Middle Eastern Cancer and Oncology Journal (MECOJ)
ISSN: 3080-1427 (online) / 3080-1419 (print)
Volume 2, Issue 2 (April – June 2026), pp: 26–32

Research Article

Clinicopathological Predictors of High Mitotic Rate in Gastrointestinal Stromal Tumors: A Cross-Sectional Study in Iraq

Noha Salman [1,a,*], Rabah Haeab [2,b], Hawraa R. Salih [2,c]

[1] Department of Medical Oncology, Al-Jawad Center, Baghdad, Iraq.
[2] Medical City Complex, Baghdad Teaching Hospital, Baghdad, Iraq.

E-mail: nohasalman1989@gmail.com [a,*]; rabahasreah@comed.uobaghdad.edu.iq [b]; Hawraa.r.salih@gmail.com [c]

Received: 19 September 2025 | Revised: 14 January 2026 | Accepted: 26 March 2026 | Published: 08 May 2026

Abstract

Gastrointestinal stromal tumors (GISTs) are the most common mesenchymal neoplasms of the gastrointestinal tract and exhibit heterogeneous biological behavior. Prognostic determinants—particularly tumor size, mitotic rate, and histopathological subtype—guide treatment decisions and surveillance intensity. This study aimed to characterize the clinicopathological features of Iraqi patients with GIST and identify factors associated with a high mitotic rate. We conducted a cross-sectional study of 50 consecutive adults with histopathologically confirmed GIST managed between April 2022 and February 2023 at the Oncology Teaching Hospital and Hematology Department, Medical City Complex, Baghdad, Iraq. Extracted variables included demographics, clinical presentation, tumor site, size, stage, metastasis, histology, and immunohistochemical markers (CD117, DOG-1, CD34, actin). Eligible patients were adults (≥18 years) with histopathologically confirmed GIST and sufficient clinicopathological data. Descriptive statistics summarized cohort characteristics. Associations with a high mitotic rate were assessed using chi-square or Fisher's exact tests, followed by multivariable logistic regression to estimate odds ratios (OR) with 95% confidence intervals (CI). The mean age was 58.7 ± 9.2 years; 56% were female. Hematemesis was the most frequent presentation (42%). The stomach was the most common primary site (36%). Metastasis was present in 58% of patients, most commonly hepatic. High mitotic rate occurred in 40% of cases and was significantly associated with age <60 years, stomach location, tumor size >5 cm, advanced stage, epithelioid histology, and metastasis. In multivariable analysis, tumor size >5 cm (OR 7.0; 95% CI 2.1–23.3), epithelioid subtype (OR 6.5; 95% CI 1.7–24.8), and advanced stage (OR 4.3; 95% CI 1.2–15.2) independently predicted a high mitotic rate. In this Iraqi cohort, larger tumor size, epithelioid morphology, and advanced stage were independently associated with high mitotic activity. These findings underscore the need for earlier detection and context-appropriate risk stratification to improve outcomes.

Keywords: *Gastrointestinal Stromal Tumor; Mitotic Rate; Epithelioid Subtype; Tumor Size; Iraq; Prognostic Factors.*

*** Corresponding Author**

Cite This Article: Noha Salman, Rabah Haeab, Hawraa R. Salih (2026). Clinicopathological Predictors of High Mitotic Rate in Gastrointestinal Stromal Tumors: A Cross-Sectional Study in Iraq. *Middle Eastern Cancer and Oncology Journal, 2(2),* 26–32. https://doi.org/10.61706/MECOJ160208

Introduction

Gastrointestinal stromal tumors (GISTs) are the most common mesenchymal neoplasms of the gastrointestinal tract, with an estimated incidence of 10–15 cases per million annually (Søreide et al., 2016). They are believed to arise from the interstitial cells of Cajal and are frequently driven by activating mutations in the KIT or PDGFRA genes, alterations that shape both tumor biology and therapeutic responsiveness (Miettinen & Lasota, 2006; von Mehren & Joensuu, 2018). Although GISTs constitute only 1–2% of all gastrointestinal malignancies, their clinical spectrum, ranging from small indolent lesions to aggressive tumors with metastatic potential, makes them a distinct and clinically important entity requiring rigorous risk stratification at diagnosis and following resection (Casali et al., 2022).

Over the past two decades, prognostic assessment has relied on validated schemes such as the NIH consensus criteria and the Armed Forces Institute of Pathology (AFIP) classification, which consistently identify tumor size, mitotic index, and anatomic site as the principal determinants of outcome (DeMatteo et al., 2008; Yang et al., 2019). Site-specific differences are well described: gastric GISTs more often follow a favorable course, whereas tumors originating in the small intestine, rectum, or extra-gastrointestinal locations exhibit a higher propensity for recurrence and aggressive behavior (Joensuu, 2008; Nishida et al., 2016). Among prognostic variables, mitotic activity is especially informative; a higher mitotic index is strongly associated with increased recurrence risk and inferior survival, reinforcing its central role in contemporary risk stratification and postoperative decision-making (Haller et al., 2011; Supsamutchai et al., 2018). Large cohort studies and registry-based analyses from Europe, Asia, and North America continue to reaffirm the prognostic weight of mitotic activity, typically in concert with size and site, supporting its routine incorporation into clinical reporting and research endpoints (Espinosa et al., 2008; Wu et al., 2019). Mitotic activity is a key indicator of tumor aggressiveness, strongly associated with recurrence risk and overall prognosis, and is therefore a cornerstone of most risk-stratification systems.

Diagnostic pathways typically integrate cross-sectional imaging for staging with histopathological confirmation and immunophenotyping, given that KIT (CD117) and DOG1 expression, together with morphology, help to substantiate the diagnosis and contextualize the underlying driver alterations (Casali et al., 2022; Miettinen & Lasota, 2006; von Mehren & Joensuu, 2018). Nevertheless, the applicability of widely used risk models may be context-dependent, particularly in regions with differing patterns of presentation and access to care. In the Middle East, and Iraq specifically, published data remain scarce, with relatively few studies characterizing the clinicopathological profile of GIST or benchmarking outcomes against global experience (Shi et al., 2017). Clinical impressions in this setting suggest more advanced stage at presentation and a greater metastatic burden, patterns plausibly linked to diagnostic delays, limited disease awareness, and gaps in organized screening or early detection pathways (Kramer et al., 2015). Given the cross-sectional design of this study and the absence of follow-up data, we focused on mitotic activity as the primary outcome, since it represents an established surrogate marker of prognosis that can be assessed at diagnosis.

Accordingly, this study was designed to evaluate the clinicopathological characteristics of Iraqi patients with GIST and to identify predictors of a high mitotic rate, thereby contributing region-specific evidence to the global understanding of GIST prognosis.

Methods

Study Design and Setting

This cross-sectional study was conducted at the Oncology Teaching Hospital and the Hematology Department within the Medical City Complex, Baghdad, Iraq. Patient accrual extended from April 2022 to February 2023.

Study Population and Eligibility

Consecutive adult patients with a histopathological diagnosis of gastrointestinal stromal tumor (GIST) who were newly diagnosed or newly treated at the study centers during the accrual period were considered for inclusion.

Patients were eligible if they (i) were ≥18 years at diagnosis; (ii) had histopathologically confirmed GIST based on compatible morphology supported by immunohistochemistry (IHC) (e.g., CD117 and/or DOG1; CD34/actin recorded when available); (iii) presented with either localized or metastatic disease at study entry; and (iv) had key clinicopathological variables available for analysis (age, sex, primary site, tumor size, stage, histology, metastasis status, and mitotic rate).
Patients were excluded if they (i) were <18 years; (ii) lacked definitive histopathological confirmation of GIST; (iii) had incomplete records such that the mitotic rate or primary tumor characteristics could not be ascertained after reasonable verification; or (iv) appeared as duplicate entries (in which case only the first eligible record was retained).

Case Ascertainment and Diagnostic Criteria

All cases were identified from pathology and oncology department logs and verified against

electronic and paper medical records. GIST diagnosis was established by staff pathologists using routine hematoxylin and eosin morphology in conjunction with IHC staining. IHC markers included CD117 and DOG1 (primary), with CD34 and smooth muscle actin recorded when performed. Mitoses were counted on representative tumor sections and reported as mitotic figures per 50 high-power fields (HPF) or according to the reporting pathologist's categorical assessment when numeric counts were not provided.

Variables and Operational Definitions

Age at diagnosis, sex, presenting symptoms (e.g., bleeding, abdominal pain, incidental finding), comorbidities, and smoking history were abstracted from clinical notes.

Primary site (stomach, small intestine, colon/rectum, extra-gastrointestinal), maximal tumor diameter (cm), stage at presentation, histological subtype (spindle, epithelioid, mixed), presence of metastasis at diagnosis, and IHC profile (CD117, DOG1, CD34, actin) were recorded from pathology reports and imaging summaries.

The primary outcome for analysis was a high mitotic rate. When pathology reports included a categorical assessment (e.g., low versus high), that categorization was used directly. When numeric mitoses per 50 HPF were reported, the institutionally stated cutoffs embedded in the report were applied to derive a binary variable (high versus low). When both numeric and categorical data were available, the categorical assessment in the official report was considered authoritative.

This approach preserved the original clinical interpretation and minimized post hoc reclassification bias across heterogeneous reports.

Data Collection and Management

Data were abstracted by trained investigators using a standardized case report form. To improve data integrity, 10% of records were randomly selected for independent verification by a second reviewer; discrepancies were resolved by consensus after re-examination of the source documents. Data were entered into a secure, de-identified database with range and logic checks (e.g., tumor size consistency, completeness of primary-site data). Missing fields were documented; no external imputation was undertaken given the modest sample size and cross-sectional design.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics, version 22. Continuous variables were summarized as mean ± standard deviation, and categorical variables as frequencies and percentages. Associations between clinicopathological factors and mitotic rate were assessed using Pearson's chi-square test or Fisher's exact test where appropriate. Binary logistic regression was performed to identify independent predictors of a high mitotic rate, with results expressed as odds ratios (OR) and 95% confidence intervals (CI). A two-sided p-value ≤ 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Iraqi Board of Medical Specializations, Scientific Council of Internal Medicine. Written informed consent was obtained from all participants prior to enrollment. All procedures adhered to the ethical principles of the Declaration of Helsinki.

Results

The study included 50 patients with histopathologically confirmed gastrointestinal stromal tumors (GISTs).

Table 1 summarizes the demographic and clinical features of the patients. Most patients were middle-aged, particularly those in the 50–59-year age group. Females slightly outnumbered males. Hematemesis and epigastric pain with anemia were the leading presenting complaints, while most patients had at least one comorbidity (Table 1).

Table 2 presents tumor characteristics and immunohistochemistry. The stomach was the most common primary site, and a large proportion of tumors were greater than 5 cm. Most patients presented with advanced-stage disease, and more than half had metastases, predominantly hepatic. The mixed histological subtype was most common, and CD117 was the most frequently expressed marker (Table 2).

Table 3 shows associations between clinicopathological variables and mitotic activity. High mitotic activity was significantly more common among younger patients, stomach tumors, those larger than 5 cm, advanced-stage disease, cases with metastasis, and epithelioid histology (Table 3).

Table 4 summarizes the logistic regression analysis. Independent predictors of high mitotic activity were tumor size greater than 5 cm, epithelioid histology, and advanced stage (Table 4).

Table 1. Demographic and Clinical Characteristics of Patients with GISTs

Variable	No.	%
<50 years	5	10.0
50–59 years	22	44.0
60–69 years	14	28.0
≥70 years	9	18.0
Male	22	44.0
Female	28	56.0
Asymptomatic	4	8.0
Hematemesis	21	42.0
Epigastric pain & anemia	16	32.0
Melena	9	18.0
Smoking (Yes)	19	38.0
Comorbidity (Yes)	32	64.0

Table 2. Tumor Characteristics and Immunohistochemistry

Variable	No.	%
Stomach	18	36.0
Jejunum	9	18.0
Duodenum	5	10.0
Ileum/terminal ileum	8	16.0
Rectum	3	6.0
Intraperitoneal/omental	4	8.0
Unknown primary	3	6.0
≤5 cm	34	68.0
>5 cm	16	32.0
Stage I–II	7	14.0
Stage IIIA–IIIB	12	24.0
Stage IVA–IVB	31	62.0
Metastasis (Yes)	29	58.0
Histology: Spindle	16	32.0
Histology: Epithelioid	10	20.0
Histology: Mixed	24	48.0
CD117 positive	33	66.0
DOG-1 positive	17	34.0
CD34 positive	22	44.0
Actin positive	12	24.0
Low mitotic rate	30	60.0
High mitotic rate	20	40.0

Table 3. Associations Between Clinicopathological Variables and High Mitotic Rate

Variable	Low (%)	High (%)	p-value
Age <60 years	11 (36.6)	16 (80.0)	0.01
Age ≥60 years	19 (63.4)	4 (20.0)	
Stomach site	9 (30.0)	9 (45.0)	0.01
Tumor size >5 cm	2 (6.7)	14 (70.0)	<0.001
Advanced stage (IV)	16 (53.3)	15 (75.0)	0.01
Metastasis present	14 (46.7)	15 (75.0)	0.04
Epithelioid histology	1 (3.3)	9 (45.0)	0.001

Table 4. Logistic Regression Analysis of Predictors of High Mitotic Rate

Variable	Adjusted OR	95% CI	p-value
Tumor size >5 cm	7.0	2.1–23.3	0.001
Epithelioid histology	6.5	1.7–24.8	0.005
Advanced stage (IV)	4.3	1.2–15.2	0.020

Discussion

Principal Findings

In this cross-sectional cohort of Iraqi patients with histopathologically confirmed GIST, most individuals were middle-aged, with a slight female predominance, and the stomach was the most common primary site. Notably, advanced-stage disease at diagnosis and metastasis were frequent, and 40% of tumors demonstrated a high mitotic rate. On multivariable analysis, tumor size >5 cm, epithelioid histology, and advanced stage independently predicted high mitotic activity. These findings complement global evidence

while highlighting context-specific features in this setting.

Comparison with the International Literature

The age distribution and near-balanced sex ratio in our cohort are broadly consistent with international series, although some reports describe a male predominance (Miettinen & Lasota, 2006; Søreide et al., 2016). The predominance of gastric primaries aligns with global data in which approximately half to two-thirds of GISTs arise in the stomach (Casali et al., 2022; von Mehren & Joensuu, 2018). In contrast, the proportion of advanced-stage disease (62%) and baseline metastasis (58%) in our cohort exceeds many reports from Europe, China, and North America, where earlier detection and lower metastatic burden at presentation are more typical (DeMatteo et al., 2008; Nishida et al., 2016; Yang et al., 2019). Potential contributors in our context include delayed health-seeking behavior, limited disease awareness, and fragmented diagnostic pathways (Joensuu, 2008).

Our results reaffirm the central prognostic importance of tumor size and mitotic index. The strong association between size >5 cm and high mitotic activity mirrors findings from large Asian and Western cohorts and supports current risk-stratification frameworks that jointly weigh size and proliferation metrics (Espinosa et al., 2008; Haller et al., 2011; Supsamutchai et al., 2018; Wu et al., 2019). Similarly, advanced stage at presentation tracked with higher mitotic activity, concordant with international observations linking stage with worse outcomes and more aggressive tumor biology (Shi et al., 2017).

Histology also carried prognostic information. Epithelioid subtype independently predicted high mitotic activity in our data, echoing evidence from German and Japanese cohorts in which epithelioid morphology was associated with more aggressive behavior and adverse features (IJzerman et al., 2020; Kramer et al., 2015), whereas spindle morphology often follows a comparatively indolent course (Abood et al., 2018). Incorporating histological subtype alongside size and mitotic index may therefore refine risk estimation in routine practice.

Immunohistochemistry remains indispensable for diagnosis; CD117 and DOG1, supported by CD34 and actin, help establish and contextualize GIST pathology (Alshok, 2020; Parab et al., 2019). Consistent with prior studies, however, IHC expression itself did not demonstrate prognostic value for mitotic activity in our cohort (Alfagih et al., 2022; Kelly et al., 2021). This reinforces that prognostication in GIST should rely primarily on clinicopathological variables rather than immunohistochemical marker expression alone.

Interpretation and Implications

Several patterns merit emphasis for regional practice. First, the high rates of advanced stage and baseline metastasis suggest opportunities to shorten time to diagnosis, particularly among patients presenting with upper gastrointestinal bleeding or anemia, through clearer referral triggers and streamlined access to endoscopy and cross-sectional imaging (DeMatteo et al., 2008; Joensuu, 2008; Nishida et al., 2016; Yang et al., 2019). Second, the robust association between larger tumors and a high mitotic rate underscores the clinical payoff of earlier detection: down-staging at presentation is likely to reduce the share of biologically aggressive disease (Espinosa et al., 2008; Haller et al., 2011; Shi et al., 2017; Supsamutchai et al., 2018; Wu et al., 2019). Third, the independent signal carried by epithelioid morphology supports routine, explicit reporting of histological subtype in pathology templates and its consideration in multidisciplinary discussions (Abood et al., 2018; IJzerman et al., 2020; Kramer et al., 2015). In practical terms, the identification of epithelioid morphology in biopsy or resection specimens should alert clinicians to the likelihood of more proliferative disease. This may support closer surveillance, multidisciplinary review, and consideration of earlier systemic therapy in selected patients.

The site-specific signal observed in bivariable analyses (e.g., stomach primaries showing more frequent high mitotic activity in our dataset) should be interpreted cautiously. Although non-gastric sites are often linked to more aggressive behavior in aggregate (Casali et al., 2022; von Mehren & Joensuu, 2018), site effects may be confounded by stage, tumor size, sampling differences, or referral patterns in smaller datasets. Our multivariable model, which adjusted for several of these factors, suggests that size, histology, and stage are the most stable correlates of high proliferation in this cohort.

Strengths and Limitations

This study adds region-specific evidence from an underreported Middle Eastern context, applies standardized data abstraction, and uses multivariable modeling to identify independent correlates of high mitotic activity (Casali et al., 2015; Mazzola, 2021). Nonetheless, its single-center design and modest sample size limit precision and generalizability. The cross-sectional design precludes survival inference, and we did not include molecular profiling, which can further refine risk stratification. Another limitation is variability in how mitotic counts were reported. Some pathology reports provided exact mitoses per 50 HPF, while others gave categorical assessments (low versus high). Although we used the pathologist's categorical

judgment as authoritative, this heterogeneity may have introduced classification variability across cases. Future multicenter cohorts that integrate molecular data and longitudinal outcomes are needed to validate and extend these findings (Casali & Le Cesne, 2021; Fletcher et al., 2002; von Mehren et al., 2022).

Future Directions

Building on these results, pragmatic steps include: (i) developing streamlined referral algorithms for patients with upper gastrointestinal bleeding or iron-deficiency anemia; (ii) standardizing pathology reports to include mitotic count per 50 HPF and explicit histological subtype; and (iii) establishing a national registry to track presentation patterns, treatments, and outcomes over time. Multicenter collaborations that pair comprehensive clinicopathological variables with genomic testing and follow-up will be particularly valuable (Casali & Le Cesne, 2021; Fletcher et al., 2002; von Mehren et al., 2022).

Conclusion

Larger tumor size, epithelioid histology, and advanced stage independently predicted high mitotic activity in Iraqi patients with GIST, aligning with global patterns while underscoring context-specific gaps in early detection and care pathways. From a clinical perspective, our findings highlight the importance of routinely documenting mitotic figures and histological subtype in pathology reports, and the potential benefits of strengthening early diagnostic pathways to reduce the proportion of patients presenting with advanced disease.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Iraqi Board of Medical Specializations, Scientific Council of Internal Medicine (Approval No: 2023/GIST/112). Written informed consent was obtained from all participants prior to enrollment. All procedures adhered to the ethical principles of the Declaration of Helsinki.

Consent for Publication

Not applicable.

Availability of Data and Material

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest / Competing Interests

The authors declare that there are no conflicts of interest.

Funding

The authors declare that this research received no external funding.

Authors' Contributions

N.S: Conceptualization, Methodology, Investigation, Formal analysis, Writing of the original draft.

R.H: Conceptualization, Methodology, Writing of the original draft, Supervision.

H.R.S: Writing of the original draft, Writing – review & editing.

Acknowledgment

Not applicable

Use of Generative AI and AI-Assisted Technologies

The authors declare that no generative AI or AI-assisted technologies were used in the preparation of this work.

References

Abood, R. A., Alasady, O. G., & Khalaf, A. A. (2018). Gastrointestinal stromal tumors in Southern Iraq: clinico-pathologic patterns and risk stratification. *Asian Journal of Biomedical and Pharmaceutical Sciences*, *7*(2), 432–440. https://doi.org/http://dx.doi.org/10.18081/2333-5106/018-7/432-440

Alfagih, A., AlJassim, A., Alshamsan, B., Alqahtani, N., & Asmis, T. (2022). Gastrointestinal Stromal Tumors: 10-Year Experience in Cancer Center—The Ottawa Hospital (TOH). *Current Oncology*, *29*(10), 7148–7157. https://doi.org/10.3390/curroncol29100562

Alshok, M. M. (2020). A clinical study on GIST in Babylon. *Oncology and Radiotherapy*, *14*(3), 1–5.

Casali, P. G., Blay, J.-Y., Abecassis, N., Bajpai, J., & Bauer, S. (2022). Gastrointestinal stromal tumours: ESMO–EURACAN–GENTURIS Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Annals of Oncology*, *33*(1), 20–33. https://doi.org/10.1016/j.annonc.2021.09.005

Casali, P. G., & Le Cesne, A. (2021). Gastrointestinal stromal tumors: New horizons. *Nature Reviews Clinical Oncology*, *18*, 621–633.

Casali, P. G., Le Cesne, A., Poveda Velasco, A., Kotasek, D., Rutkowski, P., Hohenberger, P., Fumagalli, E., Judson, I. R., Italiano, A., Gelderblom, H., Adenis, A., Hartmann, J. T., Duffaud, F., Goldstein, D., Broto, J. M., Gronchi, A., Dei Tos, A. P., Marréaud, S., van der Graaf, W. T. A., … Blay, J.-Y. (2015). Time to definitive failure to the first tyrosine kinase inhibitor in localized GI stromal tumors treated with imatinib as an adjuvant: a European Organisation for Research and Treatment of Cancer Soft Tissue and Bone Sarcoma Group Intergroup Randomized Trial. *Journal of Clinical Oncology*, *33*(36), 4276–4283. https://doi.org/10.1200/JCO.2015.62.4304

DeMatteo, R. P., Gold, J. S., Saran, L., Gönen, M., Liau, K. H., Maki, R. G., Singer, S., Besmer, P., Brennan, M. F., & Antonescu, C. R. (2008). Tumor mitotic rate, size, and location independently predict recurrence after resection of primary gastrointestinal stromal tumor (GIST). *Cancer*, *112*(3), 608–615. https://doi.org/10.1002/cncr.23199

Espinosa, I., Lee, C.-H., Kim, M. K., Rouse, B.-T., Subramanian, S., Montgomery, K., Varma, S., Corless, C. L., Heinrich, M. C., Smith, K. S., Wang, Z., Rubin, B., Nielsen, T. O., Seitz, R. S., Ross, D. T., West, R. B., Cleary, M. L., & van de Rijn, M. (2008). A novel monoclonal antibody against DOG1 is a sensitive and specific marker for gastrointestinal stromal tumors. *American Journal of Surgical Pathology*, *32*(2), 210–218. https://doi.org/10.1097/PAS.0b013e3181238cec

Fletcher, C. D. M., Berman, J. J., Corless, C., Gorstein, F., Lasota, J., Longley, B. J., Miettinen, M., O'Leary, T. J., Remotti, H., Rubin, B. P., Shmookler, B., Sobin, L. H., & Weiss, S. W. (2002). Diagnosis of gastrointestinal stromal tumors: A consensus approach. *Human Pathology*, *33*(5), 459–465. https://doi.org/10.1053/hupa.2002.123545

Haller, F., Cortis, J., Helfrich, J., Cameron, S., Schüler, P., Schwager, S., Gunawan, B., Füzesi, L., & Agaimy, A. (2011). Epithelioid/mixed phenotype in gastrointestinal stromal tumors with KIT mutation from the stomach is associated with accelerated passage of late phases of the cell cycle and shorter disease-free survival. *Modern Pathology*, *24*(2), 248–255. https://doi.org/10.1038/modpathol.2010.188

IJzerman, N. S., Drabbe, C., den Hollander, D., Mohammadi, M., van Boven, H., Desar, I. M. E., Gelderblom, H., Grünhagen, D. J., Reyners, A. K. L., van Noesel, M. M., Mathijssen, R. H. J., Steeghs, N., & van der Graaf, W. T. A. (2020). Gastrointestinal Stromal Tumours (GIST) in Young Adult (18–40 Years) Patients: A Report from the Dutch GIST Registry. *Cancers (Basel)*, *12*(3), 730. https://doi.org/10.3390/cancers12030730

Joensuu, H. (2008). Risk stratification of patients diagnosed with gastrointestinal stromal tumor. *Human Pathology*, *39*(10), 1411–1419. https://doi.org/10.1016/j.humpath.2008.06.025

Kelly, C. M., Gutierrez Sainz, L., & Chi, P. (2021). The management of metastatic GIST: current standard and investigational therapeutics. *Journal of Hematology & Oncology*, *14*(1), 2. https://doi.org/10.1186/s13045-020-01026-6

Kramer, K., Knippschild, U., Mayer, B., Bögelspacher, K., Spatz, H., Henne-Bruns, D., Agaimy, A., Schwab, M., & Schmieder, M. (2015). Impact of age and gender on tumor related prognosis in gastrointestinal stromal tumors (GIST). *BMC Cancer*, *15*, 57. https://doi.org/10.1186/s12885-015-1054-y

Mazzola, P. (2021). Epidemiology and treatment of GIST: an update. *Cancers (Basel)*, *13*, 6072.

Miettinen, M., & Lasota, J. (2006). Gastrointestinal stromal tumors: review on morphology, molecular pathology, prognosis, and differential diagnosis. *Archives of Pathology & Laboratory Medicine*, *130*(10), 1466–1478. https://doi.org/10.5858/2006-130-1466-GSTROM

Nishida, T., Blay, J.-Y., Hirota, S., Kitagawa, Y., & Kang, Y.-K. (2016). The standard diagnosis, treatment, and follow-up of gastrointestinal stromal tumors based on guidelines. *Gastric Cancer*, *19*(1), 3–14. https://doi.org/10.1007/s10120-015-0526-8

Parab, T. M., DeRogatis, M. J., Boaz, A. M., Grasso, S. A., Issack, P. S., Duarte, D. A., Urayeneza, O., Vahdat, S., Qiao, J.-H., & Hinika, G. S. (2019). Gastrointestinal stromal tumors: a comprehensive review. *Journal of Gastrointestinal Oncology*, *10*(1), 144–154. https://doi.org/10.21037/jgo.2018.08.20

Shi, Y.-N., Li, Y., Wang, L.-P., Wang, Z.-H., Liang, X.-B., & Liang, H. (2017). Gastrointestinal stromal tumor (GIST) with liver metastases: An 18-year experience from the GIST cooperation group in North China. *Medicine (Baltimore)*, *96*(46), e8240. https://doi.org/10.1097/MD.0000000000008240

Søreide, K., Sandvik, O. M., Søreide, J. A., Giljaca, V., Jureckova, A., & Bulusu, V. R. (2016). Global epidemiology of gastrointestinal stromal tumours (GIST): a systematic review of population-based cohort studies. *Cancer Epidemiology*, *40*, 39–46. https://doi.org/10.1016/j.canep.2015.10.031

Supsamutchai, C., Wilasrusmee, C., Hiranyatheb, P., Jirasiritham, J., Rakchob, T., & Choikrua, P. (2018). A cohort study of prognostic factors associated with recurrence or metastasis of gastrointestinal stromal tumor (GIST) of stomach. *Annals of Medicine and Surgery*, *35*, 1–5. https://doi.org/10.1016/j.amsu.2018.08.010

von Mehren, M., & Joensuu, H. (2018). Gastrointestinal Stromal Tumors. *Journal of Clinical Oncology*, *36*(2), 136–143. https://doi.org/10.1200/JCO.2017.74.9705

von Mehren, M., Kane, J. M., Agulnik, M., Bui, M. M., Carr-Ascher, J., Choy, E., Connelly, M., Dry, S., Ganjoo, K. N., & Gonzalez, R. J. (2022). Soft Tissue Sarcoma, Version 2.2022, NCCN Clinical Practice Guidelines in Oncology. *Journal of the National Comprehensive Cancer Network*, *20*(7), 815–833. https://doi.org/10.6004/jnccn.2022.0035

Wu, C.-E., Tzen, C.-Y., Wang, S.-Y., & Yeh, C.-N. (2019). Clinical Diagnosis of Gastrointestinal Stromal Tumor (GIST): From the Molecular Genetic Point of View. *Cancers (Basel)*, *11*(5), 679. https://doi.org/10.3390/cancers11050679

Yang, D. Y., Wang, X., Yuan, W. J., & Chen, Z. H. (2019). Metastatic pattern and prognosis of gastrointestinal stromal tumor (GIST): a SEER-based analysis. *Clinical and Translational Oncology*, *21*(12), 1654–1662. https://doi.org/10.1007/s12094-019-02094-y