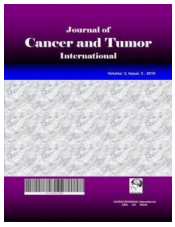

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Nutritional Intervention in Children Undergoing Chemotherapy for Cancer

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Authors' contributions

This work was carried out in collaboration between all authors. Authors CA and RAA designed, implemented and performed statistical analysis. Authors RAA, FKNA, CL and AOA supervised the implementation of the study and contributed to writing the protocol. Author CA managed the literature searches and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This non-randomised controlled study investigated the effect of a Soy Milk Powder (SMP) on nutritional status, recovery and survival of children undergoing chemotherapy for Burkitt's Lymphoma and Wilms Tumour in Kumasi, Ghana. The intervention group received the supplement, which provided 80% of their Recommended Daily Allowance for protein per day for 6 months. Compliance, nutritional impact and survival at 1 year were monitored. Sixty-four children (32 each in intervention and non-intervention) were recruited using consecutive sampling. The two groups were similar at baseline, but at 3 and 6 months follow up, all the anthropometric parameters: TSF (p=0.008), MUAC (p=0.003), BMI (p=0.013) and MAC (p=0.026), except weight and height significantly increased in the intervention group. Serum zinc (p=0.021) and Hb (p=0.023) also

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increased significantly in the intervention group. No intervention child had low BMI-for-age nor low MUAC, compared with 18.1% and 13.6% respectively, in the non-intervention. Low Hb (from 100% to 15.8%), reduced glutathione (from 21.9% to 0%) and zinc deficiency (87.5% to 52.6%) also reduced. At the one year follow up, 47% recovered and 19% died in the intervention group, compared with 16% recovery and 28% mortality in the non-intervention ($p<0.001$). In conclusion, SMP improved nutritional parameters and survival in children with cancer.

Keywords: Body mass index; dietary intervention; dietary recall; glutathione and zinc.

ABBREVIATIONS

BL : Burkitt's Lymphoma
WT : Wilms Tumour
GSH : Reduced Glutathione.
SMP : Soy milk powder
TSF : Triceps skin fold
MUAC : Mid-upper arm circumference
MAC : Muscle arm circumference
BMI : Body Mass Index
Hb : Haemoglobin
KATH : Komfo Anokye Teaching Hospital
RDA : Recommended Daily Allowance
POU : Paediatric Oncology Unit
CHRPE : Committee for Human Research Publications and Ethics
KNUST : Kwame Nkrumah University of Science and Technology

1. INTRODUCTION

Nutrition, infection/disease and immune function are synergistically interrelated [1]. Malnutrition can predispose an individual to infection, disease and make recovery from disease slower and/or disease progression more rapid. Likewise, good nutrition enhances immunity and ability to fight infections and disease [2]. Infections and disease can lead to malnutrition and nutritional deficiencies, by increasing nutrients requirement, utilization, losses and metabolism as the body tries to mount an immune response against the invading pathogen or disease [1]. Therefore, disease in general, including cancers have the potential to cause malnutrition and nutrient deficiencies [3].

Nutritional decline has been implicated as one of the challenges in cancer treatment, especially in childhood cancers, with up to 46% of children and young adults with cancer experiencing malnutrition either from the tumour or the treatment processes. Poor nutrition affects tolerance to chemotherapy, immune status and survival of patients [4]. The overall cure rates of childhood cancers in developed countries is much higher than for children living in developing countries, where challenges like access to adequate care facilities, delays in diagnosis, the prevalence of infectious diseases and malnutrition reduce survival [5].

Among the aforementioned factors, malnutrition has been widely implicated, with prevalence reaching 50% among children with cancer in developing countries [5]. To overcome this challenge, nutritional interventions in the course of cancer treatments are encouraged, and these are usually achieved by supplementing energy and protein intake [6-8] Although animal-based protein, such as whey and casein are commonly used supplemental proteins, they are costly and less accessible among poorer populations in developing countries. A plant-based protein source such as soybean, which has been ranked as the world's cheapest source of protein, can serve as a good high protein nutritional supplement alternative [9-11]. In this non-randomised controlled trial, we investigated the effect of soymilk powder (SMP) supplement on nutritional status, cure rate and survival of children undergoing chemotherapy treatment for Burkitt Lymphoma (BL) and Wilm's tumour (WT) at a tertiary hospital in Ghana.

2. MATERIALS AND METHODS

2.1 Study Site and Population

The study was conducted at the Paediatric Oncology Unit (POU) of the Komfo Anokye Teaching Hospital (KATH), Kumasi-Ghana from July, 2010-August, 2014. A total of 64 children undergoing chemotherapy for BL or WT were recruited for the study; 32 children received the intervention while another 32 served as non-intervention controls.

2.2 Participant Recruitment

The participants were selected and allocated into the intervention or non-intervention groups on a first come first serve basis. This means that once a child was diagnosed with cancer and started treatment, he or she was recruited. The first 32 children recruited formed the intervention group

while the next 32 were allocated to the non-intervention group. Any participant whose parents refused to give consent, were diagnosed with any other cancers apart from the two being investigated, or were allergic to soybean were exempted from the study.

2.3 Baseline Assessment

Once a child was recruited, baseline nutritional markers were taken. These included weight, height, mid-upper arm circumference and triceps skinfold. Muscle Arm Circumference was calculated using the formula MAC=MUAC 0.1 (3.14 × Triceps Skinfold TSF) [12].

For the biochemical analysis, 5 ml of venous blood was collected. The whole blood was used for the Hb assay and the serum for zinc, pre-albumin and reduced glutathione assessment.

A three-day consecutive 24-hour dietary recall, including a weekend was done to assess nutrients intake.

2.4 Intervention

Children recruited into the intervention group were given soymilk powder for consumption in addition to their normal diet. The supplements were given out by nurses working in the ward, who had been trained for the study. The supplement was packaged in 500 grams pack with a caloric value of 397.1 kcal per 100g. In terms of nutrient composition, the supplement contained a total of 6.3 g fat, 35.8 g carbohydrates, 2.1 g of dietary fibre, 4.7 g of ash and 49.3 g of protein per 100 grams. A ration of the supplement that lasted for two weeks as well as provided 80% of the RDA for each child based on his or her age and gender was given to carers to be given to the children. The supplement was to be added to liquid breakfast such as porridge and was to be consumed by the child alone. The rationale for the 2 weekly rations was because the patients came to the hospital for a review every 2 weeks. In cases where the next review date exceeded two weeks, the supplement was provided to last the period before the review. All carers were contacted on phone twice a week (a weekday and a weekend) to monitor their progress and compliance. During such calls, parents were encouraged to ensure the children consumed the supplement and when they came for a review, compliance was assessed. A record book was also provided at the ward to aid nurses on duty on when to give carers the supplements. The record book also contained the date of recruitment, the date for the 3 months follow up and that for the 6 months follow up. This made it easier to follow up on participant, as well as to reduce the incidence of dropouts in the study since participants were recruited at different periods. At the 3 months follow-up, dietary assessment, anthropometric measurements, blood samples for biochemical analyses of specific nutrients and physical examination for signs of malnutrition were taken. This was repeated 6 months from the time of recruiting each participant. Data on survival and recovery were collected after 1-year of recruitment. The non-intervention group did not receive the soy supplement however, they were to be on their normal diet and given the necessary nutritional education whenever they came for review. Data was collected on them at baseline, 3 and 6-months follow-up.

2.5 Ethical Approval

Ethical approval for the study was obtained from the Committee on Human Research, Publications and Ethics of KNUST and KATH with the clinical registry number (CHRPE/ KNUST/ KATH/ 17/11). All human rights procedure provided by the ethics committee regarding participants involved in this study was appropriately followed. Participants provide signed informed consent before participating in the study. All participants were informed about their freedom/right to withdraw from the study at any point with no reason for withdrawal required. All information collected in this study were given code numbers and kept confidential by the researcher. No name was recorded on questionnaires. Data collected was not linked to participants of both groups in any way.

2.6 Data Analysis and Management

Data were entered into Microsoft office 2010 excel spreadsheet. Normality of all continuous variables was tested. Non-parametric variables were normalized by log transformation before analysis and results were converted by antilog where appropriate. Continuous variables were expressed as mean ± SD, whereas categorical variables were expressed as frequencies and proportions. Comparisons of the general characteristics of the intervention group against the non-intervention group were performed using paired sample t-tests, chi (χ 2) tests, or Fisher exact tests where appropriate. For comparing the intervention and non-intervention groups at baseline, 3-months and 6-months follow up,

repeated measure analysis of variance was used. GraphPad Prism version 5.00 for Windows was used for these statistical analyses (GraphPad Software, San Diego California USA, www.graphpad.com). The WHO Anthro software v 3.2.2 and WHO AnthroPlus v 1.0.4 were used to determine the BMI-for-age z scores in order to categorise the patients as undernourished, normal or overweight.

3. RESULTS

Table 1 shows the anthropometric and biochemical indices between the intervention and non-intervention groups at baseline, 3 months and 6 months follow up. The intervention and non-intervention were not different in terms of mean height, weight, BMI, TSF, MUAC and MAC. For the biochemistry, serum reduced glutathione and zinc levels were not different between the two groups at the baseline. However, for Hb (<0.0001) and Pre-albumin (0.002), this was significantly different at baseline.

At 3 months follow up, all the anthropometric parameters were significantly higher in the intervention group except height and weight which were not significantly different, TSF (p=0.0008), MUAC (p=0.003), BMI (p=0.013) and MAC (p=0.026). Likewise, the intervention group had higher zinc (p=0.021), reduced glutathione (p=0.21), Hb (p=0.023) and pre-albumin (p=0.058) levels at 3 months following the supplementation.

After 6 months of supplementation, all the anthropometric and biochemical indices were significantly higher in the intervention group compared with the non-intervention with weight, height, BMI and serum zinc being the exceptions.

Table 2 shows the prevalence of malnutrition at baseline, 3 months and 6 months follow up for the intervention and non-intervention groups. It can be gleaned from the table that BMI-for-age, stunting, wasting status, TSF and MUAC did not vary in the non-intervention group at the 3 study points, although underweight and low MAC status were reduced. On the other hand, in the intervention group, at 6 months follow up, no child had low BMI-for-age compared with 18.1% of the non- intervention group, and no child had low MUAC, compared with 13.6% of the non-intervention. Table 3 shows the difference in prevalence of low biochemical indices between the intervention and non-intervention groups. Zinc status improved in the non-intervention group, unlike the intervention group that had anaemia reduced from 100% at baseline, through 76.9%. at 3 months to 15.8% at 6 months, and reduced glutathione deficiency reduced from 21.9% at baseline to 0% at 6 months and zinc deficiency reducing from 87.5% at baseline to 52.6% at 6 months.

Fig. 1A and 1B show the percentage of the intervention group and non-intervention respectively who recovered, not recovered or died at 12 months following the intervention. In the intervention group, 47% of the children recovered compared with 16% in the non-intervention group. Thirty-five per cent (35%) of the intervention compared with 56% of the non-intervention group did not recover and 19% of the intervention group compared with 28% of the non-intervention died. The differences were statistically significant (p<0.001).

4. DISCUSSION

The SMP intervention was associated with improved recovery and reduced death. In the intervention group, 47% of the children recovered compared with 16% of the non-intervention while 35% of the intervention compared with 56% of the non-intervention group did not recover. Our findings suggest that the SMP improved nutrient intake, which in turn led to improved nutritional parameters and consequently survival amongst children with BL and WT. At baseline, the children were all similar, whether in intervention or non-intervention category for most of the parameters. However, mean levels of the anthropometric and biochemical parameters were all higher in the intervention group at 3 and 6 months of intervention than in the non-intervention. Comparison of nutrient intake assessed by 24-hour dietary recall between the intervention and non-intervention group shows no difference. The 24-hour recall only covered food intake outside the supplementation and the lack of difference between the two groups suggests that the supplement was the main factor that separated the intervention from the non-intervention groups in terms of nutrient intake.

The proportion of malnourished children using BMI-for-age reduced by 50% in the intervention group compared to the 10.1% in the non-intervention group. The number of children who were stunted, wasted and underweight all decreased after the 6-month intervention. The percentage of children with anaemia using Hb as a marker also decreased from 100% to 15.8% in the intervention group and from 84.4% to 72.7%

Table 1. Differences between intervention and Non-intervention indices at baseline, 3-months and 6-months

Parameters	Baseline			Third month			Sixth month		
	Intervention	Non-intervention	p-value	Intervention	Non-intervention	p-value	Intervention	Non intervention	p-value
Height (cm)	111.8±3.3	107.8±3.1	0.376	113.8±3.5	110.3±3.1	0.457	114.0±3.9	111.0±3.5	0.572
Weight (kg)	18.7±1.2	17.0±0.9	0.288	20.7±1.1	17.8±1.0	0.057	20.5±1.2	18.2±1.2	0.171
BMI (kg/m^2)	14.9±0.8	14.4±0.3	0.555	15.9±0.4	14.5±0.4	0.013	15.8±0.6	14.6±0.4	0.092
TSF (cm)	4.9±0.3	4.9±0.3	0.943	6.6±0.3	5.1±0.3	0.0008	7.1±0.2	5.2±0.3	0.0001
MUAC (cm)	14.1±0.4	14.0±0.5	0.952	15.9±0.3	14.1±0.5	0.003	16.9±0.4	14.7±0.5	0.002
MAC (cm)	12.4±0.4	12.5±0.4	0.973	13.8±0.4	12.5±0.4	0.026	14.6±0.4	13.1±0.4	0.011
Zinc (Mm)	0.04±0.02	0.0078±0.0007	0.347	0.13±0.05	0.0081±0.001	0.021	0.06±0.05	0.02±0.010	0.402
GSH (µM)	30.6±6.7	53.0±15.2	0.184	68.8±14.0	47.2±10.7	0.211	136.1±21.0	59.6±14.9	0.005
Hb (g/dl)	7.8±0.2	9.3±0.3	<0.0001	10.2±0.3	9.1±0.3	0.023	11.9±0.3	9.9±0.3	<0.0001
PreAlb (ng/ml)	369.1±11.76	308.3±15.1	0.002	611±16.8	295.8±13.5	0.058	561.1±14.8	300.9±14.04	<0.0001

Data has been presented as Mean± SD and comparison between intervention and non-intervention parameters at baseline, 3-month and 6-month was done using Unpaired T-test.

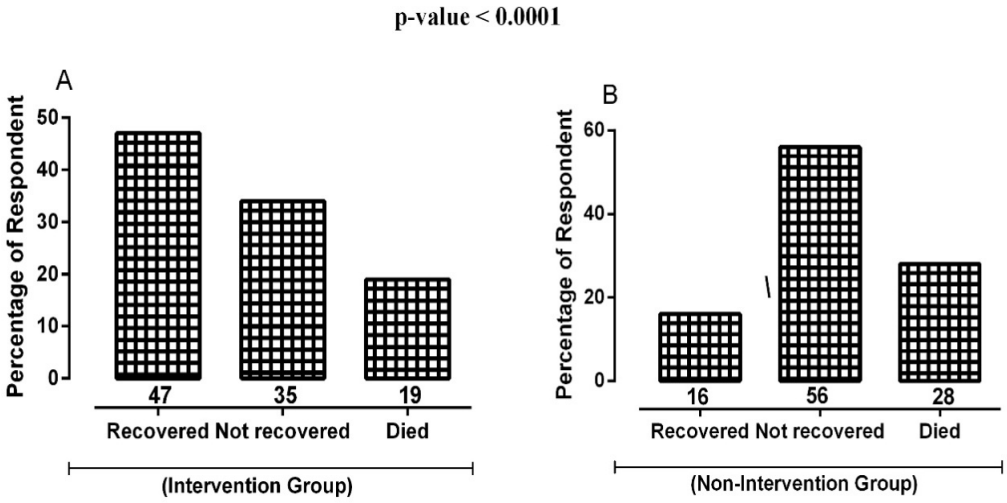

Fig 1. The rate of Recovery, treatment and expiry for intervention and non-intervention

in the non-intervention group. Similarly, the decrease in the percentage of children who were deficient in zinc, glutathione or pre-albumin was higher in the intervention group than the non-intervention. This means that supplementation was effective in improving the nutritional status of the participant.

Table 2. Prevalence of malnutrition using anthropometric markers at baseline, 3-month and 6-month for intervention and non-intervention

Parameters	Baseline	3-Months	6-Months	p-value
Non-intervention				
BMI for age				
Severely malnourished	2(6.3)	2(7.7)	1(4.5)	0.8951
Moderately malnourished	7(21.9)	6(23)	3(13.6)	
Normal	23(71.8)	18(69.3)	18(81.8)	
Height for age				
Severely malnourished	4(12.5)	3(11.6)	0(0)	0.1421
Moderately malnourished	9(28)	5(19.2)	2(9.1)	
Normal	19(59.5)	18(69.2)	20(90.9)	
Weight for height				
Severely malnourished	1(3.1)	0(0.0)	1(3.1)	0.8099
Moderately malnourished	2(6.3)	1(3.1)	2(6.3)	
Normal	9(28.1)	10(31.3)	8(25.0)	
Weight for age				
Severely malnourished	10(31.3)	1(3.8)	0(0)	0.0039
Moderately malnourished	5(15.6)	4(15.4)	2(9.1)	
Normal	17(53.1)	21(80.8)	20(90.9)	
MUAC				
Severely malnourished	5(15.6)	3(11.5)	2(9.1)	0.1949
Moderately malnourished	9(28.1)	6(23.1)	1(4.5)	
Normal	18(56.1)	17(65.4)	19(86.4)	
MAC				
Lower third	19(59.4)	12(46.2)	5(22.7)	0.021
Middle third	11(34.4)	6(23.1)	9(40.9)	
Upper third	2(6.3)	8(30.8)	8(36.4)	
TSF				
Lower third	10(31.3)	7(26.9)	6(27.3)	0.6088
Middle third	16(50)	10(38.5)	8(36.4)	
Upper third	6(18.8)	9(34.6)	8(36.4)	

Parameters	Baseline	3-Months	6-Months	p-value
Intervention				
BMI for age				
Severely malnourished	7(21.9)	3(11.5)	0(0)	0.0053
Moderately malnourished	9(28.1)	3(11.5)	0(0)	
Normal	16(50)	20(76.9)	18(100)	
Height for age				
Severely malnourished	4(12.5)	7(26.9)	1(5.3)	0.2759
Moderately malnourished	11(33.3)	5(19.2)	6(31.6)	
Normal	17(51.5)	14(53.8)	12(63.2)	
Weight for height				
Severely malnourished	1(7.7)	0(0.0)	0(0.0)	0.6879
Moderately malnourished	3(23.1)	1(10)	1(14.3)	
Normal	9(69.2)	9(90)	6(85.7)	
Weight for age				
Severely malnourished	5(15.6)	0(0)	1(11.1)	0.1186
Moderately malnourished	6(18.8)	4(15.4)	1(11.1)	
Normal	21(65.6)	22(84.6)	17(89.5)	
MUAC				
Severely malnourished	3(9.4)	0(0)	0(0)	0.0286
Moderately malnourished	4(12.5)	0(0)	0(0)	
Normal	25(78.1)	26(100)	19(100)	
MAC				
Lower third	7(21.9)	5(19.2)	7(36.8)	0.2612
Middle third	21(65.6)	17(65.4)	7(36.8)	
Upper third	4(12.5)	7(26.9)	5(26.3)	
TSF				
Lower third	8(56.3)	9(34.6)	6(31.6)	0.4859
Middle third	15(46.9)	13(50)	6(31.6)	
Upper third	9(28.1)	4(15.4)	7(36.8)	

Stunting is usually caused by long-term insufficient nutrient intake and repeated infections [13] and is termed chronic malnutrition. Wasting or low weight-for-height, on the other hand, is caused by acute significant food shortage and/or disease, and as an acute form of malnutrition, it is also a strong predictor of mortality among children under 5 years. Wasting is usually said to cause muscle and fat tissue to 'waste' away. However, wasted children can become normal after a relatively shorter intervention duration or treatment, while stunting takes a longer duration to reverse. In this study, stunting reduced by about 10% after the 6 months while wasting reduced by about 50% after 6 months of intervention. In the non-intervention group, about 40% of the children were stunted at baseline and this reduced by 10% after 3 months and by another 20% in the second 3 months, showing stunting improved more in the non-intervention group.

MUAC is an indicator of muscle mass and can be used as a proxy for wasting and a good predictor of the risk of death [14]. At baseline, the differences in MUAC between the intervention and non-intervention was not significant. However, the proportion of 25% of children in the intervention group who had low MUAC became normal after the intervention. This implies that the supplement improved muscle mass, and may prevent muscle loss in children undergoing chemotherapy for cancer. Skinfold thickness measurement is a well-established parameter for assessing the thickness of subcutaneous fat in all ages, including infants and represents a significant advance over body mass index [15,16]. In this study, mean TSF improved significantly following the intervention while the non-intervention remained between the baseline and 6 months follow up.

All the intervention children had low Hb at baseline but by six months of intervention, 84.2% of these children had normal Hb levels. On the other hand, for the non-intervention group, low Hb reduced from 84.4% at baseline to 72.7% at 6 months. Although low Hb is not enough to diagnose iron deficiency, it is known that 50% of anaemia is due to iron deficiency. The prevalence of anaemia is an important health indicator [17]. Pre-albumin is an important marker for assessing protein deficiency (Ingenbleek, Den Schrieck [18] and is a preferred marker for protein malnutrition, correlating with patients outcome in a wide variety of clinical conditions. Zinc deficiency is usually said to be prevalent among malnourished children and

Table 3. Prevalence of malnutrition using biochemical markers at baseline, 3–month and 6-month for intervention and non-intervention

Non-intervention	Baseline	3-Months	6-Months	p-value
Hb				
Anaemia	27(84.4)	22(84.6)	16(72.7)	0.485
Normal	5(15.6)	4(15.4)	6(27.3)	
Zinc				
Normal	3(9.4)	9(34.6)	7(31.8)	0.0465
Deficiency	29(90.6)	17(65.4)	15(68.2)	
Reduced glutathione				
Normal	24(75)	22(84.6)	21(95.5)	0.1334
Deficiency	8(25)	4(15.4)	1(4.5)	
Pre albumin				
Normal	31(96.9)	24(92.3)	21(95.5)	0.725
Deficiency	1(3.1)	2(7.8)	1(1.45)	
Intervention				
Hb				
Anaemia	32(100)	20(76.9)	3(15.8)	< 0.0001
Normal	0(0)	6(23.1)	16(84.2)	
Zinc				
Normal	4(12.5)	13(50)	9(47.4)	0.0039
Deficiency	28(87.5)	13(50)	10(52.6)	
Reduced glutathione				
Normal	25(78.1)	26(100)	19(100)	0.0045
Deficiency	7(21.9)	0(0)	0(0)	
Pre albumin				
Normal	32(100)	25(96.2)	19(100)	0.3702
Deficiency	0(0)	1(3.8)	0(0)	

Normal values for Hb> 11.0 g/dl, Serum Zinc> 10.09 µmol/L, Prealbumin> 170 mg/L, reduced glutathione> 4.5 µM

Table 4. Average dietary intake for the intervention group

Nutrients	Baseline nutrients	3-month nutrients	6-month nutrients	p-value
Calorie	1374± 85.55	979± 82.43	899.9±105.4	0.083
protein (g)	28.29±3.427	27.71±2.872	24.68±2.774	0.073
Total fat (g)	40.89±3.410	35.16±3.649	24.9±3.529	0.016
Ash (g)	25.63±8.812	8.919±1.064	7.601±0.8986	0.189
Carbohydrates(g)	198.6±20.53	142.1±21.21	146.2±18.98	0.113
Fibre (dietary)g	15.78±1.344	12.38±2.117	11.19±1.546	0.107
Sugars (g) total	44.8±10.08	16.28±2.803	10.35±1.448	0.018
Calcium (mg)	204.8±22.20	183.1±28.55	133.2±8.814	0.117
Iron (mg)	25.4±12.13	5.799±0.7110	5.222±0.6992	0.312
Magnesium (mg)	254.2±24.01	167.3±20.63	165.8±18.86	0.013
Phosphorus (mg)	838± 121.5	481.6±49.89	461.7±52.19	0.029
Potassium (mg)	1712±168.6	1767±385.3	1223±195.5	0.286
Sodium (mg)	2542±253.6	1949±226.5	1965±208.0	0.170
Zinc (mg)	5.225± 0.5074	4.218±0.4833	3.623±0.4424	0.098
Copper (mg)	1.183±0.1274	0.8175±0.1155	0.7727±0.08757	0.044
Manganese (mg)	5.741±1.551	2.296±0.2751	2.36±0.2570	0.129
Selenium (mg)	67.97±7.072	32.08±4.030	33.87±4.744	0.0003
Vitamin C (mg)	55.25± 7.660	65.04±11.56	44.07±7.076	0.381
Thiamine (mg)	0.7017±0.06948	0.5385±0.08348	0.5212±0.06114	0.159
Riboflavin (mg)	1.271±0.3846	0.4152±0.05532	0.3164±0.02451	0.095
Niacin (mg)	10.7±1.125	8.414±1.160	6.077±0.6068	0.023
Pantothenic acid	3.369±0.2914	2.268±0.2317	2.154±0.2475	0.126
Vit B-6 (mg)	22.83±13.55	0.9158±0.1111	0.822±0.07435	0.320
Folate (mcg)	198.4±25.32	161.4±24.20	182.1±30.13	0.650
Folic acid (mcg)	14.3±3.291	21.66±7.959	3.614±1.171	0.059

Data were presented as mean ± SEM and the differences between the baseline, 3-month and 6-months for intervention groups were determined using one-way ANOVA with Tukey multiple comparison tests as post hoc. All macro-nutrients in grams and micro-nutrients presented in milligrams

Table 5. Average dietary intake for the non-intervention group

Nutrients	Baseline nutrients	3-month nutrients	6-month nutrients	p-value
Calorie	1279± 85.55	1179± 82.43	1045.9±105.4	0.087
protein (g)	30.41±2.64	30.25±2.20	26.38±2.89	0.466
Total fat (g)	43.2±5.22	33.92±3.59	28.26±3.45	0.368
Ash (g)	18.15±0.65	9.18±0.70	8.10±1.00	0.594
Carbohydrates(g)	251.77±12.79	174.24±16.15	146.86±15.43	0.384
Fibre (dietary)g	11.77±1.13	13.80±1.47	32.41±20.77	0.418
Sugars (g) total	13.59±3.57	18.97±2.92	32.64±12.86	0.295
Calcium (mg)	147.63±12.01	166.76±20.98	200.34±32.48	0.295
Iron (mg)	5.40±0.51	6.51±0.44	6.22±0.99	0.602
Magnesium (mg)	187.76±21.29	209.46±17.29	164.33±20.96	0.276
Phosphorus (mg)	522.26±42.01	546.67±37.28	465.14±48.12	0.333
Potassium (mg)	1360.15±189.60	1790.12±257.10	1567.82±262.80	0.541
Sodium (mg)	2079.34±222.9	2174.65±189.80	1830.46±241.00	0.522
Zinc (mg)	4.37±0.45	4.77±0.35	5.56±1.33	0.674
Copper (mg)	0.75±0.06	0.91±0.08	7.27±6.44	0.374
Manganese (mg)	2.41±0.21	2.89±0.24	2.62±0.33	0.482
Selenium (mg)	43.91±4.09	39.66±3.25	41.02±8.34	0.807
Vitamin C (mg)	47.10±6.90	59.16±9.11	76.82±24.59	0.403
Thiamine (mg)	0.53±0.05	0.65±0.05	79.14±78.62	0.374
Riboflavin (mg)	0.42±0.03	0.49±0.06	90.30±89.84	0.373
Niacin (mg)	8.02±0.93	8.91±0.91	7.15±0.96	0.411
Pantothenic acid	2.41±0.18	2.62±0.20	2.31±0.23	0.563
Vit B-6	0.96±0.09	1.08±0.10	0.92±0.09	0.485
Folate (mcg)	148.65±20.79	211.60±21.18	167.42±30.55	0.184
Folic acid (mcg)	5.08±1.79	16.98±9.48	12.60562	0.456

Data were presented as Mean± SEM the p-value determined by one way ANOVA

associated with poor growth and development [19]. Reduced glutathione provides reducing capacity for several reactions as well as aids in detoxification of hydrogen peroxide and other free radicals found in the human body. Zinc deficiency reduced from 87.5% at baseline to 52.6%, a difference of 34.9%, 6 months post intervention while in the non-intervention group zinc deficiency reduced from 90.6% to 68.2%, a difference of 22.4%. It is likely that improvement in the biochemical parameters, including zinc, Hb and GSH could have led to improved outcome and subsequently survival [20,21].

The study was limited by the first come first serve basis of recruitment. The children were recruited as and when the diagnosis was made and all 32-intervention participants were recruited before the non-intervention. The recruitment method was necessitated by that fact that the two cancers under study were not common and so all children could not be diagnosed and recruited at the same time. It also meant that recruitment was done at different times and seasons of the year. Also, the 24-hour dietary recall was subjected to the recall biases and this could be a limitation for this study. While this limitation is worth noting, it does not render the findings invalid.

5. CONCLUSION

Six months supplementation of children undergoing chemotherapy for BL and WT, using soya milk powder was well tolerated, improved Hb and serum nutrients, body mass and fat mass, and ultimately reduced mortality while improving survivability. The findings clearly show that the role of nutrition in disease management cannot be overemphasised and dietary supplements should be considered in settings where food insecurity may lead to inadequate dietary intake and limit the effectiveness of treatment and recovery from disease, such as cancer.

PATIENT CONSENT

Participants provide signed informed consent before participating in the study. All participants were informed about their freedom/right to withdraw from the study at any point with no reason for withdrawal required. All information collected in this study were given code numbers and kept confidential by the researcher. No name was recorded on questionnaires. Data collected was not linked to participants of both groups in any way.

ETHICAL APPROVAL

A human ethics application was submitted and ethical approval for the study was obtained from the Committee on Human Research, Publications and Ethics of KNUST and KATH with the clinical registry number (CHRPE/ KNUST/ KATH/ 17/11). All human rights procedure provided by the ethics committee regarding participants involved in this study was appropriately followed.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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