BMC Pediatrics

RESEARCH

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Epidemiology and clinical features of childhood malignant solid tumors in a single center in southwest China over 24 years

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Abstract

Objective This study aims to analyze the epidemiological characteristics and clinical features of childhood malignant solid tumors in a single center in southwest China, thereby providing a reliable basis for formulating prevention and control strategies and rational allocation of resources for these tumors.

Methods Children less than 15 years old and under-diagnosed with malignant solid tumors for the first time at Children's Hospital of Chongqing Medical University (Children's Medical Center of Southwest China) from 2000 to 2023 were selected. They were classified according to the International Classification of Childhood Cancer, Third Edition (ICCC-3). A retrospective analysis was conducted on the disease spectrum composition and trends, distribution among different age groups and genders, and hospitalization characteristics of the patients.

Results Over 24 years, there were a total of 4,777 cases of initial diagnosis of childhood malignant solid tumors, with a male-to-female ratio of 1.33:1. The median age was 4 years old, with 12.6% in the 0-year-old group, 41.6% in the 1 to 4-year-old group, 27.3% in the 5 to 9-year-old group, and 18.5% in the 10 to 14-year-old group. The top 3 malignant solid tumors by incidence rate were central nervous system (CNS) tumors (21.8%), neuroblastoma (17.8%), and lymphoma (13.9%). The ratio of pediatric malignant solid tumor patients to total hospital admissions rose from 0.14% in 2000 to 0.52% in 2021 but showed a declining trend after 2021. Childhood malignant solid tumors were primarily diagnosed due to the discovery of mass/occupancy (34.9%), abdominal pain/bloating (21.1%), or fever (6.3%). 74.4% of neuroblastomas and 54.7% of nephroblastomas were diagnosed at an advanced stage. 84.4% of patients underwent surgery, and 71.9% received chemotherapy, with chemotherapy rates showing an upward trend.

Conclusions This study provides reliable information on the incidence characteristics and trends of childhood malignant solid tumors.

Keywords Malignant solid tumors, Children, Epidemiology, Clinical characteristics, Temporal trends

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Background

Malignant tumors continue to be a leading cause of mortality in children, despite notable improvements in survival rates over recent decades. However, the incidence of childhood malignant tumors has been steadily increasing [1–3]. Understanding the epidemiological characteristics of childhood malignant tumors is crucial for identifying trends and advancements in prevention and treatment. Yet, due to the diversity and rarity of cases,

epidemiological reports are scarce in this field, especially in developing countries lacking well-established childhood cancer registration systems [4]. Population-based cancer registries often overlook childhood cases and focus only on basic patient information, omitting detailed treatment and prognosis data. In contrast, hospital-based registries also record diagnostic and treatment details, essential for evaluating current treatment practices and supporting clinical research [5]. Globally, most regions have established hospital-based registries for childhood tumors. In China, the National Center for Pediatric Cancer Surveillance (NCPCS) was founded in June 2019, providing comprehensive data on incidence, mortality, survival rates, diagnostic methods, treatment efficacy, adverse reactions, and survival outcomes. These data aid in understanding the disease burden and trends of childhood cancer in China and guide the allocation of medical resources such as personnel, hospital beds, and facilities [5]. Malignant solid tumors account for approximately 60% of all childhood cancers [6, 7]. They are characterized by insidious onset, rapid growth, and early metastasis, significantly impacting children's development, and quality of life, and imposing burdens on families and society. There is limited reporting on the incidence characteristics and trends of childhood malignant solid tumors in China, necessitating large-scale, long-term research data. Therefore, this study retrospectively analyzes hospital records of children aged 0–14 with malignant solid tumors at Children's Hospital of Chongqing Medical University (Children's Medical Center of Southwest China) from 2000 to 2023. The study aims to explore epidemiological characteristics, clinical features, and trends of childhood malignant solid tumors, providing scientific data to support their prevention and treatment.

Methods

Patients

We selected hospitalized children at the Children's Hospital of Chongqing Medical University who were diagnosed with malignant solid tumors (including lymphoma and non-malignant CNS tumors) between 2000 and 2023. Inclusion criteria included age less than 15 years, diagnosis confirmed through pathological biopsy or clinical evaluation, and primary malignant solid tumor. Exclusion criteria included recurrent or metastatic malignant solid tumors. 97% of the tumors were morphologically verified (MV), indicating good data quality [8–11]. All patients received institution-based treatment protocols adapted by our multidisciplinary team from American or European guidelines. Due to limitations in medical equipment at our institution, radiation therapy has not yet been implemented. Children requiring radiation therapy receive treatment at other hospitals, thus we lack data in this regard. Demographic and clinical characteristics are extracted from anonymized electronic medical records without collecting identifying information.

Research subgroups

We conducted a retrospective study to analyze the medical records of hospitalized children with malignant solid tumors. Tumors were classified into 11 categories according to the International Classification of Childhood Cancer, Third Edition (ICCC-3), corresponding to classes II-XII [12]. Children were divided into four age groups: 0 years, 1–4 years, 5–9 years, and 10–14 years. The study period was categorized into four phases: 2000–2005, 2006–2011, 2012–2017, and 2018–2023. Neuroblastoma were staged using the International Neuroblastoma Staging System (INSS) [13], and Wilms tumors (nephroblastoma) were staged using the National Wilms Tumor Study Group (NWTSG) staging system [14]. Due to significant missing medical records before 2011, we only included staging data for neuroblastomas and nephroblastomas from 2011 onward.

Statistical analysis

Statistical analysis utilized SPSS 25.0 software, describing counts with rates or percentages and testing group differences with $\chi 2$ test or Fisher's exact test. A significance level of $P < 0.05$ was applied for all tests.

Results

General characteristics

From 2000 to 2023, a total of 4777 children were diagnosed with malignant solid tumors. Among them, 2726 were males (57.1%) and 2051 were females (42.9%). The median age of the children was 4 years, with 12.6% in the 0-year-old group, 41.6% in the 1–4 years old group, 27.3% in the 5–9 years old group, and 18.5% in the 10–14 years old group. Of the patients, 4,358 (91.2%) were Han Chinese, and 419 (8.8%) were from ethnic minorities. Among the patients, 3,043 (63.7%) were from rural areas, and 1,734 (36.3%) were from urban areas, with a rural-to-urban ratio of 1.75:1. Regarding regional distribution, nearly half of the children were from Chongqing municipality, amounting to 2220 cases (46.5%). Other major regions included Sichuan Province (1540 cases, 32.2%), Guizhou Province (726 cases, 15.2%), and Yunnan Province (126 cases, 2.6%). Refer to Table 1 and Fig. 1 for details.

Prevalence

Among children aged 0–14 years with malignant solid tumors, CNS tumors were the most common, totaling 1040 cases, accounting for 21.8%. Neuroblastoma ranked second (851 cases, 17.8%), followed by lymphomas (663

Table 1 Baseline characteristics and treatments ($n=4777$)

Variable	Cases (%)
Gender	
Male	2726 (57.1)
Female	2051 (42.9)
Age (years)	
Mean ± SD	4.98 ± 4.099
Median	4.0
Range	0–14
0	604 (12.6)
1–4	1988 (41.6)
5–9	1303 (27.3)
10–14	882 (18.5)
Nation	
Han	4358 (91.2)
Minority	419 (8.8)
Urban and rural	
Urban	1734 (36.3)
Rural	3043 (63.7)
Province	
Chongqing	2220 (46.5)
Sichuan	1540 (32.2)
Guizhou	726 (15.2)
Yunnan	126 (2.6)
Other	165 (3.5)
Surgery	
Yes	4032 (84.4)
No	745 (15.6)
Chemotherapy	
Yes	3433 (71.9)
No	1191 (24.9)
Unknown	153 (3.2)

Abbreviation: SD Standard deviation

cases, 13.9%), germ cell tumors (593 cases, 12.4%), renal tumors (528 cases, 11.1%), soft tissue sarcomas (461 cases, 9.7%), hepatic tumors (254 cases, 5.3%), malignant bone tumors (191 cases, 4.0%), other malignant epithelial neoplasms (108 cases, 2.3%), retinoblastomas (44 cases, 0.9%), and other malignant neoplasms (44 cases, 0.9%). See Additional file 1 and Fig. 2 for details. Among these, the neuroblastoma group included 4 cases of malignant ganglioneuroblastoma. Nephroblastoma accounted for 73.9% of renal tumors, while hepatoblastoma predominated in hepatic tumors, accounting for 89.0%.

Among male children, the top 5 malignant solid tumors were CNS tumors (22.0%), lymphomas (17.5%), neuroblastomas (17.2%), germ cell tumors (11.7%), and renal malignancies (10.2%), while the top 5 malignant solid tumors among female children were CNS tumors (21.5%), neuroblastomas (18.6%), germ cell tumors (13.4%), renal tumors (12.2%), and lymphomas (9.1%). The composition of malignant solid tumors varied significantly between male and female children, as indicated by statistical analysis ($\chi 2=80.67$, $p<0.001$). Specifically, the composition of lymphoma was higher among male children compared to female children, with a statistically significant difference ($P<0.001$). In contrast, the composition of renal malignant tumors, soft tissue sarcoma, other malignant epithelial neoplasms, and other malignant neoplasms was higher among female children than male children, with statistically significant differences ($P<0.05$). The gender distribution of different malignant solid tumors varied. Most malignant solid tumors exhibited a higher prevalence in males than females, particularly lymphomas, which had a male-to-female ratio of 2.55. Retinoblastomas exhibited an equal distribution between genders, while other malignant epithelial neoplasms and other malignant neoplasms were more prevalent in females than males (Additional file 1 and Fig. 3).

In the 0-year-old group, the top three malignant solid tumors were neuroblastoma (32.1%), germ cell tumor (18.9%), and renal malignant tumor (15.9%); in the 1–4-year-old group, they were neuroblastoma (25.0%), CNS tumor (19.3%), and renal malignant tumor (16.0%); for the 5–9 years age group, they were CNS tumor (29.3%), lymphoma (23.0%), and neuroblastoma (10.6%); and in the 10–14-year-old group, they were CNS tumor (24.5%), lymphoma (20.3%), and germ cell tumor (18.1%). The composition of malignant solid tumors varies significantly across different age groups ($P<0.001$). The incidence of different malignant solid tumors also varies with age. Neuroblastomas, retinoblastomas, renal tumors, hepatic tumors, and soft tissue sarcomas peak during the 0–4 years age group and decline thereafter. In contrast, malignant bone tumors and other malignant epithelial neoplasms increase in incidence with age, peaking at 10–14 years. The study also identifies two peaks for germ cell tumors: one at 0 years and another at 10–14 years, while lymphomas and CNS tumors predominate in the 5–9 years age group (Additional file 1 and Fig. 4).

Temporal trends

The number of newly diagnosed cases of malignant solid tumors in children rose from 25 cases in 2000 to 513 cases in 2023, representing a remarkable annual growth rate of 84.9%. The ratio of pediatric malignant solid tumor cases to total hospital admissions exhibited an upward trend from 2000 to 2021, followed by a decline from 2021 to 2023 (Table 2 and Fig. 5).

From 2000 to 2005, the top three malignant solid tumors were CNS tumors (28.6%), renal tumors (21.1%),

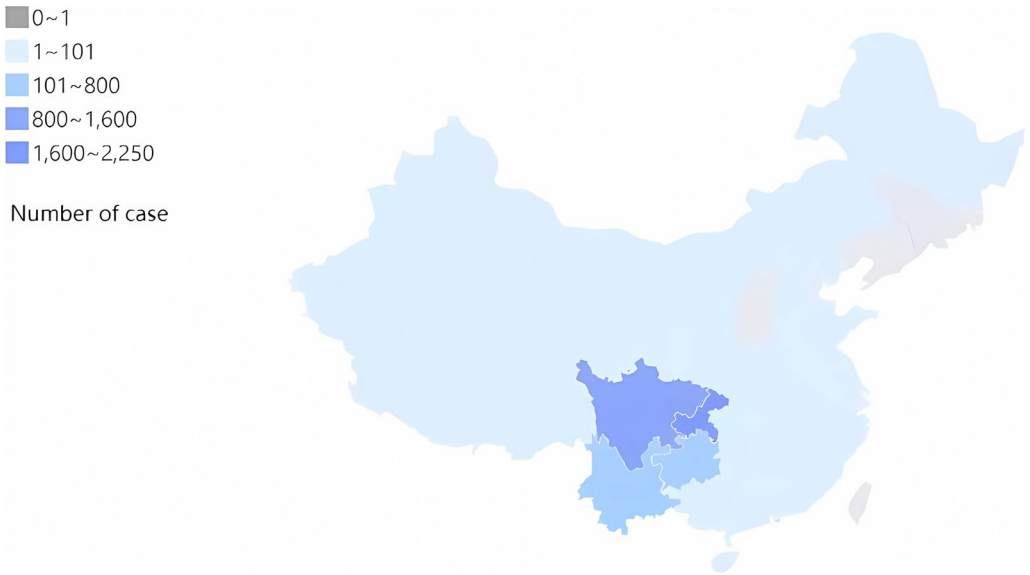

Fig. 1 Regional distribution of childhood malignant solid tumors, 2000–2023

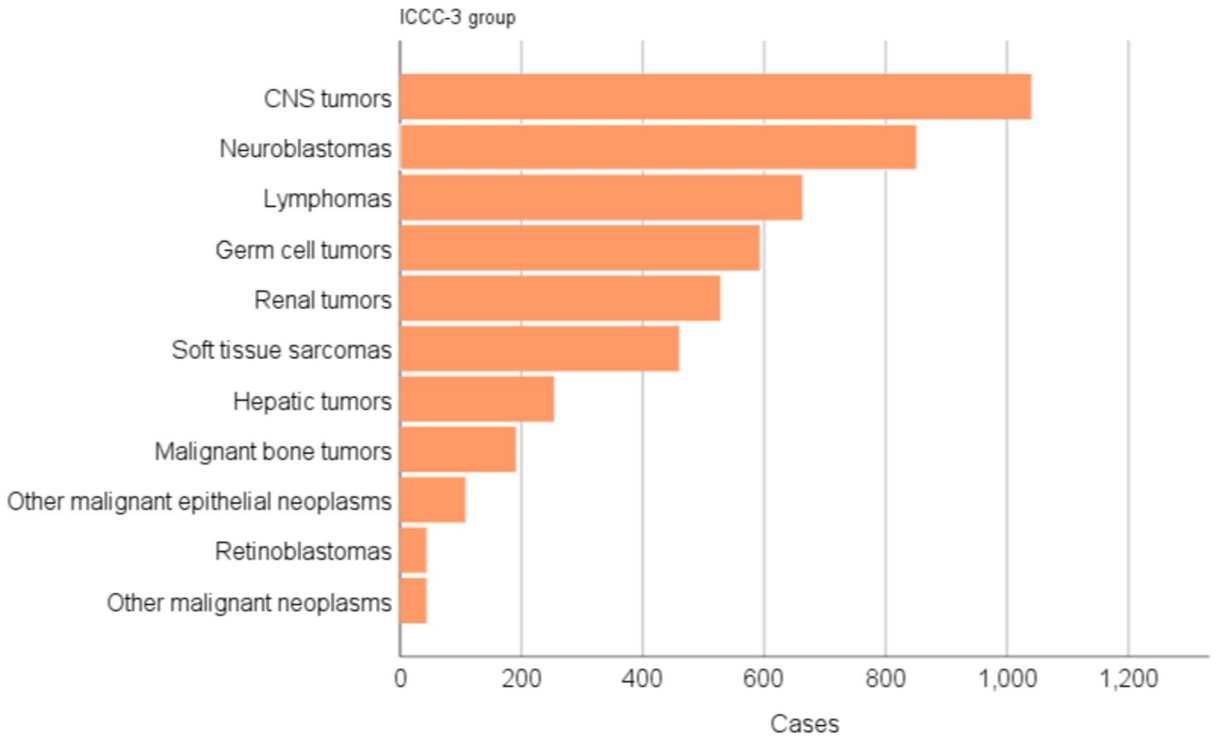

Fig. 2 Number of cases in main diagnosis group of childhood malignant solid tumors, 2000–2023. ICCC-3: International Classification of Childhood Cancer, Third Edition [12]; CNS: Central nervous system

and germ cell tumors (15.0%); from 2006 to 2011, they were CNS tumors (20.9%), renal tumors (20.5%), and neuroblastoma (19.2%); from 2012 to 2017, they were neuroblastoma (20.4%), lymphoma (18.0%), and renal tumors (12.8%); and from 2018 to 2023, they were CNS tumors (25.7%), neuroblastoma (17.1%), and lymphoma (13.7%). The composition of pediatric malignant solid tumors varies over time, and these differences are statistically significant ($\chi^2 = 272.66$, $P < 0.001$). Lymphoma, neuroblastoma, hepatic tumors, and malignant bone

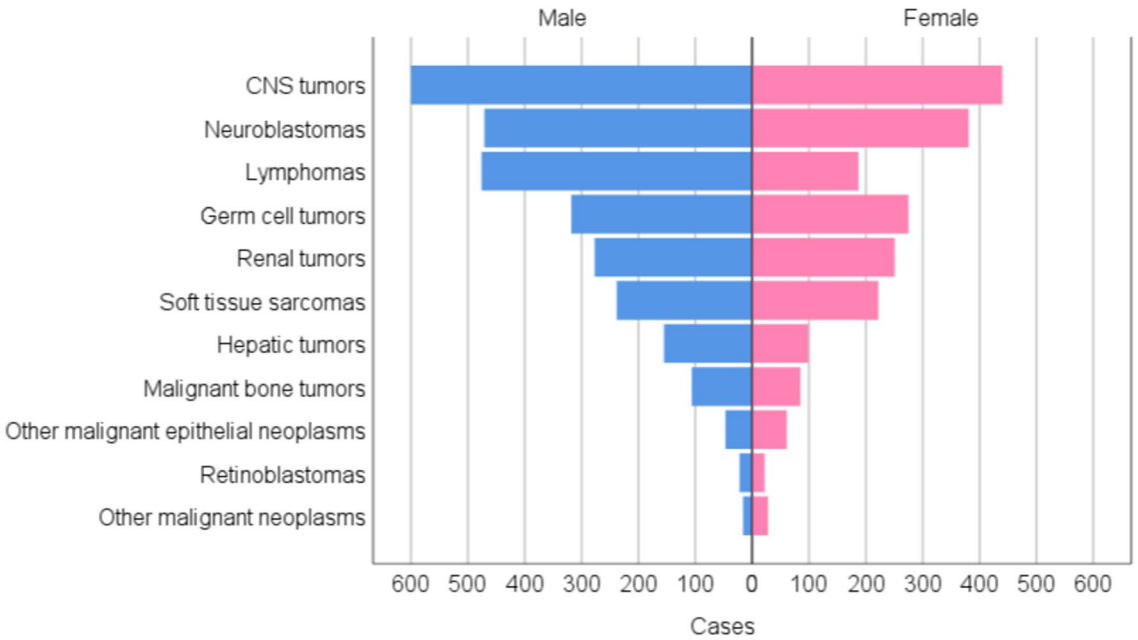

Fig. 3 Number of cases in the main diagnosis group of childhood solid malignancies, 2000–2023, by sex. CNS: Central nervous system

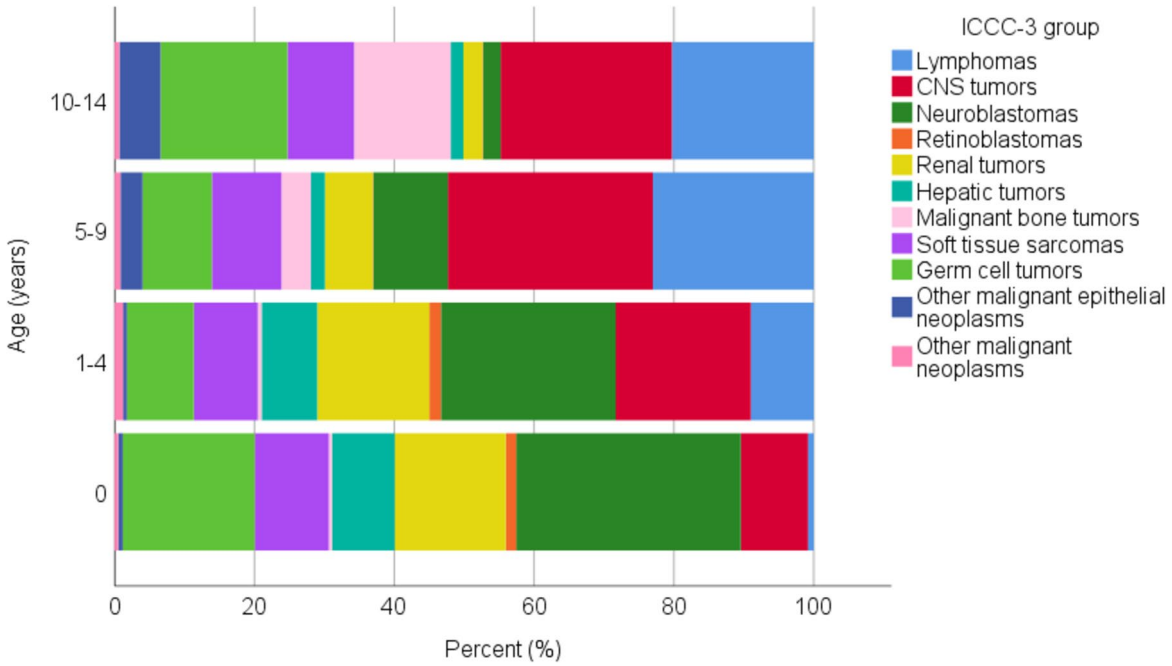

Fig. 4 Percentage of main diagnosis group of childhood malignant solid tumors, 2000–2023, by age. ICCC-3: International Classification of Childhood Cancer, Third Edition; CNS: Central nervous system

tumors show an increasing trend, with statistically significant differences, while CNS tumors, retinoblastoma, and renal tumors show a decreasing trend, also with statistically significant differences (Additional file 2).

The gender distribution of malignant solid tumors did not show significant changes ($P > 0.05$). The proportion of children aged 0 years decreased from 15.4% in the period from 2000 to 2005 to 10.7% in the period from 2018 to 2023, and the proportion of children aged

Table 2 Trends in hospitalizations of childhood malignant solid tumors, 2000–2023

Year	Total hospital admissions (A)	Malignant solid tumor cases (B)	B/A (%)
2000	18421	25	0.14
2001	18726	25	0.13
2002	21831	42	0.19
2003	23021	38	0.17
2004	26187	45	0.17
2005	29170	52	0.18
2006	33890	45	0.13
2007	38915	43	0.11
2008	41862	85	0.20
2009	46160	70	0.15
2010	52072	102	0.20
2011	53403	119	0.22
2012	54960	160	0.29
2013	59147	167	0.28
2014	65483	206	0.31
2015	67844	223	0.33
2016	75506	265	0.35
2017	79699	300	0.38
2018	88645	382	0.43
2019	95252	428	0.45
2020	81990	409	0.50
2021	102226	531	0.52
2022	99276	502	0.51
2023	113968	513	0.45

1–4 years decreased from 46.7% to 38.0%, indicating a declining trend in both age groups. In contrast, the proportion of children aged 5–9 years increased from 26.0% in the period from 2000 to 2005 to 29.9% in the period from 2018 to 2023, and the proportion of children aged 10–14 years increased from 11.9% to 21.4%, demonstrating an upward trend in both age groups. The age distribution of children with malignant solid tumors varies significantly across different periods, and these differences are statistically significant ($P<0.001$), as depicted in Additional file 2.

Clinical characteristic

Excluding CNS tumors, the four most common types of malignant solid tumors in children are neuroblastoma, lymphoma, germ cell tumors, and renal tumors, totaling 2635 cases. The most frequent initial symptoms among children with these malignancies include mass/occupancy, which accounts for 919 cases (34.9%), followed by abdominal pain/bloating (556 cases, 21.1%), fever (167 cases, 6.3%), cough (149 cases, 5.7%), physical examination findings (132 cases, 5.0%), hematuria/proteinuria (109 cases, 4.1%), dizziness/headache (79 cases, 3.0%), poor appetite (47 cases, 1.8%), limb pain (44 cases, 1.7%), nausea/vomiting (40 cases, 1.5%), and chest tightness/chest pain (28 cases, 1.1%). Among lymphoma patients, mass/occupancy and abdominal pain/bloating are the most prevalent symptoms (440 cases, 66.4%). Neuroblastoma patients commonly presented with abdominal pain//bloating, mass/occupancy, and fever (478 cases, 56.2%). Renal malignant tumor patients typically exhibited mass/occupancy, abdominal pain/bloating, and hematuria/proteinuria (440 cases, 83.4%). Germ cell tumor patients commonly displayed mass/occupancy, abdominal pain/bloating, and dizziness/headache, totaling 61.3% (Additional file 3). From 2011 to 2023, 568 cases of neuroblastoma were diagnosed at advanced stages (Stages III + IV), comprising 74.7% of cases. Wilms tumors presented advanced stages (Stages III + IV + V) in 158 cases, accounting for 54.7% (Additional file 4). The majority of pediatric malignant solid tumors were managed through a combination of treatment modalities, with 4,032 cases (84.4%) undergoing surgery and 3,433 cases (71.9%) undergoing chemotherapy (Table 1). Radiotherapy has not yet been implemented. The rate of surgery showed variation over time without statistical significance ($P>0.05$), while the rate of chemotherapy demonstrated significant variation, increasing from 47.6% in 2000–2005 to 74.3% in 2018–2023 ($P<0.001$), as depicted in Additional file 2.

Discussion

From 2000 to 2023, our center treated a total of 4,777 cases of newly diagnosed malignant solid tumors in children, with a male-to-female ratio of 1.33:1. According to a large-sample study based on NCPCS, the National Hospital Quality Monitoring System, and public databases, the incidence of malignant solid tumors among Chinese children from 2018 to 2020 was 87.22 per million for males and 72.99 per million for females, resulting in a male-to-female ratio of 1.19 [10]. Data from CHINA, 6 registries (Beijing, Dalian, Guangzhou, Hong Kong, Shanghai, and Zhongshan) in Volume 3 of the International Incidence of Childhood Cancer (IICC) also indicate a higher incidence rate in males compared to females [15], as shown in Additional file 1. However, compared with lower- and middle-income countries such as Singapore (1.46), Egypt (1.48), Uganda (1.49), India (1.57), Pakistan (1.58), Zimbabwe (1.60), Chile (1.71), and Bahrain (1.84) [16], gender bias in the diagnosis and treatment of childhood malignant solid tumors is not as pronounced in our region. Significant variations existed in the spectrum of malignant solid tumors between genders. This study shows that lymphomas constituted a

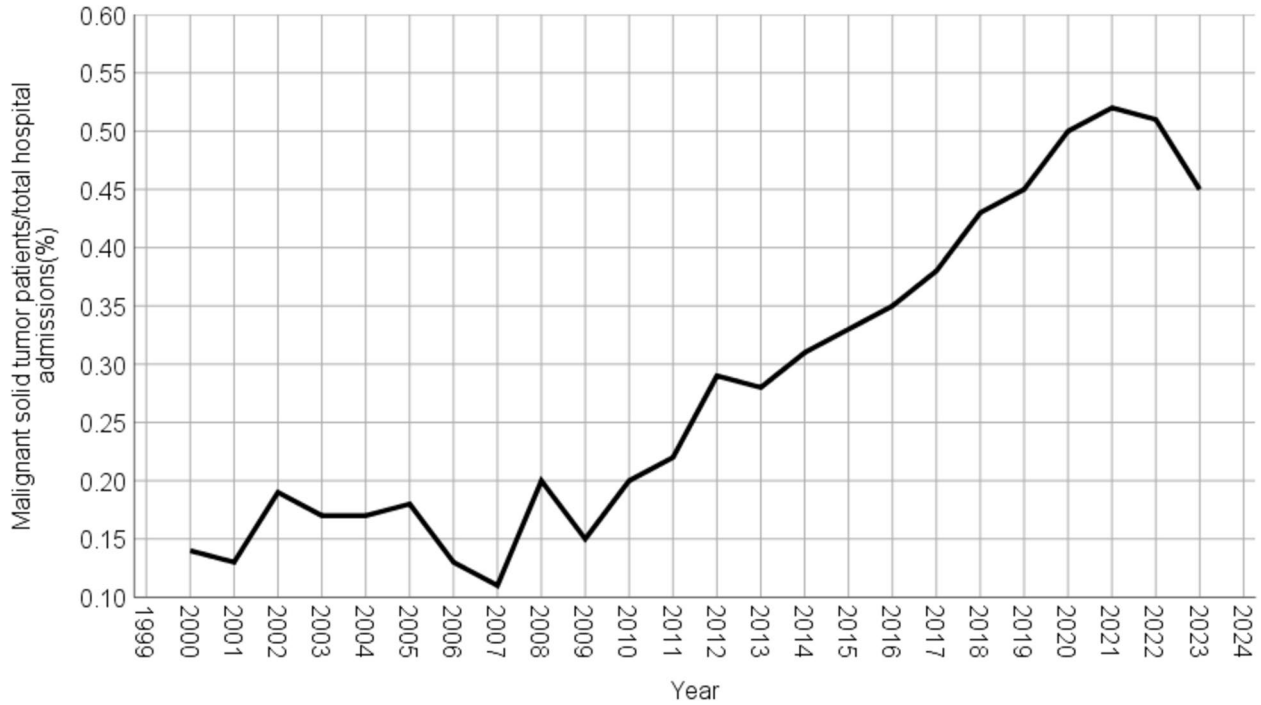

Fig. 5 Trends of hospitalization of childhood malignant solid tumors, 2000–2023

higher proportion among male children compared to female children, while renal tumors, soft tissue sarcomas, other malignant epithelial neoplasms, and other malignant neoplasms constituted a higher proportion among female children, which was similar to the findings of Kexin Sun et al. [7]. The gender distribution of different types of malignant solid tumors also varied. Most malignant solid tumors showed a higher incidence in males, particularly lymphomas, which exhibit a male-to-female ratio of 2.55. Retinoblastomas demonstrate an equal distribution between genders, whereas other malignant epithelial neoplasms (0.77) and other malignant neoplasms (0.57) were more prevalent in females. NCPCS data underscored that among the Chinese population under 15 years old, the incidence rate of lymphomas in males was 1.89 times higher than in females, while other malignant epithelial neoplasms were predominantly found in females, with a male-to-female ratio of 0.72 [10]. Additionally, data from the Swiss Childhood Cancer Registry [17] show that between 2005 and 2014, the incidence rates of lymphoma (1.77) and hepatic tumors (1.67) in children aged 0–14 were significantly higher in males than in females. A study from Thailand indicates that the incidence rates of pediatric germ cell tumors (0.44) and other malignant epithelial neoplasms (0.73) are higher in females than in males [11]. Our study was generally consistent with domestic and international research results, but there was a significant difference in the incidence rate ratio between males and females. Although the phenomenon of higher incidence rates among males in childhood cancer has been widely recognized, the underlying biological mechanisms remain unclear. A study based on the Surveillance, Epidemiology, and End Results (SEER) database suggested that the consistently higher incidence rates observed in males during childhood and adolescence suggest that hormonal fluctuations may not be the primary cause of gender differences in childhood cancer [18]. These variations likely stem from differences in exposure to environmental risk factors, genetic predispositions, or immune responses. Global cancer data [19] underscored that these gender differences were more pronounced in developing countries, possibly reflecting unequal access to healthcare services for females in those regions. Moreover, limited childhood exposure to environmental risk factors suggests that endogenous factors may primarily drive these disparities, warranting further investigation.

Our study identified that the peak incidence of childhood malignant solid tumors is between 0 and 4 years of age, aligning with existing research findings. Data from the China Cancer Registry [7] indicated that the incidence rates of malignant solid tumors per million children are 91.84 for infants, 64.05 for ages 1–4 years, 42.88 for ages 5–9 years, and 53.66 for ages 10–14 years. Notably, in our study, the proportion of pediatric patients in the 10–14 years group is relatively low. This may be

because, during the study period, some older pediatric patients sought treatment at adult hospitals. The types of malignant solid tumors prevalent in children of different ages vary, especially with significant differences in the disease spectrum between infants and older children. This study demonstrated that in the 0-year age group, neuroblastoma was the predominant malignancy(32.1%), followed by germ cell tumors (18.9%), renal tumors (15.9%), and soft tissue sarcomas (10.6%). In a 22-year epidemiological study conducted at the Istanbul University Oncology Institute in Turkey, the most common tumors in infants were retinoblastoma (31.6%), neuroblastoma (17.6%), and soft tissue sarcoma (14%) [20]. A multicenter retrospective study in Beijing [21] observed that during infancy, tumors of embryonic origin, including retinoblastoma (39.0%), neuroblastoma (28.4%), and hepatoblastoma (14.2%), are prevalent. Research by Haijun Wang et al. [22] indicated that between 1975 and 2014, the most frequent malignant solid tumors among American infants were neuroblastoma (63 per million), CNS tumors (32 per million), and retinoblastoma (27 per million). In comparison, retinoblastoma and hepatoblastoma were less common in our center. Additionally, our study revealed that embryonal tumors such as neuroblastoma, retinoblastoma, nephroblastoma, and hepatoblastoma were typically more prevalent in the 0–4 years age group, with incidence rates decreasing markedly with age. Conversely, the incidence rates of malignant bone tumors and other malignant epithelial neoplasms increased with age, reaching a peak at 10–14 years, consistent with prior research findings [11, 17, 23–25].

Varying compositions of childhood malignant solid tumors differ among different countries and regions. Literature reports [10, 17, 23–27] indicated that the top five childhood malignant solid tumors varied across different countries and regions: in Switzerland, they were CNS tumors, lymphomas, neuroblastomas, soft tissue sarcomas, and renal tumors; in England, they were CNS tumors, lymphomas, neuroblastomas, renal tumors, and soft tissue sarcomas; in Korea, they were CNS tumors, lymphomas, neuroblastomas, soft tissue sarcomas, and malignant bone tumors; in China, based on data from various regions, the top five childhood malignant solid tumors nationwide were CNS tumors, lymphomas, other malignant tumors, neuroblastomas, and germ cell tumors; in CHINA, 6 registries and Taiwan, they were CNS tumors, lymphomas, germ cell tumors, neuroblastomas, and soft tissue sarcomas; At our center, CNS tumors, neuroblastomas, lymphomas, germ cell tumors, and renal tumors constituted the top five childhood malignant solid tumors. A notable difference compared to Switzerland, the UK, and Korea is the higher incidence of germ cell tumors at our center. Additionally, the number of neuroblastoma is higher at our center compared to other regions in China. This may be due to our center being a referral center for germ cell tumors and neuroblastoma, and may also be related to factors like local geography, dietary patterns, and genetic predisposition, necessitating further investigation.

The analysis in this report shows that the proportion of childhood malignant solid tumors has generally increased from 2000 to 2021, which is consistent with the findings of most studies [7, 17, 23, 26, 28]. However, our study uses the ratio of childhood malignant solid tumor cases to the total number of hospital admissions to roughly analyze the trend in incidence. Therefore, the observed increase in incidence may be related not only to an increase in the actual incidence rate but also to changes in the disease spectrum specific to the hospital. The exact reasons for the increase in incidence remain unclear. One study pointed out that Turkey's national health care reform increased the diagnostic rate of localized/low-risk stage childhood cancers while also improving the survival of non-Hodgkin lymphoma, neuroblastoma, and renal tumors. This was attributed to children being able to access free healthcare services, increased public awareness of cancer, and improvements in diagnosis, treatment, and care [20]. We believe the increase in the incidence of childhood malignant solid tumors may be related to factors such as socioeconomic development, improvements in the healthcare system, advancements in diagnostic technologies, higher parental education levels, and increased environmental risk factors. After 2021, the proportion of childhood malignant solid tumors decreased which may be related to delays in case reporting and should not be over-interpreted. Future data can be added to continue the analysis. From 2000 to 2023, the proportions of lymphoma, neuroblastoma, hepatic malignancies, and malignant bone tumors have shown an increasing trend, while the proportions of CNS, retinoblastoma, and renal tumors have decreased. This may be related to changes in environmental risk factors and genetic susceptibility. This study also found a decreasing trend in the proportion of children aged 0–4 years, while the proportion of children aged 5–14 years increased. This may be due to the increasing number of older children being referred to our center.

Currently, there is limited overall statistical data on the symptoms of childhood malignant solid tumors. Previous studies have often focused on a single type of tumor or had small sample sizes. Our study found that the initial symptoms of childhood malignant solid tumors are typically nonspecific, with mass/occupancy (34.9%) and abdominal pain/bloating (21.1%) being the most common. 10.5% of neuroblastoma cases were detected through routine physical examinations, which

is associated with the tumor's frequent occurrence in infancy and early childhood. Maternal prenatal care and pediatric health check-ups are crucial for early diagnosis. Hematuria and proteinuria are relatively specific presentations of renal tumors, with approximately one-third of Wilms tumor patients experiencing visible or microscopic hematuria, as demonstrated in previous research [29]. Germ cell tumors present with diverse initial symptoms, including polydipsia/polyuria, difficulty in defecation, vaginal bleeding, and diarrhea. It has been suggested that, except for neuroblastoma, which can be screened for through urinary testing of homovanillic acid and vanillylmandelic acid, early diagnosis of childhood cancers depends on recognizing signs and symptoms [30]. Therefore, families should increase awareness of pediatric health care and enhance the frequency of physical examinations, especially when children present symptoms such as mass/ occupancy, abdominal pain/ bloating, or fever, prompting timely medical attention. Additionally, healthcare providers should have a thorough understanding of symptoms indicative of tumor risks, enabling early identification of pediatric malignant solid tumor patients through medical history collection and physical examinations, followed by prompt referrals. Childhood malignant solid tumors are characterized by insidious onset, strong invasiveness, and rapid progression, with a limited current understanding of the etiology of most childhood malignant solid tumors, underscoring the critical importance of timely diagnosis and treatment. Our study analyzed data from 2011 to 2023, revealing that 74.7% of neuroblastoma cases and 54.7% of nephroblastoma cases were diagnosed at advanced stage. Compared to Europe and America [31, 32], the proportion of advanced neuroblastoma and nephroblastoma treated at our center is relatively high. This may be due to a greater number of advanced cancer cases being referred from primary healthcare hospitals to our institution. Therefore, urgent strategic emphasis is needed on improving the accessibility of early diagnosis and healthcare services to effectively reduce the burden of childhood cancer. Regarding treatment, comprehensive treatment strategies for childhood malignant solid tumors typically involve surgery combined with chemotherapy and radiotherapy. In our study, 84.4% of patients underwent surgical treatment, and 71.9% received chemotherapy; radiotherapy was not implemented. Additionally, the study observed an upward trend in the chemotherapy rate for childhood malignant solid tumors at our institution over the past 24 years. This may be attributed to increased family income and improved awareness of childhood malignant tumors, leading to fewer cases of treatment abandonment or simple refusal of chemotherapy.

There are limitations to the study. Firstly, Although the Children's Hospital of Chongqing Medical University is the largest pediatric oncology center in Southwest China, the childhood malignant solid tumors included in this study are based on a single hospital registry, and we are currently unable to obtain population data to calculate the incidence rate. We are working to collaborate with other pediatric oncology centers in Southwest China to conduct a multi-center pediatric oncology epidemiological study. Secondly, this study lacks information on radiation therapy for the patients, and thus cannot provide a comprehensive analysis of the treatment of childhood malignant solid tumors. We are working on establishing collaborations with other oncology institutions, and our hospital is also actively initiating radiation therapy.

Conclusions

Understanding the epidemiological characteristics and trends of childhood malignant solid tumors is crucial for exploring their etiologies and developing prevention and treatment strategies, which are particularly important for improving the prognosis of affected children. This study focuses on the comprehensive distribution of childhood malignant solid tumors, conducting a retrospective analysis of the incidence characteristics and trends of treated solid tumors in our hospital over the past 24 years. It adds to the epidemiological data in this field and provides a reference for disease prevention and control.

Future research on the epidemiology of childhood malignant solid tumors will focus on international cooperation, standardizing information registration, and sharing data, particularly in standardizing the registration and treatment processes for tumors in low- and middle-income countries, aiming to provide high-quality epidemiological data for early diagnosis and treatment, improving cure rates and prognosis for childhood malignant solid tumors.

Abbreviations

ICCC-3	International Classification of Childhood Cancer, Third Edition
CNS	Central nervous system
NCPCS	National Center for Pediatric Cancer Surveillance
MV	Morphological verification
INSS	International Neuroblastoma Staging System
NWTSG	National Wilms Tumor Study Group
IICC	International Incidence of Childhood Cancer
SEER	Surveillance, Epidemiology, and End Results
APC	Annual percentage change

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-024-05360-3.

Additional file 1. Comparison of Childhood Malignant Solid Tumors in CHCMU and CHINA, 6 registries.

Additional file 2. Trends in the epidemiology and clinical characteristics of childhood malignant solid tumors, 2000-2023.

Additional file 3. The first symptoms of 4 common childhood malignant solid tumors, 2000-2023.

Additional file 4. Staging of 2 common childhood malignant solid tumors, 2011-2023.

Acknowledgements
Not applicable.

Authors' contributions
TL and DH designed the study; TL and XK collected and analyzed the data; TL drafted the initial manuscript; XK and DH revised the article critically. All authors read and approved the final manuscript.

Funding
Not applicable.

Data availability
All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Declarations

Ethics approval and consent to participate
This study obtained approval from the Ethics Committee of the Children's Hospital of Chongqing Medical University under the reference number [(2024) Ethics Review (Research) No. 172]. Informed consent was waived by the Institutional Review Boards because all data was collected anonymously.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 18 August 2024 Accepted: 23 December 2024
Published online: 07 January 2025

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