



ORIGINAL RESEARCH ARTICLE

Distribution and frequency of parotid gland tumors in the Anhui province: A retrospective multicenter study of 758 cases

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Abstract

Parotid gland tumors are rare, exhibit complex histopathology, and often lack early clinical symptoms. Epidemiological and pathological features of parotid gland tumors in Anhui province, China, have not yet been reported. This study aimed to retrospectively analyze the distribution and histopathological characteristics of parotid gland tumors in Anhui province. We retrospectively analyzed the clinical data from 758 patients with parotid gland tumors admitted to three centers from January 2018 to January 2022. All diagnoses were unequivocally confirmed by histopathological examination. Pleomorphic adenoma and mucoepidermoid carcinoma were the most prevalent tumors. Benign and malignant tumors were detected in six hundred forty-one and one hundred seventeen patients, respectively, with a benign-to-malignant ratio of 5.48:1. A slight female predilection (51.8%) was observed. The highest incidence occurred in the 51–60 years age group. Warthin tumor was the second most prevalent benign tumor, showing a significant male predilection. The distribution and frequency of most parotid gland neoplasms in Anhui province were similar to global reports, confirming the well-known male predilection for Warthin tumor. This multicenter study provides an epidemiological baseline for better characterizing these tumors in this region.

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1. Introduction

Salivary gland tumors (SGTs) present a significant diagnostic and therapeutic challenge within otolaryngology and head and neck surgery, primarily due to their histopathological complexity and diverse clinical behavior.¹ Although relatively rare, accounting for only 2–3% of all head and neck neoplasms, with an estimated annual incidence of approximately 0.0001%^{2–4}, their management is complicated by a broad spectrum of biological potential, ranging from indolent growth to aggressive malignancy with risk of local invasion, recurrence, and distant metastasis.

The low prevalence of SGTs at individual centers limits systematic characterization of their clinical features⁵⁻⁷, often resulting in a fragmented understanding. This scarcity underscores the critical importance of multicenter collaborations to assemble cohorts of sufficient size for meaningful analysis. Moreover, variations in the incidence of SGT among different geographic regions and ethnic groups have been reported. These disparities suggest that etiological factors—whether environmental, genetic, or lifestyle-related—may differ significantly across populations, rendering extrapolations from one region to another potentially unreliable.

As the largest of the three pairs of salivary glands (parotid, submandibular, and sublingual glands), the parotid gland is the most common site of SGTs, accounting for 80% of cases of SGTs.^{8,9} Consequently, numerous studies worldwide have reported epidemiological and histopathological data for parotid gland tumors, establishing broad patterns such as the universal predominance of pleomorphic adenoma (PA) among benign tumors and variable frequencies of Warthin tumor (WT) and mucoepidermoid carcinoma (MEC).^{10,11} These studies have established broad patterns, such as the universal predominance of PA among benign tumors and the variable frequency of WT and MEC. Despite these efforts, there remains a notable paucity of data specifically pertaining to the Anhui province of China, a region with a population exceeding 61 million. The lack of localized epidemiological studies hinders the development of region-specific diagnostic protocols, treatment guidelines, and public health strategies.

Therefore, this study was conceived to address this critical knowledge gap. We conducted a retrospective multicenter analysis of parotid gland tumors across three major medical centers in Anhui province, representing its northern, central, and southern regions. The primary objectives were to establish the comprehensive epidemiological profile of parotid gland tumors in Anhui, including their distribution, histopathological spectrum, and demographic correlates. By providing this essential baseline data, we aim to facilitate accurate diagnosis, inform treatment strategies, enable meaningful comparisons with other populations, and ultimately, contribute to improved patient care and outcomes in this region.

2. Methods

2.1. Patient selection and the inclusion and exclusion criteria

Patients diagnosed with parotid gland tumors and hospitalized between January 2018 and January 2022 at three centers in Anhui province were included in this study. These centers were: the Department of

Otorhinolaryngology, Head and Neck Surgery of the First Affiliated Hospital of Anhui Medical University (central region), Fuyang People's Hospital (northern region), and the Second People's Hospital of Wuhu (southern region).

The inclusion criteria were: (i) diagnosis of a primary parotid tumor confirmed by histopathological examination following surgical resection or biopsy, and (ii) admission for therapeutic intervention at one of the participating institutions. The exclusion criteria included mesenchymal neoplasms and lymphomas, duplicate records and recurrent tumors, as well as tumors involving the sinonasal region, nose, and trachea.

After applying these criteria, a total of 758 patients with parotid gland tumors were included in the analysis. Demographic data (sex, age) and histopathological type were collected for each case. Cases with incomplete information, duplicates, and recurrences were excluded after an initial review. The tumors were classified according to the World Health Organization (WHO) 2017 classification of SGTs. Twelve types of benign SGTs were observed in the province, including common PA, WT, basal cell adenoma (BCA), and myoepithelial adenoma (MA). Common malignant tumors included MEC, adenoid cystic carcinoma (AdCC), acinar cell carcinoma (ACC), squamous cell carcinoma (SCC), myoepithelial carcinoma, and carcinoma ex PA.

2.2. Ethics approval

All procedures involving human participants in this study were performed following the ethical standards of the institutional and/or national research committee. This study complied with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The institutional research committee of the three hospitals approved this study, and patient consent was not sought as all data were anonymized and collected retrospectively. All patient data were kept strictly confidential to protect patient privacy. All methods were performed in accordance with the relevant guidelines and regulations. For this research purpose, we collected and analyzed data of patients hospitalized between January 2018 and January 2022.

2.3. Statistical analysis

Data from the three centers were compared based on demographic parameters and histopathological types of parotid gland neoplasms. Descriptive statistical analysis was performed using frequencies and percentages of variables via Microsoft Excel (Office 2020, Microsoft, United States). Fisher's exact test and Pearson's chi-square test were used as appropriate. A two-sided p -value < 0.05 was considered statistically significant.

3. Results

3.1. General characteristics

A total of 758 patients with parotid gland tumors, comprising 641 benign and 117 malignant cases, were included in this study. A slight female predilection (51.8%) was observed among cases of benign and malignant tumors. Parotid gland tumors occurred more frequently between the ages of 40 and 70 years, with an average age of 50.77 years (Figure 1). The ratio of the prevalence of benign to malignant tumors was 5.48:1. Table 1 presents the sex and age distribution of benign and malignant tumors. The highest incidence of benign and malignant parotid tumors was observed in the age group of 51–60 years, accounting for 25.99% of the cases (Figure 2). Figure 3 presents the distribution of tumors and patients of different ages and sexes.

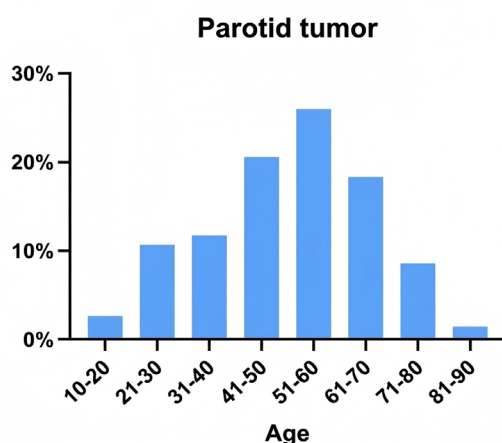


Figure 1. Overall age distribution of the patients with parotid tumors

3.2. Characteristics of benign parotid gland tumors

The most prevalent benign parotid tumors in the three centers were PAs, WTs, BCAs, and MAs, accounting for 45.87%, 18.41%, 7.02%, and 5.93% of cases, respectively (Table 2). Comparison of the incidence rates among the three hospitals revealed that PAs were the most common benign tumors, with their incidence ranging from 40.82% in Wuhu to 51.85% in Hefei. The second most common benign tumors were WTs, with their incidence ranging from 16.30% in Hefei to 21.43% in Fuyang. A slight female predilection was observed in the incidence of benign tumors in Hefei (54.13%) and Wuhu (55.75%). A slight male predilection (53.19%) was observed at Fuyang People's Hospital. The incidence of WTs was significantly higher in male patients than in female patients, with an average male-to-female sex ratio of 15.86:1, as shown in Table 2. The incidence of PAs in Hefei was higher than that

in Fuyang and Wuhu ($p < 0.05$). There was no significant difference in the incidence of PAs between Fuyang and Wuhu ($p > 0.05$) or the incidence of WTs and BCAs among the three regions ($p > 0.05$). The third most common benign tumor in Wuhu was MAs. The incidence of MA was significantly higher in Wuhu than in Fuyang and Hefei ($p < 0.05$); however, no statistically significant difference was observed between the incidence rates of Fuyang and Hefei ($p > 0.05$), as shown in Figure 4. Figure 5 shows representative pathological images of the most common benign tumors.

3.3. Characteristics of malignant parotid gland tumors

Mucoepidermoid carcinoma, AdCC, ACC, and SCC were the most common malignant parotid tumors at the three centers, accounting for 28.21%, 17.95%, 11.97%, and 8.55% of cases, respectively (Table 3 and Figure 6). Comparison of incidence rates among the three hospitals revealed that MEC was the most common malignant tumor, with incidence rates ranging from 18.75% in Hefei to 35.00% in Fuyang. AdCCs were the second most common malignant tumors, with their incidence ranging from 14.58% in Hefei to 20.69% in Wuhu. The incidence of ACCs ranged from 10% in Hefei to 17.24% in Wuhu, whereas that of SCCs ranged from 16.67% in Hefei, 5% in Fuyang, and 0% in Wuhu. A slight female predilection was observed in the incidence of malignant tumors in Fuyang (65.03%) and Wuhu (55.16%). A slight male predilection (54.05%) was observed in the First Affiliated Hospital of Anhui Medical University. SCC was the second most common malignant tumor in Hefei, as shown in Table 3. MECs were the most common malignant tumor at the three centers. No statistically significant differences were observed in the incidence of MECs, AdCCs, and ACCs among the three regions. The incidence of SCCs varied in the three regions and was higher in Hefei and Fuyang than in Wuhu ($p < 0.05$). No statistically significant difference was observed in the incidence of SCCs between Hefei and Fuyang ($p > 0.05$). Figure 7 shows representative pathological images of the most common malignant tumors.

4. Discussion

Anhui is located in the southeastern province of China, covering 140,100 square kilometers with a population of 61.13 million. Hefei is the capital and central region of Anhui province, with a permanent resident population of 9.3699 million. Fuyang is the largest northern central city of Anhui province, with a permanent resident population of 8.171 million. Wuhu is the regional center of the southern Anhui province, with a permanent resident population of 3.672 million. Many patients with parotid

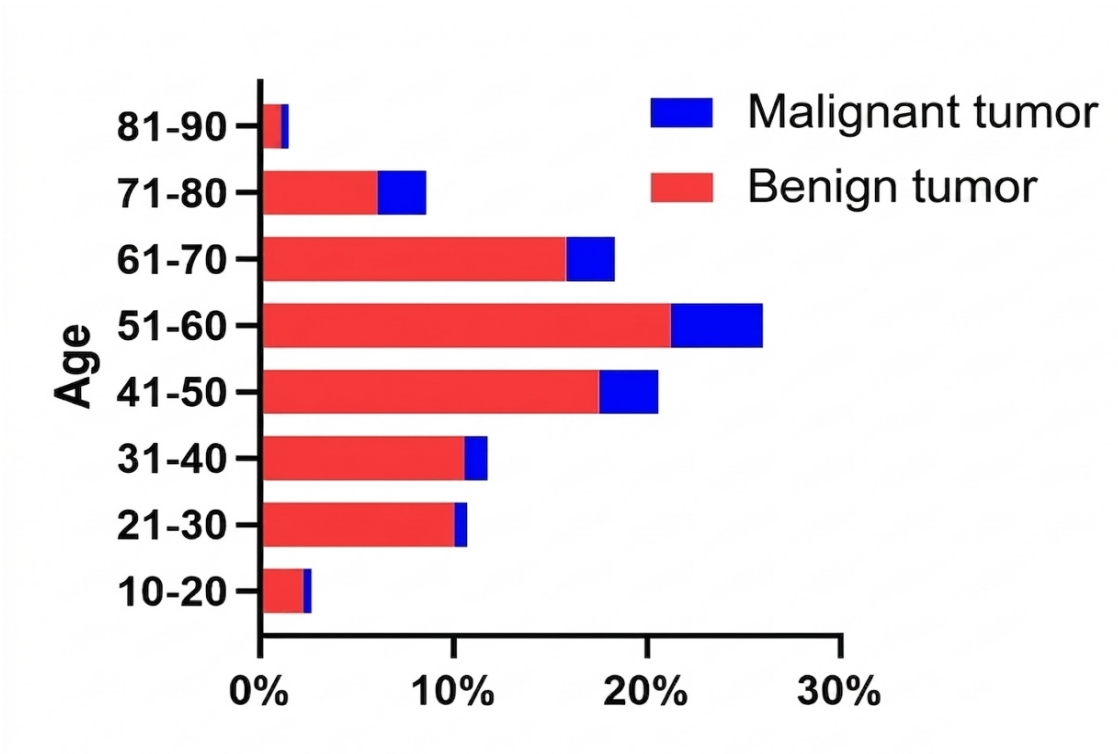


Figure 2. Age distribution of the patients with benign and malignant parotid gland tumors

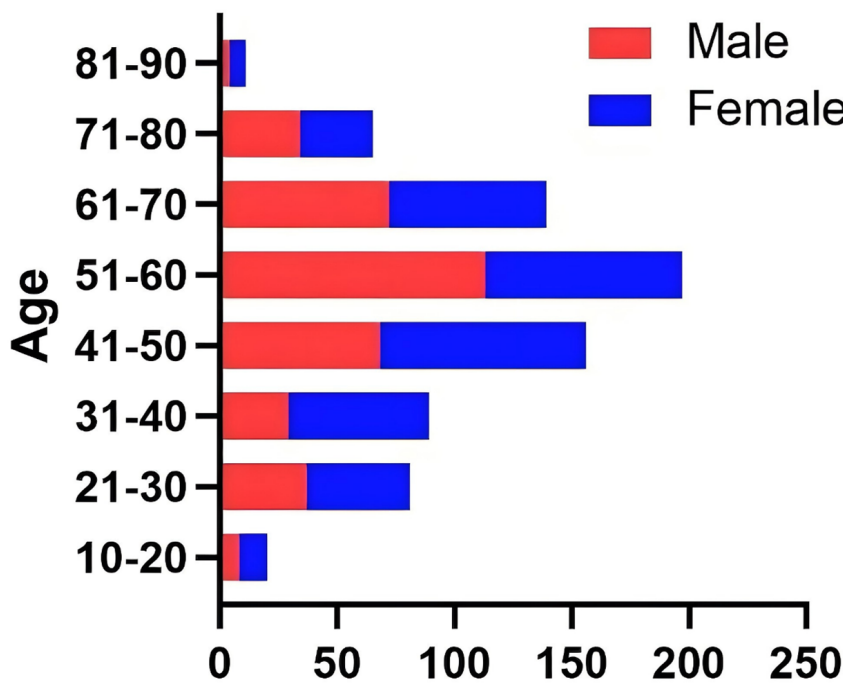


Figure 3. Age and sex distribution of the patients with parotid gland tumors

Table 1. Tumor category, sex, and age distribution of the patients with parotid tumors in the three hospitals

Age group (years)	Benign tumors			Malignant tumors			Total (%)
	Male	Female	Total (%)	Male	Female	Total (%)	
10–20	8	9	17 (2.24)	0	3	3 (0.40)	20 (2.64)
21–30	34	42	76 (10.03)	3	2	5 (0.66)	81 (10.69)
31–40	26	54	80 (10.55)	3	6	9 (1.19)	89 (11.74)
41–50	60	73	133 (17.55)	8	15	23 (3.03)	156 (20.58)
51–60	93	68	161 (21.24)	20	16	36 (4.75)	197 (25.99)
61–70	62	58	120 (15.83)	10	9	19 (2.51)	139 (18.34)
71–80	22	24	46 (6.07)	12	7	19 (2.51)	65 (8.58)
81–90	3	5	8 (1.06)	1	2	3 (0.40)	11 (1.45)

Table 2. Distribution characteristics of benign parotid gland tumors in the three hospitals

Histological type	Hefei, <i>n</i> (%)	Fuyang, <i>n</i> (%)	Wuhu, <i>n</i> (%)	Total, <i>n</i> (%)	Overall <i>p</i> -values	Pairwise <i>p</i> -values
PA	140 (51.85); M/F: 52/88	94 (41.96); M/F: 40/54	60 (40.82); M/F: 23/37	294 (45.87); M/F: 115/179	0.034	a = 0.028; b = 0.031; c = 0.826
WT	44 (16.30); M/F: 43/1	48 (21.43); M/F: 44/4	26 (17.69); M/F: 24/2	118 (18.41); M/F: 111/7	0.331	–
BCA	15 (5.56); M/F: 3/12	20 (8.93); M/F: 8/12	10 (6.80); M/F: 3/7	45 (7.02); M/F: 14/31	0.342	–
MA	14 (5.19); M/F: 8/6	4 (1.79); M/F: 0/4	20 (13.61); M/F: 8/12	38 (5.93); M/F: 16/22	<0.001	a = 0.077; b = 0.003; c < 0.001

Notes: Only the four most common histological types are presented; together, they account for 495 cases, which is a subset of the 641 benign cases included in the study. Pairwise comparisons were performed only for histological types with a statistically significant overall difference among the three hospitals. a: Comparison between Hefei and Fuyang; b: Comparison between Hefei and Wuhu; c: Comparison between Fuyang and Wuhu. Abbreviations: BCA: Basal cell adenoma; F: Female; M: Male; MA: Myoepithelial adenoma; PA: Pleomorphic adenoma; WT: Warthin tumor.

gland tumors are treated in the largest comprehensive hospitals in each region. These regional referral centers provided an opportunity to evaluate the epidemiological and pathological features of parotid gland tumors in Anhui province, China. Our multicenter retrospective study provides a comprehensive epidemiological overview of 758 cases from three geographically distinct centers. The findings invite a multi-layered discussion encompassing demographic patterns, histopathological distributions, intra-provincial variations, and their broader clinical and etiological implications.

Overall, our findings indicate a slight female predominance (51.8%) among patients with parotid gland tumors, consistent with several reports from Asia and South America.^{12–15} However, this contrasts with studies from Turkey and certain European cohorts where male predominance has been noted, suggesting that geographic, ethnic, or environmental factors may influence sex distribution.^{16,17} In the current study, the ages of the

patients ranged from 14 to 90 years (mean, 50.77 years). The mean age at diagnosis in our cohort was 50.77 years, with a peak incidence in the 51–60 year age group, similar to patterns reported in other Chinese populations.^{17,18} This age distribution probably reflects the sequential accumulation of genetic and epigenetic alterations necessary for tumorigenesis within a relatively stable cellular compartment. The notable prevalence of patients in their 30s and 40s, particularly for benign tumors like PA, underscores that these tumors are not exclusively diseases of the elderly and must be considered in the differential diagnosis of head and neck masses in younger adults. Furthermore, the incidence in women in their 30s and 40s was higher than that in men, which may be attributed to the sex characteristic of benign tumors.¹⁸

Notably, we observed a higher proportion of benign tumors (84.6%) compared to some Western series, where benign proportions typically range between 70–80%.¹³ This elevated benign-to-malignant tumor ratio can be

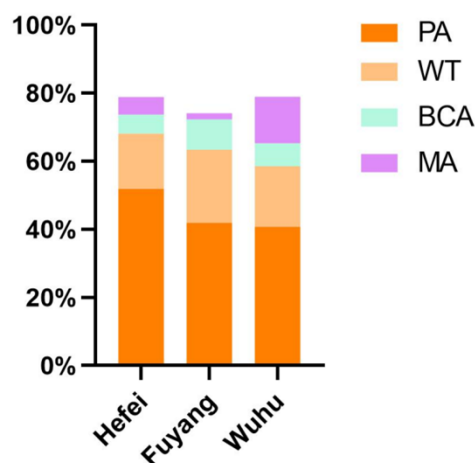


Figure 4. Composition chart of the main benign tumors of the parotid gland in three regions

Abbreviations: BCA: Basal cell adenoma; F: Female; M: Male; MA: Myoepithelial adenoma; PA: Pleomorphic adenoma; WT: Warthin tumor.

explained from two perspectives. First, it may reflect different medical-seeking behaviors. For example, slowly growing benign tumors are more likely to undergo surgical treatment. In contrast, invasive malignant tumors often remain undetected until advanced stages, when surgery is no longer an option, resulting in missed cases. Second, differences in pathological diagnosis practices likely influence these ratios. The elevated proportion of benign tumors underscores the central role of surgery as the primary radical treatment for most SGTs in the region and simultaneously highlights the importance of thorough preoperative evaluation to prevent overtreatment.

Based on the histopathological data, 84.6% of parotid gland tumors were benign tumors in the present study, which is higher than the rates reported by authors in the UK, Brazil, Shanghai, and the Sichuan region of China.¹⁷ Comparison of the incidence rates among the three hospitals revealed that PAs were the most common benign tumors, with their incidence varying from 40.82% in Wuhu to 51.85% in Hefei, consistent with the findings of a previous study.⁷ Our observation that PA incidence was significantly higher in Hefei compared to Fuyang and Wuhu invites further investigation into potential regional risk factors, such as environmental exposures or referral patterns. The present study revealed that WTs were the second most common benign tumors, similar to the findings of earlier demographic studies.^{15,19,20} BCAs were found to be the third most common benign tumors in Hefei and Fuyang. However, MAs were the third most common benign tumors in Wuhu, and their incidence was significantly higher than that of BCAs. This trend may be characteristic of the disease distribution in Wuhu.

In the present study, a large female predilection was observed in cases of PAs. Previous studies have reported pseudopodia in PA, characterized by infiltration of neoplastic cells into the capsule.²¹ PAs have a wide range of histopathological features that typically exhibit various cell types, including round, angular, oval, and plasmacytoid cells with a duct-like space dominated by fibrous and mucoid stroma.²² Squamous metaplasia and incomplete capsules are observed commonly, whereas other features, such as vascular invasion, crystals, and psammoma bodies, are observed less commonly. Zbären and Stauffer²³ reported that 48% of 218 cases of parotid PAs had features of pseudopodia and/or satellite nodules, with a higher incidence in classical subtypes. The high rate of tumor infiltration into encapsulated tissue may be a risk factor for recurrence, especially after surgical resection, as tumor tissue within the capsule may remain at the surgical site.²⁴ This is the theoretical basis for performing superficial parotidectomy in cases with PA.²¹

In the present study, WT accounted for 18.4% of benign tumors, a proportion lower than that reported in some European and American studies. For example, Franzen *et al.* analyzed 806 cases of parotid gland tumors in a German population and found that WT constituted 42.1% of benign tumors.²⁵ A marked male predominance was observed (male-to-female ratio, 15.86:1). This finding is consistent with previous epidemiological reports.²⁶ Some studies have reported a relationship between smoking and WT.¹⁷ This overwhelmingly underscores the etiological primacy of tobacco smoking, which has historically been a male-dominated habit in China. The association is so robust that a WT diagnosis in a female patient should prompt careful inquiry into smoking history or consideration of rare associations, such as autoimmune conditions. The proportion of WT (18.41% of benign tumors) places Anhui in a range similar to other Asian and European population¹³, distinct from regions with markedly low reported rates. This prevalence may reflect the historical smoking patterns in the region. As smoking rates among Chinese women rise, a future epidemiological shift toward a lower male-to-female ratio for WT is a predictable and important trend to monitor.

Mucoepidermoid carcinomas were the most common malignant tumors of the parotid gland, accounting for 18.75–35% of cases; this finding was consistent with the findings of previous reports of global prevalence.^{14,18,27,28} Interestingly, we noted considerable inter-center variation in the reported incidence of MECs and SCCs. ACCs were the second most common malignant tumors, accounting for 20% of all malignant tumors in all centers except Hefei, where SCCs were the second most common malignant tumors. The prevalence of SCCs was found to be higher

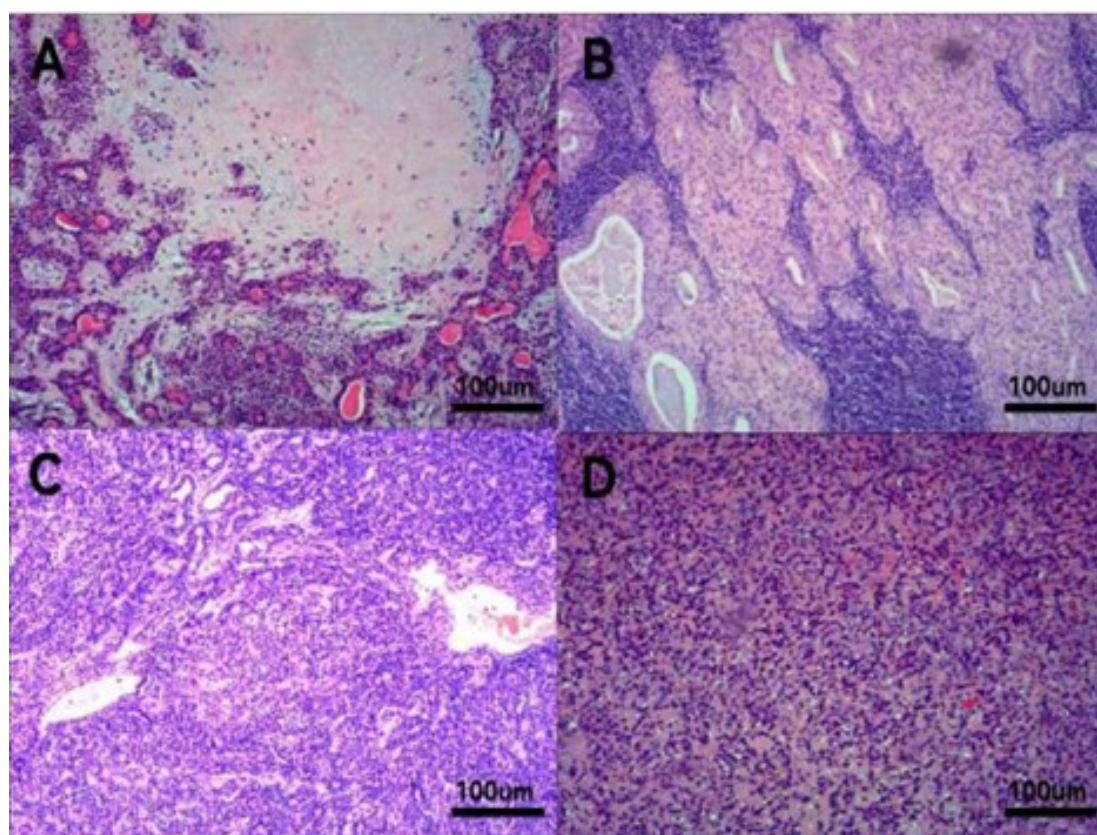


Figure 5. Representative images of benign tumors. (A) Pleomorphic adenoma; (B) Warthin tumor; (C) Basal cell adenoma; (D) Myoepithelial adenoma. Scale bars: 100 µm; magnification: 200×.

than that of other regions, which was inconsistent with the findings of a previous report.²⁰ Lee *et al.* reported that SCCs (30%) were the most frequent malignant tumors in the parotid gland, which was considered to be the epidemiologic distribution of parotid gland tumors in the Chumnam area of Korea.²⁹ High-grade solid MECs and SCCs are pathologically confusing and susceptible to the subjective influence of pathologists. In the present study, the prevalence of MECs in Hefei was lower than that in the other two centers. This variability may stem from pathological diagnostic challenges in distinguishing high-grade MEC from SCC, influenced by institutional expertise and diagnostic criteria. Alternatively, it may reflect true regional differences in risk factors such as viral infections, environmental carcinogens, or previous radiation exposure.

Adenoid cystic carcinoma and ACC together constituted nearly 30% of malignant tumors, with AdCC showing a relatively consistent incidence across centers. ACC, though less common globally, represented 11.97% of malignancies in our cohort, higher than reported in some Western series but comparable to other Asian studies.²⁷

Reported prevalence rates of ACC may vary across studies, possibly because of small sample sizes, single-center designs, or regional heterogeneity in malignant subtypes, suggesting the necessity of developing regional diagnosis and treatment strategies.

The observed intra-provincial differences, such as the higher incidence of MA in Wuhu and SCC in Hefei/Fuyang, are among the most thought-provoking findings. While statistical fluctuation must be considered, these patterns merit hypothesis generation. Could regional differences in environmental exposures, dietary habits, or pathological diagnostic traditions influence these rates? For SCC, could variations in the prevalence of risk factors like high-risk HPV infection or occult cutaneous metastases misclassified as primary play a role? A focused review of clinical and imaging records for these specific cases would be a valuable next step.

Although this study successfully mapped the epidemiological profile of SGTs in Anhui province, it had limitations due to its retrospective design. Key data such as smoking history, family history, and clinical outcomes were not included, resulting in some important

Table 3. Distribution characteristics of malignant parotid gland tumors in the three hospitals

Histological type	Hefei, n (%)	Fuyang, n (%)	Wuhu, n (%)	Total, n (%)	Overall <i>p</i> -value	Pairwise <i>p</i> -values
MEC	9 (18.75); M/F: 6/3	14 (35.00); M/F: 8/6	10 (34.48); M/F: 7/3	33 (28.21); M/F: 21/12	0.166	–
SCC	8 (16.67); M/F: 6/2	2 (5.00); M/F: 2/0	0 (0.00); M/F: 0/0	10 (8.55); M/F: 8/2	0.025	a = 0.168; b = 0.022; c = 0.506
AdCC	7 (14.58); M/F: 4/3	8 (20.00); M/F: 2/6	6 (20.69); M/F: 2/4	21 (17.95); M/F: 8/13	0.729	–
ACC	7 (14.58); M/F: 1/6	4 (10.00); M/F: 0/4	5 (17.24); M/F: 2/3	14 (11.97); M/F: 3/11	0.669	–
Others	17 (35.42); M/F: 9/8	12 (30.00); M/F: 2/10	8 (27.59); M/F: 2/6	39 (33.33); M/F: 13/24	–	–
Total	48	40	29	117		–

Notes: Pairwise comparisons were performed only for histological types with a statistically significant overall difference among the three hospitals; a: Comparison between Hefei and Fuyang; b: Comparison between Hefei and Wuhu; c: Comparison between Fuyang and Wuhu; The “others” category, it was excluded from separate statistical comparison because it includes multiple rare histological subtypes of parotid malignancies, which did not meet the statistical assumptions for valid comparison.

Abbreviations: ACC: Acinar cell carcinoma; AdCC: Adenoid cystic carcinoma; MEC: Mucoepidermoid carcinoma; SCC: Squamous cell carcinoma.

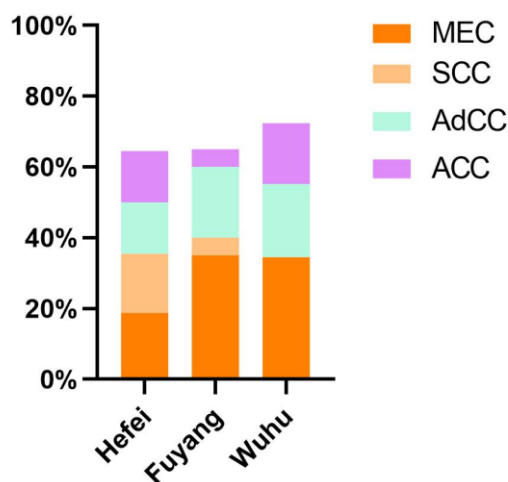


Figure 6. Composition chart of the main malignant tumors of the parotid gland in three regions

Abbreviations: ACC: Acinar cell carcinoma; AdCC: Adenoid cystic carcinoma; MEC: Mucoepidermoid carcinoma; SCC: Squamous cell carcinoma.

etiological questions remaining unanswered. The lack of clinical follow-up data prevents linkage between the

pathologic diagnosis and the patients' final outcomes (such as survival rates, recurrence rates, and quality of life), which are precisely the core indicators for assessing clinical relevance. These limitations should be addressed in future prospective cohort studies incorporating detailed risk-factor assessment and long-term follow-up, which would improve etiological and prognostic interpretation. By comparing the molecular characteristics of tumors across different sub-regions in Anhui province, we hope to identify subgroups with genetic differences, thereby explaining the observed geographical distribution differences. Finally, integrating these epidemiological data with treatment registries will facilitate outcome studies and provide a basis for developing optimized treatment strategies tailored to the specific tumor characteristics of this population.

In summary, this study delineated the distribution and incidence of parotid tumors in Anhui province and highlighted regional variation in histopathological subtypes. These findings provide baseline data for future clinical evaluation and scientific research on parotid tumors in the region. The study may also contribute to improved understanding of diagnostic patterns and potential public health implications. Importantly, this

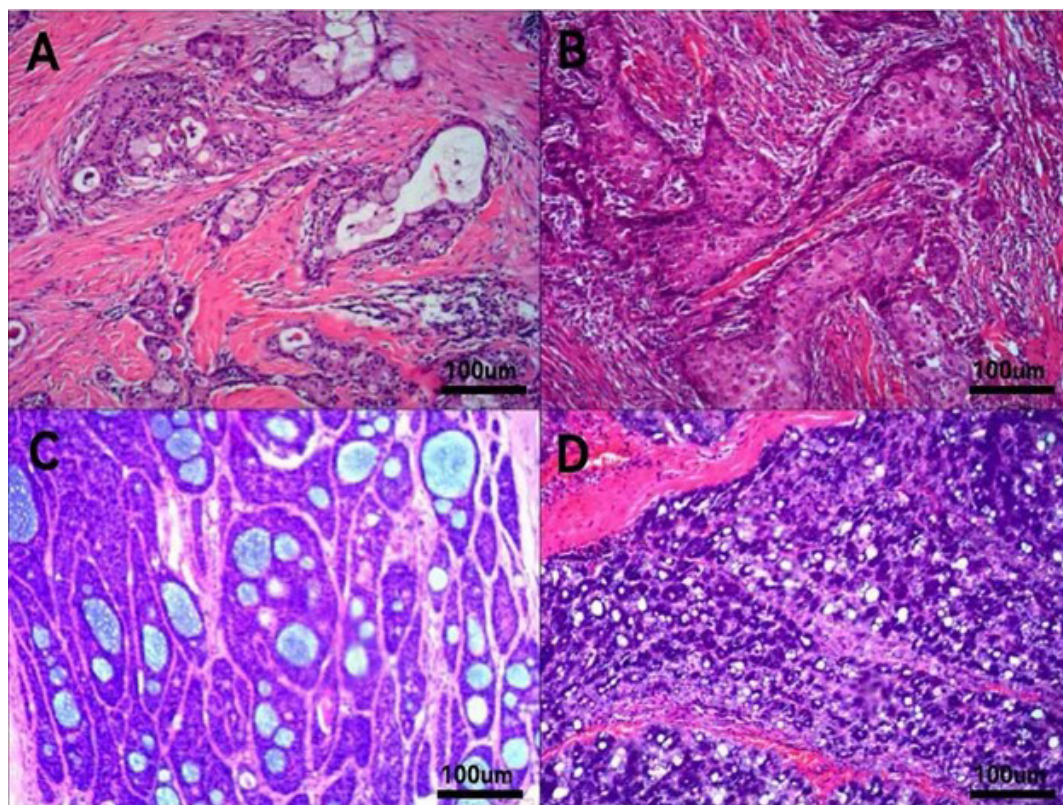


Figure 7. Representative images of malignant tumors. (A) Mucoepidermoid carcinoma; (B) Squamous cell carcinoma; (C) Adenoid cystic carcinoma; (D) Acinar cell carcinoma. Scale bars: 100 µm; magnification: 200×.

work lays an essential foundation for subsequent clinical and scientific research on these complex tumors.

5. Limitations

This study has several limitations inherent in its retrospective, multi-institutional design. First, selection bias may exist due to the tertiary-care setting of participating hospitals. These centers may attract more complex or advanced cases, potentially skewing the distribution toward malignant or rare tumors. Second, the absence of clinical outcome data, treatment details, and long-term follow-up limits our ability to correlate histopathological subtypes with prognosis, recurrence, or survival—representing a critical gap in understanding the real-world impact of these tumors. Third, data on potential risk factors such as smoking history (crucial for WT), occupational exposures, viral status, or familial predisposition were not systematically collected, which precludes any etiological analyses. Fourth, despite using the WHO 2017 classification and the requirement for histopathological confirmation, inter-pathologist variability in diagnostic criteria, especially for borderline or high-grade tumors (e.g., high-grade MEC vs. SCC),

may affect the consistency of subtype classification across centers. Finally, the study period of four years may not capture long-term epidemiological trends, and the study sample, though substantial, represents only a fraction of the provincial population.

6. Conclusion

This retrospective multicenter study compared the epidemiological and histopathological characteristics of parotid gland tumors in three regions of Anhui province, based on a cohort of 758 histologically confirmed cases. PAs and WTs were the most common benign tumors, whereas MECs were the most frequent malignant tumors. The significant male predominance for WTs and the identified regional variations in the incidence of certain subtypes within Anhui highlight the influence of demographic, lifestyle, and possibly local environmental factors. Overall, the distribution and frequency of most parotid gland neoplasms in Anhui province were similar to those reported worldwide, while exhibiting subtle yet significant regional distinctions. This study establishes an important epidemiological baseline for future research, clinical practice, and health policy planning in the region.

and underscores the indispensable value of generating rigorous, population-specific data to advance the diagnosis and management of salivary gland neoplasms.

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Conflict of interest

The authors declare no conflict of interest.

Author contributions

Conceptualization: Xinghong Yin

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Writing—review & editing: All authors

Ethics approval and consent to participate

All procedures involving human participants in this study were performed following the ethical standards of the institutional and/or national research committee. This study complied with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The institutional research committee of the three hospitals approved this study, and patient consent was not sought as all data were anonymized and collected retrospectively. All patient data were kept strictly confidential to protect patient privacy. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Patient consent was not sought as all data were anonymized and collected retrospectively.

Availability of data

Data is available from the corresponding author upon reasonable request.

References

1. Ferreira JCB, Morais MO, Elias MRA, Batista AC, Leles CR, Mendonça EF. Pleomorphic adenoma of oral minor salivary glands: An investigation of its neoplastic potential based on apoptosis, mucosecretory activity and cellular proliferation. *Arch Oral Biol.* 2014;59(6):578-585.
doi: 10.1016/j.archoralbio.2014.03.002
2. Takebayashi S, Shinohara S, Tamaki H, *et al.* Adenoid cystic carcinoma of the head and neck: a retrospective multicenter study. *Acta Oto-Laryngologica.* 2017;138(1):73-79.
doi: 10.1080/00016489.2017.1371329
3. Honda K, Tanaka S, Shinohara S, *et al.* Survival in patients with parotid gland carcinoma – Results of a multi-center study. *Am J Otolaryngol.* 2018;39(1):65-70.
doi: 10.1016/j.amjoto.2017.10.012
4. Pinkston JA, Cole P. Incidence Rates of Salivary Gland Tumors: Results from a Population-Based Study. *Otolaryngol –Head Neck Surg.* 1999;120(6):834-840.
doi: 10.1016/s0194-5998(99)70323-2
5. Hay AJ, Migliacci J, Karassawa Zanoni D, McGill M, Patel S, Ganly I. Minor salivary gland tumors of the head and neck—Memorial Sloan Kettering experience: Incidence and outcomes by site and histological type. *Cancer.* 2019;125(19):3354-3366.
doi: 10.1002/cncr.32208
6. Alramadhan SA, Fitzpatrick SG, Cohen DM, Bhattacharyya I, Islam MN. Retrospective Study of Buccal Mucosal Salivary Neoplasms. *Head Neck Pathol.* 2020;14(4):1013-1020.
doi: 10.1007/s12105-020-01190-8
7. Sentani K, Ogawa I, Ozasa K, Sadakane A, Utada M, Tsuya T, *et al.* Characteristics of 5015 Salivary Gland Neoplasms Registered in the Hiroshima Tumor Tissue Registry over a Period of 39 Years. *JCM.* 2019;8(5):566.
doi: 10.3390/jcm8050566
8. Aldelaimi AA, Enezei HH, Aldelaimi TN, Mohammed KA, Al-Ani RM. Salivary Gland Diseases: A Retrospective Clinicopathological Study of 159 Cases. *Cureus.* 2022;14(9).
doi: 10.7759/cureus.29589
9. Grosheva M, Shabli S, Volk GF *et al.* Sensation loss after superficial parotidectomy: A prospective controlled multicenter trial. *Head Neck.* 2017;39(3):520-526.
doi: 10.1002/hed.24647
10. El-Naggar AK, Chan JKC, Takata T, Grandis JR, Slootweg PJ. The fourth edition of the head and neck World Health Organization blue book: editors' perspectives. *Hum Pathol.* 2017;66:10-12.
doi: 10.1016/j.humpath.2017.05.014
11. Jansen L, Mayer M, Stang A *et al.* Incidence and survival of primary major salivary gland carcinoma in Germany over the last decade: A nationwide population-based study. *Eur J Cancer.* 2026;234:116196.
doi: 10.1016/j.ejca.2025.116196
12. Bassani S, Santonicco N, Eccher A *et al.* Artificial intelligence in head and neck cancer diagnosis. *J Pathol Inform.*

- 2022;13:100153.
doi: 10.1016/j.jpi.2022.100153
13. Alsanie I, Rajab S, Cottom H *et al.* Distribution and Frequency of Salivary Gland Tumours: An International Multicenter Study. *Head Neck Pathol.* 2022;16(4):1043-1054.
doi: 10.1007/s12105-022-01459-0
 14. Da Silva LP, Serpa MS, Viveiros SK *et al.* Salivary gland tumors in a Brazilian population: A 20-year retrospective and multicentric study of 2292 cases. *J Craniomaxillofac Surg.* 2018;46(12):2227-2233.
doi: 10.1016/j.jcms.2018.09.028
 15. Fonseca FP, Carvalho MDV, de Almeida OP *et al.* Clinicopathologic analysis of 493 cases of salivary gland tumors in a Southern Brazilian population. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2012;114(2):230-239.
doi: 10.1016/j.oooo.2012.04.008
 16. Kızıl Y, Aydil U, Ekinci O *et al.* Salivary gland tumors in Turkey: demographic features and histopathological distribution of 510 patients. *Indian J Otolaryngol Head Neck Surg.* 2013;65(S1):112-120.
doi: 10.1007/s12070-012-0594-6
 17. Tian Z, Li L, Wang L, Hu Y, Li J. Salivary gland neoplasms in oral and maxillofacial regions: a 23-year retrospective study of 6982 cases in an eastern Chinese population. *Int J Oral Maxillofac Surg.* 2010;39(3):235-242.
doi: 10.1016/j.ijom.2009.10.016
 18. Ito FA, Ito K, Vargas PA, de Almeida OP, Lopes MA. Salivary gland tumors in a Brazilian population: a retrospective study of 496 cases. *Int J Oral Maxillofac Surg.* 2005;34(5):533-536.
doi: 10.1016/j.ijom.2005.02.005
 19. Bradley PJ, McGurk M. Incidence of salivary gland neoplasms in a defined UK population. *Br J Oral Maxillofac Surg.* 2013;51(5):399-403.
doi: 10.1016/j.bjoms.2012.10.002
 20. Vasconcelos AC, Nör F, Meurer L, *et al.* Clinicopathological analysis of salivary gland tumors over a 15-year period. *Braz oral res.* 2016;30(1).
doi: 10.1590/1807-3107bor-2016.vol30.0002
 21. Lopes MLDD, Barroso KMA, Henriques ÁCG *et al.* Pleomorphic adenomas of the salivary glands: retrospective multicentric study of 130 cases with emphasis on histopathological features. *Eur Arch Otorhinolaryngol.* 2017;274(1):543-551.
doi: 10.1007/s00405-016-4253-5
 22. Matsumiya-Matsumoto Y, Morita Y, Uzawa N. Pleomorphic Adenoma of the Salivary Glands and Epithelial-Mesenchymal Transition. *J Clin Med.* 2022;11(14).
doi: 10.3390/jcm11144210
 23. Zbären P, Stauffer E. Pleomorphic adenoma of the parotid gland: histopathologic analysis of the capsular characteristics of 218 tumors. *Head Neck.* 2007;29(8):751-757.
doi: 10.1002/hed.20569
 24. Witt RL, Eisele DW, Morton RP *et al.* Etiology and management of recurrent parotid pleomorphic adenoma. *Laryngoscope.* 2015;125(4):888-893.
doi: 10.1002/lary.24964
 25. Franzen AM, Kaup Franzen C, Guenzel T, Lieder A. Increased incidence of Warthin tumours of the parotid gland: a 42-year evaluation. *Eur Arch Otorhinolaryngol.* 2018;275(10):2593-2598.
doi: 10.1007/s00405-018-5092-3
 26. Saravakos P, Kourtidis S, Hartwein J, Preyer S. Parotid Gland Tumors: A Multicenter Analysis of 1020 Cases. Increasing Incidence of Warthin's Tumor. *Indian J Otolaryngol Head Neck Surg.* 2022;74(Suppl 2):2033-2040.
doi: 10.1007/s12070-020-01981-z
 27. Gao M, Hao Y, Huang MX *et al.* Salivary gland tumours in a northern Chinese population: a 50-year retrospective study of 7190 cases. *Int J Oral Maxillofac Surg.* 2017;46(3):343-349.
doi: 10.1016/j.ijom.2016.09.021
 28. Taghavi N, Sargolzaei S, Mashhadiabbas F, Akbarzadeh A, Kardouni P. Salivary Gland Tumors: A 15- year Report from Iran. *Turk Patoloji Derg.* 2016;32(1):35-39.
doi: 10.5146/tjpath.2015.01336
 29. Lee YM, Choi HJ, Kim JW, Kim JH. Parotid gland tumors in a Korean population. *J Craniofac Surg.* 2012;23(3):e205-e209.
doi: 10.1097/SCS.0b013e31824de357