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Article

## Analysis of Mortality Factors in the Pediatric Hemato-Oncology Department of the Children's Hospital of Rabat, 2022-2023

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# Colorectal Cancer in Latin America: Quick Comment

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## ABSTRACT

**Background:** Morocco was selected as a pilot site for the WHO launched the Global Initiative for Childhood Cancer GICC and a childhood cancer control strategy was set up to reduce mortality and the 2030 survival target was set at 80%.

**Objective:** This study analyzes the mortality causes for children treated at the Pediatric Hemato-Oncology Center in Rabat.

**Methodology:** We included all cancer patients admitted for cancer and who died over the period from January 1st, 2022, to December 31, 2023. A descriptive analysis was performed on the causes and circumstances of death, the epidemiological and clinical characteristics of the patients.

**Results:** During the study period, 429 pediatric patients with cancer were admitted to the Pediatric Hematology-Oncology Department of Rabat. Leukemias were the most common malignancies, accounting for 119 cases.

Over the same period, 51 deaths were recorded, including 24 in 2022 and 27 in 2023 corresponding to an overall mortality rate of 12% among admitted patients. The primary cause of death was tumor progression (61%), followed by treatment-related toxicity (31%). 45% of deaths occurred over the weekend, on public holidays, and on Mondays. October accounted for 18% of deaths. Urban patients appeared to have a higher mortality rate than rural patients. The majority of deaths (29%) occurred within the first month following diagnosis. The

most commonly reported cancer was leukemia (25.5%), followed by lymphomas (19.6%) and neuroblastomas (17.6%). The sex ratio favored males, with a ratio of 1.22. The median survival time after diagnosis was estimated at approximately 8 months, with a range from 1 to 36 months.

**Conclusion:** The study highlighted that deaths were mainly associated with tumor progression followed by treatment-related toxicity (31%). These results suggest that the causes are likely linked to patients presenting at advanced disease stages, underscoring the importance of early diagnosis. This study serves as a crucial starting point for improving clinical practices, enhancing patient stratification, and better managing treatment toxicity to achieve the country's 2030 objective.

## INTRODUCTION

Childhood cancers represent a major public health issue and are among the leading causes of child mortality worldwide. Despite their relative rarity, their impact in terms of morbidity and mortality remains considerable. Over the past decades, significant progress has been made in the diagnosis and management of pediatric cancers, notably through the optimization of chemotherapy protocols, advances in bone marrow transplantation, and the development of targeted therapies. These improvements have led to a substantial increase in survival rates, particularly for certain diseases such as acute lymphoblastic leukemia and brain tumors<sup>1,2,3</sup>.

Marked disparities exist between countries. In many

resource-limited regions, access to care remains restricted, often resulting in late diagnoses due to insufficient infrastructure, a shortage of qualified healthcare professionals, and limited access to recent treatments<sup>4</sup>. To address this situation, the WHO launched the Global Initiative for Childhood Cancer in 2018. This program aims to support governments in reaching a survival rate of at least 60% by 2030, which would allow nearly one million children to be saved over ten years<sup>5</sup>.

In Morocco, data on cancer incidence and survival rates remain fragmented, reflecting the need for improved epidemiological collection. The absence of national registries complicates resource planning and the development of management strategies. Morocco was selected as a pilot site for the WHO Global Initiative for Childhood Cancer. A retrospective study conducted between 2022 and 2023, titled "Implementing the WHO Global Initiative for Childhood Cancer in Morocco: Survival study for the six indexed childhood cancers," showed a 10% increase in the five-year survival rate, rising from 45% to 55%. However, early mortality and regional disparities in access to care continue to limit treatment effectiveness<sup>6</sup>.

In the aftermath of this study, a national strategic plan dedicated to pediatric oncology was initiated in Morocco and is currently under development, with the ambitious goal of achieving an overall survival rate of 80% by 2030. Nevertheless, a thorough understanding of the determinants of mortality remains a critical challenge to improving the quality of care and informing evidence-based national strategies for childhood cancer control.

In this context, we conducted a single-center study at the Pediatric Hematology-Oncology Department of the Children's Hospital of Rabat, the main national referral center for pediatric oncology in Morocco, to describe the causes of death and to identify the principal factors contributing to mortality among affected children. Secondary objectives included the analysis of clinical, disease-related, and organizational characteristics, with the aim of providing an initial institutional overview and generating hypotheses to guide future multicenter investigations. This study was not designed to estimate national mortality rates but rather to adopt a descriptive and exploratory approach.

## METHODOLOGY

Our study is a retrospective descriptive analysis conducted over a 2-year period, from January 2022 to December 2023. Our reference population consisted of all cancer patients followed in the Department of Pediatric Hematology and Oncology at the Children's Hospital of Rabat (SHOP) who died between January 2022 and December 2023. The list of deceased children was established using the department's mortality registry. The necessary data were collected from various sources: the electronic database, handwritten

archives, and patients' medical records. They were then compiled using a data collection form detailing epidemiological, clinical, prognostic, and therapeutic aspects, as well as the causes and circumstances of death for each patient.

Data processing and analysis were carried out using Google Forms and Google Sheets. The study complied with ethical considerations, particularly strict respect for patient anonymity and data confidentiality, with no sharing of personal or identifiable medical information.

## RESULTS

During the study period, 429 pediatric patients with cancer were admitted to the Pediatric Hematology-Oncology Center of Rabat. Leukemias were the most frequent malignancies, accounting for 119 cases, followed by lymphomas with 65 cases. Among all patients, 70 (16.3%) presented with metastatic disease at diagnosis, whereas 359 (83.7%) had localized disease. Over the same period, 51 deaths were recorded, including 24 in 2022 and 27 in 2023.

The pediatric population managed in our institution exclusively comprised children under 15 years of age. Mortality varied according to age, with a marked predominance in the 0–5-year age group, accounting for 25 deaths (48%). This proportion was consistent with the high representation of this age group in the overall patient population admitted during the same period (207 cases). The 6–10-year age group recorded 16 deaths (32%) among 137 admitted patients. The 11–15-year age group, which represented the smallest proportion of admissions (85 patients), also exhibited the lowest mortality, with 10 deaths (20%).

The sex ratio was 1.22, with a male predominance: boys accounted for 55% of deaths compared with 45% in girls.

The cumulative monthly peak of mortality was observed in October with nine deaths, followed by January with six deaths. Nearly 45% of deaths occurred during weekends (Saturday and Sunday), public holidays, and Mondays. Furthermore, mortality was higher among patients from urban areas, with 37 deaths corresponding to an overall mortality rate of 72.5%, compared with 14 deaths among patients from rural areas. The majority of deaths, 29%, occurred within the first month following diagnosis, 50% within the first three months, and 75% within the first 12 months.

The study revealed significant disparities in mortality according to cancer type. Leukemias represented the most frequent diagnosis among admitted patients, with 119 cases. In the leukemia group, 13 deaths were reported, accounting for 10.9% of this group and 25.5% of all deaths. Among these deaths, seven were related to acute lymphoblastic leukemia, five to acute myeloid

leukemia, and one to chronic juvenile myelomonocytic leukemia.

Lymphomas were the second most frequent diagnosis, with 65 admitted patients. In the lymphoma group, 10 deaths were reported, representing 15.4% of lymphoma patients and 19.6% of all deaths. Among these deaths, eight involved non-Hodgkin lymphomas and two Hodgkin lymphomas.

Neuroblastomas involved 43 admitted patients. In the neuroblastoma group, nine deaths were reported, representing 20.9% of neuroblastoma patients and 17.6% of all deaths.

Bone tumors accounted for 31 admitted patients. In the bone tumor group, eight deaths were reported, representing 25.8% of patients with bone tumors and 15.7% of all deaths.

**Table 1: Distribution of admitted patients, deaths, and mortality rates by tumor type**

Tumor type	Admitted patients (n)	Deaths (n)	% of total deaths	Mortality rate (%)
<b>Leukemias</b>	119	13	25.5 %	10.9 %
<b>Lymphomas</b>	65	10	19.6 %	15.4 %
<b>Neuroblastomas</b>	43	9	17.6 %	20.9 %
<b>Bone tumors</b>	31	8	15.7 %	25.8 %
<b>Brain tumors</b>	30	3	5.9 %	10.0 %
<b>Malignant embryonal tumors (MET)</b>	35	3	5.9 %	8.6 %
<b>Malignant germ cell tumors (MGCT)</b>	11	1	2.0 %	9.1 %
<b>Malignant mesenchymal tumors (MMT)</b>	23	3	5.9 %	13.0 %
<b>Total</b>	-	<b>51</b>	<b>100 %</b>	-

The main cause of death was tumor progression, accounting for 61% of all deaths. It was followed by treatment-related toxicity, responsible for 31% of deaths. Finally, tumor relapse and indeterminate causes each represented only 4% of deaths.

The analysis of causes of death according to survival interval shows that tumor progression

remained the leading cause at all early and intermediate time points. Indeed, 73% of deaths occurred before the first month and 75% between one and three months. Toxicity represented the second cause of death. Its distribution, relatively homogeneous across the different survival intervals, indicates a persistent risk throughout the course of treatment.

**Table 2: Distribution of patients who died during the 2022–2023 period according to cause of death and survival time**

Cause of death	> 1 month	1 - 3 months	3 - 6 months	6 - 12 months	12 - 48 months	>60 months	Total
<b>Tumor progression</b>	11 (73%)	6 (75%)	6 (67%)	2 (64%)	6 (50%)	0 (0%)	31 (61%)
<b>Treatment-related toxicity</b>	4 (27%)	2 (25%)	3 (33%)	3 (31%)	4 (33%)	0 (0%)	16 (31%)
<b>Tumor relapse</b>	0 (0%)	0 (0%)	0 (0%)	1 (3%)	1 (8%)	0 (0%)	2 (4%)
<b>Not specified</b>	0 (0%)	0 (0%)	0 (0%)	1 (3%)	1 (8%)	0 (0%)	2 (4%)
<b>Total</b>	<b>15 (100%)</b>	<b>8 (100%)</b>	<b>9 (100%)</b>	<b>7 (100%)</b>	<b>12 (100%)</b>	<b>0 (100%)</b>	<b>51 (100%)</b>

For leukemias, treatment-related toxicity is predominant, with seven deaths. Tumor progression is the second leading cause, with three deaths. Tumor relapses and indeterminate causes are rare, accounting for three

deaths. For the other tumors, the majority of deaths are associated with tumor progression: six deaths for lymphomas, seven deaths for bone tumors, and five deaths for neuroblastoma.

**Table 3: Distribution of patients who died during the period 2022-2013 according to type of tumor and cause of death**

**MMT:** Malignant Mesenchymal Tumors

**MET:** Malignant Epithelial Tumors

**MGT:** Malignant Germ Cell Tumors

		Cause of Death				Total
		Tumor Progression	Treatment Toxicity	Tumor Relapse	Undetermined	
<b>Type of Tumor</b>	<b>Leukemia</b>	03 (23%)	07 (54%)	02 (15%)	01 (8%)	<b>13 (100%)</b>
	<b>Lymphoma</b>	06 (60%)	04 (40%)	00 (0%)	00 (0%)	<b>10 (100%)</b>
	<b>NBL</b>	05 (56%)	03 (33%)	00 (0%)	01 (11%)	<b>09 (100%)</b>
	<b>Bone Tumor</b>	07 (88%)	01 (12%)	00 (0%)	00 (0%)	<b>08 (100%)</b>
	<b>Brain Tumor</b>	03 (100%)	00 (0%)	00 (0%)	00 (0%)	<b>03 (100%)</b>
	<b>MET</b>	03 (100%)	00 (0%)	00 (0%)	00 (0%)	<b>03 (100%)</b>
	<b>MMT</b>	02 (67%)	01 (33%)	00 (0%)	00 (0%)	<b>03 (100%)</b>
	<b>MGT</b>	01 (100%)	00 (0%)	00 (0%)	00 (0%)	<b>01 (100%)</b>
	<b>Pineal Tumor</b>	01 (100%)	00 (0%)	00 (0%)	00 (0%)	<b>01 (100%)</b>
	<b>Total</b>	<b>31 (61%)</b>	<b>16 (31%)</b>	<b>02 (4%)</b>	<b>02 (4%)</b>	<b>51 (100%)</b>

The study showed that patient survival varied according to cancer type. Among the 13 leukemia cases who died, ten patients had a survival of less than 12 months, and three patients survived between one and four years. Among the 10 lymphoma cases who died, seven patients had a survival of less than 12 months, and three patients survived between one and four years. Among the nine neuroblastoma cases who died, eight patients had a survival of less than 12 months, and one patient survived between one and four years. Among the eight bone tumor cases who died, seven patients had a survival of less than 12 months, and one patient survived between one and four years.

The majority of deaths, 45% (23 cases), occurred at SHOP. Thirty-three percent of deaths occurred at home (17 cases). Deaths in the intensive care unit accounted for 16% (8 cases). Three deaths occurred during transport to a healthcare facility.

## DISCUSSION

Pediatric cancer represents a major public health challenge in Morocco. It is estimated that 1,000 to 1,500 new cases of pediatric cancer are diagnosed each year in the country, accounting for a significant proportion of the overall cancer burden among children and adolescents under 15 years of age<sup>7,8</sup>.

Between 2018 and 2023, data from the Pediatric Hemato-Oncology Center of Rabat show overall stability in admission and mortality rates, with an annual average of 240 admissions and a total of 51 deaths during the study period. A peak in mortality was observed in 2021, with 67 deaths, largely attributable to diagnostic delays and interruptions in treatment linked to the COVID-19 health crisis. This relative stability of indicators highlights the importance of maintaining and strengthening resilient care strategies in the face of major health disruptions.

In our study, the incidence and mortality of pediatric cancers were higher among boys, with a sex ratio of 1.22, corresponding to 55% of deaths among boys versus 45% among girls. This male predominance is consistent with results reported in several studies<sup>6,9,10</sup>.

More recent data from international childhood cancer registries confirm this trend at the global level, with male-to-female incidence ratios exceeding 1.2 for several major tumor types, particularly leukemias, lymphomas, and tumors of the central nervous system<sup>11</sup>. These sex-related differences may be explained by a combination of biological, genetic, hormonal, and environmental factors influencing cancer susceptibility and disease progression in children.

Children aged 0 to 5 years accounted for 48% of the deaths. This trend is consistent with data reported in the literature<sup>6,12,13</sup>. This high prevalence in early childhood may be attributed to a peak incidence of embryonal

tumors, typically observed during this period. In addition, delayed exposure to infections may impair the regulation of immune responses, thereby promoting the development of cancers<sup>14</sup>.

The analysis of monthly mortality distribution within SHOP revealed a significant peak in October, with nine deaths, followed by January, with six deaths. This seasonal variation may be partly explained by an increase in viral and bacterial infections during autumn and winter, periods during which immunocompromised children are particularly vulnerable. Winter conditions associated with acute respiratory infections such as influenza, as well as potential delays in care related to climatic constraints and end-of-year organizational factors, may also contribute to the increased mortality observed in January. Furthermore, influenza infection has been identified as a major cause of severe morbidity in children with cancer, supporting recommendations for influenza vaccination despite a sometimes attenuated immune response in this population<sup>15,16</sup>.

In our study, 45% of deaths occurred during weekends, public holidays, and Mondays. This situation may be related to organizational factors, notably reduced medical staffing and limited availability of multidisciplinary teams during these periods, which may lead to delays in managing critical situations. This phenomenon, known as the "weekend effect," has been widely reported in international literature. Several studies, notably in Canada and the United Kingdom, as well as meta-analyses, have demonstrated a significant increase in hospital mortality associated with admissions during weekends and holidays, particularly among patients with severe conditions. Monday also appears to be a high-risk period, possibly linked to the organizational transition between the weekend and the resumption of weekday activity, which may lead to an accumulation of complications that were not detected early enough<sup>17,18,19</sup>.

Among the deaths observed, 72.5% occurred in urban areas, a rate comparable to that reported in a study conducted in Iran, where 72% of cases also originated from urban regions<sup>20</sup>. In rural settings, access to specialized pediatric oncology care remains limited due to multiple structural and socioeconomic factors, frequently leading to diagnostic delays and inadequate management. Symptoms may sometimes be underestimated by parents, resulting in the absence of early medical consultation. Consequently, some children die without having received an accurate diagnosis or appropriate treatment. This situation is often exacerbated by comorbidities, including malnutrition and poor hygiene conditions. Thus, living in a rural area constitutes a major risk factor for poor survival, as highlighted by several studies<sup>21,22</sup>.

According to the results of our study, 29% of deaths occurred within the month following diagnosis, 50% within the first three months, and 75% within the

first 12 months. These findings highlight significant early mortality. In pediatric oncology, particularly in low- and middle-income countries, early mortality is multifactorial. It is associated with diagnostic delays, socioeconomic constraints limiting access to care, the high cost of treatments, medication shortages, treatment abandonment, toxicity of therapeutic protocols, and high relapse rates<sup>23,24</sup>.

In our study, bone tumors and neuroblastomas showed high disease-specific mortality rates (25.8% and 20.9%, respectively), reflecting diagnoses frequently established at an advanced stage. These results are consistent with data from the literature, which report significantly reduced survival in pediatric bone tumors when metastatic disease is present at diagnosis, as well as in high-risk neuroblastomas<sup>25,26</sup>.

In our study, tumor progression was the main cause of death (61%), occurring predominantly within the first year following diagnosis. These findings are consistent with the literature, particularly in low- and middle-income countries where delayed diagnoses and locally advanced disease remain common. Treatment-related toxicity was the second leading cause of mortality (31%), occurring mainly during the early phases of management, reflecting the intensity of therapeutic protocols and limitations in supportive care. These proportions are comparable to those reported by the World Health Organization and several international series<sup>23,27</sup>.

In our study, 61% of deaths occurred in the hospital (45% at SHOP and 16% in the intensive care unit), while 33% occurred at home. However, Jain et al. reported an increase in home deaths and a decrease in hospital deaths, reflecting better integration of pediatric palliative care delivered in the home setting<sup>28</sup>. Similarly, Johnston et al. showed that home death most often corresponds to parental preferences, although the actual place of death remains influenced by clinical severity and access to palliative care services<sup>29</sup>.

## CONCLUSION

Reducing mortality from pediatric cancers remains a critical public health priority. The present study provides an initial descriptive framework for characterizing mortality patterns within the Pediatric Hematology-Oncology Department, thereby enabling the generation of hypotheses to inform future large-scale, multicenter, and population-based epidemiological studies.

The study showed that deaths were primarily attributable to tumor progression, followed by treatment-related toxicity. The results demonstrate that the observed mortality is largely associated with late management at advanced stages of the disease, thereby underscoring the central role of early diagnosis. The recommendations arising from this study emphasize optimizing available resources and improving access to care, particularly

for rural and disadvantaged populations. They also highlight the importance of patient stratification, adaptation of therapeutic protocols, management of treatment-related toxicity, strengthening of healthcare infrastructure, and continuous training of healthcare professionals.

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