Nutritional Status of Children with Cancer at the University of Nigeria Teaching Hospital, Ituku/Ozalla, Enugu, Nigeria

Abstract

Background: Childhood cancer is a leading cause of child mortality in developed countries as well as a recognized contributor to malnutrition and death in developing countries, in particular those of low socioeconomic status. It is estimated that about 50% of children with cancer in developing countries are malnourished while in developed countries, malnutrition among cancer patients is related to the type and the extent of tumor. Anthropometry is the most common and easy way for assessing the nutritional status of children.

Objectives: This study aimed at assessing the nutritional status of children with cancer at the University of Nigeria Teaching Hospital, Enugu, compared with non cancer controls, by using anthropometric parameters. It also attempted to determine the best anthropometric parameter to detect malnutrition in cancer patients.

Methods: Over a 36 month period, a case controlled study of children aged 3 months to 18 years with or without cancer was conducted to determine their nutritional status. The children comprised 104 patients with cancer (cases) and 104 controls seen at children's outpatient clinic with minor illnesses. Their anthropometric measurements were taken within 24 hours of admission and at point of contact for the controls.

Result: The prevalence of malnutrition was higher in cancer patients as the anthropometric parameters were significantly lower among them than the controls (WFA: t=0.019, HFA: t=0.019). Prevalence of malnutrition was higher in the low socioeconomic group. Skin fold thickness was observed to be a more sensitive indicator than weight related anthropometry in assessing the nutritional status of children with cancer.

Conclusion: Children with cancer on admission were significantly more malnourished than those without cancer and will require nutritional support to reduce the morbidity and mortality arising from such illness.

Keywords: Cancer; Nutrition; Status; Children; Enugu; Neuroblastoma; Anthropometry; Chemotherapy; Malnutrition

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Abbreviations: WAZ: Weight- for- Age Z-Score; WHZ: Weight-for-Height - Score; HAZ: Height-for-Age Z-Score; BAZ: BMI-for-Age Z-Score; MUACP: Mid-Upper Arm Circumference-for-Age Percentile; TSFT: Triceps Skin Fold Thickness; TSFP: Triceps Skin Fold-for-Age Percentile; SSFP: Sub scapular Skin Fold-for-Age Percentile

Introduction

Malnutrition is a recognized co-morbidity in cancer patients and is usually related to the type and extent of tumor. It develops mainly during the intensive phase of treatment of the disease but may be obvious or apparent at diagnosis. Nutritional support, therefore, is an important aspect of management as poor nutrition may be associated with poor prognosis [1,2].

Prevalence of malnutrition ranges from <10% in standard risk acute lymphoblastic leukemia (ALL) to 50% in advanced neuroblastoma [3-5]. Israels and co-workers [6] in Malawi reported that among children with cancer, 44.5% were stunted, 39.8% were underweight, 55.1% had an arm muscle area (AMA) for age below the 5th percentile while 59.3% had both mid upper arm circumference (MUAC) and triceps skin fold thickness (TSFT) below the 5th percentile. Also in Guatemala, Sala et al. [2] reported 68% prevalence of malnutrition in cancer patients with 46% of them severely malnourished.

Poor nutrition is associated with impaired immune function, higher risk of infections, delayed wound healing and altered drug metabolism [7]. These may result in impaired tolerance to chemotherapy, delay in initiating and need for more frequent chemotherapy adjustments [8]. Children with cancer are vulnerable to malnutrition because of increased substrate needs due to primary disease and its treatment as well as increased nutrient requirement to achieve appropriate growth and development [9].

There are different methods of evaluating nutritional status in children. Anthropometry has been the most popular and most useful among the methods. However, Sala and co-workers [2] noted that weight for height (WFH) is potentially misleading in children with large abdominal tumors who can weigh over 10% of their total body weight. Oguiz et al. [10] reported that arm anthropometry is a valuable means of assessing nutritional status since it is independent of tumor mass and recommended that the most essential information in evaluating nutritional status is the lean body mass. In determining the lean body mass, measurement of MUAC is essential while TSFT is important in measuring fat mass.

There is a dearth of information on the nutritional status of children with cancer in Nigeria, necessitating the current study which aims to determine the prevalence of malnutrition among children with cancer on admission at The University of Nigeria Teaching Hospital (UNTH), Ituku/Ozalla, Enugu as well as determining the best anthropometric indicator for detecting malnutrition among these children.

Subjects and Methods

This was a case controlled study conducted over a 3 year period (Jan 2011-Dec 2013) in the pediatric wards of UNTH, Ituku/Ozalla, Enugu. There are two pediatric wards with bed capacity of 60, where children with cancer are admitted for work up before commencement of cancer therapy.

All children aged 3 months to 18 years admitted into the pediatric wards with newly diagnosed cancer, classified according to International classification of childhood cancer (ICCC), and cancer therapy naïve were included in the study [11]. The control group included children of same age, sex and socioeconomic status attending the children's out-patient clinic with minor ailments such as cough and cold, uncomplicated malaria etc. Cancer patients who had received any cancer therapy before presenting to our health facility or whose parents/caregivers declined informed consent were excluded from the study. Ethical approval was obtained from the hospital's Health Research and Ethics committee before commencement of the study. Consent to publish the data from the study group was obtained from the parents/ care-givers as well as children 18 years of age.

The children had the following epidemiological information obtained and recorded in a pro forma designed for this study: age, gender, home address and residential address. The date of admission and complaints of patients were recorded as well as the age, occupation and socio-economic classification of parents/ care-givers. The socio-economic classification was determined using the classification by Ogunlesi et al. [12] which is based on the highest educational attainment, occupation and mean monthly income of the parents. The classification ranged from 1-5 with class 1 as the highest and 5 as the lowest. A general clinical examination and anthropometric measurements (weight for age, length/height for age, mid upper arm circumference and triceps and sub scapular skin fold thicknesses) were done within 24 hours of admission for cancer patients and at point of contact for the controls by one of the researchers who had special training on the use of the instruments.

Anthropometry

The Basinet weighing scale (Way master, England), measuring up to 20kg with 50g increments was used to measure the weight of infants. The child was placed in the basinet with all the clothing and diaper removed. The weight was recorded when the scale pointer was stable. Infants and children less than two years had their lengths measured in recumbent position with an infantometer (Sec G, model 416) measuring up to 100cm with an accuracy of 0.1cm. The infantometer or length board has a fixed head board and an adjustable foot board. The child was placed on the board after removing the shoes and socks with the eyes looking straight up. An assistant went to the back of the board and held the child's head in this position making sure the child's shoulders touched the board and the back not arched while the researcher held the child's legs, applying little pressure on the knees to strengthen the legs with one hand and moved the adjustable foot board with the other hand until the board touched the feet, making sure the soles were flat on the board and toes pointing upwards. The length was read to the nearest 0.1cm and recorded.

The weight and height of children up to two years and above and could stand without support were measured using a well calibrated stadiometer (Health Medical Equipment, England, RG 2-160). The instrument has a weighing scale that can weigh up to 160kg with 100g increments and a well calibrated adjustable vertical measuring rod attached to the rear of the weighing scale. A flat piece of metal is attached to the upper end of the measuring rod. The measuring rod is used to measure height up to 200cm with an accuracy of 0.1cm. The measuring rod was adjusted to a length higher than the height of the child and the flat metal lowered to touch the head of child who was standing erect on the weight measuring scale without shoes, wearing only underwear with the heels, buttocks and occiput touching the vertical rod. The feet were at an angle of 45° and heels together. The child was instructed to look straight ahead with the external auditory meatus and lower border of the orbit in the same horizontal plane. The feet were checked to be flat on the weighing scale before measurement was taken.

For the child up to two years and above but too sick to stand, the recumbent length was measured using the child length board and measured as described above for the younger child. 0.7cm was then subtracted from the value obtained as recommended by World Health Organization (WHO) to convert to the height [13]. The weight was measured by first measuring the weight of the caregiver alone on the stadiometer, then while carrying the child. The difference was then recorded as the child's weight. All weight and height measurements were done twice and the mean recorded on each occasion.

The skin fold thicknesses were measured at two sites, left triceps and left sub scapular regions using Pediatric Holtian skin fold calipers (Crymych, UK) which has a constant pressure

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of 10g/mm of contact surface area with the subjects standing or sitting relaxed and arms hanging by the sides. The measurements were expressed in millimeters (mm) and read directly in a dial with 0.2mm precision. The mid upper arm circumference was measured with a non-elastic tape placed at the mid-point between the acromion and olecranon processes and measurement read to the nearest 0.1cm.

The WHO in 1993 did a comprehensive review of the uses and interpretation of available growth charts and recommended that new growth curves were necessary since the NCHS/ WHO growth reference which had been in use since late 1970s did not adequately represent early childhood growth. The recommendation was endorsed in 1994 by the World Health Assembly and a Multicenter Growth Reference Study involving healthy breast fed children from Brazil, Ghana, Oman, Norway, India and United States of America (USA) was conducted between 1997 and 2003. New growth curves were generated for assessing the growth and development of children all over the world. The cut-off values were recommended to define the nutritional status of children [14]. Wasting was defined as weight-for-age Z-score (WAZ) of -2 to -3 or weight- for-length/ height Z-score (WFZ) of -2 to -3. Length/height-for-age Z-score (HAZ) of -2 to -3 was regarded as stunting. A child whose body mass index (BMI) Z-score (BMZ) is -2 to -3 is said to be thin. Anthropometric value with Z-score > -3 was defined as severe malnutrition while severe acute malnutrition (SAM) was defined as weight-for-length/ height Z-score < -3, MUAC of < 115mm (< -3 SD) and presence of bilateral leg edema.

Data analysis: Data was analyzed using WHO Anthro software (version 3.2.2) for children ≤5 years while WHO Anthro plus software (version 1.0.4) was used to analyze data for children above 5 years [15]. The Z- Scores for weight for age (WAZ), weight for height/length (WFZ), length/height for age (HAZ), BMI for age (BAZ); and mid upper arm circumference for age (MUACZ) and Triceps skin fold thickness for age (TSFZ) were generated once the age, sex and anthropometric parameters of the child were input.

The frequency, mean, standard deviation and range of continuous variables were determined. Chi-square test was used to compare differences in proportions while Student's t- test was used to compare means. Significance level was set at p<0.05.

Result

The subjects were 104, consisting of 64 (61.5%) males and 40 (38.5%) females while the controls (104) consisted of 63 (60.6%) males and 41 (39.4%) females. The gender of the study group was well matched (Fischer's exact, p = 1.00). The mean age of subjects was 7.7 (4.2) years while that of the controls was 7.8 (4.2) years. Seventy four (71.2%) from each group were under 10 years of age while 30 (28.8%) were above 10 years. Thirty seven of the participants from each group were under five years of age. There was no significant difference between the age of the subjects and controls (t = 1.05, d f= 191, p = 0.29).The result of the socio-economic classification showed that seven subjects and seven controls belonged to social class two while 17 from each group belonged to social class three. Thirty four and 32 participants respectively were from social class four while 46 and 48 of subjects and controls respectively belonged to social class five. None of the participants was from social class one. There was no significant difference in the social class of the study group (χ^2 =0.1032, df= 3.0, p=0.9915). The gender distribution of each socio-economic group is as depicted in (Table 1).

Table 1: Socio-economic classification and gender of subjects and controls.

Social Class	Subjects			Controls		
	M	F	Total	M	F	Total
1	0	0	0	0	0	0
2	4	3	7	4	3	7
3	10	7	17	11	6	17
4	21	13	34	19	13	32
5	29	17	46	29	19	48
Total	64	40	104	63	41	104

The subjects were diagnosed of various types of malignancies which were generally divided into hematological and solid malignancies as shown in (Table 2). The hematological malignancies were the leukemia and the lymphomas while the remaining ones were the solid tumors. Burkitt lymphoma was the most common malignancy, responsible for about 23% of all the malignancies followed by acute leukemia (17.3%) and renal tumors (16.3%). Brain tumors were not recorded because such tumors are usually diagnosed and managed by the neurosurgical unit of the hospital.

Table 2: Frequency of various malignancies among the subjects.

Tumor type	No	%
Burkitt's lymphoma	24	23.1
Renal tumors	17	16.3
ALL	11	10.6
Retinoblastoma	10	9.6
Rhabdomyosarcoma	8	7.7
Non Hodgkin's lymphoma	8	7.7
Hodgkin's disease	6	5.8
AML	7	6.7
Osteosarcoma	3	2.9
Hepatic tumors	3	2.9
Neuroblastoma	3	2.9
Others	4	3.8
Total	104	100

When the different anthropometric parameters were compared between the subjects and controls, it was noted that most of the parameters were significantly lower among the subjects than the controls except the body mass index (BMI) which was comparable in both groups. The mean weight for age (WFA) for the subjects was 23.58 (10.7) and 27.42 (12.52) for the controls (t= -2.374, df=206, p= 0.019). The mean height for age (HFA) for the subjects was 119.80 (24.0) while that for the controls was 127.83 (24.1), (t= -2.373, df=206, p=0.019) (Table 3).

Table 3: Comparison of anthropometric values between subjects and controls.

Anthropometry	Mean		p value
	Cases	Controls	
Weight (kg)	23.58±10.7	27.42±12.52	0.019
Height/Length (m)	1.19±0.24	1.27±0.24	0.019
BMI (Kg/M ^{2})	15.76±3.1	15.96±2.7	0.618
MUAC (cm)	13.73±2.6	16.43±1.5	0.001
TSFT (mm)	4.66±1.8	6.15±1.6	0.001
SSFT (mm)	4.1±1.8	5.81±1.0	0.001

When the anthropometric values of the study group were compared with WHO standard values to assess their nutritional status, it was observed that 12.2% of the eligible subjects were wasted (WAZ, <-2) compared with controls where all had normal weight (Fischer's exact, p=0.003). Using weight for length/height Z-score for age (WHZ) which is appropriate for children under 5 years of age, 16.2% of subjects and 5.4% of controls were wasted (Fischer's exact, p=0.26). On the other hand, 11.5% of the subjects were stunted compared with only 1.0% of controls when length/height for age Z-score (HAZ) was used as an indicator of nutritional status ($\chi 2$ = 9.928, p = 0.002). The thin subjects were 9.6% (10/104) (BAZ < -2) compared with 5.8% of the controls (Fischer's exact, p=0.44). It was also noted that 6.7% (7/104) and 8.7% (9/104) of the subjects were overweight and obese respectively compared with 10.6% and 1.0% of controls. When triceps skin fold thickness (TSFT) was used, 70.3% of under 5 subjects were found to have malnutrition (TSFT, < -2 Z-score) compared with 35.1% of the controls (Fischer's exact test, p= 0.001). On the other hand, 54.1% of eligible subjects (< 5 years) had malnutrition while none of the eligible controls was diagnosed of malnutrition by using MUAC, < -2 Z-score (p= 0.005). Although TSFT is more sensitive, its specificity is lower as a measure of malnutrition than MUAC. (Table 4) compares the anthropometric values of subjects and controls with WHO standard values.

Table 4: Prevalence of malnutrition among the study groups.

	Subjects	Controls	P value
	n (%)	n (%)	
WAZ	9/74 (12.2)	0/74 (0)	0.003*
WHZ	6/37 (16.2)	2/37 (5.4)	0.26
HAZ	12/104(11.5)	1/104 (1.0)	0.002*
BAZ	10/104 (9.6)	6/104(5.8)	0.44
MUACZ	20/37 (54.1)	0	0.001*
TSFZ	26/37 (70.3)	13/37(35.1)	0.005*

*Statistically significant
WAZ is only appropriate for children ≤ 10 years of age
WHZ, MUACZ (MUAC Z-score) and TSFZ (TSFT Z-score) are only appropriate for children ≤ 5 years of age
HAZ and BAZ are appropriate for all age groups.

With respect to the different tumors, the prevalence of malnutrition was 25% (8/32) among patients with hematological malignancies and 54.2% among their counterparts with the four most common solid tumors (Table 5). 70.5% (12/17) of the children with renal tumors and 100% (10/10) of those with retinoblastoma were malnourished. Also 25% (6/24), 33.3% (6/18), 50% (4/8) and 14.3% (2/14) of patients with Burkkit lymphoma, acute leukemia, rhabdomyosarcoma and lymphomas respectively were malnourished.

Table 5: Prevalence of malnutrition among patients with different tumors.

Tumor Type	No	Malnourished	Not Malnourished	% Malnourished
Hematologic	32	8	24	25
*Solid Tumors	59	32	27	54.2
Hematologic				
Acute Leukemia	18	6	12	33.3
Lymphomas	14	2	12	14.3
***Solid tumors**				
Burkkit Lymphoma	24	6	18	25
Renal Tumors	17	12	5	70.6
Retinoblastoma	10	10	0	100
Rabdomyosarcoma	8	4	4	50

*Four most common solid tumors.

However, detecting malnutrition in individual tumor cases was dependent on the anthropometric parameter used. Among the under five children with renal tumors, 90.9% (10/11) had malnutrition based on either MUAC or TSFT < - 2 Z-score for age and sex respectively while none was detected based on WHZ < -2. In fact, Two (18.2%) of the 11 under five children with renal tumor were overweight (WHZ > 2). Three out of four (75%) patients ≤ 5 years of age with acute leukemia were malnourished based on either TSFT or MUAC <-2 Z-score while 25% (1/4)was overweight (WHZ >2). On the other hand, among same category of patients with retinoblastoma, 70%-100% of them were able to be detected by measuring MUAC or TSFT while only 50% could be detected by WFH alone (Table 6).

Relating the socio-economic status of the subjects and nutritional status, the prevalence of malnutrition was 67.4% among the lowest socio-economic class (class 5) and 41.2% (14/34), 29.4% (5/17), 28.6% (2/7) among socio-economic classes 4, 3 and 2 respectively. There was a significant difference in the prevalence of malnutrition among the subjects in the different socio-economic groups ($\chi 2$ =10.79, p= 0.01). On the other hand, 12.5% (6/48) of the controls in socio-economic class 5 were malnourished while the prevalence of malnutrition was 9.4% (3/32), 11.8% (2/17) and 14.3% (1/7) among socio-economic classes 4, 3 and 2 respectively. However, there was no significant difference ($\chi 2$ =0.242, p= 0.97) in the prevalence of malnutrition amongst the controls with respect to their socio-economic class. The diagnosis of malnutrition was based on any of the anthropometric parameters (weight for age, weight for height, Body mass index, triceps skin fold thickness or mid upper arm circumference) below 2 SD of child's age and sex.

Table 6: Skin fold thickness and weight for height in assessing nutritional status of under 5 year old children with different tumors.

Tumor type	No	TSFT/ MUAC <-2	WHZ <-2	WHZ >2
BL	4/24 (16.7%)	1/4 (25%)	1/4 (25%)	1/4 (25%)
Acute leukemia	4/18 (22.2%)	3/4 (75%)	-	1/4 (25%)
Renal tumors	11/17 (64.7%)	10/11 (90.9%)	-	2/11 (18.2%)
Retinoblastoma	10/10 (100%)	7/10 (70%)	5/10 (50%)	-
Rhabdomyosarcoma	4/8 (50%)	1/4 (25%)	-	1/4 (25%)

BL: Burkkit lymphoma; WHZ: weight for height, Z-score; MUACZ: Mid-upper circumference Z-score

TSFZ: Triceps skin fold thickness Z-score; MUACZ, TSFZ and WHZ are only appropriate in children ≤ 5 years of age

Discussion

Cancer is a significant cause of morbidity and mortality in children and tends to occur more in males than females with some cancers occurring more in economically deprived families than affluent ones. From the current study, more males were affected than the females. This gender difference has been documented by some authors from other parts of the globe and may be explained by the fact that during childhood, the extra X-chromosome or absence of Y-chromosome in females confers them with inherent survival advantage [16]. A second explanation which may be peculiar to the Eastern part of Nigeria and some parts of Asia is family sex preference, where families tend to seek health care for their male children earlier than the female ones [17]. Majority of the affected patients were from the low socio-economic class which makes them more susceptible to infections and malnutrition both of which have been documented as risk factors for development of cancer [18]. Therefore, improvement in the socio-economic status of the populace as well as improvement in the health care system to prevent infections may significantly reduce the prevalence of malignancies in our society. This proactive approach has been shown to yield positive result in a recent study in Brazil and should be adopted by the developing countries [19]. Cancer on the other hand may suppress patient's immunity with subsequent increase susceptibility to infections and malnutrition; due to anorexia, vomiting, diarrhea and increased catabolism.

Cancer is a known contributor to childhood malnutrition in both developed and developing countries of the world [20]. Most studies [21,22] on cancer and nutritional status have concentrated on adults or those who were already on cancer treatment but our study evaluated treatment naïve children. In the current study, it was noted that over 70% of children with cancer were malnourished with TSFT < - 2 Z-score compared with 35.1% of the controls. Also with MUAC, 54.1% of subjects and none of the controls had malnutrition. This indicates that although TSFT may be more sensitive in detecting malnutrition, MUAC is more specific, as it is a measure of lean body mass; loss of which is more important clinically than fat mass. With use of MUAC as a measure of malnutrition, the prevalence of malnutrition in the subjects was slightly lower than that obtained by Israels et al. [6] in Malawi (59.3%) and Sala et al. [2] in Guatemala (68%) among their study populations. The difference in figures may probably be due to differences in the background malnutrition in these countries. However, in the study by Maia Lemos et al. [19] in Brazil, the prevalence of inadequate nutrition was reported as 27.02% and 24.74% using TSFT and MUAC respectively. The low prevalence was attributed to improved organization in basic care and promotion of access to health care facilities. The under developed countries like Nigeria and Malawi should therefore borrow a leaf from the Brazilian authorities to improve the economic and health care needs of their citizenry which may result in a reduction in the prevalence of childhood primary and malignancy related malnutrition. 16.2% of the subjects were wasted (WHZ < - 2) compared with 5.4% of the controls. The prevalence of wasting in our subjects is comparable with the 17.2% documented by Israels et al [6] in Malawi. This may not be surprising as both countries are poor developing countries in Africa. On the other hand, prevalence of stunting (HAZ < - 2) was noted to be 11.5% and 1.0% in subjects and controls respectively in the present study. This prevalence in our subjects is much lower than 39.8% documented by Israels and colleques. [6] A child is wasted when he/she has low weight-for-height and in most cases indicates a recent and severe process of weight loss, but may also arise from a chronic unfavorable condition such as cancer. On the other hand, stunted growth reflects low height/length-for-age and indicates a failure to achieve linear growth potential which can result from suboptimal health or poor nutritional intake. Use of height for age is a reliable way to assess chronicity of malnutrition and is likely to be low in children with advanced stage disease. The difference in both studies may therefore be related to possible differences in the stages of cancer among the two study populations or due to difference in the background malnutrition in the general population. It has been documented that children with advanced stage cancer may suffer more malnutrition than those with early stage disease [23]. The reason for developing malnutrition in cancer is related to the cachectic effect of the disease. Cachexia is a syndrome of anorexia, early satiety, weight loss, anemia and marked asthenia [24]. It may also be due to increased metabolic demand, associated vomiting, decreased absorption and excessive loss from diarrhea as well as inadequate intake due to mechanical obstruction from head and neck and gastrointestinal tumors [25]. The effect of cancer on nutrition is dependent on the stage of the tumor as it has been observed that the prevalence of malnutrition in newly diagnosed cancer patients is not different from that in the reference population or in children with benign tumors [26]. However, with advancement in stage and the consequent catabolic effect of the tumor, cancer patients may be more predisposed to malnutrition. Most of the patients with cancer in developing countries present late to oncology centers when the disease would have advanced [27,28]. In our previous study, we observed that majority of our cancer patients presented late to the oncology center which consequently resulted in delayed diagnosis [27]. It is therefore important that nutritional assessment, diagnosis and possible intervention be started at time of diagnosis of cancer to minimize the nutritional depletion imposed by the disease.

From the present study, it was observed that many children with cancer who were malnourished would have been omitted if only weight and height related anthropometry such as WFH and BMI were used to assess malnutrition. Less than 20% would have been identified if only weight related anthropometry was used while less than 15% would have been identified if only height related measurement was used. However, about 70% was identified with the use of TSFT and 54.1% with MUAC. These were in keeping with findings by Oguz et al. [10] who noted no significant difference in weight related anthropometric values of children with and without cancer but showed a significant difference in the prevalence of malnutrition between the two groups when TSFT and MUAC were used to assess malnutrition in Turkish population. Also Brinksma et al. [29] observed the incidence of under nutrition in newly diagnosed pediatric cancer patients to be between 23-29% using weight and height as parameters.

However, assessing the weight of a child with cancer at presentation is very important as it is usually the first pointer to malnutrition. Alongside anthropometric data, a thorough clinical and dietary history should be taken by the health care team. Clinicians should enquire about significant weight loss over the past few months, as severe weight loss can be masked by large tumor mass in children presenting with appropriate weight parameters for age. This situation can be averted if the weight at diagnosis is compared with weight before the onset of disease [29]. Using BMI alone can be more misleading in assessing nutritional status in children with cancer as observed in the current study that a substantial number were overweight. This observation may be in apparent and can be due to large tumor mass especially with intra-abdominal tumors [9]. However, actual obesity has been noted in cancer patients by Rogers et al. [30].

In relating nutritional status with the type of cancer, the prevalence of malnutrition was higher in patients with solid tumors than those with hematological malignancies. This may be due to the fact that most solid tumors present chronically and patients especially in our setting present late. This late presentation allows for the tumor to impart on child's nutrition with its competing metabolic demand for growth [31]. It was observed that weight and height related anthropometry was still deficient in identifying patients with malnutrition. Most Patients with large tumor masses such as renal tumor or Burkitt lymphoma would not have been detected as having malnutrition if weight or height related anthropometric parameters were used alone to assess their nutritional status, as such large tumors would add to their weight. This same observation has also been documented by other authors who noted that some intra-abdominal tumors would add up to 10-20% to patient's weight [2]. Many Patients with retinoblastoma had malnutrition despite small volume tumors. This may be as a result of cachectic effect of advanced tumors as most patients with retinoblastoma in our center present late with metastatic tumors. Metastatic deposits through hematogenous spread to tissues such as lungs, liver and bone may result in aberrant less reduction in weight with more marked reduction in arm anthropometry.

Conclusion

This study showed that a significant number of children with cancer were malnourished at presentation. The prevalence of malnutrition was significantly related to the socio-economic status of patients and skin fold thickness was a better indicator of malnutrition than weight related parameters in children with cancer.

Recommendations

Nutritional support and/or intervention should be incorporated in the management program of cancer patients in developing countries. Development of a nutrition algorithm is recommended to address high nutritional risk patients. Nutritional rehabilitation program was instituted on the patients who were malnourished. The daily caloric requirement was calculated based on the patients' current weight and were fed using locally made high energy mixture (HEMIX) prepared in the Dietetics Department of the Hospital. Each 100ml of full strength HEMIX contains 130 calories of energy.

Use of height and weight related measurements in assessing nutritional status of children with cancer can be misleading. Therefore use of skin fold thickness which is more reliable should be adopted in the nutritional assessment of children with cancer.

Limitation of the study

A limitation of this study was inability to seek for other factors contributing to malnutrition other than cancer. Also the authors did not include the diagnosis in the control group.

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