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ISSN Online 2704-4890 | ISSN Print 2720-7609

Online first publication

Original Research Article

HSI Journal (2022) Volume 3 (Issue 2):365-373. https://doi.org/10.46829/hsijournal.2022.12.3.2.365-373

Open Access

Nutritional status at diagnosis of childhood cancer in Korle Bu Teaching Hospital, Accra, Ghana

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Received June 2022; Revised August 2022; Accepted October 2022

Abstract

Background: Although most childhood cancers are curable, comorbid malnutrition can result in delayed initiation of treatment, increased treatment toxicity, and reduced overall survival. At cancer diagnosis, appropriate classification of nutritional status enhances nutritional surveillance to improve supportive care and cancer treatment outcomes.

Objective: The study objective was to assess the prevalence of malnutrition at the diagnosis of childhood cancer, compare weight-based measurements with arm anthropometry in the assessment of acute malnutrition (wasting) and determine the association between malnutrition and selected cancer characteristics.

Methods: The study was conducted at the Paediatric Oncology Unit (POU) at the Korle-Bu Teaching Hospital. Using consecutive recruitment, 133 participants of age ≤ 12 years with a new diagnosis of cancer were enrolled from January to December 2019. Stunting was assessed using a height-for-age z-score (HAZ). Wasting was assessed using a weight-for-height z-score (WHZ), body mass index-for-age z-score (BAZ), mid-upper arm circumference (MUAC), and upper arm muscle area (UAMA) percentile. Pearson's Chi-square and Fisher's exact tests were used to determine the association between nutritional status, cancer type and risk group.

Results: The median age of participants was 4.5 years, and 64.7% (n = 86/133) were male. Of the 133 participants, 60.9% (n = 81) were diagnosed with solid tumours, 23.3% (n = 31) with leukaemia, and 15.8% (n = 21) with lymphoma. At cancer diagnosis, the prevalence of stunting was 16.8% (n = 22/131) while the prevalence of wasting was 21.8% (n = 29/133) and 40.5% (n = 53/131) using weight-based measurements (WHZ or BAZ) and arm anthropometry (MUAC or UAMA), respectively. No participant was obese. Lymphomas were significantly associated with wasting (p = 0.022). Participants with high-risk cancers were more likely to be stunted and wasted.

Conclusion: Mid-upper arm circumference and UAMA detected more children with wasting than WHZ and BAZ at cancer diagnosis. Advanced-stage disease and lymphoma were associated with wasting. Establishing a nutritional rehabilitation programme at the POU, KBTH would ensure early and appropriate nutritional interventions to correct or prevent further nutritional deficits.

Keywords: nutrition, cancer, children, diagnosis, Ghana

INTRODUCTION

Globally, over 400,000 children develop cancer each year, with about 80% of these occurring in low- and middle-income countries (LMIC) [1]. In high-income countries, childhood cancer cure rates exceed 80% but remain below 50% in LMIC due to factors such as delayed diagnosis, abandonment of therapy, and comorbid conditions such as malnutrition [2]. Malnutrition refers to both overnutrition and undernutrition. In children with cancer, both forms result in adverse outcomes [3]. Undernutrition is common at the initial diagnosis of cancer, while overnutrition tends to develop during the treatment when patients are exposed to corticosteroids, especially when used in acute lymphoblastic leukaemia (ALL) treatment regimens [4]. Children with cancers are particularly at risk of undernutrition at diagnosis due to anorexia, nausea, vomiting, early satiety (from large abdominal tumours), poor absorption from disrupted gastrointestinal mucosal surfaces and deranged metabolism [3]. There is a wide prevalence of wasting and stunting across published studies, ranging from 30 – 85%, depending on the tumour type and the tools used to determine nutritional status [5-7]. Children who present

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with advanced-stage solid tumours are more likely to be wasted than those with acute leukaemias. Additionally, the use of weight-based anthropometric measurements alone may underestimate the burden of undernutrition due to the presence of oedema or tumour mass which falsely increases body weight [8,9]. Weight-independent parameters such as arm anthropometry are therefore invaluable for the clinical evaluation of body composition in oncology patients. The mid-upper arm circumference (MUAC) is a quick, simple measurement of fat, muscle, and humeral diameter used in health facilities and field settings to assess acute malnutrition. The World Health Organization (WHO) has validated MUAC for use in children aged 6 – 59 months, and interpretations for both males and females within that age range are the same [10]. Mid-upper arm circumference z-scores for children aged 5 – 19 years are not yet validated for universal use [11]. The MUAC can be utilised with the triceps skinfold thickness (TSFT) to compute fat and muscle area in the upper arm. This measurement, known as the upper arm muscle area (UAMA), is a better proxy of lean mass which constitutes functional nutritional reserves in the body [12]. The upper arm muscle area can be used to assess wasting in children ≥ 12 months old.

Malnutrition is associated with higher rates of treatment-related complications, cancer relapse, and lower overall survival [5,13,14]. Where children survive cancer, there may be long-term sequelae to growth and development [15]. In Ghana, approximately 300 cases of childhood cancer are reported annually [16], representing less than one-quarter of expected cases due to underdiagnosis and the absence of a population-based national cancer registry. Although the International Society of Paediatric Oncology (SIOP) recommends baseline nutritional assessments for all children with newly diagnosed cancer, data from Ghana are limited. A cross-sectional study conducted in Ghana to assess the nutritional status of children with cancers focused only on two cancers: Burkitt Lymphoma and Wilm's Tumour [17]. Knowledge of the burden of nutritional deficits across all types of cancer would enable the implementation of tailored nutritional intervention programmes to reverse or prevent malnutrition, maintain growth, reduce acute and chronic complications, and improve quality of life. The objective of the present study was to determine the prevalence of malnutrition at the diagnosis of cancer in the Paediatric Oncology Unit (POU) and its association with selected cancer characteristics.

MATERIALS AND METHODS

Study design and sites

This was a hospital-based prospective cohort study where each participant was consecutively recruited at diagnosis before the start of any cancer-directed therapy. Participant enrolment was from January to December 2019.

Study site

The Paediatric Oncology Unit (POU), located within the Department of Child Health, KBTH, is one of only two comprehensive childhood cancer treatment centres in Ghana. About 160 to 180 new childhood cancer cases are diagnosed annually at KBTH, with referrals from across Ghana and other countries within the West African sub-region. At the time the study began, there was an age limit of 12 years for admissions to the Department of Child Health.

Eligibility criteria

The inclusion criteria were age ≤ 12 years with any one of the following: a new diagnosis of first cancer, new cancer after completion of treatment for first cancer, or a relapsed cancer after completion of initial cancer treatment (in remission for at least one year before relapse). Children with comorbid chronic diseases such as tuberculosis, HIV infection, heart disease, or kidney disease were excluded. Children who had already started chemotherapy or radiotherapy were also excluded.

Sample size and sampling technique

The sample size was determined using Cochran's formula [18] to achieve a sample size of 381, using 55% as the prevalence of wasting by arm anthropometry, as reported by Israels et al. [19]. Approximately 170 newly diagnosed paediatric cancer patients present at the study site annually. Therefore correction was done for a finite population [20] to achieve a sample of 118 because the calculated sample size (381) exceeded 5% of newly diagnosed cases. Allowing approximately a 10% loss to follow-up, the minimum sample size was 132. The study assumed a 5% level significance and a level of precision of 0.05. Study participants were consecutively recruited until the minimum sample size was attained.

Data collection and measurement of anthropometry

Socio-demographic data were obtained using an interviewer-administered questionnaire. In this study, cancer characteristics, including cancer type and stage, were documented. Anthropometric measurements included weight, height, MUAC, and TSFT. Measuring instruments were calibrated by the Ghana Standards Authority. Each measurement was performed by a trained physician and an assistant. All measurements were taken twice, and the mean value was documented. For participants able to stand unassisted, body weight was measured using a class III Seca 786® column dial scale (Biotechne, USA), which measures weight to the nearest 0.1kg. Participants were weighed barefoot and in minimal clothing. Infants were weighed naked using a class III top loading scale Seca 232® (Biotechne, USA), which measures weight to the nearest 0.01 kg. Standing height (participants ≥ age 24 months) was measured with the height gauge of class III Seca 786® (Biotechne, USA) column dial scale with a range of 0 – 200 cm and minimum readability of 1 mm. The length of children < 24 months and older participants who, due to illness, could

not stand was measured in the supine position. For patients ≥ 24 months, length was measured instead of height, with 0.7 cm deducted from the reading per WHO standards [21]. We measured MUAC in the left arm with the three colour-coded Shakir tapes (for children aged ≥ 6 months up to five years). A non-colour-coded and non-stretchable MUAC tape was used to obtain MUAC for children above five years. The TSFT was measured in the left arm with a pair of Harpenden skinfold callipers (Hydrotechnik, UK) with a range of 0 – 80 mm and a readability of 0.2 mm. If the two measurements differed more than 2 mm, a third measurement was taken, and the average value of the two closest measurements was documented.

Categorisation of nutritional status

Stunting and weight-based determination of wasting

The WHO Anthro version 3.2.2 [10] software for age < 5 years and AnthroPlus version 1.0.4 [22] software for age ≥ 5 years were used to compute height-for-age z-score (HAZ), weight-for-height z-score (WHZ) and body mass index-for-age z-score (BAZ). For all participants, HAZ < -2 and < -3 were classified as stunting and severe stunting, respectively. For those age < 5 years, WHZ < -2, < -3, > +2, and > +3 were classified as wasting, severe wasting, overweight, and obese respectively. Body mass index-for-age z-score (BAZ) categories were as follows: < -2: thinness, < -3: severe thinness, > +1; overweight, and > +2: obese.

Wasting by arm anthropometry

For participants aged 6 – 59 months, MUAC measurement < 11.5 cm was considered severe wasting, 11.5 – < 12.5 cm moderate wasting, and 12.5 – < 13.5 cm at risk of wasting. The upper arm muscle area (for age ≥ 1 year) was determined as follows: UAMA (mm^2) = $(MUAC - \pi TSFT)^2/4\pi$. This formula was embedded in Microsoft Excel 2016, and UAMA was automatically generated. The percentile of the UAMA muscle area was interpreted using the Frisancho percentile chart [12] and stratified into five categories: low (wasted), low average, average, above average, and high muscle. Each participant's nutritional status at diagnosis was communicated to the clinical care team. The study did not actively track the nature or implementation of any clinical decisions.

Classification and risk grouping of cancers

Participants diagnosed with solid tumours and lymphomas which were confirmed by histopathology were stratified into two risk groups based on the extent of the disease (staging). Low risk was defined as tumours confined to the tissue/organ of origin (stages 1 and 2 diseases), while the high risk was locally advanced and metastatic disease (stages 3 and 4 diseases). Hodgkin lymphoma stage IIB, using the Ann Arbor Classification, was classified as high risk [23]. Acute lymphoblastic leukaemia was categorised into standard and high-risk groups, defined by National Cancer Institute/Rome criteria [24]. Acute myeloid leukaemia (AML) was grouped as a standard risk if WBC ≤ 100,000 cells/microlitre and high risk if WBC > 100,000 cells/microlitre [25]. Chronic myeloid leukaemia was grouped under standard risk if the participant presented in a chronic phase and under high risk if in the accelerated phase or with a blast crisis [26].

Statistical analysis

Data were entered into Microsoft Excel 2016. All statistical analyses were done using Stata IC version 16 (Stata Corp, College Station, Austin, Texas). Data were summarised using frequencies and percentages for categorical variables, whilst median and interquartile range was used for continuous variables due to the non-normal distribution of the continuous variables. Non-normality of the continuous variables was established from a significant test ($p < 0.05$) from the Shapiro Wilks, Shapiro Francia, skewness and kurtosis tests. Socioeconomic status was generated into wealth quintiles using household asset data via principal component analysis. Pearson's chi-square and Fisher's exact tests were used for the association between nutritional status, cancer type and risk group. The level of statistical significance was set at an alpha of 0.05.

RESULTS

A total of 162 children presented to the POU during the study period and were assessed for study eligibility. Of these, 133 were recruited (Figure 1).

Socio-demographic characteristics

Participant ages ranged from 1 month to 12.9 years, with a median age of 4.5 years [interquartile range (IQR)] (2.4, 9.0 years). Nearly two-thirds were male (86; 64.7%). The participants were almost equally distributed across the five wealth quintiles (Table 1).

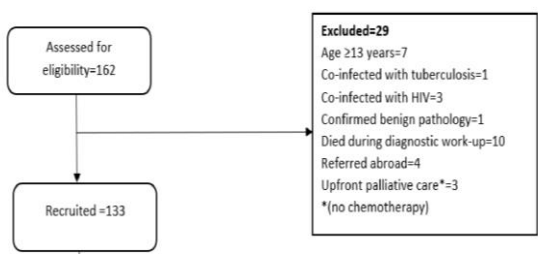

Figure 1: Flow chart showing study participant elibility assessment

Types of cancer

The types of cancers diagnosed in study participants are shown in Figure 2, with the commonest being solid tumours (60.9%, n = 81). The majority of participants with embryonal tumours (74.1%, n = 40/54) were below five years old, with a median age (IQR) of 3.5 years (1.8, 4.9

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years). Almost two-thirds of participants with ALL (n = 16/25; 64%) were also < 5 years with a median age of 4.3 years (2.4, 8.2 years). In contrast, about half of the participants with lymphomas (n = 11/21; 52.4%) were in the age group 5 – 9 years with a median age of 8 years (5.8, 10.4 years).

Nutritional status at diagnosis of cancer

Table 2 shows the nutritional status at diagnosis of cancer. Twenty-two participants (n = 22/131; 16.8%) were stunted. Two participants were too ill to stand or lie supine for accurate height or length measurements. Of those who were stunted, about two-thirds (n = 15/22; 68.2%) were under five years old. Thus, there was a higher proportion of stunting among participants within that age group (n = 15/70; 21.4%). Using weight-based parameters (WHZ and BAZ), about one-fifth (n = 29/133; 21.8%) of the study participants were wasted and thin, respectively. Arm anthropometry was obtained in 131 participants (two were aged < 6 months and could not be categorised using UAMA or MUAC). Of these, more than a third (53; 40.5%) were wasted. Three were aged < 1 year and thus identified with MUAC only. Using arm anthropometry, wasting was highest in the age group 5 – 9 years (n = 26/34; 76.5%) and least in the age < 5 years (n = 9/68; 13.2%). Leukaemias and lymphomas were the underlying diagnoses in nearly half (n = 26/53; 49.1%) of those with wasting, with lymphomas alone accounting for more than half (n = 15/26; 57.7%). Only one participant was classified as obese by BAZ (Table 2). However, arm anthropometry classified the same participant as wasted. This participant subsequently had surgery to remove a five-kilogram tumour, following which the BAZ reclassification was thin. Three participants were overweight using BAZ, and two presented with large

Table 1. Sociodemographic characteristics of study participants at diagnosis of cancer

Characteristics	Frequency (N=133)	Percentage
Age group in years		
<1	10	7.5
1 to <5	60	45.1
5 to 9	34	25.6
≥10	29	21.8
Total	133	100.0
Sex		
Male	86	64.7
Female	47	35.3
Total	133	100.0
Region* or country of residence		
Brong Ahafo region	3	2.2
Central region	19	14.3
Eastern region	14	10.5
Greater Accra region	58	43.6
Northern region	5	3.7
Upper East region	2	1.5
Volta region	22	16.5
Western region	5	3.8
Ivory Coast	1	0.8
Liberia	1	0.8
Sierra Leone	1	0.8
Togo	2	1.5
Total	133	100.0
Wealth index		
Quintile 1 (lowest socioeconomic status)	27	20.2
Quintile 2	27	20.2
Quintile 3	26	19.7
Quintile 4	27	20.2
Quintile 5 (Highest socioeconomic status)	26	19.7
Total	133	100.0

**Ghana had 10 regions during the study period*

Table 2. Nutritional status of study participants at diagnosis of cancer

Nutritional parameters	Frequency	Percentage
HAZ		
Severe stunting	11	8.4
Moderate stunting	11	8.4
Normal	109	83.2
Total	131	100.0
WHZ		
Severe wasting	12	17.9
Moderate wasting	5	7.5
Normal	49	73.1
Overweight	1	1.5
Total	67	100.0
BAZ		
Severe thinness	15	11.5
Thinness	14	10.8
Normal	97	74.6
Overweight	3	2.3
Obese	1	0.8
Total	130	100.0
MUAC		
Severe wasting	5	7.3
Moderate wasting	7	10.1
At risk of wasting	8	11.6
Adequately nourished	49	71.0
Total	69	100.0
UAMA		
Wasting	50	40.7
Low average	30	24.4
Average	43	34.9
Total	123	100.0

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Table 3. Association between nutritional status at diagnosis and cancer type

Nutritional parameters	Cancer type: Leukaemias n (%)	Lymphomas n (%)	Solid tumours n (%)	Total n (%)	Chi-square	P-value
UAMA						
Average	12 (41.4)	2 (9.5)	29 (39.7)	43 (35.0)	11.4	0.022*
Low average	6 (20.7)	4 (19.1)	20 (27.4)	30 (24.3)		
Wasted	11 (37.9)	15 (71.4)	24 (32.9)	50 (40.7)		
Total	29 (100.0)	21 (100.0)	73 (100.0)	123 (100.0)		
HAZ					1.3	0.518
Normal	27 (87.1)	15 (75.0)	67 (83.8)	109 (83.2)		
Stunted	4 (12.9)	5 (25.0)	13 (16.3)	22 (16.8)		
Total	31 (100.0)	20 (100.0)	80 (100.0)	131 (100.0)		
WHZ					F	0.783
Normal	13 (81.3)	2 (66.7)	35 (72.9)	50 (74.6)		
Wasted	3 (18.8)	1 (33.3)	13 (27.1)	17 (25.4)		
Total	16 (100.0)	3 (100.0)	48 (100.0)	67 (100.0)		
BAZ					1.4	0.503
Normal	5 (16.1)	6 (30.0)	18 (22.8)	29 (22.3)		
Thin	26 (83.9)	14 (70.0)	61 (77.2)	101 (77.7)		
Total	31 (100.0)	20 (100.0)	79 (100.0)	130 (100.0)		
MUAC					F	0.495
Normal	16 (88.9)	2 (66.7)	39 (81.2)	57 (82.6)		
Wasted	2 (11.1)	1 (33.3)	9 (18.8)	12 (17.4)		
Total	18 (100.0)	3 (100.0)	48 (100.0)	69 (100.0)		

Table 4. Association between nutritional status at cancer diagnosis and cancer risk group

Nutritional parameter at diagnosis of cancer	Risk group: High risk	Low risk	Test of equal proportion
UAMA Wasted (low)	41/50 (92.0%)	9/50 (18.0%)	p<0.001*
HAZ Stunted + severely stunted	16/22 (72.7%)	6/22 (27.3%)	p=0.033*
WHZ Wasted + severely wasted	7/17 (41.2%)	10/17 (58.8%)	p=0.470
BAZ Thinness + severe thinness	18/29 (62.1%)	11/29 (37.9%)	p=0.194
MUAC Moderate acute malnutrition + Severe acute malnutrition	8/12 (66.7%)	4/12 (33.3%)	p=0.248

UAMA-Upper arm muscle area, HAZ-Height-for-age z-score, WHZ-Weight-for-height z-score, BAZ-Body mass index z-score, MUAC-Mid upper arm circumference
*All tests are from the one sample test of proportion; *level of significance is p-value <0.05*

tumour masses. Following surgery, both participants were reclassified by BAZ as thin, consistent with the initial arm anthropometry classification as wasted. There was no participant within the UAMA' above average' or 'high muscle' categories (Table 3).

Association between nutritional status at diagnosis and cancer type

When stratified by grade of UAMA, participants with lymphomas were proportionately more wasted than those with other cancer types (p = 0.022). There was, however, no significant association between cancer type and

undernutrition using other anthropometric parameters (Table 3).

Association between nutritional status at diagnosis and cancer risk group

Overall, more than two-thirds (n = 94/133; 70.7%) had advanced (high risk) disease, which was similar across solid tumours and haematolymphoid cancers. For all anthropometric parameters except WHZ, proportionately more participants in the high-risk groups were stunted (HAZ), thin (BAZ), or wasted (UAMA or MUAC). This was statistically significant for HAZ and UAMA (Table 4).

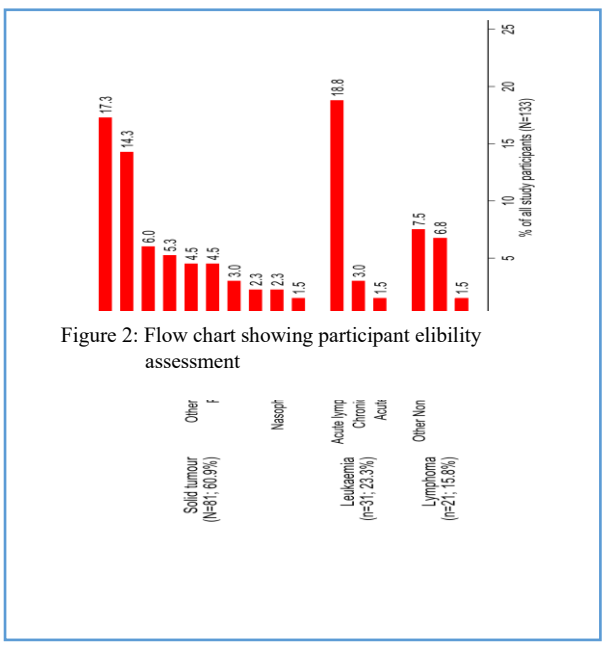

Figure 2: Flow chart showing participant elibility assessment

DISCUSSION

Among the 133 participants in this study, the commonest underlying types of cancers were ALL (18.8%), retinoblastoma (17.3%), and lymphomas (15.8%). This distribution is similar to the findings in the study by Segbefia et al. [27]. The study showed a changing pattern in cancers seen at the POU, KBTH and an increasing proportion of patients being diagnosed with ALL, compared to historical data where two-thirds of patients presented with lymphomas [28]. At diagnosis, evaluation of chronic undernutrition showed that 16.8% of the study participants were stunted, particularly in those aged < 5 years (21.4%). This is slightly higher than the stunting prevalence of 19% reported in 2014 by the Ghana Demographic and Health Survey (GDHS) for children under five years [29]. In Malawi, Israels et al. [19] reported a much higher prevalence of stunting (44.5%) among children ages 1 – 16 diagnosed with cancers. This was, however, similar to their national prevalence of stunting (45%) among children under five years [14]. While the prevalence of stunting at diagnosis of cancer may differ between countries, it often closely matches the prevalence of stunting in the general population and mirrors the country's economic status and access to child welfare interventions [30]. Arm anthropometry identified almost two times more participants with wasting compared to weight-based measurements (40% vs 21.8%), similar to previous reports [9,19,31]. Large tumour masses, ascites, and oedema reduce WHZ and BAZ's sensitivity to identify wasting accurately. Furthermore, stunting can inadvertently make wasted children measured by WFH appear normal since the low weights and heights are proportionate. In the present study, the use of MUAC was limited to classifying participants aged 6 months to 5 years. In contrast, UAMA was applicable to all participants except infants. While UAMA may be preferred, it is not always feasible in LMIC due to the unavailability of Harpenden® or other brands of callipers in many clinical settings and the need for a trained person skilled in their use [32].

Only one participant in this study was overweight, and none were truly obese. Overweight and obesity have, however, been reported in the general population of Ghanaian children. In a systematic review and meta-analysis by Akowuah and Kobia-Acquah, the prevalence of childhood overweight and obesity were 8.6% and 10.7%, respectively, with a relatively higher burden in rural Ghana [33]. The 2014 GDHS [29] reported an overweight prevalence of 5% in children < 5 years old. There is a paucity of data on the prevalence of overnutrition in childhood cancer in sub-Saharan Africa. It may be that it is truly negligible at diagnosis of cancer as the disease increases the risk of wasting, worsened by the high baseline prevalence of wasting in the general population. In some studies from high-income countries (HIC), overnutrition is low at diagnosis but gradually increases during treatment, especially with corticosteroid-based treatment regimens such as in ALL [34,35]. This could be the focus of a future study to track participants long-term for the development of obesity. Amongst the parameters used to determine nutritional status, only UAMA showed a significant association with cancer type (lymphomas) at diagnosis. A review of studies in LMIC by Gross and Biondi [36] found that children with non-Hodgkin lymphomas commonly present with nutritional depletion. In HIC, children with multiply-relapsed lymphomas are at higher risk of undernutrition [3].

The initial diagnoses of cancers and lymphomas are made early in HIC; therefore, only those with the treatment-refractory disease tend to be undernourished. On the contrary, the initial presentation in sub-Saharan Africa is usually with advanced disease. The majority of lymphomas in this study were non-Hodgkin lymphomas which are highly proliferative with significant nutrient demands on the host, increasing the likelihood of undernutrition. Other reasons for the high prevalence of undernutrition among non-Hodgkin lymphomas could be from cytokine release. These cytokines, such as IL-1, IL-6,

and TNF-α, impair appetite by their actions on the brain, impair skeletal muscle synthesis, and increase skeletal muscle and fat wasting [37]. Additionally, the common sites of these tumours are the jaw and abdomen, which place mechanical impediments to adequate food ingestion, mastication, and problems with early satiety. In the current study, about 70% of study participants with solid tumours and lymphomas presented with advanced-stage disease (high-risk), which was significantly associated with stunting (HAZ) and wasting (UAMA).

Pribnow et al. [38] in Nicaragua retrospectively assessed the effect of malnutrition on treatment-related morbidity and survival in children aged 6 months to 18 years. Their findings were that advanced-stage cancers had almost twice the prevalence of undernutrition across the different cancer groups. The study in Nicaragua used a similar classification of cancer stage as in the present study. However, the method of nutritional classification included serum albumin, therefore making strict comparisons difficult. Although many published studies on nutritional status at cancer diagnosis, many did not assess nutritional status by cancer stage [4,9,19,31]. A prospective study with a larger cohort is needed to provide more information on the different cancer stages, risk groups and their relationship with nutritional status from diagnosis of cancer and throughout treatment. More importantly, increased public awareness, adherence to referral protocols, and treatment resources, regardless of caregivers' ability to pay for diagnosis and treatment, are key to addressing late presentation and advanced-stage disease. Renner and McGill [39], in a qualitative study to explore factors influencing health-seeking decisions and retention in childhood cancer treatment programmes at KBTH found, among other issues, that delays in seeking care from the first sign of disease ranged from two weeks to over a year. For families, delays in seeking care included a lack of knowledge, financial difficulties, fears about treatment, alternative therapies such as herbal treatments, faith healing, and self-medication [39]. The health system also contributes to these delays by rescheduling appointments due to physicians' unavailability, misdiagnosis, and long waits for the results of investigations [40].

This study had some limitations. Children aged 13 years and older were not included because, during the study period, there was an age limit of 12 years on admissions to the Department of Child Health, KBTH. This limited the number of more prevalent cancers in adolescents, like osteosarcoma and Hodgkin lymphoma. Two participants below age 6 months were also not classified using MUAC or UAMA as no validated age-appropriate measure was available.

Conclusion

Undernutrition is high at diagnosis of cancer at the POU, KBTH, with MUAC and UAMA identifying more children with wasting than WHZ and BAZ. Many children also presented with advanced-stage cancers associated with stunting and wasting. Lymphomas were also significantly associated with wasting. We recommend a nutritional rehabilitation protocol incorporating arm anthropometry for initial nutritional status assessment and a future prospective study to assess improvement in nutritional outcomes over the entire course of treatment.

DECLARATIONS

Ethical considerations

Ethical clearance was obtained from the Institutional Review Board, Korle Bu Teaching Hospital (KBTH-IRB 000112/2018).

Consent to publish

All authors agreed to the content of the final paper.

Funding

None

Competing Interest

No potential conflict of interest was reported by the authors.

Author contributions

The study concept and design were by NS, CS, ET and LR. NS collected study data. YA performed the statistical analysis. NS, CS, ET and YA interpreted the study results. NS and CS drafted the manuscript. All authors critically revised the manuscript and approved the final submitted version.

Acknowledgements

We would like to thank the children and caregivers who participated in the study. We also thank Dr Kokou Amegan-Aho and Mr Ayire Adongo for assisting in data cleaning and Dr Deborah Adotey and Dr Yussif Issaka who helped with data collection.

Availability of data

Data is available upon request to the corresponding author.

REFERENCES

1. WHO (2020) Cancer in Children. In: Available: https://www.who.int/news-room/fact-sheets/detail/cancer-in-children. (Accessed June 3, 2020).
2. Lam C, Howard S, Bouffet E, Pritchard-Jones K (2019) Science and health for all children with cancer. Science (1979) 363:1182–1187.
3. Bauer J, Jürgens H, Frühwald M (2011) Important Aspects of Nutrition in Children with Cancer. Adv Nutr 2:67–77.
4. Brinksma A, Roodbol P, Sulkers E, Kamps W, de Bont E, Boot A, Burgerhof J, Tamminga R, Tissing W (2015) Changes in nutritional status in childhood cancer patients: A prospective cohort study. Clin Nutr 34:66–73.

5. Israëls T, van de Wetering M, Hesseling P, van Geloven N, Caron H, Molyneux E (2009) Malnutrition and neutropenia in children treated for Burkitt lymphoma in Malawi. Pediatr Blood Cancer 53:47–52.

6. Bozzetti F, Mariani L, Vullo S, Amerio M, Biffu R, Caccialanza R, Capuano G, Correja I, Cozzaglio L, di Leo A, di Cosmo L, Finocchiaro C, Gavazzi C, Giannoni A, Magnanini P, Mantovani G, Pellegrini M, Rovera G, Rovera L, Sandri G, Tinivella M, Vigevani E (2012) The nutritional risk in oncology: a study of 1,453 cancer outpatients. Support Care Cancer 20:1919-1928.

7. Hébuterne X, Lemarié E, Michallet M, de Montreuil C, Schneider S, Goldwasser F (2014) Prevalence of malnutrition and current use of nutrition support in patients with cancer. J Parenter Enter Nutr 38:196-204.

8. Tazi I, Hidane Z, Zafad S, Harif M, Benchekroun S, Ribeiro R (2008) Nutritional status at diagnosis of children with malignancies in Casablanca. Pediatr Blood Cancer 51:495-498.

9. Shah P, Jhaveri U, Idhate T, Dhingra S, Arolkar P, Arora B (2020) Nutritional status at presentation, comparison of assessment tools, and importance of arm anthropometry in children with cancer in India . Indian J Cancer 52:210-215.

10. WHO (2020) WHO Anthro Survey Analyser and other tools. In: vailable:http://www.who.int/childgrowth/software/en/. (Accessed June 18, 2020)

11. Mramba L, Ngari M, Mwangome M (2017) A growth reference for mid upper arm circumference for age among school age children and adolescents, and validation for mortality: growth curve construction and longitudinal cohort study BMJ 358

12. Frisancho A (1974) Triceps skin fold and upper arm muscle size norms for assessment of nutritional status. Am J Clin Nutr 27:1052-1058.

13. Orgel E, Sposto R, Malvar J, Seibel N, Ladas E, Gaynon P, Freyer D (2014) Impact on survival and toxicity by duration of weight extremes during treatment for pediatric acute aymphoblastic leukemia: A report from the Children's Oncology Group. J Clin Oncol 32:1331-1337.

14. Israëls T, Borgstein E, Jamali M, de Kraker J, Caron H, Molyneux E (2009) Acute malnutrition is common in Malawian patients with a Wilms tumour: A role for peanut butter. Pediatr Blood Cancer 53:1221–1226

15. Joffe L, Ladas E (2020) Nutrition during childhood cancer treatment: current understanding and a path for future research. Lancet Child Adolesc Health 4:465

16. (2018) Childhood cancers on the rise – expert. In: http://www.ghanaweb.com/GhanaHomePage/health/Childhood-cancers-on-the-rise-expert-510946. (Accessed July 29, 2018)

17. Apprey C, Annan R, Arthur F, Boateng S, Animah J (2014) The assessment and prediction of malnutrition in children suffering from cancer in Ghana. European Journal of Experimental Biology. 4:31-37

18. Charan J, Biswas T (2013) How to calculate sample size for different study designs in medical research. Indian J Psychol Med 35:121-126.

19. Israëls T, Chirambo C, Caron H, Molyneux E (2008) Nutritional status at admission of children with cancer in Malawi. Pediatr Blood Cancer 5:626-628.

20. Available: https://stattrek.com/statistics/dictionary.aspx?definition=finite_population_correction (Accessed August 6 2018.) (2018) Finite population correction: Definition

21. de Onis M, Onyango A, Borghi E, Siyam A, Alain P (2006) WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and Development. . Geneva: WHO Press

22. (2020) WHO | Application tools. WHO. In: Available: http://www.who.int/growthref/tools/en/. (Accessed June 18, 2020)

23. Metzger ML KMCJHM (2016) Hodgkin Lymphoma. In Pizzo PA, Poplack DG, editors. Principles and Practice of Pediatric Oncology. Seventh Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins 568–584

24. Rabin K, Gramatges M, Margolin J, Poplack D (2016) Acute Lymphoblastic Leukaemia. In: Principles and Practice of Pediatric Oncology. Seventh Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins 463-493.

25. Arceci R, Meshinchi S (2016) Acute Myeloid Leukaemia and Myelodysplastic Syndromes. In Pizzo PA, Poplack DG, editors. Principles and Practice of Paediatric Oncology. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins 498–535

26. Rau R, Loh M (2016) Myeloproliferative Neoplasms of Childhood. In Pizzo PA, Poplack DG, editors. Principles and Practice of Pediatric Oncology. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins 545–564

27. Segbefia C, Renner L, Dei-Adomakoh Y, Welbeck J (2013) Changing pattern of childhood cancers at Korle Bu Teaching Hospital, Accra, Ghana. Postgrad Med J Ghana 2:65-67.

28. Welbeck J, Hesse A (1998) Pattern of childhood malignancy in Korle Bu Teaching Hospital, Ghana. West Afr J Med 17:81–84

29. (2015) Ghana Demographic and Health Survey 2014 - Key Indicators Report [PR59] - PR59.pdf. . In: Available: http://dhsprogram.com/pubs/pdf/PR59/PR59.pdf. (Accessed May 1, 2015)

30. McGovern M, Krishna A, Aguayo V, Subramanian S (2017) A review of the evidence linking child stunting to economic outcomes. Int J Epidemiol 46:1171–1191

31. BF C (2016) Nutritional Status of Children with Cancer at the University of Nigeria Teaching Hospital, Ituku/Ozalla, Enugu, Nigeria. Journal of Cancer Prevention & Current Research 5. https://doi.org/10.15406/jcpcr.2016.05.00167

32. Ladas E, Arora B, Howard S, Rogers P, Mosby T, Barr R (2016) A framework for adapted nutritional therapy for children with cancer in low- and middle-income Countries: A report from the SIOP PODC Nutrition Working Group. Pediatr Blood Cancer 63:1339–1348

33. Akowuah PK, Kobia-Acquah E (2020) Childhood Obesity and Overweight in Ghana: A Systematic Review and Meta-Analysis. Journal of Nutrition and Metabolism 2020:1–11. https://doi.org/10.1155/2020/1907416

34. Odame I, Reilly J, Gibson B, Donaldson M (1994) Patterns of obesity in boys and girls after treatment for acute lymphoblastic leukaemia. Arch Dis Child 71:147-149.

35. Reilly J (2009) Obesity during and after treatment for childhood cancer. In: Wallace WHB, Kelnar CJH, editors. Endocrine Development Basel: Karger 40-58.

36. Gross T, Biondi A (2016) Paediatric non-Hodgkin lymphoma in low and middle-income countries. Br J Haematol 173:651-654.

37. Laine A, Iyengar P, Pandita T (2013) The role of inflammatory pathways in cancer-associated cachexia and radiation resistance. Mol Cancer Res 11:967–972

38. Pribnow AK, Ortiz R, Báez LF, Mendieta L, Luna-Fineman S (2017) Effects of malnutrition on treatment-related morbidity and survival of children with cancer in Nicaragua. Pediatric Blood & Cancer 64:e26590. https://doi.org/10.1002/pbc.26590

39. Renner L, McGill D (2016) Exploring factors influencing health-seeking decisions and retention in childhood cancer treatment programmes: perspectives of parents in Ghana. Ghana Med J 50:149-156.

40. Brown B, Adeleye A, Ibeh J (2015) A prospective study on the causes of delayed diagnosis of childhood cancer in Ibadan, Nigeria. Pediatr Hematol Oncol 32:365-373.