ORIGINAL ARTICLE

Profile of Childhood Cancers From Hospital-Based Cancer Registries in India, 2012-19

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ABSTRACT

Objective: To describe the clinical pattern of childhood and adolescent cancers across India using hospital-based data in the National Cancer Registry Program.

Methods: Records of 60720 cancer cases in the 0-19 year age group for the period 2012-2019 from 96 hospital-based cancer registries were reviewed. Childhood cancers were classified based on the International Classification of Childhood Cancer (ICCC). Descriptive analysis was used to examine the distribution of cancer by five-year age groups, sex and ICCC diagnostic groups and subgroups. Data were analysed using IBM SPSS software and visualised using R software.

Results: 3.2% and 4.6% of all cancer cases in India were among children in the 0-14 year and 0-19 year age groups respectively. The male-to-female ratio for all cancers was 1.72 for 0-14 years and 1.73 for 0-19 years. The four leading groups of cancers among 0-14 year olds were leukemia (40%), lymphoma (12%), central nervous system tumor (11%) and bone cancer (8%). The four leading cancers among the 0-19 year age group were leukemia (36%), lymphoma (12%), bone (11%) and central nervous system tumor (10%).

Conclusion: Cancers in the 0-14 and 0-19 age groups accounted for a considerable proportion of all cancers with significant male preponderance. Such information helps to fine-tune research and planning strategies.

Keywords: *Adolescent, Cancer, Child, India, Registries*

INTRODUCTION

Strategies to control cancer start with understanding the occurrence of cancer and its distribution. Knowing how many patients develop, are treated for, and ultimately survive cancer is vital data for evidence-based resource allocation. Cancer registries collect accurate and complete cancer data that can be used for cancer control and epidemiological research, public health program planning, and patient care improvement. In childhood cancer, such information helps to understand disease etiology, improve access to care, plan investments in service delivery, advocate for resource allocation, and measure the quality of different health system components involved [1]. Ultimately, all of these activities reduce the burden of cancer.

Data from the National Cancer Registry Programme (NCRP), established by the Indian Council of Medical Research (ICMR) in 1981, is generated through a network of 38 Population-Based Cancer Registries (PBCRs) and 246 Hospital-Based Cancer Registries (HBCRs). The recent NCRP report of 96 HBCRs has captured data on the topography (site), clinical staging, histology, site of pediatric cancers and treatment details [2].

In India, previous publications on the distribution of childhood cancer in India have been restricted to particular geographical regions [3,4] and have generally excluded adolescents with cancer. Globally, there is a relative lack of representation on registry-level information on childhood

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and adolescent cancer from low and middle-income countries (LMIC), which account for more than 80% of the burden of children with cancer [5]. The present paper offers an opportunity to address this gap and describes the clinical pattern of childhood and adolescent cancers across India using hospital-based data in the NCRP.

METHODS

The present study was a descriptive cross-sectional analysis based on eight-year data (2012 to 2019) on childhood cancers from 96 HBCRs [2]. These HBCRs are located in specialised oncology centres /general or multi-speciality hospitals (public and private) covering urban and rural areas of the country. Data collection was done using a standardized common core form consisting of patient identifying and socio-demographic information, details of diagnosis, clinical extent of disease, and broad type of treatment.

Topography (site) was coded according to the International Classification of Diseases-10th Revision (ICD-10) and morphology by the International Classification of Diseases for Oncology, 3rd edition (ICD-O-3) [6,7]. Only tumors with malignant behaviour were reported.

Childhood cancers were defined as cancers in two broad categories: 0-14 and 0-19 years that were classified based on the International Classification of Childhood Cancer (ICCC), 3rd edition [8].

Statistical analysis: Descriptive analysis was used to examine the distribution of cancer by five-year age groups, sex and ICCC diagnostic groups and subgroups. Data were analyzed using SPSS software (Version 27.0; IBM Corp, Armonk, NY, USA) and visualized using R software.

RESULTS

Among the 1332207 cancer cases in all sites that were registered at 96 HBCRs during 2012-19, 3.2% (42527) were among children in the 0-14 year age group, 1.4% (18193) were adolescents in the 15-19 year age group, and the cancers in the combined group (0-19 year) constituted 4.6 % of all cases (**Table I**). The male-to-female ratio was 1.72 in the 0-14 and 1.73 in the 0-19 age groups.

The four leading groups of cancers among 0-14 years were leukemia (40%), lymphoma (12%), central nervous system (CNS) tumor (11%) and bone cancer (8%) (**Fig. 1**). The distribution among boys and girls was broadly similar, except that the proportion of lymphoma was higher in boys (15%) than in girls (7%).

The four leading cancers among the 0-19 year age group were leukemia (36%), lymphoma (12%), bone (11%), CNS (10%) and soft tissue cancers (7%), as seen in **Fig.1**. Lymphomas were more common among males than females (15% vs 8%). However, the reverse was observed for carcinomas (5% vs 7%) and germ cells (2% vs 4%).

Leukemias constituted the most prominent group across all ages, constituting half of all cancers in the 0-4 year (42.1%) and the 5-9 year age group (42.5%), as described in **Table II**. This was followed by lymphomas (12.3%) that had the most significant proportion in the 5-9 year age group (15.7%), of which Hodgkin lymphoma was the most typical (7.9%). Malignant bone tumors (10.7%) were the third largest group overall and the second most common cancer group in the 10-14 year (16.0%) and 15-19 year age group (17.9%), mainly constituted by osteosarcoma and Ewing sarcoma. Rhabdomyosarcoma, retinoblastoma, Wilm's tumor and neuroblastoma were all seen primarily in the 0-4 year age group. CNS tumors had an overall proportion of 9.6% in the 0-19 year age group, with the highest proportion between 5-9 years, and the most significant pathological type was primitive neuroectodermal tumors (PNET).

DISCUSSION

Based on NCRP data, the present study analyzed 60720 cancer cases (0-19 years) from 96 HBCRs, over eight years. With a younger population pyramid, it is not

Table I Childhood Cancers Relative to Cancers Across All Ages: Data from 96 Hospital-Based Cancer Registries, India, 2012-2019

Age (y)	*Boys (n = 705395)*		*Girls (n = 626812)*		*Total (n = 1332207)*	
	n	*% of all cancers*	*n*	*% of all cancers*	*n*	*% of all cancers*
0-4	9320	1.3	5764	0.9	15084	1.1
5-9	8883	1.3	4728	0.8	13611	1.0
10-14	8668	1.2	5164	0.8	13832	1.0
15-19	11589	1.6	6604	1.1	18193	1.4
0-14	26871	3.8	15656	2.5	42527	3.2
0-19	38460	5.5	22260	3.6	60720	4.6

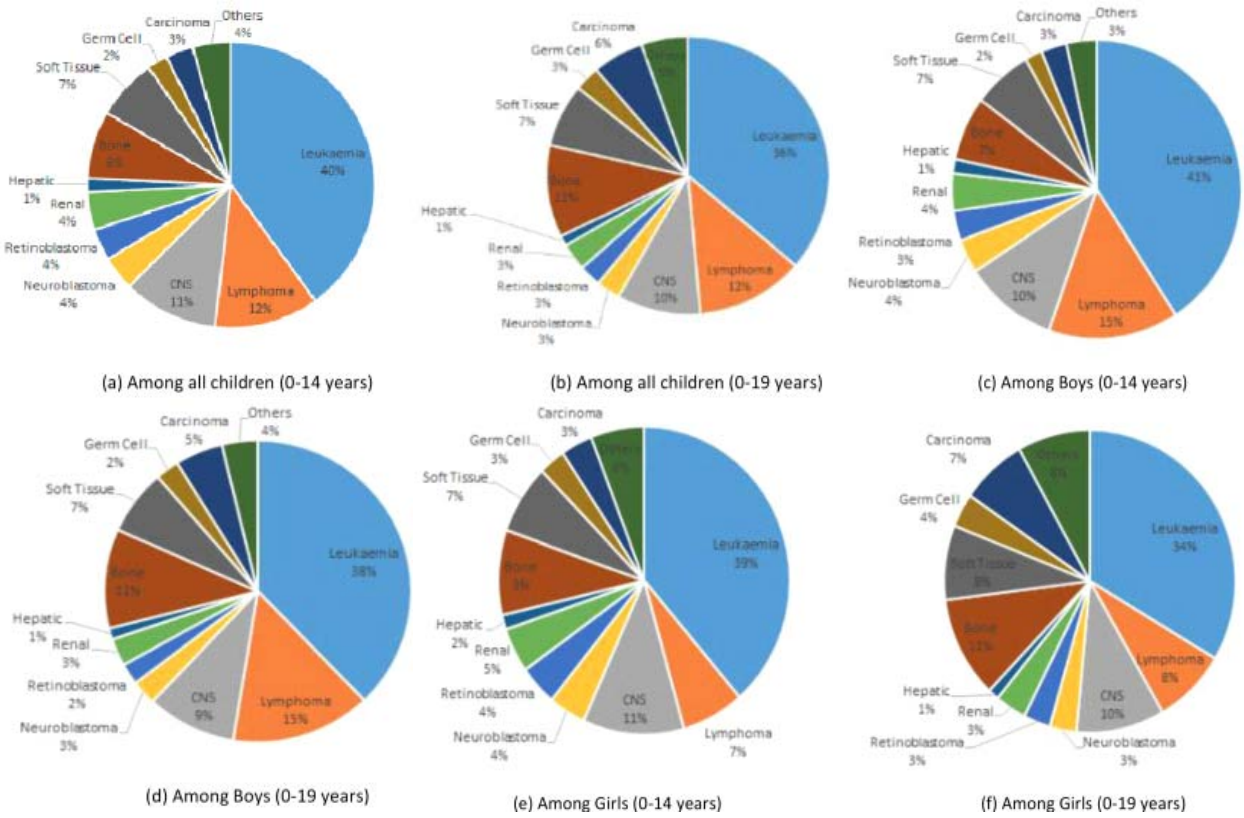

Fig. 1 Relative contribution of the 12 diagnostic groups of childhood cancer in (0-14) and (0-19) years.

surprising that children 0-14 and adolescents 0-19 years of age represent 3.2% and 4.6% of the total cancers reported at hospitals. In contrast, this proportion is 1-2% in countries with high human development index [9].

Leukemias comprised nearly half of all cancers in the 0-14 and 0-19 age groups, which is in accordance with findings from other studies [10,11]. Lymphoid leukemia, including acute lymphoblastic leukemia (ALL), comprised most leukemia types. Similar to the high male-to-female ratio of cancer cases observed in our study, sex disparity in cancer registration has previously been described in LMICs, especially those with low female education rates, wherein girls with cancer often go undiagnosed [12]. The higher sex differential in India could be ascribed to social determinants such as gender discrimination and skewed sex ratio due to male birth preferences that outnumber female births in India [13]. The proportion of leukemias and bone cancer in the 0-14 and the 0-19 year age group was higher than population-based data from India in the IICC paper by Steliarova-Foucher et al in which reported proportions of leukemia were 38.4% and 34.1% and for bone cancer, 5.6% and 7.6% in the 0-14 and 0-19 year age groups respectively, which could be accounted for by differences in the hospital referral practices [14]. Furthermore, the proportional distribution of CNS tumors reported internationally (17-26%) is remarkably higher than that observed in the present analysis (11% in 0-14 and 10 % in 0-19 age group). One explanation for this wide gap is that CNS tumors are possibly treated in neurosurgical centres in multi-speciality (general) hospitals rather than dedicated cancer centres in India. Another explanation could be that currently, the NCRP only registers "malignant" (defined as World Health Organization Grade 3 and 4) CNS tumors.

The proportion of Non-Hodgkin lymphomas (NHL) increased with rising age groups in our analysis, supporting evidence that NHL increases steadily with age and more so in males, which may result from innate sex differences in susceptibility and HIV [15]. The higher proportion of malignant bone tumors in girls is probably due to earlier skeletal maturity. The data from the Indian HBCRs not only gives us valuable information on the distribution of cancer in children and adolescents but also supplements the PBCRs, allowing estimates of incidence and longitudinal trends. Cancers in the 0-19 age group accounted for a considerable proportion of all cancers, with significant male preponderance.

Table II Number and Proportion of Specific Types of Cancers (ICCC-3 Classification) by 5 Year Age Groups, India, 2012-2019

	0-4y		*5-9y*		*10-14y*		*15-19y*		*Total (0-14y)*		*Total (0-19y)*	
Cancer classification	n	%	n	%	n	%	n	%	n	%	n	%
Leukemia	6354	42.1	5790	42.5	4843	35.0	4963	27.3	16987	39.9	21950	36.1
Lymphoid leukemia	4871	32.3	4227	31.1	3037	22.0	2649	14.6	12135	28.5	14784	24.3
Acute non-lymphocytic leukemia	897	5.9	950	7.0	1132	8.2	1249	6.9	2979	7.0	4228	7.0
Chronic myeloid leukemia	54	0.4	133	1.0	279	2.0	539	3.0	466	1.1	1005	1.7
Other specified leukemia	55	0.4	29	0.2	24	0.2	38	0.2	108	0.3	146	0.2
Unspecified leukemia	477	3.2	451	3.3	371	2.7	488	2.7	1299	3.1	1787	2.9
Lymphomas and reticuloendothelial neoplasm	762	5.1	2134	15.7	2089	15.1	2502	13.8	4985	11.7	7487	12.3
Hodgkin lymphoma	170	1.1	1070	7.9	943	6.8	1163	6.4	2183	5.1	3346	5.5
Non-Hodgkin lymphoma	315	2.1	673	4.9	869	6.3	1132	6.2	1857	4.4	2989	4.9
Burkitt's lymphoma	140	0.9	273	2.0	138	1.0	69	0.4	551	1.3	620	1.0
Miscellaneous lymphoreticular neoplasms	108	0.7	35	0.3	33	0.2	31	0.2	176	0.4	207	0.3
Unspecified lymphomas	29	0.2	83	0.6	106	0.8	107	0.6	218	0.5	325	0.5
Central Nervous System and miscellaneous intracranial and intraspinal neoplasms	1047	6.9	1907	14.0	1604	11.6	1249	6.9	4558	10.7	5807	9.6
Ependymoma	233	1.5	262	1.9	173	1.3	122	0.7	668	1.6	790	1.3
Astrocytoma	138	0.9	369	2.7	461	3.3	512	2.8	968	2.3	1480	2.4
Primitive neuroectodermal tumors	434	2.9	706	5.2	562	4.1	271	1.5	1702	4.0	1973	3.2
Other gliomas	131	0.9	424	3.1	293	2.1	244	1.3	848	2.0	1092	1.8
Other specified intracranial and intraspinal neoplasms	42	0.3	39	0.3	51	0.4	52	0.3	132	0.3	184	0.3
Unspecified intracranial and intraspinal neoplasms	69	0.5	107	0.8	64	0.5	48	0.3	240	0.6	288	0.5
Sympathetic Nervous System tumors	1139	7.6	407	3.0	116	0.8	72	0.4	1662	3.9	1734	2.9
Neuroblastoma and ganglioneuroblastoma	1128	7.5	395	2.9	100	0.7	45	0.2	1623	3.8	1668	2.7
Other SNS tumors	11	0.1	12	0.1	16	0.1	27	0.1	39	0.1	66	0.1
Retinoblastoma	1284	8.5	219	1.6	29	0.2	3	<0.1	1532	3.6	1535	2.5
Renal tumors	1279	8.5	435	3.2	103	0.7	74	0.4	1817	4.3	1891	3.1
Wilm's tumor, rhabdoid and clear cell sarcoma	1260	8.4	410	3.0	73	0.5	24	0.1	1743	4.1	1767	2.9
Renal carcinoma	19	0.1	25	0.2	30	0.2	50	0.3	74	0.2	124	0.2
Hepatic tumors	475	3.1	108	0.8	64	0.5	80	0.4	647	1.5	727	1.2
Hepatoblastoma	425	2.8	77	0.6	26	0.2	3	<0.1	528	1.2	531	0.9
Hepatic carcinoma	29	0.2	24	0.2	36	0.3	70	0.4	89	0.2	159	0.3

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0-4y		*5-9y*		*10-14y*		*15-19y*		*Total (0-14y)*		*Total (0-19y)*	
Unspecified malignant hepatic tumors	21	0.1	7	0.1	2	< 0.1	7	< 0.1	30	0.1	37	0.1
Malignant bone tumors	216	1.4	822	6.0	2212	16.0	3253	17.9	3250	7.6	6503	10.7
Osteosarcoma	24	0.2	314	2.3	1285	9.3	2120	11.7	1623	3.8	3743	6.2
Chondrosarcoma	2	0.0	7	0.1	43	0.3	86	0.5	52	0.1	138	0.2
Ewing sarcoma	140	0.9	453	3.3	757	5.5	804	4.4	1350	3.2	2154	3.5
Other specified malignant bone tumors	24	0.2	13	0.1	41	0.3	123	0.7	78	0.2	201	0.3
Unspecified malignant bone tumors	26	0.2	35	0.3	86	0.6	120	0.7	147	0.3	267	0.4
Soft-tissue sarcomas	1059	7.0	839	6.2	1022	7.4	1532	8.4	2920	6.9	4452	7.3
Rhabdomyosarcoma and embryonal sarcomas	650	4.3	398	2.9	272	2.0	267	1.5	1320	3.1	1587	2.6
Fibrosarcoma, neurofibrosarcoma and other fibromatous neoplasms	51	0.3	44	0.3	75	0.5	138	0.8	170	0.4	308	0.5
Kaposis sarcoma	0	0.0	0	0.0	3	< 0.1	3	< 0.1	3	< 0.1	6	< 0.1
Other specified soft tissue sarcoma	257	1.7	297	2.2	512	3.7	814	4.5	1066	2.5	1880	3.1
Unspecified soft tissue sarcoma	101	0.7	100	0.7	160	1.2	310	1.7	361	0.8	671	1.1
Germ-cell trophoblastic and other gonadal neoplasms	528	3.5	150	1.1	299	2.2	779	4.3	977	2.3	1756	2.9
Intracranial and intraspinal GC tumors	23	0.2	28	0.2	60	0.4	53	0.3	111	0.3	164	0.3
Other and unspecified non-gonadal GC tumors	232	1.5	20	0.1	33	0.2	119	0.7	285	0.7	404	0.7
Gonadal germ cell tumors	264	1.8	89	0.7	179	1.3	503	2.8	532	1.3	1035	1.7
Gonadal carcinomas	5	< 0.1	5	< 0.1	15	0.1	65	0.4	25	0.1	90	0.1
Other and unspecified gonadal tumors	4	0.0	8	0.1	12	0.1	39	0.2	24	0.1	63	0.1
Carcinoma and other malignant epithelial neoplasms	211	1.4	331	2.4	774	5.6	2251	12.4	1316	3.1	3567	5.9
Adrenocortical carcinoma	26	0.2	17	0.1	13	0.1	10	0.1	56	0.1	66	0.1
Thyroid carcinoma	3	< 0.1	8	0.1	33	0.2	159	0.9	44	0.1	203	0.3
Nasopharyngeal carcinoma	0	0.0	26	0.2	181	1.3	323	1.8	207	0.5	530	0.9
Malignant melanoma	11	0.1	9	0.1	7	0.1	31	0.2	27	0.1	58	0.1
Skin carcinoma	8	0.1	27	0.2	27	0.2	63	0.3	62	0.1	125	0.2
Other and unspecified carcinoma	163	1.1	244	1.8	513	3.7	1665	9.2	920	2.2	2585	4.3
Other and unspecified malignant neoplasms	389	2.6	180	1.3	188	1.4	383	2.1	757	1.8	1140	1.9
Other specified malignant tumors	22	0.1	13	0.1	16	0.1	30	0.2	51	0.1	81	0.1
Other unspecified malignant tumors	708	4.7	456	3.4	661	4.8	1406	7.7	1825	4.3	3231	5.3
Total	15085	100.0	13611	100.0	13832	100.0	18194	100.0	42528	100.0	60722	100.0

WHAT THIS STUDY ADDS?

- Descriptive profile of 60,720 childhood cancer cases (0-19 years) in India from 96 hospitals between 2012-2019.

One of the main limitations of the present analysis was that cancer incidence rates could not be calculated since the data used was hospital-based. However, there is a wide belief that HBCRs could provide population-based statistics for childhood cancers since these are primarily treated at highly specialised hospitals. Therefore, it is vital to strengthen the HBCRs to obtain robust data which may be achieved by increasing the number of HBCRs (as has been steadily happening) and ensuring that data capture in each hospital is not limited to one department. By providing patient registration from all relevant departments within the hospital, including pathology and radiology, the case ascertainment can be close to complete.

Future efforts should include strengthening the existing childhood component of the HBCRs. A robust childhood cancer policy would augment better allocation of resources for the overall growth and survival of children.

Ethics clearance: Institutional Ethics Committee, ICMR-NCDIR; No.NCDIR/IEC/2017/5, dated March 1, 2017.
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