Section: Pathology

Original Research Article

MAPPING PEDIATRIC MALIGNANCIES: A HISTOPATHOLOGICAL ANALYSIS FROM A TERTIARY CARE PERSPECTIVE

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Received *: 11/03/2025*
Received in revised form *: 24/04/2025*
Accepted *: 16/05/2025*

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DOI: 10.70034/ijmedph.2025.2.325

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (2); 1821-1826

ABSTRACT

Background: Pediatric malignancies, though rare, are a leading cause of childhood morbidity and mortality. Early and accurate diagnosis is crucial for optimal outcomes. The pattern and distribution of pediatric cancers vary across regions and are influenced by multiple factors, including genetics and access to healthcare. This study aimed to evaluate the histopathological spectrum of pediatric malignancies diagnosed in a tertiary care center over a two-year period, analyzing age-wise, gender-wise, and tumor-type distributions to identify regional trends.

Materials and Methods: A retrospective descriptive study was conducted from January 2023 to December 2024 at the Department of Pathology. Pediatric patients aged 0–14 years with histologically confirmed malignancies or acute leukemias with flow cytometry confirmed diagnosis were included. Demographic and clinical data were collected and analyzed using descriptive statistics. Tumors were categorized based on standard histopathological criteria.

Results: The prevalence of pediatric malignancies was found to be 2%. The highest incidence was seen in the 5–9 year age group (47.62%), followed by 10–14 years (28.57%) and 0–4 years (23.81%). A male predominance was noted (M:F = 2:1). Leukemias, especially Acute Lymphoblastic Leukemia (ALL), constituted the majority (59.52%) of cases. Lymphomas (11.90%), soft tissue sarcomas (9.52%), and CNS tumors, retinoblastoma, and bone tumors (each 4.76%) were also identified. Nephroblastoma and germ cell tumors were rare (2.38% each).

Conclusion: The study highlights the predominance of hematolymphoid malignancies in pediatric patients, with ALL being the most frequent. The findings emphasize the importance of histopathological evaluation in diagnosing pediatric cancers and provide valuable data for regional oncology surveillance and healthcare planning.

Keywords: Pediatric malignancies, Histopathology.

INTRODUCTION

Pediatric malignancies are relatively rare, constituting approximately 1–3% of all cancers worldwide.[1] Despite their rarity, they represent a significant cause of morbidity and mortality in children. Unlike adult cancers, pediatric malignancies are more often embryonal in origin, show a rapid rate of progression, and require distinct diagnostic and therapeutic approaches.[2] Early and accurate histopathological diagnosis plays a pivotal role in guiding effective treatment strategies and improving survival outcomes in affected children.[3]

The pattern and prevalence of childhood cancers vary across different geographic regions due to genetic, environmental, and socio-economic factors.[4] In developing countries like India, there is an increasing recognition of childhood cancer burden. However, limited diagnostic facilities, lack of awareness, and late presentation often delay treatment.[5] Comprehensive data from tertiary care centres can offer valuable insights into the regional spectrum of

pediatric malignancies, facilitating better planning of healthcare resources and interventions.

Leukemias and lymphomas are typically the most commonly encountered pediatric malignancies, followed by central nervous system (CNS) tumors, sarcomas, and embryonal tumors such as nephroblastoma and retinoblastoma.[1] Recent advances in histopathological techniques, supported by immunohistochemistry, have significantly enhanced the diagnostic accuracy and classification of these tumors, enabling precise subtyping and risk stratification.[6]

While population-based cancer registries provide broad estimates of pediatric cancer incidence, institutional data remain critical in regions where such registries are underdeveloped or incomplete. Tertiary care centres, serving as referral hubs, are uniquely positioned to capture diverse and uncommon pediatric malignancies, making them ideal sources for understanding regional cancer trends.

This study aims to map the histopathological spectrum of pediatric malignancies diagnosed over a two-year period at a tertiary care center. By analyzing age-wise, gender-wise, and tumor-wise distributions, the study provides an updated perspective on the burden and pattern of childhood cancers in a hospital-based setting, contributing to the growing body of regional oncology literature.

MATERIALS AND METHODS

This retrospective descriptive study was conducted at the Department of Pathology in a tertiary care teaching hospital over a period of two years, from January 2023 to December 2024. The study aimed to evaluate the spectrum and distribution of pediatric malignancies based on histopathological diagnosis. All biopsy and surgical specimens received in the department during the study period were reviewed, and cases confirmed to be malignant in pediatric patients (0–14 years) were included in the analysis.

The selection criteria included histopathologically confirmed cases of malignancy in patients aged 0 to 14 years. Cases with inconclusive biopsy results, incomplete demographic data, or those diagnosed purely on radiological findings without tissue confirmation were excluded from the study. A total of 2100 malignancy cases were registered during the study period. Out of these, 42 pediatric cases were included in the study for analysis.

Relevant clinical information including age, sex, site of tumor, and clinical diagnosis were obtained from histopathology requisition forms and hospital records. All tissue specimens were fixed in 10% formalin, processed routinely, embedded in paraffin blocks, and stained with hematoxylin and eosin (H&E) for microscopic examination. In round cell tumors and poorly differentiated neoplasms, followup of the patients was done and diagnosis was confirmed based on their IHC marker positivity. In hematological malignancies, blood smears were stained with Leishman staining and diagnosis of acute leukemias was confirmed by flow cytometry during patient follow up.

The tumors were classified according to standard pathological criteria, and grouped into categories such as leukemia, lymphomas, central nervous system (CNS) tumors, bone tumors, soft tissue sarcomas, renal tumors, germ cell tumors, and others. Each malignancy was further sub-classified where applicable (e.g., ALL, AML under leukemias). Age-wise distribution was categorized into three groups: 0–4 years, 5–9 years, and 10–14 years. The data was compiled using Microsoft Excel and analyzed in terms of frequencies and percentages. Patient confidentiality was strictly maintained throughout, and only anonymized data were used for analysis and publication purposes.

RESULTS

Out of a total of 2100 malignant cases evaluated during the study period, 42 were diagnosed with pediatric malignancies, yielding a prevalence rate of pediatric malignancies as 2%. These finding highlights that although pediatric malignancies constitute a small fraction of overall pediatric presentations, their clinical significance warrants dedicated attention and early intervention strategies [Table 1].

Table 1: Prevalence of Pediatric Malignancies.

Total Number of Malignancies detected	2100
Number of Pediatric malignancies	42
Prevalence	2%

When stratified by age, the majority of pediatric malignancies were observed in the 5–9 year age group, accounting for 47.62% (20/42) of cases. This was followed by the 0–4 year group with 23.81% (10/42) and the 10–14 year group with 28.57% (12/42). These results suggest a peak occurrence of pediatric cancers during the middle childhood years, with relatively lower frequencies in early childhood and adolescence [Table 2].

Table 2: Age-wise distribution of pediatric malignancies (n = 42)

Age Group (years)	Number of Cases	Percentage (%)
0–4	10	23.81 %
5–9	20	47.62 %
10–14	12	28.57 %
Total	42	100.00 %

A clear male predominance was observed in the study cohort. Of the 42 cases, 28 (66.67%) were male and 14 (33.33%) were female, resulting in a male-to-female ratio of nearly 2:1. This gender disparity is consistent with patterns reported in other pediatric oncology literature, suggesting potential biological or environmental factors influencing susceptibility [Table 3].

Table 3: Gender-wise distribution of cases (n = 42)

Gender	Number of Cases	Percentage (%)
Male	28	66.67 %
Female	14	33.33 %
Total	42	100.00 %

Leukemia emerged as the most common category of pediatric malignancy, representing 59.52% (25/42) of all cases. This was followed by lymphomas at 11.90% (5/42), soft tissue sarcomas at 9.52% (4/42), and CNS neoplasms, retinoblastoma, and bone tumors each contributing 4.76% (2/42). Renal neoplasms and germ cell tumors were the least common, with 2.38% (1/42) each. These findings reflect the haematolymphoid system's predominance in childhood cancers within this demographic [Table 4].

Table 4: Distribution of pediatric malignancies by category (n = 42)

S. No.	Type of Tumor	Number of Cases	Percentage (%)
1	Leukemia	25	59.52 %
2	Lymphomas	5	11.90 %
3	CNS Neoplasms	2	4.76 %
4	Retinoblastoma	2	4.76 %
5	Renal Neoplasms	1	2.38 %
6	Bone Tumors	2	4.76 %
7	Soft Tissue Sarcomas	4	9.52 %
8	Germ Cell Tumors	1	2.38 %
Total		42	100.00 %

Detailed age-wise analysis of tumor types revealed that Acute Lymphoblastic Leukemia (ALL) remained the most frequently encountered malignancy across all age groups, with the highest concentration observed in the 5–9 year age group (11 cases), followed by 7 cases in children aged 0–4 years and 6 cases in those aged 10–14 years. Acute Myeloid Leukemia (AML), although rare, was identified in one adolescent patient (10–14 years). Non-Hodgkin's lymphoma (NHL) showed equal distribution across the 5–9 and 10–14 age groups, whereas Hodgkin's lymphoma was seen exclusively in an adolescent (10–14 years). CNS neoplasms like astroblastoma and anaplastic ependymoma were distributed between the 5–9 and 10–14 year age groups, respectively. Notably, retinoblastoma was confined to children under five years, while nephroblastoma (renal tumor) also occurred only in this age group. Bone tumors, including osteosarcoma and Ewing's sarcoma, were found in older children, with osteosarcoma seen in the 10–14 year group and Ewing's sarcoma in the 5–9 year group. All soft tissue sarcomas—including alveolar rhabdomyosarcoma, low-grade fibrosarcoma, soft tissue sarcoma (NOS), and extraosseous Ewing's sarcoma were seen exclusively in the 5–9 year group, which also recorded the sole case of immature teratoma, a germ cell tumor. Overall, the 5–9 year age group demonstrated the broadest tumor spectrum, reinforcing its importance as a peak period for pediatric oncological surveillance and intervention [Table 5].

Table 5: Age-wise and Tumor-wise Distribution of Pediatric Malignancies (n = 42)

Tumor Type		0–4 years	5–9 years	10–14 years	Total (n)	Percentage
Leukemias	Acute Lymphoblastic Leukemia (ALL)	7	11	6	24	57.14%
	Acute Myeloid Leukemia (AML)	0	0	1	1	2.38%
Lymphomas	Hodgkin's Lymphoma	0	0	1	1	2.38%
	Non-Hodgkin's Lymphoma (NHL)	0	2	2	4	9.52%
CNS Neoplasms	Astroblastoma	0	1	0	1	2.38%
	Anaplastic Ependymoma WHO grade 2	0	0	1	1	2.38%
Eye tumor	Retinoblastoma	2	0	0	2	4.76%
Renal Neoplasms (Nephroblastoma)		1	0	0	1	2.38%
Bone Tumors	Osteosarcoma	0	0	1	1	2.38%
	Ewing's Sarcoma	0	1	0	1	2.38%
Soft Tissue Sarcomas	Alveolar Rhabdomyosarcoma	0	1	0	1	2.38%
	Low Grade Fibrosarcoma	0	1	0	1	2.38%
	Soft Tissue Sarcoma (NOS)	0	1	0	1	2.38%
	Extraosseous Ewing's Sarcoma	0	1	0	1	2.38%
Germ Cell Tumor (Immature Teratoma)		0	1	0	1	2.38%
Total Cases per Age Group		10	20	12	42	100%

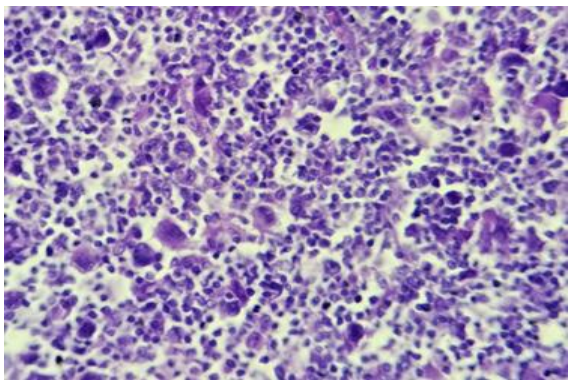

Figure 1: Photomicrograph of Hodgkin's Lymphoma showing scattered Reed- Sternberg cells in a background of small lymphocytes and few eosinophils (H&E stain, 400X)

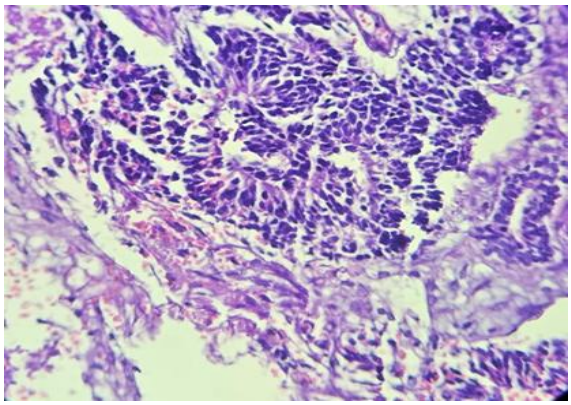

Figure 2: Photomicrograph of Immature Teratoma showing immature neural component with rosette formation (H&E stain, 400X)

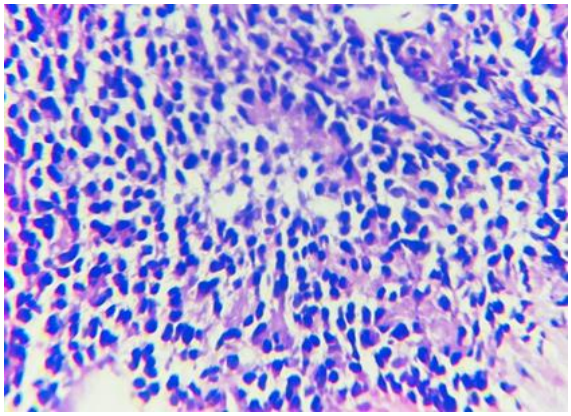

Figure 3: Photomicrograph of Ewings sarcoma composed of uniform undifferentiated round cells (H & E stain, 400X)

DISCUSSION

Pediatric malignancies, though comprising a small fraction of total cancer burden, pose significant challenges due to their aggressive nature, diagnostic complexity, and the lifelong impact of therapy. In the present study, pediatric malignancies constituted 2% of all malignancy cases over a two-year period. This aligns with global and national data reporting pediatric cancers to represent approximately 1–3% of total cancer cases, underscoring their relative rarity but clinical importance. According to National cancer registry programme, childhood cancers represent 0.7-4.4% of total malignancies.[7,8] In a study by Karim I et al,[11] the prevalence of peediatric malignancies was 1.92% of all malignancies which is in agreement to our study.

In the current study, the 5–9 year age group accounted for the highest proportion of pediatric cancers (47.62%), followed by the 10–14 year (28.57%) and 0–4 year (23.81%) groups. Similarly, Mittal et al,[10] found a predominance of cases in the 5–10 year age bracket, supporting the observed age trend across diverse geographic regions. This age clustering likely reflects the biological timing of oncogenic events during rapid cellular proliferation phases in childhood. In contrast, Chauhan et al. [9] observed 10-14 years as the predominant age group involved.

The current study revealed a clear male predominance (M:F ratio ~2:1), with 66.67% of cases occurring in boys. This is in agreement with both comparative studies. Chauhan et al. [9] observed a male predominance with a M:F ratio of 1.6:1, while Mittal et al,[10] reported 67.8% of male population. The consistent male preponderance across studies may suggest gender-based biological susceptibility, environmental exposure differences, or healthcare-seeking behaviors favoring male children in certain cultural contexts.

In the present study, leukemias, particularly ALL were the most frequently observed pediatric malignancies, accounting for 57.14% of all cases. Including a single case of AML, leukemias collectively comprised 59.52% of the pediatric cancer cases. Although these were initially reported as acute leukemias based on preliminary findings, the diagnoses of ALL and AML were subsequently confirmed through flow cytometry during patient follow-up. This finding aligns with that of Chauhan et al,[9] who reported leukemias in 29% of childhood cancers in their study population. Likewise, Mittal et al,[10] identified ALL as the most common pediatric cancer, with leukemias making up 40% of their total cases. Variations in these figures may be attributed to differences in referral patterns, diagnostic criteria, or the time periods during which data were collected. Nonetheless, the consistent observation across studies is that leukemia remains the predominant pediatric malignancy. Unlike adult cancers, which most commonly affect organs such as the skin, lungs, breasts, prostate, and colon, childhood cancers more frequently originate in the hematopoietic system, central nervous system, soft tissues, bones, and kidneys.[9]

Lymphomas formed the second most common group in our study, contributing 11.9% of cases. Notably, Non-Hodgkin's Lymphoma (NHL) was more common than Hodgkin's Lymphoma (HL), with NHL equally distributed between the 5–9 and 10–14 age groups. HL appeared exclusively in the adolescent group (10–14 years). These findings are congruent with the study by Chauhan et al., where

lymphomas accounted for 17% of pediatric malignancies, again with a higher frequency of NHL. Mittal et al,[10] reported lymphomas comprising 14.2% of cases, with HL slightly more frequent than NHL in their cohort, suggesting possible regional or demographic variability in subtype prevalence. HL typically presents with well-defined histological features (e.g., Reed-Sternberg cells), while subtyping of NHL often requires immunohistochemical confirmation. This diagnostic challenge is particularly pertinent in resource-limited settings.

In the present study, tumors of the Central Nervous System (CNS), eye (such as retinoblastoma), and bone (such as osteosarcoma) were relatively uncommon, each representing 4.76% of pediatric malignancies. This relatively low frequency could either indicate a truly lower incidence in the study population or may be the result of referral bias; for instance, children with suspected CNS or ocular tumors might be referred directly to tertiary centers with specialized neurosurgical or ophthalmologic services, bypassing the reporting center. Retinoblastoma was observed in 4.76% and was exclusively found in the 0–4 year age group in our study, aligns with its known presentation in infancy and early childhood due to the embryonal origin and RB1 gene mutations. When comparing these findings with previous literature, Chauhan et al,[9] reported a higher frequency of CNS tumors (8%) and bone tumors (11%). In contrast, Mittal et al,[10] found CNS malignancies to be lower (1.4%) but noted higher rates of retinoblastoma (11%) and bone tumors (10%), highlighting regional and institutional variability. IHC was not deemed necessary in the majority of cases in this study, particularly for tumors like retinoblastoma and osteosarcoma. This is because these tumors often exhibit well-defined and characteristic histopathological features on routine H&E staining. For example: Retinoblastoma typically shows sheets of small, round, blue cells with hyperchromatic nuclei and areas of rosette formation (Flexner–Wintersteiner or Homer Wright rosettes), making it readily identifiable on morphology alone. Osteosarcoma often shows malignant osteoid production by pleomorphic tumor cells, a hallmark feature that confirms the diagnosis.

Soft tissue sarcomas contributed to 9.52% of our cases and were observed exclusively in the 5–9 year group. Similarly, Mittal A et al,[10] observed soft tissue sarcomas in 5% of cases. This supports the notion that sarcomas, although less common than hematolymphoid tumors, represent an important category of solid tumors in children. The exclusive occurrence in the middle childhood group may also offer insights into tumor biology and developmental susceptibility.

Renal tumors, particularly nephroblastoma (Wilms tumor), and germ cell tumors were rare in the present study, each accounting for 2.38% of pediatric malignancies. These tumors were diagnosed with confidence based on their characteristic histomorphological features. Immature teratomas are composed of elements derived from all three germ layers ectoderm, mesoderm, and endoderm with the presence of immature neuroectodermal tissue (such as primitive neuroepithelium) being the hallmark for diagnosis and grading. The architectural arrangement of immature neural tissue in rosettes or tubules, often admixed with mature tissues like cartilage, glandular structures, and squamous epithelium, is readily recognizable under light microscopy. Similarly, nephroblastoma (Wilms tumor) was identified based on its classic triphasic morphology, comprising blastemal, epithelial and stromal components.

Histopathology continues to serve as the cornerstone of pediatric cancer diagnosis, providing the essential morphological foundation for identifying neoplastic lesions. However, in certain cases particularly those involving poorly differentiated tumors or small round cell neoplasms morphology alone may be insufficient for a definitive diagnosis. In the current study, initial histopathological evaluation raised suspicion for a malignant round cell tumor (for example, Ewing's sarcoma), but a conclusive diagnosis could not be established based solely on routine staining. During patient follow-up, IHC played a critical role in reaching a final diagnosis. IHC markers specific for Ewing sarcoma, such as CD99, showed diffuse membranous positivity, which confirmed the diagnosis of Ewing's sarcoma. This case highlights the indispensable role of IHC as an adjunct to histopathology, especially in diagnostically challenging cases.

CONCLUSION

The landscape of pediatric malignancies, though numerically small, represents a critical frontier in oncological pathology due to the distinct biological behavior, diagnostic challenges, and therapeutic implications of childhood cancers. This study reinforces the predominance of hematolymphoid neoplasms particularly ALL as the leading pediatric malignancy within this regional cohort, while also underscoring the age-specific and tumor-type patterns unique to the pediatric population. This institution-based audit contributes valuable regional data to the growing pediatric oncology literature, especially in settings where population-based cancer registries remain limited. It underscores the need for enhanced pediatric cancer awareness, improved early detection strategies, and continued investment in pathology infrastructure. As pediatric malignancies demand multidisciplinary coordination and long-term survivorship care, histopathological clarity remains the first and most vital step toward curing childhood cancer.

REFERENCES

1. Pfister SM, Reyes-Múgica M, Chan JKC, Hasle H, Lazar AJ, Rossi S, et al. A Summary of the Inaugural WHO Classification of Pediatric Tumors: Transitioning from the

Optical into the Molecular Era. Cancer Discov. 2022;12(2):331-355.
2. Filbin M, Monje M. Developmental origins and emerging therapeutic opportunities for childhood cancer. Nat Med. 2019;25(3):367-376.
3. Blionas A, Giakoumettis D, Klonou A, Neromyliotis E, Karydakis P, Themistocleous MS. Paediatric gliomas: diagnosis, molecular biology and management. Ann Transl Med. 2018;6(12):251.
4. Kehm RD, Spector LG, Poynter JN, Vock DM, Osypuk TL. Socioeconomic Status and Childhood Cancer Incidence: A Population-Based Multilevel Analysis. Am J Epidemiol. 2018;187(5):982-991.
5. Cotache-Condor C, Kantety V, Grimm A, Williamson J, Landrum KR, Schroeder K, et al. Determinants of delayed childhood cancer care in low- and middle-income countries: A systematic review. Pediatr Blood Cancer. 2023;70(3):e30175.
6. Orr BA. Pathology, diagnostics, and classification of medulloblastoma. Brain Pathol. 2020;30(3):664-678.
7. Ganguly S, Kinsey S, Bakhshi S. Childhood cancer in India. Cancer Epidemiol. 2021 Apr;71(Pt B):101679
8. Three Year Report of the Population Based Cancer Registries 2009-2011: Report of 25 PBCRs, National Cancer Registry Programme, Indian Council Medical Research, Bangalore, 2013 (n.d.)
9. Chauhan R, Tyagi A, Verma N, Tyagi M, Singh P, Singh A. Spectrum of Pediatric Malignancies at a Tertiary Care Centre in Western Uttar Pradesh. National Journal of Laboratory Medicine. 2017;6(1):23-27
10. Mittal A, Kanu Neemawat, Sandeep Jasuja, Chaturvedi A. Spectrum of Pediatric Malignancies: An Observational Single Center Study from Western India. Journal of Oncology Research. 2021;3(2):29-32
11. Karim, M., Ali, S., Akhter, S., Islam, S., Karim, M., & Alam, M. A Study on Histomorphological Spectrum of Childhood Malignant Tumour: Evaluation of 60 Cases at Different Center in Dhaka City. Journal of Armed Forces Medical College, Bangladesh. 2014; 9(1): 57–62