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SPECTRUM OF CHILDHOOD MALIGNANCIES IN NORTHEAST INDIA: A PROSPECTIVE STUDY

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ABSTRACT

Background: Childhood cancer patterns vary geographically, and published data from Northeast India remain limited. This study aimed to describe the demographic profile and spectrum of childhood malignancies presenting to tertiary referral centers in Guwahati, Assam.

Materials and Methods: This prospective hospital-based descriptive study was conducted from September 2019 to August 2020 at Apollo Hospitals, Guwahati, and Dr. B. Borooah Cancer Institute, Guwahati. Children aged ≤15 years with newly diagnosed malignancy were enrolled. Diagnoses were confirmed by appropriate hematological, histopathological, cytological and/or radiological investigations and classified using the International Classification of Childhood Cancer. Data were summarized using descriptive statistics.

Results: Of 318 symptomatic children screened, 309 had confirmed malignancy. Boys accounted for 57.9% and girls for 42.1%. Children aged 0-4 years formed the largest group (41.1%), followed by those aged 10-15 years (37.2%). Leukemias were the most common malignancies (33.3%), followed by malignant bone tumors (14.9%) and lymphomas and reticuloendothelial neoplasms (11.0%). Among children aged 10-15 years, malignant bone tumors were the predominant group (34.8%).

Conclusions: Lymphoid leukemia was the predominant childhood malignancy overall, while malignant bone tumors were prominent among older children and adolescents. These hospital-based findings reflect the case mix of tertiary referral centers and should not be interpreted as population incidence. Larger multicentric and population-based studies are needed to confirm regional patterns.

Keywords: Childhood cancer; leukemia; bone tumors; pediatric oncology; Northeast India; hospital-based study.

INTRODUCTION

Childhood cancers are uncommon but constitute an important cause of morbidity and mortality. Globally, approximately 400,000 children and adolescents aged 0-19 years develop cancer each year, with a disproportionately greater burden and poorer survival in low- and middle-income countries.[1] In India, childhood malignancies account for a relatively small proportion of all cancers, yet their absolute burden is substantial because of the large pediatric population.[2,3]

Pediatric malignancies differ considerably from adult cancers in their biological behavior, histological spectrum, age distribution, and prognosis. Leukemias, lymphomas, central nervous system tumors, and embryonal tumors predominate during childhood, while bone tumors, soft-tissue sarcomas, and certain carcinomas become relatively more frequent with increasing age.[4] Consequently, childhood cancers are classified primarily according to morphology and histology rather than anatomical site alone.

Considerable geographical variation in the incidence and distribution of childhood cancers has been documented within India. Population-based cancer registry analyses have demonstrated wide inter-regional differences, with comparatively lower recorded childhood cancer incidence in Northeast

India than in several other regions of the country.[5,6] Northeast India is geographically and demographically distinct, and variations in population characteristics, healthcare accessibility, referral pathways, diagnostic facilities, and completeness of cancer registration may influence the observed pattern of childhood malignancies. Thus, the recorded regional differences may reflect both true epidemiological variation and differences in case detection and ascertainment. The causes of most childhood cancers remain incompletely understood, so attributing regional differences to specific environmental or lifestyle exposures without supporting evidence is inappropriate.[7]

Region-specific data are therefore important for defining the local disease spectrum, improving clinical recognition and referral, and planning pediatric oncology services. However, published information describing the spectrum of childhood malignancies from Northeast India remains relatively limited. This study aimed to describe the demographic profile and spectrum of childhood malignancies presenting to the participating centers in Northeast India.

MATERIALS AND METHODS

This prospective, hospital-based descriptive study was conducted over one year, from September 2019 to August 2020, at Apollo Hospitals, Guwahati, and the Department of Pediatric Oncology, Dr. B. Borooah Cancer Institute (BBCI), Guwahati, Assam. Children aged ≤15 years who were newly diagnosed with malignancy during the study period were eligible for inclusion.

Children with malignancies confirmed by appropriate hematological, histopathological, cytological and/or radiological investigations were included. We excluded children aged >15 years, those diagnosed outside the study period, non-Indian patients, and those whose parents or legal guardians did not provide consent.

Eligible children presenting to the outpatient and inpatient services of the participating centers were enrolled during the study period. All participants underwent a detailed clinical evaluation, followed by appropriate diagnostic and staging investigations based on the suspected malignancy. Childhood cancers were classified according to the International Classification of Childhood Cancer (ICCC), based on the International Classification of Diseases for Oncology, Third Edition (ICD-O-3).[4,8]

To analyze age-specific patterns, we categorized participants into three groups: 0-4 years, 5-9 years, and 10-15 years. We assessed the distribution of childhood malignancies by age group and sex.

Based on childhood cancer incidence estimates reported in the National Cancer Registry Program report published in 2013, which represented the national registry data available at the time of study planning, the calculated sample size was 440, considering a 95% confidence level, 80% power, and a margin of error of 2.3%.[9] However, the COVID-19 pandemic and associated lockdowns and movement restrictions substantially affected recruitment, reducing outpatient and inpatient attendance during the latter part of the study. Consequently, we included 309 eligible children in the final analysis. Data were summarized using descriptive statistics. We expressed categorical variables, including type of malignancy, age group, and sex, as frequencies and percentages.

We obtained written informed consent from the parents or legal guardians of all participants, and assent from children aged 7-15 years, where applicable. The Institutional Ethics Committees of Apollo Hospitals, Guwahati, and BBCI, Guwahati, approved the study protocol.

RESULTS

During the study period, we screened 318 symptomatic children; of these, 309 were confirmed to have malignancy and were included in the final analysis. Of these, 179 (57.9%) were boys, and 130 (42.1%) were girls. The largest proportion of cases occurred in the 0-4 year age group (41.1%), followed by those aged 10-15 years (37.2%) and 5-9 years (21.7%). [Table 1]

Table 1: Demographic characteristics of children with malignancy (n = 309)

Characteristic	n	%
Sex		
Male	179	57.9
Female	130	42.1
Age group		
0-4 years	127	41.1
5-9 years	67	21.7
10-15 years	115	37.2

Leukemias were the most common childhood malignancy, accounting for 103 (33.3%) cases. Of these, 92 (29.8% of the total cohort) were lymphoid leukemias and 11 (3.6%) were acute non-lymphocytic leukemias/acute myeloid leukemia (AML). Malignant bone tumors were the second most common group, accounting for 46 (14.9%) cases, comprising 27 (8.7%) osteosarcomas, 17 (5.5%) Ewing sarcomas, and 2 (0.6%) unspecified malignant bone tumors. Lymphomas and reticuloendothelial neoplasms accounted for 34 (11.0%) cases, followed by renal tumors in 25

(8.1%), retinoblastoma in 22 (7.1%), soft-tissue sarcomas in 21 (6.8%), and central nervous system (CNS) and other intracranial/intraspinal neoplasms in 17 (5.5%). [Table 2]

Table 2: Distribution of childhood malignancies according to tumor category (n = 309)

Tumor category	n	%
Leukemias	103	33.3
Lymphoid leukemia	92	29.8
Acute non-lymphocytic leukemia/AML	11	3.6
Malignant bone tumors	46	14.9
Osteosarcoma	27	8.7
Ewing sarcoma	17	5.5
Unspecified malignant bone tumors	2	0.6
Lymphomas and reticuloendothelial neoplasms	34	11.0
Renal tumors	25	8.1
Retinoblastoma	22	7.1
Soft-tissue sarcomas	21	6.8
CNS and other intracranial/intraspinal neoplasms	17	5.5
Sympathetic nervous system tumors	12	3.9
Carcinomas and other malignant epithelial neoplasms	10	3.2
Germ-cell, trophoblastic and other gonadal neoplasms	10	3.2
Other/not classified	6	1.9
Hepatic tumors	3	1.0
Total	**309**	**100.0**

CNS, central nervous system. Hospital-based proportions reflect the case mix of the participating tertiary referral centers and should not be interpreted as population incidence for Northeast India.

Subcategories listed under leukemias and malignant bone tumors are included in the parent-category totals and must not be added again. Percentages use the full cohort denominator (n = 309) and may not sum to 100 because of rounding.

Malignancy distribution varied across age groups. Among children aged 0-4 years, leukemias were the predominant malignancy (38.6%), followed by renal tumors (15.7%) and retinoblastoma (14.2%). Leukemias also predominated among children aged 5-9 years (37.3%), followed by lymphomas and reticuloendothelial neoplasms (22.4%) and CNS tumors (10.4%). In contrast, malignant bone tumors were the most frequent malignancies among children aged 10-15 years (34.8%), followed by leukemias (25.2%) and lymphomas and reticuloendothelial neoplasms (13.0%).

Sex-related differences were observed in malignancy distribution. Leukemias accounted for 38.0% of malignancies among boys compared with 26.9% among girls, whereas malignant bone tumors accounted for 11.2% and 20.0%, respectively. Lymphomas and reticuloendothelial neoplasms were more frequent among boys (13.4%) than girls (7.7%), whereas renal tumors were relatively more frequent among girls (10.8% vs. 6.1%). Germ-cell, trophoblastic, and other gonadal neoplasms accounted for 6.2% of malignancies in girls compared with 1.1% in boys. [Table 3]

Table 3: Distribution of childhood malignancies according to age group and sex

Tumor category	0-4 years (n = 127) n (%)	5-9 years (n = 67) n (%)	10-15 years (n = 115) n (%)	Male (n = 179) n (%)	Female (n = 130) n (%)
Leukemias	49 (38.6)	25 (37.3)	29 (25.2)	68 (38.0)	35 (26.9)
Malignant bone tumors	1 (0.8)	5 (7.5)	40 (34.8)	20 (11.2)	26 (20.0)
Lymphomas and reticuloendothelial neoplasms	4 (3.1)	15 (22.4)	15 (13.0)	24 (13.4)	10 (7.7)
Renal tumors	20 (15.7)	1 (1.5)	4 (3.5)	11 (6.1)	14 (10.8)
Retinoblastoma	18 (14.2)	3 (4.5)	1 (0.9)	12 (6.7)	10 (7.7)
Soft-tissue sarcomas	11 (8.7)	3 (4.5)	7 (6.1)	13 (7.3)	8 (6.2)
CNS and other intracranial/intraspinal neoplasms	5 (3.9)	7 (10.4)	5 (4.3)	11 (6.1)	6 (4.6)
Sympathetic nervous system tumors	8 (6.3)	1 (1.5)	3 (2.6)	8 (4.5)	4 (3.1)
Carcinomas and other malignant epithelial neoplasms	2 (1.6)	4 (6.0)	4 (3.5)	5 (2.8)	5 (3.8)
Germ-cell, trophoblastic and other gonadal neoplasms	3 (2.4)	1 (1.5)	6 (5.2)	2 (1.1)	8 (6.2)
Other/not classified	3 (2.4)	2 (3.0)	1 (0.9)	2 (1.1)	4 (3.1)
Hepatic tumors	3 (2.4)	0 (0.0)	0 (0.0)	3 (1.7)	0 (0.0)
Total	**127 (100.0)**	**67 (100.0)**	**115 (100.0)**	**179 (100.0)**	**130 (100.0)**

Percentages are calculated within each age-group or sex-specific column and may not sum to 100 because of rounding. CNS, central nervous system.

At the individual diagnosis level, lymphoid leukemia was the single most frequent malignancy, occurring in 92 (29.8%) children. Osteosarcoma followed, with 27 (8.7%), non-Hodgkin lymphoma with 26 (8.4%), retinoblastoma with 22 (7.1%), and Ewing sarcoma with 17 (5.5%) children. Wilms tumor, rhabdoid tumor, and clear-cell sarcoma together accounted for 15 (4.9%) cases, while neuroblastoma and ganglioneuroblastoma accounted for 12 (3.9%).

DISCUSSION

The present study describes the spectrum of childhood malignancies among children aged ≤15 years presenting to two tertiary referral centers in Guwahati, Assam, including a center specifically designated for cancer diagnosis and treatment. Consequently, the observed distribution represents the pattern of childhood cancers encountered at referral-level institutions rather than population-based incidence. The availability of specialized oncology and surgical services at the cancer center, including management of bone tumors, may also have influenced referral patterns and contributed to the relatively high representation of bone malignancies. Therefore, consider the referral characteristics of the participating centers when interpreting the relative frequency of individual malignancies. Guwahati is a major medical and tertiary-care referral hub for Assam and neighboring northeastern states, giving these centers a wide regional catchment. Although this does not make the cohort population-representative, it provides a broad referral-level perspective on the spectrum of childhood malignancies encountered across Northeast India.

Children aged 0-4 years constituted the largest group (41.1%), followed by those aged 10-15 years (37.2%), while children aged 5-9 years accounted for 21.7% of cases. This predominance of younger children is broadly consistent with recent national hospital-based cancer registry data from India, in which the 0-4 year age group constituted the largest proportion of childhood cancers among children aged 0-14 years.[10] Similar observations have also been reported in earlier Indian studies.[11-14] Differences in the relative distribution across age groups may reflect regional variation, referral patterns, institutional case mix, and differences in the age categories used across studies.

Leukemias were the most frequent malignancy group in the present cohort, accounting for 33.3% of all cancers. Lymphoid leukemia was the largest component, accounting for 29.8% of the cohort, while acute non-lymphocytic/acute myeloid leukemia accounted for 3.6%. The predominance of leukemia, particularly lymphoid leukemia, is consistent with several Indian studies.[6,12,15,16] In contrast, Jabeen et al. and Devi et al. reported lymphomas as the most frequent childhood malignancy in their respective cohorts.[17,18] Differences between hospital-based studies may reflect geographical variation, referral pathways, access to specialized oncology services, and the characteristics of the populations served.

A notable finding was the relatively high proportion of malignant bone tumors, which constituted 14.9% of all malignancies and represented the second most common cancer group. Osteosarcoma accounted for 8.7% and Ewing sarcoma for 5.5% of the total cohort. Bone tumors were also prominently represented in the non-hematological pediatric tumor series reported by Punia et al.[19] A similarly high proportion of malignant bone tumors (18.0%) was reported by Samanta et al. from a tertiary cancer center in Odisha.[20] However, differences in age groups, referral pathways, and institutional case mix limit direct comparison, and hospital-based proportions should not be interpreted as population incidence. Osteosarcoma was also the most frequent individual non-hematological malignancy in the present study. The high representation of bone tumors should, however, be interpreted in the context of the tertiary referral and specialized cancer-treatment setting of the participating institutions.

The malignancy distribution showed a clear age-related pattern. Among younger children aged 0-4 years, leukemias were the predominant group (38.6%), followed by renal tumors (15.7%) and retinoblastoma (14.2%). At the individual diagnosis level, lymphoid leukemia accounted for 37.0% of cancers in this group, followed by retinoblastoma (14.2%) and Wilms tumor/rhabdoid and clear-cell renal tumors (10.2%). Bhalodia et al., Pattnaik et al., and Chauhan et al,[12,13,15] also reported lymphoid leukemia as predominant in this age group. In contrast, Jabeen et al. and Hazarika et al. reported retinoblastoma as the most frequent malignancy.[16,17] Among school-age children aged 5-9 years, leukemias remained the most frequent cancer group (37.3%), followed by lymphomas (22.4%) and central nervous system tumors (10.4%). The relatively lower proportion of CNS tumors observed in the present study may partly reflect differences in referral and diagnostic ascertainment, as underdiagnosis and barriers to timely diagnosis of childhood brain tumors have been reported in India.[10,21] Lymphoid leukemia was the most frequent individual diagnosis (29.9%), followed by non-Hodgkin lymphoma (16.4%). This pattern broadly matched that reported by Pattnaik et al., Hazarika et al., and Chauhan et al.[13,15,16] However, Jabeen et al. reported lymphoma as the most common malignancy in this age group.[17]

A distinctly different pattern was observed among older children and adolescents aged 10-15 years. Malignant bone tumors constituted the largest cancer group (34.8%), followed by leukemias (25.2%) and lymphomas (13.0%). At the individual diagnosis level, lymphoid leukemia (21.7%) and osteosarcoma (20.9%) occurred with a similar frequency, while Ewing sarcoma accounted for a further 13.0%. Thus, the spectrum shifted from predominance of leukemia

and embryonal tumors in younger children toward a substantially greater contribution of bone malignancies in older children and adolescents. Previous Indian studies have also demonstrated considerable variability in this age group, with leukemia, lymphoma, osteosarcoma, or combinations of these being reported as the leading malignancies.[13,15-17]

Overall, the findings demonstrate that lymphoid leukemia was the predominant childhood malignancy in this northeastern Indian referral cohort. At the same time, malignant bone tumors constituted an unusually prominent component, particularly among older children and adolescents. The marked variation in cancer spectrum across age groups emphasizes the importance of age-specific diagnostic suspicion and timely referral to pediatric oncology services.

The study has certain limitations. Because the study was hospital-based and conducted at two tertiary referral institutions, including a specialized cancer-treatment center, the observed proportions cannot be extrapolated to population incidence in Assam or the wider northeastern region. Referral patterns and the availability of specialized oncology services may have influenced the relative distribution of malignancies, particularly the representation of bone tumors. Furthermore, the COVID-19 pandemic and associated restrictions affected recruitment, resulting in a smaller sample than originally planned. Nevertheless, prospective enrollment and classification of malignancies using a standardized childhood cancer framework provide useful information on the spectrum of pediatric cancers encountered at tertiary-care level in this region.

CONCLUSION

The spectrum of childhood malignancies in this tertiary referral cohort from Northeast India showed a clear age-related pattern. Lymphoid leukemia was the predominant childhood malignancy overall and remained the leading diagnosis in younger and school-age children. In contrast, malignant bone tumors constituted a substantial proportion of the cancer burden. They became the predominant tumor group among older children and adolescents, with osteosarcoma and Ewing sarcoma contributing prominently. The relatively high representation of malignant bone tumors, particularly in the 10-15-year age group, is an important observation from this Northeast Indian cohort and merits further evaluation in larger studies. These findings provide region-specific information on childhood cancer patterns encountered at tertiary referral and specialized cancer treatment centers. They may help strengthen age-specific clinical suspicion, early referral pathways, diagnostic services, and pediatric oncology planning in the region.

Declarations

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Ethical approval: The study was approved by the Institutional Ethics Committees of Apollo Hospitals, Guwahati, and Dr. B. Borooah Cancer Institute, Guwahati.

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