution and facility-level random effects adjusted for age category and sex (Model 3). HRs of < 1.0 indicate lower mortality among patients treated at board-certified facilities.

cancer (aHR, 1.01; 95% CI, 0.89–1.16). For stage I–II disease, these associations were generally attenuated; mortality was lower among patients with cancers of the oral cavity and hypopharyngeal cancers treated at board-certified facilities (aHR, 0.90; 95% CI, 0.83–0.97 and aHR, 0.85; 95% CI, 0.75–0.97, respectively).

Treatment patterns by facility certification status

Among patients with HNCs, the proportion of patients receiving surgery as the first treatment was consistently higher in board-certified facilities than in non-certified facilities across all stage groups: stage I, 64.6% vs. 55.9%; stage II, 56.5% vs. 49.5%; stage III, 58.1% vs. 48.9%; and stage IV, 54.8% vs. 43.9%. The detailed subsite-specific surgery proportions according to the stage and certification status are shown in Fig. 3. Surgery rates varied markedly according to subsite and stage. For cancers of the oral cavity, larynx, major salivary glands, and nasal cavity/paranasal sinuses, surgical rates were similar between board-certified and non-certified facilities in early-stage disease but progressively diverged with advancing stage, with board-certified facilities performing surgery more frequently in stage III–IV disease. In contrast,

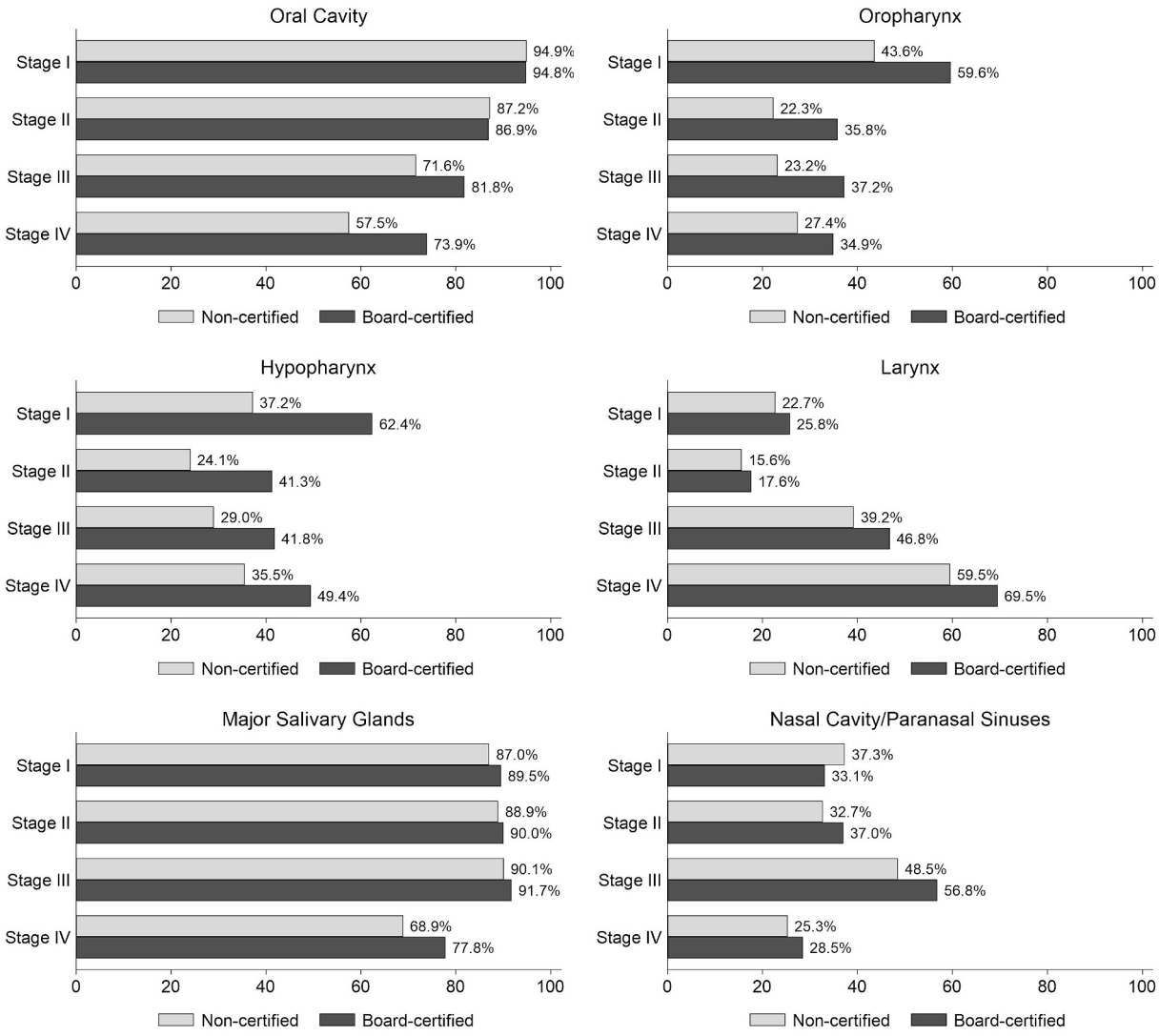

Fig. 3. Patients receiving surgery in first-course treatment, by tumour subsite, disease stage, and facility certification status Abbreviations: BCF, board-certified facility; NCF, non-certified facility.

there were substantial interfacility differences in surgical rates for oropharyngeal and hypopharyngeal cancers, even at stage I, with board-certified facilities consistently having higher rates across all stages.

Prefecture-level variation in treatment at board-certified facilities

The geographic variation in the proportion of residents diagnosed with HNCs who received first-course treatment at board-certified facilities is shown in Fig. 4. Across all 47 prefectures, the proportion of residents treated at board-certified facilities ranged from 9.7% to 91.9%, with a median of 61.1% (interquartile range, 48.1%–73.9%).

Discussion

In this nationwide HBCR study, we compared the 5-year OS between board-certified and non-certified facilities in Japan, stratified by disease stage and tumour subsite. Unlike previous studies that focused primarily on facility case volume,[5,16–18] we evaluated board certification as a composite quality marker. Treatment at board-certified facilities was associated with better OS among patients with stage III–IV disease but not among those with stage I–II disease. This pattern was generally consistent across subsites, except for nasopharyngeal and major salivary gland cancers. A survival advantage was also observed among patients with stage I–II oral cavity and hypopharyngeal cancers.

The observed associations may reflect how these structural features translate into care delivery at experienced centres, including timely initiation and completion of multimodality therapy, supportive care, and complication management. Our findings are consistent with those of a recent nationwide German study, which also reported improved survival at certified HNC centres. Treatment at academic centres has likewise been independently associated with improved survival in patients with locally advanced disease, even after accounting for facility volume. [19] Such differences are particularly consequential for patients with stage III–IV disease, where management is coordination-intensive and outcomes may be sensitive to treatment delays or incomplete treatment. In contrast, early-stage disease is more often managed using relatively standardized approaches, which may reduce between-facility variations in OS.

For the most common subsites, the associations observed in stage III–IV disease were consistent with the overall results. The exceptions were nasopharyngeal and major salivary carcinomas, for which the association was less evident. Nasopharyngeal carcinoma is primarily managed with concurrent chemoradiotherapy following well-established, largely standardized protocols. This high degree of treatment standardization may reduce practice variation between facilities

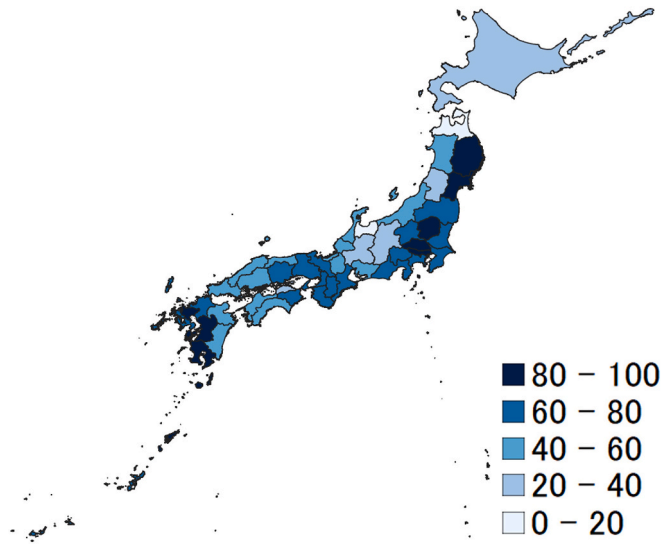

Fig. 4. Prefecture-level proportions of head and neck cancer patients who received first-course treatment at board-certified facilities Choropleth map showing geographic variation across Japan's 47 prefectures. For each prefecture, the proportion was categorized into equal-interval groups (0%–20%, 20%–40%, 40%–60%, 60%–80%, and 80%–100%).

regardless of certification status, potentially explaining the attenuated association. However, some reports have identified associations between facility volume and outcomes, even in cases of nasopharyngeal carcinoma.[20,21] For major salivary gland cancers, the absence of a clearly discernible difference may reflect rarity and histological heterogeneity that dilute facility-level signals. Moreover, the value of specialized care may be underestimated when OS is considered the sole endpoint, because important treatment trade-offs involve functional outcomes and quality of life, such as facial nerve function, which are not captured in the HBCR. Conversely, a survival advantage at board-certified facilities was also apparent for stage I–II oral cavity and hypopharyngeal cancers. More consistent surgical decision-making at board-certified facilities may explain this finding, particularly regarding neck management and margin assessment.

These overall and subsite-specific findings are consistent with the view that board-certified facilities may confer the greatest benefit when clinical judgment and technical proficiency are most consequential for advanced HNC management. These findings support the potential value of Japan's board certification system as a marker of healthcare quality. The observed survival advantage may reflect broader differences in the quality of care, including surgical proficiency at specialized centres [22,23] and the consistently higher surgical rates observed at board-certified facilities across stages and subsites. The stage- and subsite-specific patterns identified in this study may also help inform decisions regarding which patients should be prioritized for referral to specialized facilities. However, the substantial geographical variation in access across Japan's 47 prefectures, with rates ranging from 9.7% to 91.9%, indicates that these benefits remain inaccessible to a significant proportion of patients. This inequity highlights the need for policies that balance regional standardization of HNC care with appropriate centralization of complex cases.[9]

This study has some limitations. First, the HBCR does not include information on comorbidities, smoking and alcohol history, socioeconomic status, performance status, or treatment details. Therefore, the possibility of residual confounding remains. Second, facility certification status was assigned using the 2020 publicly available certification list, which may have introduced time-dependent misclassification. However, certification status changed little between 2015 and 2020: 123 of 128 facilities retained certification, and only one previously non-certified facility became certified. These findings suggest that temporal changes in certification status were unlikely to have materially affected our results. Third, dental, oral, and maxillofacial surgeons provide substantial care for oral cavity cancers in Japan, and the otolaryngology-based board certification system may not fully represent the treatment specialty mix at each facility.[24] Fourth, the mechanisms underlying the survival differences between board-certified and non-certified facilities could not be fully determined. Although we compared surgical treatment rates by subsite and stage as an indicator of differences in treatment patterns, these analyses do not identify which specific components of multidisciplinary care contributed to the observed survival advantage. Future studies incorporating more detailed information on care processes and multidisciplinary management are needed to clarify which aspects of specialized care contribute to improved survival. Finally, because this study was conducted within Japan's specific board certification framework and healthcare system, the generalizability of these findings to other countries warrants further study.

Conclusion

This study provided nationwide evidence that supports the value of Japan's board certification system as a quality marker in head and neck oncology, particularly for patients with advanced disease. The stage- and subsite-specific findings may help inform which patients should be prioritized for treatment at certified facilities, while the marked geographic variation in access highlights the need for policy efforts that balance regional standardization of HNC care with appropriate centralization of complex cases.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During manuscript preparation, the authors used Claude (Anthropic) to assist with drafting and language editing. The authors subsequently reviewed and edited all AI-assisted content and take full responsibility for the final manuscript.

Data availability statement

The data used in this study were obtained from the hospital-based cancer registry (HBCR) database managed by the National Cancer Centre Japan. The data are not publicly available because of institutional data-use restrictions and are available only with permission from the National Cancer Centre Japan.

CRediT authorship contribution statement

Kensuke Uraguchi: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Formal analysis, Conceptualization. **Ryoko Rikitake:** Writing – review & editing, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Munechika Tsumura:** Writing – review & editing, Methodology, Conceptualization. **Mizuo Ando:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization.

Ethics declaration

The authors have NOT obtained informed consent from participants or their legal representatives. The requirement for individual informed consent was waived because this retrospective study involved secondary analysis of de-identified data from the nationwide Hospital-Based Cancer Registry. The study was approved by the Data Utilization Review Committee for the Nationwide Collection of the Hospital-Based Cancer Registry data, National Cancer Center, Japan (review no. 24–04), and the Ethics Committee of the Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, and Okayama University Hospital (approval no. 2502–009).

This study was performed in compliance with relevant laws, regulatory frameworks and guidelines where the research took place.

This study was approved by the Ethics Committee of the Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, and Okayama University Hospital.

(Approval No. 2502–009).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.oraloncology.2026.108152.

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