Malnutrition among Pediatric Cancer Patients: A Study of Government Hospitals in Delhi

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Abstract

Introduction Research indicates a considerably higher incidence of malnutrition at the time of diagnosis among patients with pediatric cancer. Studies have also shown that malnutrition tends to worsen with anti-cancer therapies. However, there are limited studies conducted in the Indian context, and those available often involve small sample sizes.

Objectives This study aims to address this gap by analyzing data of patients with pediatric cancer treated at two government hospitals in Delhi.

Materials and Methods This retrospective study includes data from 1,042 patients with pediatric cancer, collected over 6 years from April 2018 to April 2024. The dataset includes age at diagnosis, cancer type, and anthropometric measurements recorded at the initial contact. The analysis focuses on the prevalence of malnutrition, stratified by gender, age group, and cancer type.

Results Among patients with pediatric cancer, more than 80% were diagnosed with hematological malignancies. This study identified an overall malnutrition prevalence of 39.7% (414 out of 1,042). Notably, the prevalence increases with age.

Conclusion Given the substantially higher levels of malnutrition among patients with pediatric cancer at baseline and the anticipated increase during anticancer therapy, there is a pressing need for close monitoring and the development of targeted, individualized nutritional interventions. Such measures are essential to mitigate the impact of malnutrition on treatment outcomes and quality of life.

Keywords
- malnutrition
- incidence
- pediatric cancer
- WHO norms
- acute lymphoblastic leukemia
- prevalence

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Introduction

Malnutrition is a critical concern among patients with pediatric cancer, with its impact varying across cancer types and treatment stages.[1] Several studies have explored malnutrition and undernutrition in patients with pediatric cancer. These studies underscore the critical role of nutritional status in influencing both the immediate treatment outcomes and the long-term prognosis in patients with pediatric cancer.

However, only three studies in the Indian context have been conducted in the past decade,[2–4] and these are limited by small sample sizes. Therefore, it is crucial to examine malnutrition among patients with pediatric cancer using a larger sample size, particularly with a focus on the North Indian population. This study focuses on patients with pediatric cancer receiving care at two major public sector hospitals in Delhi.

Materials and Methods

Study Design and Setting

This is a retrospective study analyzing data from patients with pediatric cancer who received treatment at two major hospitals in Delhi—Safdarjung Hospital and Kalawati Saran Children's Hospital. These patients were also supported through Cankids with other required supplementary cancer care services. The study covers data from the past 6 years, spanning from April 2018 to April 2024.

Inclusion Criteria

Children in the age group up to 18 years diagnosed for the first time with cancer, availing treatment from these hospitals, and supported through CanKids during the period under study were included.

Exclusion Criteria

Those patients with incomplete records were excluded.

The information collected for each patient are date of birth, date of diagnosis, and anthropometric measurements (weight, height, and body mass index [BMI]) at baseline (i.e., at the time of first contact). Anthropometric data were collected by professional dietitians using calibrated and standardized equipment. The data are maintained in Google spreadsheets with in-built auto-computation of BMI and nutritional status categorization. Age at diagnosis was calculated as the difference between the date of birth and the diagnosis date. The average height, weight, and BMI were calculated for each age separately for boys and girls. These have been compared with the Indian Academy of Pediatrics (IAP) and World Health Organization (WHO) median norms/standards. Importantly, WHO growth standards are used for children younger than 5 years[5], while IAP growth charts are applied for children aged 5 to 17 years. The nutritional status grading was done using the WHO classification of nutritional status of infants and children.[6,7] These are given in ►**Tables 1** and **2**.

Table 1 Nutritional status grading as per the WHO classification for 0 to 59 months

Grade	Nutritional status markers
Normal	Weight-for-length/height or BMI-for-age 0 (median) to −2 SD
Moderate acute malnutrition	Weight-for-length/height or BMI-for-age < -2 SD and ≥ -3 SD of the median
Severe acute malnutrition	Weight-for-length/height or BMI-for-age < -3 SD of the median

Table 2 Nutritional status grading as per the WHO classification for 5 to 18 years

Grade	Nutritional status markers
Normal	BMI-for-age 0 (median) to −2 SD
Thinness	BMI-for-age < -2 SD and ≥ -3 SD of the median
Severe thinness	BMI-for-age $<-$ 3 SD of the median

Statistical Analysis

An analysis of nutritional status was conducted based on gender, age group, and type of cancer. An appropriate test of significance (Chi-square test) was applied to assess differences in nutritional status between gender, age groups, and cancer types. A *p*-value of less than 0.05 was considered statistically significant. The analysis was conducted using SPSS version 24.

Ethical Approval

Since this is a retrospective study, ethical permission and consent from patients and their guardians were not needed.

Results

The sample consisted of 1,042 patients with pediatric cancer, of whom 707 (67.8%) were boys and 335 (32.2%) were girls. Regarding age distribution, 498 (47.8%) were younger than 5 years, 426 (40.8%) were pre-adolescents (ages 5–11), and 118 (11.3%) were adolescents (ages 12–17). A significantly large proportion of the sample, 872 (83.7%), were diagnosed with hematological malignancies (►**Table 3**).

Comparison of Anthropometric Parameters with WHO and IAP Norms

The average height, weight, and BMI of boys and girls were compared against the standard median norms of the WHO for children younger than 5 years and the norms of IAP for children 5 to 17 years to calculate growth achievement. This was assessed as the ratio of the observed mean values to the median norms for height, weight, and BMI, separately for boys and girls.

It was observed that the average height of patients with pediatric cancer was ~94.2% of the expected values for boys

Table 3 Profile of study subjects according to gender, age groups, and cancer type

Category	Frequency	Percentage
Gender		
Male	707	67.8
Female	335	32.1
Age groups		
0–59 mo	429	41.1
5–11 y	488	46.8
12–17 y	125	11.9
Cancer type		
Hematological malignancies	872	83.7
Solid tumors (except CNS tumors)	78	7.5
CNS tumors	92	8.8

Abbreviation: CNS, central nervous system.

and 96.3% for girls (►**Table 4**). Similarly, the average weight was ~79.1% of the reference values for boys and 80.2% for girls (►**Table 5**). Furthermore, the average BMI was 89.6% of the corresponding benchmarks for boys and 86.6% for girls (►**Table 6**).

Nutritional Status

Nutritional status was graded using the WHO classification.

Measured in terms of sigma limits and categorized as normal, moderately malnourished, or severely malnourished, the following findings emerged (►**Table 7**):

1. Overall, 414 children (39.7%) were found to be malnourished, including a significant 202 children (19.3%) with weight-for-length/height or BMI-for-age ≤ -3 SD of the median (i.e., severely malnourished).
2. The prevalence of malnutrition was similar among boys (39.4%) and girls (40.3%), with the difference not being statistically significant ($p = 0.94$).
3. Malnutrition increased with age: 32.9% among children younger than 5 years, 41.9% among pre-adolescents, and 55.5% among adolescents. Among the severely malnourished, there were 69 (16.1%) children younger than 5 years, 92 (18.9%) pre-adolescents, and 42 (33.3%) adolescents. The differences were statistically significant ($p < 0.001$).
4. The prevalence of severe malnutrition was lower among patients with hematological malignancies compared with those with other cancers, with the differences being statistically significant ($p = 0.0005$).

Table 4 Comparison of average height with standard median norm by gender

Age (years)	Height (in cm)					
	Gender					
	Male			Female		
	Mean	Standard norms	Achievements of growth norms	Mean	Standard norms	Achievements of growth norms
1	77	75.7	101.7	78	74	105.4
2	84	87.1	96.4	87	85.7	101.5
3	89	96.1	92.6	89	95.1	93.6
4	95	103.3	92.0	94	102.7	91.5
5	104	108.9	95.5	105	107.5	97.7
6	110	114.8	95.8	102	113.5	89.9
7	114	120.7	94.4	118	119.4	98.8
8	123	126.4	97.3	124	125.4	98.9
9	122	131.8	92.6	127	131.4	96.7
10	132	137.2	96.2	129	137.4	93.9
11	137	142.7	96.0	139	143.3	97.0
12	139	148.4	93.7	136	148.4	91.6
13	140	154.3	90.7	146	152.2	95.9
14	136	159.9	85.1	149	154.7	96.3
15	152	164.5	92.4	146	156.1	93.5
16	160	168.1	95.2	–	–	
17	160	171.0	93.6	156	157.4	99.1
Average			94.2			96.3

Note: WHO growth standards are used for children younger than 5 years, while IAP growth charts are applied for children aged 5 to 17 years.

Table 5 Comparison of average weight with standard median norm by gender

Age (years)	Weight (in kg)					
	Gender					
	Male			Female		
	Mean	Standard norms	Achievements of growth norms	Mean	Standard norms	Achievements of growth norms
1	8.7	9.6	90.6	8.9	8.9	100.0
2	9.9	12.2	81.1	10	11.5	87.0
3	12.7	14.3	88.8	11.7	13.9	84.2
4	14.2	16.3	87.1	12.5	16.1	77.6
5	15.6	18.3	85.2	15	18.2	82.4
6	16.7	19.3	86.5	15.5	18.7	82.9
7	18	21.9	82.2	19	21.2	89.6
8	20.7	24.8	83.5	20.2	24.0	84.2
9	22.9	27.9	82.1	23	27.2	84.6
10	25.8	31.1	83.0	23.9	31.0	77.1
11	26.5	34.7	76.4	27	35.4	76.3
12	27.4	39.0	70.3	25.1	39.8	63.1
13	28.7	43.3	66.3	33.8	43.6	77.5
14	34.3	48.2	71.2	32.3	46.4	69.6
15	36.3	53.1	68.4	29	48.4	59.9
16	43	56.8	75.7	–	–	
17	40	59.5	67.2	44.1	50.9	86.6
Average			79.1			80.2

Note: WHO growth standards are used for children younger than 5 years, while IAP growth charts are applied for children aged 5 to 17 years.

Discussion

The study represents the longest cohort in India specifically covering childhood cancer and nutrition, highlighting the prevalence of malnutrition among children with cancer. Overall, 39.7% of the children were malnourished, with 20.3% moderately malnourished and 19.3% severely malnourished. The prevalence of malnutrition varied by cancer type, with hematological malignancies showing 37% malnutrition (21.9% MAM, 15.02% SAM), solid tumors (except CNS tumors) having the highest burden at 52.56% malnutrition (21.79% MAM, 30.77% SAM), and CNS tumors at 50.00% malnutrition (18.48% MAM, 26.09% SAM). A statistical review by Ward et al[8] provides a detailed breakdown of childhood cancer incidence rates, with acute lymphoblastic leukemia consistently showing the highest prevalence among leukemias and solid tumors, which aligns with our findings that hematological malignancies constituted the largest subgroup in our cohort.

Furthermore, a review study by Diakatou and Vassilakou[9] found that malnutrition is common at diagnosis and is linked to poor health-related quality of life and nutritional issues in survivors, reinforcing the need for early nutritional assessment and interventions to mitigate long-term complications in childhood cancer survivors.

The 39.7% prevalence of malnutrition observed in this study is comparable to the 56.8% reported by Jain et al using weight-for-age criteria.[2] In their study, they also assessed nutritional status using hematological and biochemical markers, with malnutrition reflected through low hemoglobin (82%), low total proteins (25%, i.e., <5.7 g/dL), low serum albumin (20.5%, i.e., <3.2 g/dL), low serum transferrin (27.3%, i.e., <210 mg/dL), and low serum iron (16.3%, i.e., <60 µg/dL). However, this is much higher than the level of 37.2% as reported by Sakthikumar et al in another Indian study.[3] This study suggested that early nutritional intervention should be an essential part of the multidisciplinary treatment protocol.[3]

In another Indian study by Radhakrishnan et al, undernutrition was seen in 44% of patients at diagnosis. He also reported that active nutritional intervention and education were able to significantly reduce the prevalence of undernutrition in patients by the end of treatment.[4]

Maia-Lemos et al evaluated 1,154 children and adolescents with cancer using various measures like weight, height, BMI, and arm measurements. They found that 10.85 to 27.32% of patients were malnourished at diagnosis, highlighting the need for early nutritional monitoring in pediatric cancer care.[10] A study in the Netherlands by Brinksma et al reported that 40 to 50% of patients with pediatric cancer experienced malnutrition during treatment. It emphasized the adverse effects of malnutrition on treatment outcomes and suggested the need for routine nutritional assessments and interventions in oncology care.[11]

Table 7 Nutritional status according to gender, age group, and cancer type

Nutritional status grade						
Category	Normal		Weight-for-length/-height or BMI-for-age < -2 SD and ≥ -3 SD of the median		Weight-for-length/-height or BMI-for-age < -3 SD of the median	
	Number	%	Number	%	Number	%
Overall						
	628	60.3	212	20.30	202	19.30
Gender						
Male	428	60.5	144	20.3	136	19.2
Female	200	59.7	68	20.3	67	20.0
$\chi^2 = 0.09$; $p = 0.94$						
Age group						
0–59 mo	288	67.1	72	16.8	69	16.1
5–11 y	284	58.2	112	23.0	92	18.9
12–17 y	56	44.4	28	22.2	42	33.3
$\chi^2 = 28.54$; $p < 0.001$						
Cancer type						
Hematological malignancies	546	62.61	191	21.90	131	15.02
Solid tumors (except CNS tumors)	37	47.44	17	21.79	24	30.77
CNS tumors	46	50.00	17	18.48	24	26.09
$\chi^2 = 19.96$; $p = 0.0005$						

Abbreviations: CNS, central nervous system.

Table 6 Comparison of average BMI for age with standard median norm by gender

Age (years)	BMI					
	Gender					
	Male			Female		
	Mean	Standard norms	Achievements of growth norms	Mean	Standard norms	Achievements of growth norms
1	14.7	16.8	87.5	14.6	16.4	89.0
2	14.0	16.0	87.5	13.2	15.7	84.1
3	16.0	15.6	102.6	14.8	15.4	96.1
4	15.7	15.3	102.6	14.1	15.3	92.2
5	14.4	14.7	98.0	13.6	14.3	95.1
6	13.8	14.9	92.6	14.9	14.5	102.8
7	13.9	15.1	92.1	13.6	14.9	91.3
8	13.7	15.5	88.4	13.1	15.3	85.6
9	15.4	15.9	96.9	14.3	15.8	90.5
10	14.8	16.4	90.2	14.4	16.5	87.3
11	14.1	17.0	82.9	14.0	17.2	81.4
12	14.2	17.7	80.2	13.6	18.0	75.6
13	14.6	18.2	80.2	15.9	18.8	84.6
14	18.5	18.7	98.9	14.5	19.4	74.7
15	15.7	19.3	81.3	13.6	19.9	68.3
16	16.8	19.9	84.4	–	–	
17	15.6	20.5	76.1	18.1	20.6	87.9
Average			89.6			86.6

Note: WHO growth standards are used for children younger than 5 years, while IAP growth charts are applied for children aged 5 to 17 years.

Another study by Lemos et al concluded that the prevalence of malnutrition was higher in malignancies.[12]

In our study, the prevalence of malnutrition increased with age, which aligns with the study by Huibers et al, where it was reported that malnutrition was more common in children aged ≥5 years (70.0%) compared with children aged <5 years.[13]

The study by Zimmermann et al, though reporting a low prevalence of malnutrition at diagnosis, showed a steady increase in malnutrition during anticancer therapy.[14] A review study by Barr mentioned that the prevalence and severity of malnutrition in children with cancer in LMICs demand attention.[15] Opportunities exist to conduct studies in India to examine the effects of nutritional interventions, including on the overall well-being of survivors.[15]

The findings of this study align with prior research emphasizing the critical impact of malnutrition on pediatric cancer outcomes. Zimmermann et al demonstrated that while the prevalence of malnutrition at diagnosis was relatively low, it worsened during therapy due to treatment-induced side effects such as reduced appetite and gastrointestinal complications. Similarly, a study by Brinksma et al identified that malnutrition during cancer therapy adversely affected treatment tolerance and recovery rates, underscoring the necessity for routine nutritional assessment.[11–14] Peccatori et al mentioned that nutritional support considerably improved 1-year event-free survival (EFS) by ∼13% compared with a historical cohort in their study.[16] Schoeman, Pedretti et al, and Bauer et al found that proactive nutritional management significantly improves treatment tolerance, reduces complications, and enhances overall outcomes for children undergoing cancer treatment.[17–19] Another study by Fabozzi et al provided practice recommendations for systematic nutritional management in pediatric oncology, reinforcing the importance of structured nutritional interventions to improve treatment outcomes and quality of life.[20]

While survival and toxicity data were not the focus of the current study, previous evidence strongly links poor nutritional status to both increased treatment toxicity and reduced survival. These insights highlight the importance of integrating tailored nutritional support into treatment protocols to mitigate therapy-associated nutritional deterioration and improve overall outcomes.

Strengths

This is one of the largest Indian studies on pediatric patients with cancer and malnutrition, analyzing data from 1,042 patients over 6 years. It draws from two major public hospitals, ensuring real-world relevance. Standardized anthropometric assessments and comparisons with WHO/IAP norms enhance data reliability. Stratified analysis by age, gender, and cancer type offers actionable insights for targeted nutritional interventions. The study fills a critical gap in Indian literature and supports the integration of nutrition into pediatric oncology care.

Limitations

Malnutrition can be assessed using various well-established indicators, such as mid-upper arm circumference (MUAC), height-for-age, weight-for-age, weight-for-height, BMI-for-age, and triceps skinfold thickness (TSF). In this study, malnutrition was measured using weight-for-height and BMI-for-age. However, incorporating additional measures, such as MUAC and TSF, could enhance the comprehensiveness and accuracy of the assessment, providing a more nuanced understanding of the nutritional status of pediatric patients.

Future Prospects and Gray Areas for Research

The study focuses primarily on two government hospitals, highlighting the need for data on additional measures of malnutrition to provide a more comprehensive understanding.

Generalizability of Study

To ensure proper generalization, it would be beneficial to include data from private hospitals and healthcare facilities in other regions of the country.

Conclusion

The considerably high prevalence of malnutrition among patients with pediatric cancer observed in this study underscores the urgent need for routine nutritional assessment and timely intervention as part of standard oncology care. Our findings highlight that nearly 40% of children were either moderately or severely malnourished at the time of diagnosis, with variation by cancer type and age group. This emphasizes the necessity for proactive nutritional planning and individualized care strategies to identify and support at-risk patients early. While this study did not directly assess clinical outcomes, therapy tolerability, or quality of life, the findings reinforce the importance of integrating structured nutritional support into multidisciplinary pediatric oncology care. Future research should aim to explore how early nutritional interventions may influence treatment outcomes, therapy adherence, and the overall well-being of patients with pediatric cancer.

Authors' Contributions

A.S.—Concept design, definition of intellectual content, clinical studies, data acquisition, manuscript preparation, manuscript editing, and manuscript review.

P.M.—Concept design, definition of intellectual content, manuscript preparation, manuscript editing, and manuscript review.

P.B.—Concept design, definition of intellectual content, manuscript preparation, manuscript editing, and manuscript review.

N.F.—Concept design, definition of intellectual content, literature search, data acquisition, manuscript preparation, manuscript editing, and manuscript review.

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The manuscript has been read and approved by all the authors that the requirements for authorship have been met and that each author believes that the manuscript represents honest work.

Patient Consent
Patient consent is not required due to the retrospective nature of the study.

Conflict of Interest
None declared.

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