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Clinical Features and Prognostic Insights in Sinonasal Sarcomas: A 76-Case Single-Institution Experience

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ABSTRACT

Objective: This study analyzed the clinical characteristics, treatment outcomes, and prognostic factors of sinonasal sarcomas through a single-institution experience involving 76 cases over 27 years.

Methods: A retrospective review was conducted on 76 patients diagnosed with sinonasal sarcoma at a tertiary medical center from 1995 to 2022. Data collected included demographic information, tumor characteristics, and treatment modalities. Survival outcomes were assessed using Kaplan–Meier analysis, and prognostic factors were identified through univariate and multivariate Cox proportional hazards models.

Results: The cohort included 45 males and 31 females, with a mean age of 42.6 years. The most common presenting symptom was nasal obstruction (22%). Rhabdomyosarcoma was the most prevalent subtype, accounting for 27.6% of cases. The 5- and 10-year overall survival (OS) rates were 62% and 56%, while the disease-free survival (DFS) rates were 51% and 41%. Survival outcomes were significantly worse in patients aged ≥61 years ($p = 0.030$), with a smoking history ($p = 0.005$), or with neurovascular extension ($p = 0.015$). In the univariate analysis, smoking history increased the mortality risk by 2.95-fold ($p = 0.008$) and neurovascular involvement by 2.87-fold ($p = 0.020$). Multivariate Cox analysis confirmed smoking history as an independent predictor of mortality (HR = 2.38, 95% CI: 1.05–5.40, $p = 0.038$).

Conclusions: The results showed that advanced age, smoking history, and neurovascular involvement were key contributors to reduced survival, with identified as a significant independent predictors of higher mortality risk. These findings offer critical insight into the therapeutic management of this rare malignancy.

Level of Evidence: 4

1 | Introduction

Sarcomas are rare malignant neoplasms originating from mesenchymal tissues, encompassing over 50 histopathological subtypes. They account for approximately 2% of cases of head and neck cancers. In adults, 4%–10% of sarcomas arise in the head and neck region [1–3]. Notably, sinonasal tract sarcomas represent an even more uncommon subset, comprising approximately 7%–30% of head and neck sarcomas [4, 5]. Despite their rarity, these tumors pose significant clinical challenges due to their aggressive nature and complex anatomical positioning. The sinonasal tract's proximity to critical structures, such as the skull

base, orbital cavity, and major neurovascular pathways, complicates both diagnosis and treatment. Patients often present with non-specific symptoms that mimic benign conditions, delaying diagnosis and contributing to poorer outcomes [6]. Compared to other head and neck sarcomas, sinonasal sarcomas often show a higher propensity for advanced-stage presentation and exhibit histological heterogeneity, making both diagnosis and management difficult. Previous studies have explored various aspects of sinonasal tract malignancies, noting that squamous cell carcinoma and adenocarcinoma are more frequently encountered in this anatomical region. Sinonasal sarcomas, while less common, are notable for their poor prognosis, with 5-year survival rates varying significantly based on histological subtype. For instance, rhabdomyosarcoma is associated with particularly unfavorable outcomes compared to other subtypes [7, 8].

The small sample size of previous single-institution studies on sinonasal or head and neck sarcoma, typically fewer than 50 cases, is attributed to the rarity of sinonasal sarcoma [6, 9, 10]. Multi-institution studies using resources like the SEER database or the French Sarcoma Group database have managed to include larger sample sizes compared to single-institution studies. However, they face limitations such as insufficient detail in clinical data and variability in treatment approaches [4, 11, 12]. In this study, we utilized meticulously curated clinical records collected over a long period of time at a leading tertiary referral medical center in South Korea, enabling us to address these limitations by providing a comprehensive and standardized dataset suitable for robust analysis.

Building on this foundation, the present study reviews 76 cases of sinonasal tract sarcoma diagnosed and treated at this institution over the past 27 years. The objectives of this study were to categorize tumor subtypes, document clinical characteristics, and analyze survival rates along with factors influencing these outcomes in patients with this rare condition. By evaluating the dataset, this study aims to provide insights that facilitate the advancement of approaches for the treatment of sinonasal sarcoma.

2 | Material and Methods

2.1 | Study Design

This study is a retrospective review of all sinonasal sarcoma cases diagnosed at Asan Medical Center, Seoul, Korea, between January 1995 and July 2022. Ethical approval was obtained from the Institutional Review Board (number 2022-0750), which waived the requirement for written informed consent due to the study's retrospective nature.

2.2 | Patient Selection and Data Collection

Patients were included based on confirmed histological diagnoses by expert pathologists specializing in head and neck sarcomas, each with over 20 years of experience in the field. Cases with incomplete data or nonmalignant histologies were excluded from the analysis. Medical records were systematically reviewed to extract comprehensive information, including demographic details (age, sex, and smoking history), clinical presentations, tumor characteristics, and treatment modalities. Tumor location, lymph node involvement, distant metastasis, neurovascular extension (NVE), and histopathological subtypes were documented. Tumor staging adhered to the 8th edition of the American Joint Committee on Cancer (AJCC) TNM classification, with specific adjustments for rhabdomyosarcoma cases. Treatment approaches, including surgery, chemotherapy, and radiotherapy, were reviewed. Surgical interventions were categorized by type, such as endoscopic resection, partial maxillectomy, and craniofacial resection. Nonsurgical treatments included specific chemotherapy regimens and radiation therapy techniques. Diagnostic changes between initial evaluation and postoperative histological confirmation were recorded to evaluate the implications on clinical outcomes. This detailed documentation enabled an understanding of the extent to which diagnostic revisions impacted treatment strategies and patient survival.

2.3 | Survival Analysis and Statistical Methods

Kaplan–Meier survival curves were generated to evaluate overall survival (OS) and disease-free survival (DFS) across 1-, 5-, and 10-year intervals. Survival differences between groups were assessed using the log-rank test, with statistical significance set at $p < 0.05$. Univariate analyses were performed to evaluate associations between survival outcomes and various clinical and pathological factors, including age, sex, smoking history, NVE, initial T stage, nodal metastasis, distant metastasis, histological subtypes, and treatment modalities. Multivariate analysis was conducted using Cox proportional hazards regression to adjust for potential confounding variables and identify independent prognostic factors influencing survival. The analysis generated hazard ratios (HRs) with 95% confidence intervals (CIs) for each variable to quantify their impact. All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS), version 21 (IBM, Chicago, IL).

3 | Results

Among the 76 patients analyzed, 45 were male (59.2%), and 31 were female (40.8%). The mean age at diagnosis was 42.6 years (range: 3–86 years). Smoking history was reported in 22.4% of the cohort, with 11 current smokers and six ex-smokers. The baseline characteristics of the cohort are summarized in Table 1. The most frequent initial symptom was nasal obstruction, observed in 22.4% of cases, followed by epistaxis (18.4%) and facial pain (17.1%). Less common symptoms included cheek swelling, neck mass, and exophthalmos. Table 1 also shows that the maxillary sinus was the most common tumor site, accounting for 44.7% of all cases, while the ethmoid sinus and nasopharynx represented 25% and 10.5%, respectively.

Histopathological analysis revealed rhabdomyosarcoma as the most prevalent subtype, observed in 27.6% of patients, including both alveolar and embryonal variants. Spindle cell sarcomas were observed in 20 patients, while pleomorphic sarcomas and teratocarcinosarcomas were less prevalent. Connective tissue sarcomas, such as chondrosarcoma, osteosarcoma, and

TABLE 1 | Baseline characteristics, initial symptoms, and histopathological subtypes of patients with sinonasal sarcoma.

Variables		Total, $N=76$	%
Sex	Male	45	59.2
	Female	31	40.8
Age at diagnosis, mean		42.6 (3–86)	
Smoking history	Current smoker	11	14.5
	Ex-smoker	6	7.9
	Never smoked	59	77.6
Initial symptoms	Nasal obstruction	17	22.4
	Epistaxis	14	18.4
	Facial pain	13	17.1
	Cheek swelling	7	9.2
	Neck mass	4	5.3
	Visual disturbance	3	3.9
	Exophthalmos	3	3.9
	Diplopia	2	2.6
	Headache	2	2.6
	Orbital swelling	2	2.6
	Nasolabial mass	2	2.6
	Other uncommon symptoms[a]	7	9.2
Site	Maxillary sinus	34	44.7
	Ethmoid sinus	19	25.0
	Nasopharynx	8	10.5
	Sphenoid sinus	6	7.9
	Nasal septum	3	3.9
	Nasolabial fold	2	2.6
	Nasal dorsum	1	1.3
	Frontal sinus	1	1.3
	Inferior turbinate	1	1.3
	Nasal vestibule	1	1.3
Histopathological subtypes			
Soft tissue sarcoma	Rhabdomyosarcoma, alveolar	12	15.8
	Rhabdomyosarcoma, embryonal	9	11.8
	Spindle cell sarcoma		
	Malignant fibrous histiocytoma	7	9.2
	Spindle cell sarcoma, others	8	10.5
	Leimyosarcoma	2	2.6
	Fibrosarcoma	3	3.9
	Pleomorphic sarcoma	6	7.9
	Teratocarcino sarcoma	5	6.6

(Continues)

TABLE 1 | (Continued)

Variables		Total, $N=76$	%
	Fibromyxoid sarcoma	1	1.3
	Granulocytic sarcoma	1	1.3
	Myeloid sarcoma	1	1.3
	Biphenotypic sinonasal sarcoma	1	1.3
	Undifferentiated round cell sarcoma	1	1.3
Connective tissue sarcoma	Chondrosarcoma	7	9.2
	Osteosarcoma	6	7.9
Neuroectodermal origin	Ewing sarcoma	5	6.6
	Primitive neuroectodermal tumor	1	1.3
Diagnostic discrepancies	No change	49	64.5
	Reclassification to another sarcoma type	12	15.8
	Complete revision[b]	15	19.7

[a]Includes nasal dorsum mass, upper lip numbness, oroantral fistula, palate bulging, ptosis, postnasal drip, and vestibule mass.
[b]Refers to cases where initial and final diagnoses completely differ.

TABLE 2 | Distribution of TNM staging among 76 patients with sinonasal sarcoma.

T stage			N stage			M stage		
Stage	***N***	**%**	**Stage**	***N***	**%**	**Stage**	***N***	**%**
1	7	9.2	0	62	81.6	0	62	81.6
2	10	13.2	1	7	9.2	1	5	6.6
2a	7	9.2	X	7	9.2	X	9	11.8
2b	10	13.2						
3	4	5.3						
4a	25	32.9						
4b	5	6.6						
X[a]	8	10.5						
Total	76	100	Total	76	100	Total	76	100

[a]X, unknown or not assessed.

neuroectodermal tumors, including Ewing sarcoma, were identified. Cases with discrepancies between the initial and final diagnoses accounted for 35.5% of the cohort, with 12 cases reclassified to another sarcoma type and 15 cases where the initial and final diagnoses completely differed (Table 1).

The distribution of TNM staging is illustrated in Table 2, with 44.8% of patients presenting with advanced T3 or T4 tumors, nodal involvement observed in seven patients (9.2%), and distant metastasis confirmed in five patients (6.6%). Table 3 further details the TNM staging and treatment approaches for the major histologic subtypes, including rhabdomyosarcoma (alveolar and embryonal), spindle cell sarcoma, chondrosarcoma, and osteosarcoma. Figure 1 presents the treatment modalities used in the study. Surgical treatment was performed in 60.5% of patients, while nonsurgical treatments included chemotherapy and/or radiotherapy. Among surgical cases, combined treatment modalities included surgery, chemotherapy, and radiotherapy (21 patients) as well as surgery and radiotherapy (11 patients). Nonsurgical treatments consisted of combined chemotherapy and radiotherapy (18 patients), chemotherapy alone (five patients), and conservative treatment (seven patients). Notably, no patients received radiotherapy alone. Figure 2 illustrates the surgical techniques employed. Endoscopic resection was the most common technique, performed in 45.7% of cases, followed by maxillectomy in 22.4%.

The OS rates at 1, 5, and 10 years were 89%, 62%, and 56%, respectively, while the DFS rates at 1, 5, and 10 years were 75%, 51%, and 41%, respectively (Figure 3). The log-rank test, illustrated in Figure 4, demonstrated significant differences in survival outcomes based on age, smoking history, and NVE. Patients aged ≥ 61 years had significantly poorer survival compared with younger patients ($p=0.030$). Similarly, patients with a history of smoking demonstrated reduced survival outcomes

TABLE 3 | TNM staging and treatment approaches for major histologic subtypes of sinonasal sarcoma.

Subtype	TNM staging					Treatments					
	N[a]	T1	T2	T3–T4	N+	M+	OP + CT + RT	OP + RT	OP + CT	OP only	CT + RT	CT	Conservative Tx
Rhabdomyosarcoma	21	2	18	0	5	3	8	0	0	0	11	2	0
Alveolar	12	2	10	0	5	1	5	0	0	0	7	0	0
Embryonal	9	0	8	0	0	2	3	0	0	0	4	2	0
Spindle cell sarcoma	20	2	3	13	0	1	3	3	4	3	4	0	3
Chondrosarcoma	7	0	0	6	0	0	0	3	0	2	0	0	2
Osteosarcoma	6	0	0	5	0	0	3	0	0	0	1	1	1

Abbreviations: CT, chemotherapy; M+, presence of distant metastasis; N+, presence of node metastasis; OP, operation; RT, radiotherapy; Tx, treatment.
[a]Patients for whom TNM staging was not available or could not be assessed were excluded from this table.

FIGURE 1 | Treatment modality for patients with sinonasal sarcoma. CT, chemotherapy; OP, operation; RT, radiotherapy; Tx, treatment. †Conservative Tx: Patients who did not receive chemotherapy (CT), operation (OP), or radiotherapy (RT) but underwent symptomatic or palliative medication management.

FIGURE 2 | Surgical techniques used for sinonasal sarcoma resection. C-L op, Caldwell-Luc operation; OP, operation.

when compared with non-smokers ($p = 0.005$). Patients with NVE had a significantly poorer survival compared to those without NVE ($p = 0.015$). Conversely, survival outcomes were not significantly associated with sex (male vs. female, $p = 0.409$), initial T stage (T1/T2 vs. T3/T4, $p = 0.244$), nodal metastasis (present vs. absent, $p = 0.229$), or distant metastasis (present vs. absent, $p = 0.101$). Additionally, no significant differences were observed among histological subtypes (rhabdomyosarcoma vs. others, $p = 0.335$), surgical treatment (performed vs. not performed, $p = 0.099$), or the use of multimodal therapy (surgery, chemotherapy, and radiotherapy vs. others, $p = 0.687$).

The Cox proportional hazards regression analysis, detailed in Table 4, identified several prognostic factors impacting survival outcomes. In univariate analysis, smoking history was associated with a 2.95-fold higher risk of mortality (95% CI: 1.33–6.54, $p = 0.008$), and NVE increased the risk of mortality by 2.87 times (95% CI: 1.18–7.00, $p = 0.020$). Age ≥ 61 years was a significant predictor, with a 2.19-fold higher risk of mortality compared to younger patients (95% CI: 1.06–4.54, $p = 0.034$). In multivariate analysis, smoking history remained a significant

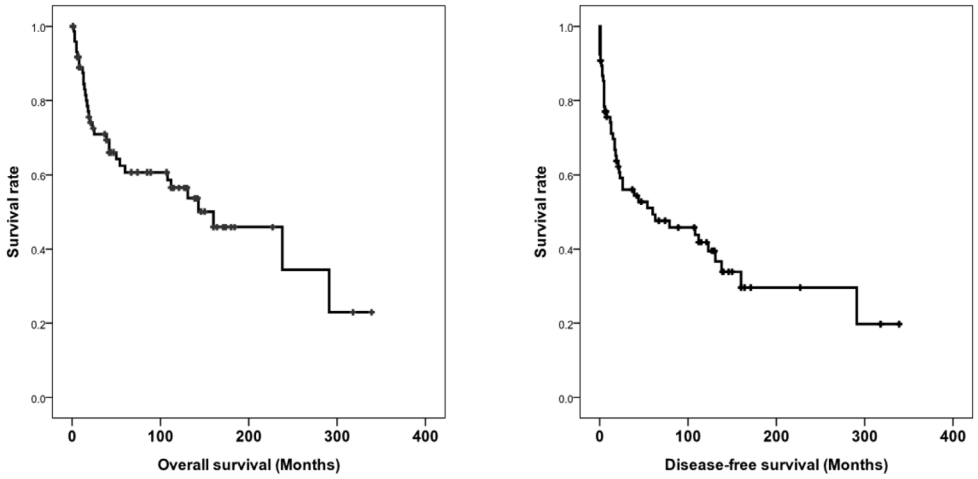

FIGURE 3 | Kaplan–Meier curves for overall survival and disease-free survival in patients with sinonasal sarcoma.

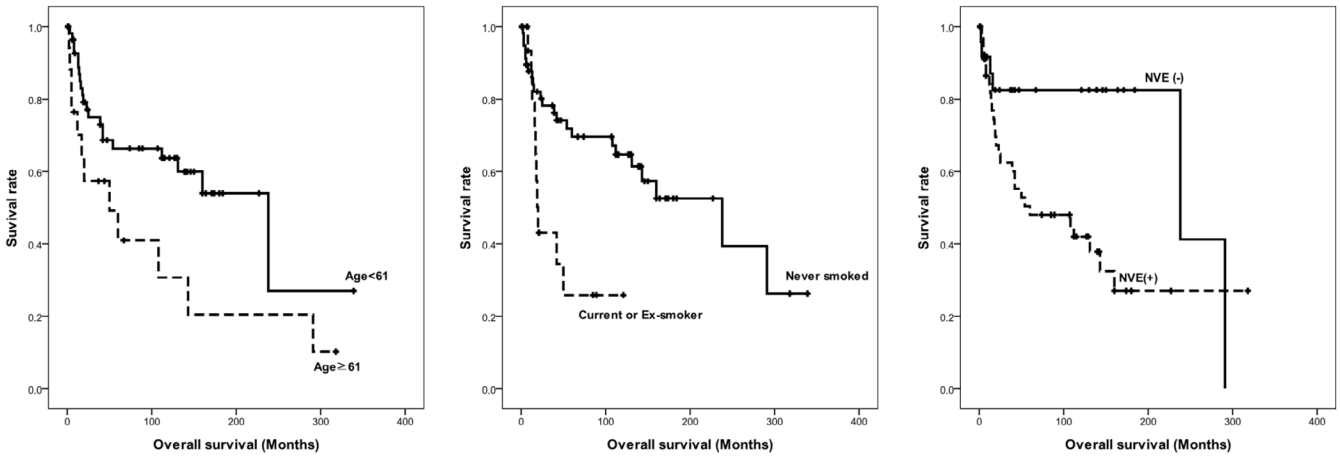

FIGURE 4 | Kaplan–Meier curves for age, smoking history, and neurovascular extension. NVE, neurovascular extension.

predictor of mortality, with an adjusted HR of 2.38 (95% CI: 1.05–5.40, $p = 0.038$).

4 | Discussion

This study analyzed 76 patients with sinonasal sarcoma, of whom 59.2% were male, with a mean diagnostic age of 42.6 years. Nasal obstruction was the most common symptom, with the maxillary sinus as the most frequent site. Among the histological subtypes, rhabdomyosarcoma was the most prevalent subtype. Surgery was performed in 60.5% of cases, with endoscopic resection the most employed surgical method. The 5-year OS rate was 62%, and the 5-year DFS rate was 51%. Reduced survival was significantly linked to older age (≥ 61 years), smoking history, and NVE. Notably, smoking history was associated with a 2.38-fold increase in mortality risk. These findings provide critical insights into prognostic factors and treatment outcomes, contributing to better strategies for managing this rare malignancy.

Sinonasal sarcomas most commonly present with non-specific symptoms, such as nasal obstruction and nasal discharge. In this study's cohort, nasal obstruction was the most frequent presenting symptom (22.4%). This aligns with prior studies reporting nasal obstruction and epistaxis as common symptoms in sinonasal malignancies [11, 13]. However, these nonspecific symptoms are commonly observed in other benign conditions, such as chronic sinusitis or allergic rhinitis, which often lead to delayed diagnosis. Additionally, the maxillary sinus was the most common tumor site in this study, a result consistent with previous studies, in which the maxillary and ethmoid sinuses are frequently cited as primary sites of sinonasal sarcomas [6, 11].

Many subtypes of sarcomas are found in the cohorts of our study. While rhabdomyosarcoma was the most prevalent histological subtype (28%), the literature demonstrates variability in the distribution of different histological subtypes based on geographic and institutional differences. Sinonasal sarcoma is rare and encompasses diverse histological subtypes, making accurate diagnosis from small biopsies, particularly, challenging [14]. The complex anatomy of the sinonasal tract, coupled with its histological diversity, often results in diagnostic discrepancies. In this study, 35.5% of cases exhibited differences between the initial and final diagnoses, with 19.7% undergoing complete revision. Advances in diagnostic techniques, such as immunohistochemistry and next-generation sequencing, have facilitated more accurate classifications by identifying specific genetic

TABLE 4 | Prognostic factors affecting survival in sinonasal sarcoma.

Variates		Univariate analysis		Multivariate analysis	
		Hazard ratio (95% CI)	*p*	Hazard ratio (95% CI)	*p*
Age	< 61	1		1	
	≥ 61	2.19 (1.06–4.54)	**0.034**.	1.75 (0.82–3.74)	0.150
Sex	Male	1			
	Female	0.74 (0.36–1.53)	0.412		
Smoking	Never	1		1	
	Current or ex-smoker	2.95 (1.33–6.54)	**0.008**	2.38 (1.05–5.40)	**0.038**
Neurovascular extension	Negative	1		1	
	Positive	2.87 (1.18–7.00)	**0.020**	2.45 (0.99–6.05)	0.053
Initial T stage	1, 2	1			
	3, 4	1.53 (0.74–3.17)	0.249		
Initial node metastasis	Negative	1			
	Positive	1.91 (0.65–5.59)	0.238		
Initial distant metastasis	Negative	1			
	Positive	2.36 (0.82–6.83)	0.112		
Rhabdomyosarcoma	Rhabdomyosarcoma	1			
	Others	1.50 (0.65–3.47)	0.340		
Operation	Nonoperation	1			
	Operation	0.57 (0.29–1.13)	0.105		
Multimodality	Others	1			
	OP + CT + RT	1.18 (0.53–2.65)	0.688		

Note: Bold indicates statistically significant results ($p < 0.05$), highlighting variables with meaningful associations in the analysis.
Abbreviations: CI, confidence interval; CT, chemotherapy; NVE, neurovascular extension; OP, operation; RT, radiotherapy.

mutations [15]. However, challenges persist, as misdiagnoses can lead to suboptimal treatment plans, adversely affecting survival outcomes. Thus, improving diagnostic accuracy through enhanced molecular diagnostics and expert pathological review is critical for optimizing patient outcomes.

In this study, the primary treatment approach mirrored the trends observed in the literature, with surgical resection being the most utilized method (60.5%), frequently combined with chemotherapy and/or radiotherapy in a multimodal strategy. Endoscopic resection was the preferred surgical approach, reflecting advances in techniques that are less invasive while remaining effective in tumor control. The treatment of sarcomas has evolved significantly over time, emphasizing a multidisciplinary approach. Traditionally, surgery with a wide local excision and clear margins has been considered the cornerstone of treatment, particularly for localized tumors [5, 6]. Radiotherapy has often been used as an adjunct, either preoperatively to reduce tumor size or postoperatively to address microscopic residual disease [16]. Chemotherapy, while less commonly employed for localized sinonasal sarcomas, has played a critical role in managing advanced or metastatic disease and certain histological subtypes, such as rhabdomyosarcoma or Ewing sarcoma [4, 17, 18]. Recent studies highlight the increasing utilization of multimodal treatment strategies, combining surgery, chemotherapy, and radiotherapy, to optimize outcomes [5, 16]. Advances in surgical techniques, including endoscopic approaches, have enabled less invasive procedures with comparable efficacy in tumor control.

Sinonasal sarcomas are not only rare but are associated with poor survival. In this study, the 5-year OS rate was 62% and the DFS rate was 51%, consistent with rates reported in the literature. For example, a systematic review reported a 5-year OS of 61.3% and DFS of 53.3% [16], with the French Sarcoma Group study reporting a 5-year OS of 62.3% [11]. In comparison, studies utilizing the SEER database reported slightly lower 5-year survival rates, at 47% [12] and 31% [4]. Sinonasal sarcomas also exhibit poorer survival outcomes compared to other types of head and neck cancers, including squamous cell carcinoma, which has a 5-year OS of 65%–75% [19–21], and sarcomas in other anatomical sites, such as soft tissue sarcomas, with a 5-year local control rate of 83% [22].

Given the poor survival rates associated with sinonasal sarcoma, several studies have focused on identifying prognostic factors. This study revealed that advanced age, particularly, 61 years or older, was significantly associated with a reduced

5-year OS rate compared to younger patients. Advanced age is a well-established prognostic factor influencing survival outcomes among many cancers, including sinonasal sarcomas. An analysis of the SEER database found that advanced age significantly reduced survival, with patients over 50 years experiencing a median OS of 28 months compared to 74 months for younger patients [12]. One study also demonstrated that older age was significantly associated with reduced OS [6]. Another key prognostic factor in the present study was NVE, which likely impacts survival due to the anatomical complexities of the sinonasal region. Neurovascular involvement increases systemic spread and recurrence, complicating treatment and reducing surgical or radiation efficacy [6, 22]. Moreover, achieving complete surgical resection with clear margins is particularly challenging in this region, contributing to recurrence rates as high as 35% within the first year following treatment in some studies [5, 23]. Consistent with our findings, a single-center study of 27 patients with sarcoma aged >47 years also reported that NVE negatively affected survival [6]. Among the 76 patients, 25% were current or former smokers, with smoking associated with an increase in the mortality risk by 2.38 times. Smoking, long established as a poor prognostic indicator in other head and neck cancers, has only recently been identified in sinonasal sarcoma, as demonstrated by the present study. Although the results suggest that smoking exacerbates tumor aggressiveness and impairs immune response, further studies are needed to confirm these effects specifically in sinonasal sarcomas.

Certain factors were not found to be statistically significant in this analysis, despite reports identifying them as significantly influencing survival in the literature. For example, the TNM staging system exhibited no significant association with survival. Kauke et al. reported that nodal involvement reduced DFS to 20 months, highlighting the aggressive nature of tumors with regional spread [6]. Similarly, Gore et al. demonstrated that distant metastasis significantly impacted survival in a systematic review [16]. In the present study, the relatively high proportion of patients with N0 stage (84.2%) and M0 stage (85.5%) may have influenced these results. Histological subtypes, including rhabdomyosarcoma, did not significantly impact survival in our cohort. Previous studies have reported 5-year OS rates of 28.4%–32.9% for rhabdomyosarcoma [7, 11, 12]. Wu et al. reported that rhabdomyosarcoma had the highest mortality (HR = 3.62) and the lowest 5-year OS among all sarcoma subtypes [12]. Martin's analysis of the SEER database also indicated that rhabdomyosarcoma had a median survival of only 30 months, shorter than the 40 months reported for other sarcoma subtypes [4]. Notably, in the present study, the 5-year OS rate for rhabdomyosarcoma was 62%, significantly higher than those reported in earlier studies. While rhabdomyosarcoma was the most common histological subtype in our cohort, survival differences among subtypes were not statistically significant, which could be attributed to the limited sample size, which may have reduced statistical power. Furthermore, among the 21 patients with rhabdomyosarcoma, the majority (19 patients) received multimodal therapy, with 11 patients undergoing chemotherapy and radiotherapy, and 8 patients receiving a combination of surgery, chemotherapy, and radiotherapy. The high utilization of these intensive treatment regimens may have contributed to the observed survival outcomes by mitigating potential disparities among subtypes. Although the present study did not identify surgery or multimodal treatment as statistically significant prognostic factors, their importance in managing sinonasal sarcoma is well-documented in the literature. Wide local excision with clear resection margins has been deemed essential for achieving long-term survival in head and neck sarcoma [6]. Similarly, Stavrakas et al. demonstrated the critical role of surgery in head and neck sarcoma treatment, highlighting that achieving clear margins is fundamental for improving survival outcomes [5]. Comprehensive reviews by Gore et al. have further reinforced this by showing that patients who underwent a combination of surgery, radiotherapy, and chemotherapy had a 5-year overall survival (5YOS) rate of 90.9%, significantly higher than those treated with single-modality therapy [16]. Additionally, Szablewski et al. reported that surgery was a predictive factor for complete response, with a 5-year OS of 69.9% in surgical patients compared to 36.9% in nonsurgical patients [11]. These findings collectively highlight the pivotal role of surgery, often as part of a multimodal treatment strategy, in improving survival outcomes for patients with sinonasal sarcoma.

This study has several limitations. As a single-institution, retrospective analysis, the external validity of our findings may be limited. Moreover, the rarity of sinonasal sarcomas restricted the sample size, although a cohort of 76 patients represents one of the larger series for this rare tumor type. In addition, the heterogeneity in the histological subtypes and treatment modalities complicates direct comparisons and may obscure subtype-specific trends. Lastly, the study did not extensively analyze the impact of specific surgical techniques or chemotherapy regimens due to the variability in treatment protocols over the study period. Despite these limitations, this study offers valuable insights into sinonasal sarcoma survival and prognostic factors. With one of the largest sample sizes among single-institution studies on sinonasal sarcoma, this analysis offers foundational data for future research and may serve as a basis for multicenter studies or meta-analyses aimed at validating and expanding upon these findings.

5 | Conclusion

This study represents one of the largest single-institution analyses of sinonasal sarcoma, examining 76 cases over 27 years. The overall 5YOS and DFS rates of 62% and 51%, respectively, highlight the aggressive and challenging nature of this rare malignancy. Key findings include the identification of advanced age, smoking history, and neurovascular involvement as critical factors in poor survival outcomes. Smoking history was particularly associated with an increased risk of mortality.

Acknowledgments

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. D. H. Kraus, S. Dubner, L. B. Harrison, et al., "Prognostic Factors for Recurrence and Survival in Head and Neck Soft Tissue Sarcomas," *Cancer* 74 (1994): 697–702.

2. H. T. Hoffman, R. A. Robinson, J. L. Spiess, and J. Buatti, "Update in Management of Head and Neck Sarcoma," *Current Opinion in Oncology* 16 (2004): 333–341.

3. B. O. Potter and E. M. Sturgis, "Sarcomas of the Head and Neck," *Surgical Oncology Clinics of North America* 12 (2003): 379–417.

4. E. Martin, S. Radomski, and E. Harley, "Sarcomas of the Paranasal Sinuses: An Analysis of the SEER Database," *Laryngoscope Investigative Otolaryngology* 4 (2019): 70–75.

5. M. Stavrakas, I. Nixon, K. Andi, et al., "Head and Neck Sarcomas: Clinical and Histopathological Presentation, Treatment Modalities, and Outcomes," *Journal of Laryngology and Otology* 130 (2016): 850–859.

6. M. Kauke, A. F. Safi, A. Grandoch, H. J. Nickenig, J. Zöller, and M. Kreppel, "Sarcomas of the Sinonasal Tract," *Head & Neck* 40 (2018): 1279–1286.

7. K. Stepan, N. Konuthula, M. Khan, et al., "Outcomes in Adult Sinonasal Rhabdomyosarcoma," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology-Head and Neck Surgery* 157 (2017): 135–141, https://doi.org/10.1177/0194599817696287.

8. A. A. Unsal, S. Y. Chung, A. B. Unsal, S. Baredes, and J. A. Eloy, "A Population-Based Analysis of Survival for Sinonasal Rhabdomyosarcoma," *Otolaryngology—Head and Neck Surgery: Official Journal of American Academy of Otolaryngology-Head and Neck Surgery* 157 (2017): 142–149.

9. S. Yamaguchi, H. Nagasawa, T. Suzuki, et al., "Sarcomas of the Oral and Maxillofacial Region: A Review of 32 Cases in 25 Years," *Clinical Oral Investigations* 8 (2004): 52–55.

10. R. de Bree, P. van der Valk, D. J. Kuik, et al., "Prognostic Factors in Adult Soft Tissue Sarcomas of the Head and Neck: A Single-Centre Experience," *Oral Oncology* 42, no. 7 (2006): 703–709, https://doi.org/10.1016/j.oraloncology.2005.11.009.

11. V. Szablewski, A. Neuville, P. Terrier, et al., "Adult Sinonasal Soft Tissue Sarcoma: Analysis of 48 Cases From the French Sarcoma Group Database," *Laryngoscope* 125 (2015): 615–623.

12. A. W. Wu, J. D. Suh, R. Metson, and M. B. Wang, "Prognostic Factors in Sinonasal Sarcomas: Analysis of the Surveillance, Epidemiology and End Result Database," *Laryngoscope* 122 (2012): 2137–2142.

13. J. A. Sercarz, R. J. Mark, L. Tran, I. Storper, and T. C. Calcaterra, "Sarcomas of the Nasal Cavity and Paranasal Sinuses," *Annals of Otology, Rhinology, and Laryngology* 103 (1994): 699–704.

14. A. K. Israel, V. Cracolici, and C. C. Griffith, "Challenging Differential Diagnoses in Small Biopsies From the Sinonasal Tract," *Seminars in Diagnostic Pathology* 40 (2023): 321–332.

15. A. Viramontes, N. Mueller, C. D. Gocke, T. R. Deklotz, and M. Ozdemirli, "Novel PAX3::INO80D Fusion in Biphenotypic Sinonasal Sarcoma in an Adult," *JAMA Otolaryngology. Head & Neck Surgery* 149 (2023): 849–850.

16. M. R. Gore, "Treatment, Outcomes, and Demographics in Sinonasal Sarcoma: A Systematic Review of the Literature," *BMC Ear, Nose and Throat Disorders* 18 (2018): 4.

17. K. J. Contrera, N. M. Woody, M. Rahman, R. Sindwani, and B. B. Burkey, "Clinical Management of Emerging Sinonasal Malignancies," *Head & Neck* 42 (2020): 2202–2212.

18. A. L. Shaari, R. Ho, A. M. Patel, S. Haimowitz, J. Anderson Eloy, and C. H. Fang, "Ewing Sarcoma of the Sinonasal Tract: A Scoping Review," *Laryngoscope* 135 (2025): 1571–1580.

19. A. Barsouk, J. S. Aluru, P. Rawla, K. Saginala, and A. Barsouk, "Epidemiology, Risk Factors, and Prevention of Head and Neck Squamous Cell Carcinoma," *Medical Science* 11, no. 2 (2023): 42, https://doi.org/10.3390/medsci11020042.

20. F. Islami, R. L. Siegel, and A. Jemal, "The Changing Landscape of Cancer in the USA—Opportunities for Advancing Prevention and Treatment," *Nature Reviews Clinical Oncology* 17 (2020): 631–649.

21. K. D. Miller, L. Nogueira, A. B. Mariotto, et al., "Cancer Treatment and Survivorship Statistics, 2019," *CA: A Cancer Journal for Clinicians* 69 (2019): 363–385.

22. G. K. Zagars, M. T. Ballo, P. W. Pisters, et al., "Prognostic Factors for Patients With Localized Soft-Tissue Sarcoma Treated With Conservation Surgery and Radiation Therapy: An Analysis of 1225 Patients," *Cancer* 97, no. 10 (2003): 2530–2543, https://doi.org/10.1002/cncr.11365.

23. M. T. Figueiredo, L. A. Marques, and N. Campos-Filho, "Soft-Tissue Sarcomas of the Head and Neck in Adults and Children: Experience at a Single Institution With a Review of Literature," *International Journal of Cancer* 41 (1988): 198–200.