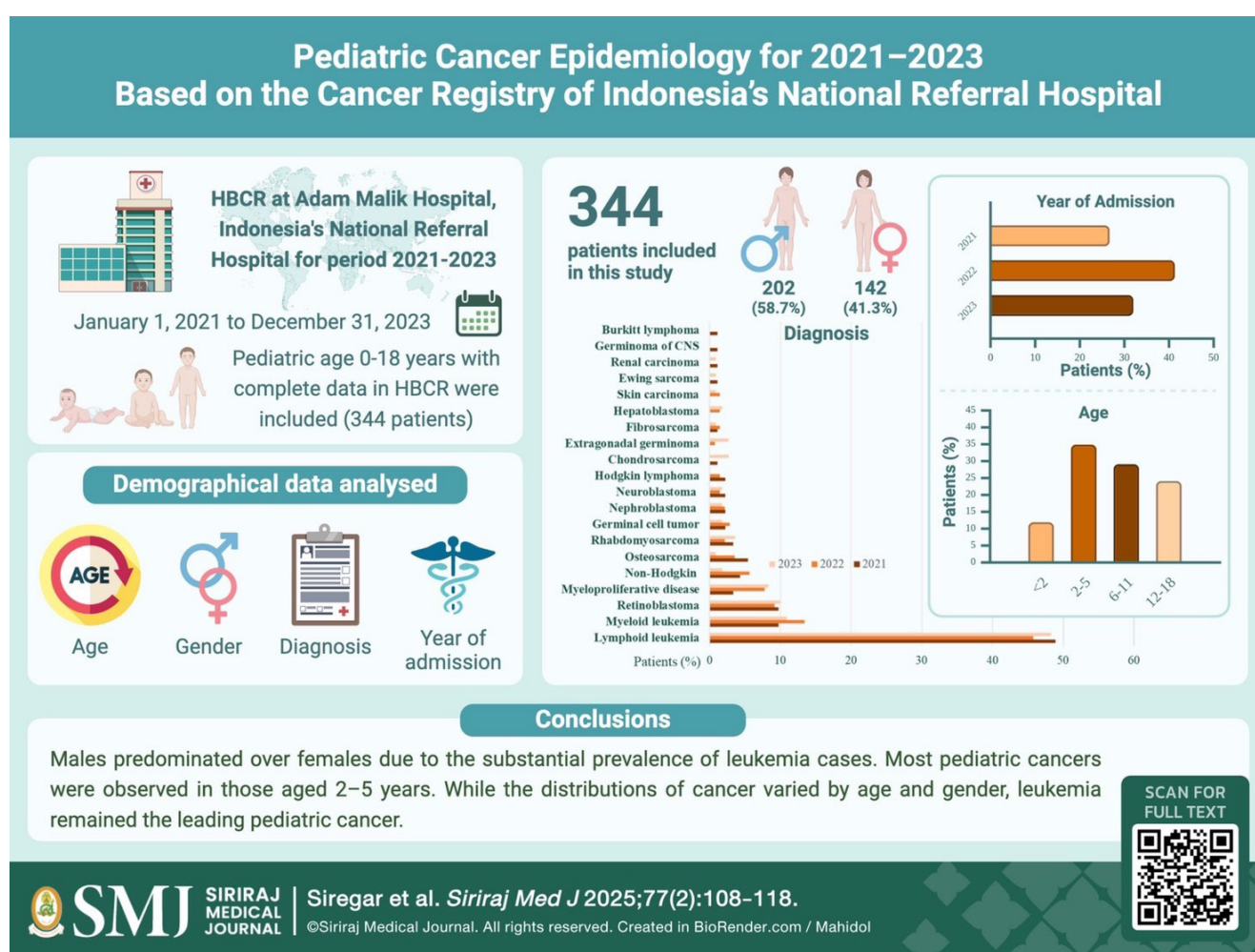


Pediatric Cancer Epidemiology for 2021–2023 Based on the Cancer Registry of Indonesia's National Referral Hospital

Olga Rasiyanti Siregar^{1,*}, Bidasari Lubis¹, Peggy Liberty²

¹Department of Pediatrics, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia, ²Medical Study Program, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia.



*Corresponding author: Olga Rasiyanti Siregar

E-mail: olga.rasiyanti@usu.ac.id

Received 7 October 2024 Revised 1 November 2024 Accepted 15 November 2024

ORCID ID: <http://orcid.org/0000-0002-6939-5739>

<https://doi.org/10.33192/smj.v77i2.271534>



All material is licensed under terms of the Creative Commons Attribution 4.0 International (CC-BY-NC-ND 4.0) license unless otherwise stated.

ABSTRACT

Objective: This study aimed to present epidemiological data on pediatric cancers based on the hospital-based cancer registry (HBCR) at Indonesia's National Referral Hospital.

Material and Methods: This descriptive study analyzed data on pediatric cancers from the HBCR for 2021–2023. Demographical data, including age, gender, diagnosis, and admission year, were extracted from the HBCR data. Univariate data analysis was conducted.

Results: This study included 344 patients, consisting of 202 males and 142 females. Of those patients, 92 (26.7%) were admitted in 2021, 142 (41.3%) in 2022, and 110 (32%) in 2023. The highest cancer incidence was observed in patients aged 2–5 years (34.9%) and the lowest in those aged <2 years (11.9%). The three most common reported cancers were lymphoid leukemia (47.4%), myeloid leukemia (11.6%), and retinoblastoma (9.6%).

Conclusion: Males predominated over females due to the substantial prevalence of leukemia cases. Most pediatric cancers were observed in those aged 2–5 years. While the distributions of cancer varied by age and gender, leukemia remained the leading pediatric cancer.

Keywords: Cancer; data registry; epidemiology; malignancy; pediatric (Siriraj Med J 2025; 77: 108-118)

INTRODUCTION

Cancer is one of the leading causes of mortality in children. In 2020, over 200,000 new cancer cases and over 80,000 cancer-related deaths were reported in children. The global incidence of childhood cancer was 10.5 per 100,000 population, and the mortality rate was 4.1 per 100,000 population.¹ While the global incidence and mortality rate of pediatric cancer had declined from those in 2017 (incidence rate = 16.2 per 100,000 population, mortality rate = 5.5 per 100,000 population), the mortality rate remained higher in low- and middle-income countries, including Indonesia, compared to high-income countries.² One previous study reported that the mortality rate for pediatric cancer in low- and middle-income countries was twice that in high-income countries, with Southeast Asia reporting the highest mortality among low- and middle-income countries (mortality rate = 4.5 per 100,000 population).¹

Indonesia, as a part of low- and middle-income countries in Southeast Asia, also reported a notable prevalence of pediatric cancer. According to Basic Health Research of Indonesia (RISKESDAS), the prevalence of pediatric cancer in Indonesia was 0.42 per 1,000 population in 2018.³ The Global Cancer Observatory (GLOBOCAN) estimated that 291 per 100,000 Indonesians were diagnosed with cancer in 2018, and the number is expected to increase in the future.⁴ According to data from the Social Insurance Administration Organization of Indonesia, approximately 2.2 trillion rupiahs were allocated to treating cancers, including pediatric cancers, in 2016, increasing by about 30% in 2017 and reaching 7.6 trillion rupiahs in 2020.⁵ Despite the considerable funding designated for cancer treatment in Indonesia,

the treatment success rate remains low, contributing to the high mortality rate. This unsuccessful treatment has been attributed to the delayed diagnosis, leading to advanced disease at diagnosis and delays in treatment.⁶

Understanding the characteristics and distribution of pediatric cancers should facilitate their accurate early diagnosis and prompt treatment. To our knowledge, no valid data has been reported for pediatric cancers. Therefore, this study aimed to report epidemiological data on pediatric cancers based on the hospital-based cancer registry (HBCR) at the National Referral Hospital of Indonesia for the period 2021–2023.

MATERIALS AND METHODS

This cross-sectional descriptive study analyzed data from the HBCR of Adam Malik Hospital, Indonesia's National Referral Hospital. In 2016, Adam Malik Hospital, a tertiary healthcare in Indonesia, had been appointed by the Ministry of Health of Indonesia as one of the national cancer registry hospitals. All pediatric cancer cases detected in primary healthcare were referred to secondary healthcare for confirmation of diagnosis by histopathological examinations. The primary healthcare in this study included district hospitals and general practitioner clinics, while the secondary healthcare included regional referral hospitals. Confirmed cases were referred to tertiary healthcare, including Adam Malik Hospital, for diagnostic stratification and treatment decision. All pediatric cancer cases referred to Adam Malik Hospital will be included in the HBCR. This study was conducted between July and August 2024 and used data collected from the HBCR for all patients treated in the Pediatric Oncology Center at Adam Malik Hospital from January

1, 2021, to December 31, 2023. Its inclusion criteria were pediatric patients aged 0–18 years newly diagnosed with cancer based on pathological anatomy criteria or other diagnostic procedures at Adam Malik Hospital between 2021 and 2023 and recorded in the HBCR from January 1, 2021, to December 31, 2023. The exclusion criteria were patients with incomplete or missing registry data.

Data collection

The HBCR data were collected and processed in several steps: (1) raw data collection, (2) data abstraction and coding, (3) data verification (first), (4) data input, and (5) data verification (second). The Pediatric Oncology Center at Adam Malik Hospital prepared a list of patients, which was filtered to remove duplicates, and patients' medical records were manually tracked to collect the raw data. The raw data then underwent data abstraction and coding, and was verified by intervariable matching. After verification, the data were entered into the HBCR, and a second verification was performed. This study included all patients registered in the HBCR who met the eligibility criteria. The data collection process was susceptible to missing data and reporting bias. A pilot test was conducted prior to the study to mitigate such bias.

Data analyses

Demographical data, including age, gender, diagnosis, and admission year, were extracted from the HBCR. The data underwent univariate analysis using Microsoft Excel and IBM SPSS (version 25.0).⁷

Ethical approval

This study was reviewed and approved by the Research Ethical Committee of the Faculty of Medicine, Universitas Sumatera Utara (clearance number: 1011/

KEPK/USU/2024) and was conducted according to the Declaration of Helsinki.

RESULTS

Patients' characteristics

This study included 344 pediatric patients with cancer, consisting of 202 (58.7%) males and 142 (41.3%) females (Fig 1). Of those patients, 92 (26.7%) were admitted in 2021, 142 (41.3%) in 2022, and 110 (32%) in 2023. Their characteristics are summarized in Table 1, and their age distribution is shown in Table 2, stratified by gender and year.

Cancer incidence was highest in patients aged 2–5 years ($n = 120$, 34.9%) and lowest in patients aged <2 years ($n = 41$, 11.9%). Regarding sex, cancer incidence was highest among males aged 2–5 years ($n = 80$, 39.6%) and females aged 6–11 years ($n = 43$, 30.3%) and lowest among males and females aged <2 years.

Distribution of pediatric cancers

The distribution of pediatric cancers is presented in Table 3 (stratified by admission year) and Table 4 (stratified by age). The most common pediatric cancer was lymphoid leukemia ($n = 163$, 47.4%), followed by myeloid leukemia ($n = 40$, 11.6%) and retinoblastoma ($n = 33$, 9.6%). The least common pediatric cancers were germinoma of the central nervous system and Burkitt lymphoma, each with only one case reported within the three-year study period. The most common pediatric cancer in all age groups was lymphoid leukemia. Myeloid leukemia was diagnosed most often among those aged 5–11 years ($n = 16$, 16%). The incidence of retinoblastoma was higher among those aged <2 ($n = 8$, 19.5%) and 2–5 ($n = 24$, 20.0%) years. Burkitt lymphoma, chondrosarcoma, and renal carcinoma were reported only among those aged 12–18 years. A rare case of germinoma of the central

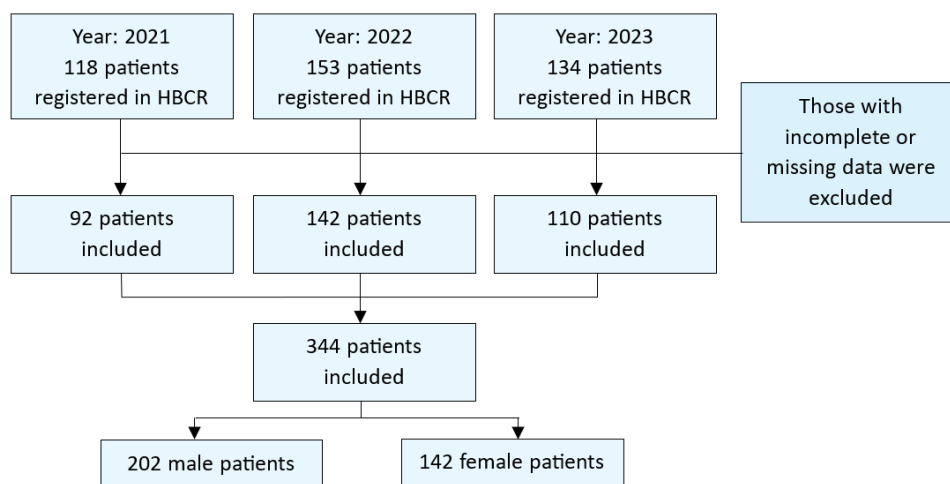


Fig 1. Flowchart of patient inclusion.

TABLE 1. Characteristics of the pediatric patients with cancer.

Characteristics	2021		2022		2023		Total	
	n: 92	%	n: 142	%	n: 110	%	n: 344	%
Gender								
Male	46	50	84	59.2	72	65.5	202	58.7
Female	46	50	58	40.8	38	34.5	142	41.3
Age (years)								
<2	7	7.6	23	16.2	11	10.0	41	11.9
2–5	31	33.7	50	27.6	39	35.5	120	34.9
6–11	28	30.4	41	22.7	31	28.2	100	29.1
12–18	26	28.3	28	15.5	29	26.4	83	24.1

TABLE 2. Age distribution of the pediatric patients with cancer, stratified by gender.

Age	2021				2022				2023				Total			
	Male		Female		Male		Female		Male		Female		Male		Female	
	n:46	%	n:46	%	n:84	%	n:58	%	n:72	%	n:38	%	n:202	%	n:142	%
<2	5	10.9	2	4.3	13	15.5	10	17.2	5	6.9	6	15.8	23	11.4	18	12.7
2–5	15	32.6	16	34.8	36	42.9	14	24.1	29	40.4	10	26.3	80	39.6	40	28.2
6–11	12	26.1	16	34.8	22	26.1	19	32.8	23	31.9	8	21.1	57	28.2	43	30.3
12–18	14	30.4	12	26.1	13	15.5	15	25.9	15	20.8	14	36.8	42	20.8	41	28.8

nervous system ($n = 1$, 0.8%) was reported in a patient aged 2–5 years. Osteosarcoma and Ewing sarcoma were reported only in patients aged >5 years. Three of the four cases of hepatoblastoma were found in patients aged <2 years.

Pediatric cancers by gender

The top 10 most frequent pediatric cancers by gender are shown in Fig 2. The top four predominant pediatric cancers for both genders were lymphoid leukemia, myeloid leukemia, retinoblastoma, and myelodysplastic and myeloproliferative disease. Non-Hodgkin lymphoma (except Burkitt lymphoma), osteosarcoma, and rhabdomyosarcoma were in the top ten most common pediatric cancers for both sexes. However, osteosarcoma and rhabdomyosarcoma were slightly more common in females (six cases of osteosarcoma, five cases of rhabdomyosarcoma) than in males (five cases of osteosarcoma, three cases of rhabdomyosarcoma). In contrast, non-Hodgkin lymphoma (except Burkitt lymphoma) was more slightly common in males ($n = 8$) than in females ($n = 6$ cases). Neuroblastoma and

neuroblastoma were included in the top ten cancers for males, whereas hepatoblastoma and Hodgkin lymphoma were included in the top ten cancers for females.

DISCUSSION

Our study examined 344 pediatric cancer cases reported between 2021 and 2023, with 92 (26.7%) reported in 2021, 142 (41.3%) in 2022, and 110 (32%) in 2023. Throughout the study period, there was no discernible difference in the annual reports of pediatric cancer. The ratio of male to female patients was 1.4: 1 in our study, similar to those reported by Supriyadi *et al.* in Yogyakarta.⁸ Previous studies have firmly established that males are more susceptible to childhood cancer than females. Males were reported to have a higher incidence of most pediatric cancers, with an overall male-to-female incidence ratio of 1.19.⁹ Various factors have been reported to contribute to a higher incidence of pediatric cancers in males, including congenital abnormalities,¹⁰ birth weight,¹¹ X-linked gene expression,¹² and immunological responses.¹³ In 2020, the GLOBOCAN also reported that

TABLE 3. Distribution of pediatric cancers, stratified by admission year.

Cancer type	ICD-10	2021		2022		2023		Total	
		n:92	%	n:142	%	n:110	%	n:344	%
Lymphoid leukemia	C91	45	48.9	65	45.8	53	48.3	163	47.4
Myeloid leukemia	C92	9	9.7	19	13.4	12	10.9	40	11.6
Retinoblastoma	C69.2	9	9.7	13	9.2	11	10.0	33	9.6
Myelodysplastic and myeloproliferative disease	C94.6	3	3.3	11	7.8	9	8.3	23	6.7
Non-Hodgkin lymphoma (except Burkitt lymphoma)	C82-C86	4	4.3	8	5.6	2	1.8	14	4.1
Osteosarcoma	C41.9	5	5.4	5	3.5	1	0.9	11	3.2
Rhabdomyosarcoma	C49.9	3	3.3	3	2.1	4	3.6	10	2.9
Malignant gonadal germinal cell tumor	C59.9/ C62.9	2	2.2	4	2.8	2	1.8	8	2.3
Nephroblastoma and other nonepithelial renal tumors	C64	2	2.2	3	2.1	2	1.8	7	2.0
Neuroblastoma	C74.9	2	2.2	2	1.4	2	1.8	6	1.7
Hodgkin lymphoma	C81	2	2.2	2	1.4	0	0	4	1.2
Chondrosarcoma	C49.9	1	1.1	0	0	3	2.7	4	1.2
Extragenital germinoma	C38.3/ C48.8/ C72.9	0	0	1	0.7	3	2.7	4	1.2
Fibrosarcoma	C49	1	1.1	2	1.4	1	0.9	4	1.2
Hepatoblastoma	C22.2	0	0	2	1.4	2	1.8	4	1.2
Skin carcinoma	C44.91/ C44.92	0	0	2	1.4	1	0.9	3	0.9
Ewing sarcoma	C40.0/ C40.1/ C40.2/ C40.3/ C41.2/ C41.3/ C41.4	1	1.1	0	0	1	0.9	2	0.6
Renal carcinoma	C64.1	1	1.1	0	0	1	0.9	2	0.6
Germinoma of the central nervous system	C72.9	1	1.1	0	0	0	0	1	0.2
Burkitt lymphoma	C83.7	1	1.1	0	0	0	0	1	0.2

TABLE 4. Distribution of pediatric cancer cases, stratified by age group.

Cancer type	ICD-10	Age group (years)							
		<2		2–5		5–11		12–18	
		n:41	%	n:120	%	n:100	%	n:83	%
Lymphoid leukemia	C91	14	34.2	63	52.5	53	53.0	33	39.8
Myeloid leukemia	C92	3	7.3	8	6.7	16	16.0	13	15.7
Retinoblastoma	C69.2	8	19.5	24	20.0	1	1.0	0	0
Myelodysplastic and myeloproliferative disease	C94.6	2	4.9	3	2.5	7	7.0	11	13.3
Non-Hodgkin lymphoma (except Burkitt lymphoma)	C82-C86	2	4.9	2	1.7	6	6.0	4	4.8
Osteosarcoma	C41.9	0	0	0	0	6	6.0	5	6.0
Rhabdomyosarcoma	C49.9	3	7.3	2	1.7	3	3.0	2	2.4
Malignant gonadal germinal cell tumor	C59.9/ C62.9	2	4.9	3	2.5	1	1.0	2	2.4
Nephroblastoma and other nonepithelial renal tumors	C64	1	2.4	4	3.3	1	1.0	1	1.2
Neuroblastoma	C74.9	2	4.9	3	2.5	1	1.0	0	0
Hodgkin lymphoma	C81	0	0	1	0.8	1	1.0	2	2.4
Chondrosarcoma	C49.9	0	0	0	0	0	0	4	4.8
Extragenital germinoma	C38.3/ C48.8/ C72.9	0	0	2	1.7	0	0	2	2.4
Fibrosarcoma	C49	1	2.4	2	1.7	1	1.0	0	0
Hepatoblastoma	C22.2	3	7.3	1	0.8	0	0	0	0
Skin carcinoma	C44.91/ C44.92	0	0	1	0.8	2	2.0	0	0
Ewing sarcoma	C40.0/ C40.1/ C40.2/ C40.3/ C41.2/ C41.3/ C41.4	0	0	0	0	1	1.0	1	1.2
Renal carcinoma	C64.1	0	0	0	0	0	0	2	2.4
Germinoma of the central nervous system	C72.9	0	0	1	0.8	0	0	0	0
Burkitt lymphoma	C83.7	0	0	0	0	0	0	1	1.2

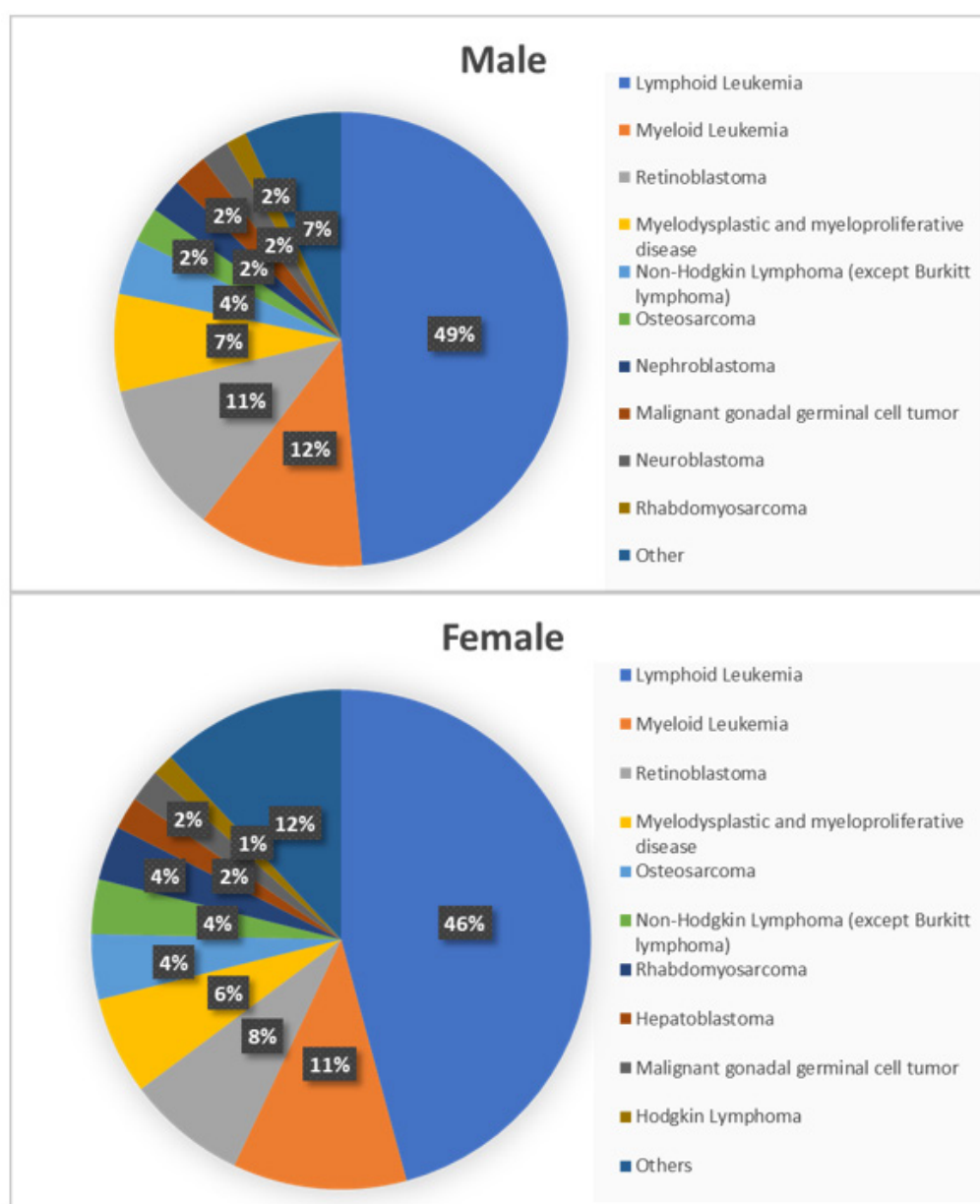


Fig 2. Top 10 cancers in male and female pediatric patients.

leukemia was more common in males than females.¹⁴ Leukemia was the most common pediatric cancer in our study, potentially explaining the higher number of observed cases in males than females.

Cancer was reported most often in patients aged 2–5 years and least often in patients aged <2 years in our study. Cancer incidence among children and adolescents is known to vary by age.¹⁵ Leukemia and brain tumors were found to be most commonly reported in children aged <9 years, and lymphoma, germinoma, and epithelial cancer in adolescents.¹⁶ Leukemia was the most frequently reported cancer in our study. Therefore, the age group with the most cancer reports aligned with the age group with the highest leukemia incidence, which was reported as age 1–4 years.¹⁷ The relatively small proportion of pediatric

cancers reported in patients aged <2 years may reflect undiagnosed cases. Diagnosing cancer in very young patients is challenging for medical professionals due to the presence of nonspecific indications and symptoms, frequently resulting in misdiagnosis and delayed diagnosis.¹⁸ There had been numerous initiatives to improve the early diagnosis of pediatric cancer. Both genetic and clinical screenings for retinoblastoma were deemed useful for early diagnosis.¹⁹ Nonetheless, screening for nephroblastoma through the evaluation of homovanillic acid and vanillylmandelic acid excretion frequently resulted in overdiagnosis. Thus, risk-based screening had become the preferable option.²⁰ To comprehensively implement risk-based screening in a country, health policies governing such screening are necessary. This study demonstrated

the prevalence of pediatric cancers by age and gender, particularly among children in Indonesia. Based on this epidemiological data, a well-structured health policy regarding early diagnosis might be accomplished.²¹

The top three pediatric cancers reported in our study were lymphoid leukemia, myeloid leukemia, and retinoblastoma. This finding is consistent with data from the World Health Organization's (WHO) Global Initiative for Childhood Cancer, which reported hematopoietic neoplasms, such as leukemia, and embryonal tumors, including retinoblastoma, to be the leading pediatric malignancies.²² Leukemia has been acknowledged as the most common pediatric cancer worldwide throughout past decades. Previous studies on childhood cancer from 2003 to 2019 reported that leukemia had the highest incidence among pediatric cancers in the United States.¹⁶ Other studies also reported leukemia as the most common in other continents, including Asia and Australia.^{23,24}

Our finding is also consistent with data from the WHO's Cancer Country Profile 2020, which indicated that leukemia was the most common cancer in those aged 0–14 years in Indonesia (2251 cases).²⁵ Acute lymphoblastic leukemia was the predominant leukemia subtype in pediatric patients.²⁶ In our study, lymphoid leukemia was the most common pediatric cancer reported in all age groups, while myeloid leukemia was most frequently reported in those aged 5–11 years. One study on leukemia trends from 1990 to 2019 demonstrated that while leukemia had the highest incidence among those aged <5 years, its overall incidence was considerably high in all age groups.²⁷ Our study reported 33 cases of retinoblastoma, mostly in those aged <5 years. Retinoblastoma is the most common ocular malignancy in children. Globally, 14.1 per 1 million children aged <5 years are diagnosed with retinoblastoma.²⁸ Retinoblastoma is remarkably diagnosed within early childhood, with a median age at diagnosis of 23.2 months.²⁹

The last reported cancers in our study were germinoma of the central nervous system and Burkitt lymphoma, which is consistent with previous studies that reported a low incidence of both cancers. The incidence of germinoma of the central nervous system was 0.1 and 0.4 per 100,000 children annually in the United States and Asia, respectively.^{30,31} The incidence of Burkitt lymphoma was also particularly low in Asia at <2 cases per million population.³² Germinoma of the central nervous system is a rare malignancy of the central nervous system in children, accounting for 3% of all pediatric brain tumors.³³ It is reportedly more common in males than females, with a median age at diagnosis of approximately 13 years.³¹ Burkitt lymphoma is an uncommon form of

non-Hodgkin lymphoma.³² One study reported that Burkitt lymphoma was more commonly diagnosed in males than females, with a median age at diagnosis of around 4–5 years.³⁴

The distribution of pediatric cancers by age group varied in our study. For those aged <2 years, the top five pediatric cancers were lymphoid leukemia (34.2%), retinoblastoma (19.5%), myeloid leukemia (7.3%), rhabdomyosarcoma (7.3%), and hepatoblastoma (7.3%). For those aged 2–5 years, the top five pediatric cancers were lymphoid leukemia (52.5%), retinoblastoma (20%), myeloid leukemia (6.7%), nephroblastoma (3.3%), and three cancers with the same frequency (2.5%): myelodysplastic and myeloproliferative disease, malignant gonadal germinal cell tumor, and neuroblastoma. For those aged 5–11 years, the top five pediatric cancers were lymphoid leukemia (53%), myeloid leukemia (16%), myelodysplastic and myeloproliferative disease (7%), non-Hodgkin Lymphoma (except Burkitt lymphoma) (6%), and osteosarcoma (6%). For those aged 12–18 years, the top five pediatric cancers were lymphoid leukemia (39.8%), myeloid leukemia (15.7%), myelodysplastic and myeloproliferative disease (13.3%), osteosarcoma (6%), and two cancers with the same frequency (4.8%): non-Hodgkin Lymphoma (except Burkitt lymphoma) and chondrosarcoma.

Regarding gender, lymphoid leukemia, myeloid leukemia, retinoblastoma, and myelodysplastic and myeloproliferative disease were among the top four pediatric cancers reported in both genders, with an overall incidence slightly higher in males. Non-Hodgkin lymphoma (except Burkitt lymphoma), nephroblastoma, and neuroblastoma were slightly more common in males, whereas osteosarcoma, rhabdomyosarcoma, and hepatoblastoma were slightly more common in females. The incidence of lymphoma among male and female was nearly equal, consistent with findings from prior research.³⁵

Leukemia, particularly lymphoid leukemia, remained the leading cancer in all age groups and genders, which is consistent with the high incidence of leukemia reported in previous studies.^{18, 23–25} Retinoblastoma was mostly reported in males aged <5 years, similar to a study by Barbosa et al. that reported 91% of retinoblastoma patients were aged <4 years with a male-to-female ratio of 1.3:1, with its incidence declining with age (<4 years: 7.02 per million; 5–9 years: 0.46 per million; 10–14 years: 0.05 per million; 15–19 years: 0.03 per million).³⁶ Myelodysplastic and myeloproliferative disease was reported among patients aged 2–18 years and was slightly more common in males (7%) than females (6%) in our study. These findings are consistent with a previous study that reported

this disease occurred at any age and affected males and females almost equally.³⁷

Rhabdomyosarcoma and hepatoblastoma were frequently reported in patients aged <2 years, with the incidence slightly higher in females than males. Both rhabdomyosarcoma and hepatoblastoma were reported to be diagnosed in early childhood. Rhabdomyosarcoma, especially embryonal rhabdomyosarcoma, was reported to be more frequent than other subtypes, with over 40% of cases involving patients aged 0–4 years.³⁸ Hepatoblastoma was also reported to be diagnosed with a median age of 14 months.³⁹ However, in our study, more rhabdomyosarcoma and hepatoblastoma cases were reported in females than males, which is inconsistent with previous studies that reported them to be more common in males (male-to-female ratio: 1.51 for rhabdomyosarcoma and 1.57 for hepatoblastoma).^{38,40} This disparity was suspected to be caused by the lower overall survival of male than female patients with rhabdomyosarcoma and hepatoblastoma, leading to undiagnosed cases due to death before confirmed diagnosis.^{40,41}

Osteosarcoma and Ewing sarcoma were reported in patients aged >5 years in our study, consistent with the epidemiology of these cancers, which are common in adolescents.⁴² Osteosarcoma was slightly more common in females than males in our study, similar to a previous study that reported 51.2% and 48.8% of patients with osteosarcoma were female and male, respectively.⁴³ This study reported that nephroblastoma was more common in males (5/8 cases), and more than half of the cases involved patients aged <5 years. On average, nephroblastoma is more common in females than in males. Nonetheless, one study demonstrated that the male-to-female ratio was 1:1 in early childhood and increased with age.⁴⁴ In our study, two-thirds of neuroblastoma cases involved males, consistent with a previous study that demonstrated male preponderance, with a male-to-female ratio of 1.2.⁴⁵

Limitations

This study was based on data from the HBCR of Indonesia's National Referral Hospital, which cancer cases were referred from primary and secondary healthcare to tertiary healthcare. Thus, we excluded cases that were not referred to the tertiary healthcare. The potential of underreporting was a limitation in this study.

Strengths and Future Aspects

This study provided important epidemiological data on pediatric cancers in Indonesia. We believe that this study could serve as a fundamental framework for the initiation of a population-based data registry in pediatric

cancers. Both hospital-based and population-based data registries in Indonesia are expected to contribute to the GLOBOCAN model, thus improving the global pediatric cancer epidemiological data. By providing this epidemiological data on pediatric cancers, our expectation was that health policy regulators could establish a well-structured policy regarding pediatric cancer screening strategies, thereby improving early diagnosis. Thus, an accurate and early treatment could be given in order to reduce the mortality rate of pediatric cancers.

CONCLUSION

As a conclusion, the three most common pediatric cancers were lymphoid leukemia, myeloid leukemia, and retinoblastoma. No significant disparity was observed in the annual reports of pediatric cancers. Males predominated over females due to the substantial prevalence of leukemia cases. Most pediatric cancers were observed in patients aged 2–5 years. While the distributions of pediatric cancers varied by age and gender, leukemia remained the leading pediatric cancer.

Data Availability Statement

The data of this study is available upon request.

ACKNOWLEDGEMENTS

None

DECLARATION

Grants and Funding Information

None

Conflict of Interest

None

Author Contributions

Conceptualization and methodology, O.R.S, B.L., P.L.; Investigation, O.R.S, B.L., P.L.; Formal analysis, O.R.S, B.L., P.L.; Visualization and writing – original draft, O.R.S, B.L., P.L.; Writing – review and editing, O.R.S, B.L., P.L. All authors have read and agreed to the final version of the manuscript.

REFERENCES

1. Huang J, Chan SC, Ngai CH, Lok V, Zhang L, Lucero-Prisno DE, et al. Global incidence, mortality and temporal trends of cancer in children: A joinpoint regression analysis. *Cancer Med.* 2023;12(2):1903-11.
2. Force LM, Abdollahpour I, Advani SM, Agius D, Ahmadian E, Alahdab F, et al. The global burden of childhood and adolescent cancer in 2017: an analysis of the Global Burden of Disease Study 2017. *Lancet Oncol.* 2019;20(9):1211-25.

3. Health Research and Development Agency: Basic Health Research 2018. Jakarta, Indonesia, Ministry of Health Republic of Indonesia, 2018. Available from: <https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan%20Risikesdas%202018%20Nasional.pdf>
4. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018;68(6):394-424.
5. Prasetya D, Layyinah A, Putri S, Rosita E, Nurjanah AI, Maftuchan A. Financial Consequences of Cancer Treatment in Indonesia: A Study Case in the Capital City of Jakarta. Jakarta: Perkumpulan PRAKARSA, 2023.
6. Gondhowiardjo S, Hartanto S, Wirawan S, Jayalie VF, Astiti IAP, Panigoro SS, et al. Treatment delay of cancer patients in Indonesia: a reflection from a national referral hospital. *Med J Indones*. 2021;30(2):129-37.
7. Songmuang J, Akatat P, Wattanagulanurak S, Rittayamai N, Sripalakit S. Comparison Study between Using Disposable and Non-Disposable Ventilator Circuits on Ventilator-Associated Pneumonia and Health Care Costs at a Respiratory Care Unit, Siriraj Hospital. *Siriraj Med J*. 2023;75(3):191-9.
8. Supriyadi E, Purwanto I, Armytasari I, Ritter J, Widjajanto PH, Veerman AJP. A province-wide childhood malignancy profiles in Indonesia (2010-2019): Yogyakarta Pediatric Cancer Registry. *Paediatr Indones*. 2023;63(4):226-7.
9. Williams LA, Richardson M, Marcotte EL, Poynter JN, Spector LG. Sex ratio among childhood cancers by single year of age. *Pediatr Blood Cancer*. 2019;66(6):e27620.
10. Marcotte EL, Schraw JM, Desrosiers TA, Nembhard WN, Langlois PH, Canfield MA, et al. Male Sex and the Risk of Childhood Cancer: The Mediating Effect of Birth Defects. *JNCI Cancer Spectr*. 2020;4(5):pkaa052.
11. O'Neill KA, Murphy MF, Bunch KJ, Puumala SE, Carozza SE, Chow EJ, et al. Infant birthweight and risk of childhood cancer: international population-based case control studies of 40 000 cases. *Int J Epidemiol*. 2015;44(1):153-68.
12. Dunford A, Weinstock DM, Savova V, Schumacher SE, Cleary JP, Yoda A, et al. Tumor-suppressor genes that escape from X-inactivation contribute to cancer sex bias. *Nat Genet*. 2017;49(1):10-16.
13. Klein SL, Flanagan KL. Sex differences in immune responses. *Nat Rev Immunol*. 2016;16:626-38.
14. Amini M, Sharma R, Jani C. Gender differences in leukemia outcomes based on health care expenditures using estimates from the GLOBOCAN 2020. *Arch Public Health*. 2023;81(1):151.
15. Siegel DA, Li J, Henley SJ, Wilson RJ, Lunsford NB, Tai E, et al. Geographic Variation in Pediatric Cancer Incidence - United States, 2003-2014. *MMWR Morb Mortal Wkly Rep*. 2018;67(25):707-13.
16. Siegel DA, King JB, Lupo PJ, Durbin EB, Tai E, Mills K, et al. Counts, incidence rates, and trends of pediatric cancer in the United States, 2003-2019. *J Natl Cancer Inst*. 2023;115(11):1337-54.
17. Miranda-Filho A, Piñeros M, Ferlay J, Soerjomataram I, Monnereau A, Bray F. Epidemiological patterns of leukaemia in 184 countries: a population-based study. *Lancet Haematol*. 2018;5(1):e14-e24.
18. Chen J, Mullen CA. Patterns of Diagnosis and Misdiagnosis in Pediatric Cancer and Relationship to Survival. *J Pediatr Hematol Oncol*. 2017;39(3):e110-e15.
19. Gupta H, Malaichamy S, Mallipatna A, Murugan S, Jeyabalan N, Babu VS, et al. Retinoblastoma genetics screening and clinical management. *BMC Med Genomics*. 2021;14:188.
20. Mullen CJR, Barr RD, Franco EL. Timeliness of diagnosis and treatment: the challenge of childhood cancers. *Br J Cancer*. 2021;125(12):1612-20.
21. Arun ARK, Kumari BA, Ramachandra C, Vijay C R, Ramesh C, Apajji L, et al. National childhood cancer comprehensive management policy-a road map. *Onkol Radioter*. 2020;14(1):6-10.
22. Downing JR, Ghebreyesus TA. WHO Global Initiative for Childhood Cancer on the path to bridging the Survival Gap and attaining Universal Health Coverage: a 5-Year Review. WHO 2021.
23. Yang L, Yuan Y, Sun T, Li H, Wang N. Characteristics and trends in incidence of childhood cancer in Beijing, China, 2000-2009. *Chin J Cancer Res*. 2014;26(3):285-92.
24. Baade PD, Youlten DR, Valery PC, Hassall T, Ward L, Green AC, et al. Trends in incidence of childhood cancer in Australia, 1983-2006. *Br J Cancer*. 2010;102(3):620-6.
25. World Health Organization. Cancer Indones 2020 Country Profile. Available from: <https://www.who.int/publications/m/item/cancer-idn-2020>
26. Bhatnagar N, Qureshi A, Hall G. Leukaemias: a review. *PCH*. 2017;27(11):489-94.
27. Cui Y, Yan Y. The global burden of childhood and adolescent leukaemia and attributable risk factors: An analysis of the Global Burden of Disease Study 2019. *J Glob Health*. 2024;14:04045.
28. Stacey AW, Bowman R, Foster A, Kivelä TT, Munier FL, Cassoux N, et al. Incidence of Retinoblastoma Has Increased: Results from 40 European Countries. *Ophthalmology*. 2021;128(9):1369-71.
29. Global Retinoblastoma Study Group. The Global Retinoblastoma Outcome Study: a prospective, cluster-based analysis of 4064 patients from 149 countries. *Lancet Glob Health*. 2022;10(8):e1128-e40.
30. Ostrom QT, de Blank PM, Kruchko C, Petersen CM, Liao P, Finlay JL, et al. Alex's Lemonade Stand Foundation Infant and Childhood Primary Brain and Central Nervous System Tumors Diagnosed in the United States in 2007-2011. *Neuro Oncol*. 2015;16(Suppl 10):x1-x36.
31. Chang HY, Chiu CF, Jung SM, Wong AM, Wu CT, Lo FS. Neurological and endocrinological manifestations of 49 children with intracranial pure germinoma at initial diagnosis in Taiwan. *Pediatr Neonatol*. 2021;62(1):106-12.
32. Mbulaiteye SM, Devesa SS. Burkitt Lymphoma Incidence in Five Continents. *Hemato* 2022;3(3):434-53.
33. Ostrom QT, Cioffi G, Waite K, Kruchko C, Barnholtz-Sloan JS. CBTRUS Statistical Report: Primary Brain and Other Central Nervous System Tumors Diagnosed in the United States in 2014-2018. *Neuro Oncol*. 2021;23(12 Suppl 2):iii1-iii105.
34. Cunha KC, Oliveira MC, Gomes AC, de Castro LP, Viana MB. Clinical course and prognostic factors of children with Burkitt's lymphoma in a developing country: the experience of a single centre in Brazil. *Rev Bras Hematol Hemoter*. 2012;34(5):361-6.
35. Ngamdarmrongkiat P, Arromdee E, Vongwiwatana A, Owattanapanich W, Sukpanichnant S. Histopathological and Clinical Features of Methotrexate-Associated Lymphoproliferative

- Disorders and Post-Transplant Lymphoproliferative Disorders. *Siriraj Med J*. 2022;74(9):575-89.
36. Barbosa AC, de Magalhães-Barbosa MC, Moreira JPL, Colombini GNUI, Prata-Barbosa A. Incidence of retinoblastoma in children and adolescents in Brazil: A population-based study. *Front Pediatr*. 2022;10:1048792.
37. Hofmann, I. Pediatric myelodysplastic syndromes. *J Hematopathol*. 2015;8:127-41.
38. Skapek SX, Ferrari A, Gupta AA, Lupo PJ, Butler E, Shipley J, et al. Rhabdomyosarcoma. *Nat Rev Dis Primers*. 2019;5(1):1.
39. Tayfun KF, Akınel AN, Akbaş H, Sivrice Ç, Kintrup GT, Karagüzel G, et al. Multidisciplinary Management of Pediatric Hepatoblastoma: A 20-Year Single-Center Experience. *Turk J Gastroenterol*. 2022;33(12):1069-78.
40. Kahla JA, Siegel DA, Dai S, Lupo PJ, Foster JH, Scheurer ME, et al. Incidence and 5-year survival of children and adolescents with hepatoblastoma in the United States. *Pediatr Blood Cancer*. 2022;69(10):e29763.
41. Wang X, Feng J, Li Z, Zhang X, Chen J, Feng G. Characteristics and prognosis of embryonal rhabdomyosarcoma in children and adolescents: An analysis of 464 cases from the SEER database. *Pediatr Investig*. 2020;4(4):242-9.
42. Balmant NV, De Souza Reis R, De Oliveira Santos M, Maschietto M, Camargo B. Incidence and mortality of bone cancer among children, adolescents and young adults of Brazil. *Clinics*. 2019;74:e858.
43. Riza M, Salimo H, Wasita B, Idulhaq M, Saputra RD, Widyaningsih V, et al. Survival and prognostic factors in pediatric osteosarcoma: A 5-year single-center experience in Central Java, Indonesia. *Paediatr Indones*. 2024;64(1):10.
44. Doganis D, Panagopoulou P, Tragiannidis A, Georgakis MK, Moschovi M, Polychronopoulou S, et al. Childhood nephroblastoma in Southern and Eastern Europe and the US: Incidence variations and temporal trends by human development index. *Cancer Epidemiol*. 2018;54:75-81.
45. Farouk FS, Viqar OA, Sheikh Z, Castro G, Barengo NC. The Association between Race and Survival among Pediatric Patients with Neuroblastoma in the US between 1973 and 2015. *Int J Env Res Public Health*. 2020;17(14):5119.