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Original article

Effects of nutritional intervention and dietary modification on the health status of pediatric acute lymphoblastic leukemia patients

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Summary. In order to ascertain the effectiveness of nutrient rich diet and dietary counseling on the health status of pediatric acute lymphoblastic leukemia patients, this experimental study was conducted at the Institute of Radiology and Nuclear Medicine, Peshawar. A sample of 30 leukemia patients were divided into experimental and control groups based on written consents. Data regarding demographic characteristics, anthropometric measurements, and retrospective food intakes were recorded on self-constructed questionnaire. Patients in the experimental group received dietary guidelines for nutrient rich diet. Anthropometry, dietary evaluation, and blood nutrients namely serum ferritin, albumin, globulin, total protein and creatinine at 30, 60 and 90 days intervals were assessed. The data showed low height for age and low weight or height at diagnosis indicating malnourishment and wasting among all the patients. After nutritional intervention mean weights of patients in the experimental group increased significantly over period of three months. Progressive weight loss was observed in patients of control group. Blood nutrients at diagnosis showed low Hb (9.19±3.11 and 9.31±1.07 g/dL) and serum ferritin (530±4.28 and 525±3.22 ng/mL) and increased total protein (7.28±3.07 and 7.67±2.76) in both groups. These indices improved in the experimental group over a period of 90 days. Nutrient intake in the experimental group patients improved significantly for all the nutrients.

Key words: acute lymphoblastic leukemia, nutrient rich diet, anthropometry, blood proteins, hemoglobin

Introduction

Leukemia though a rare disease accounts for 1 out of 3 cancers in children and teenagers. Genetic factors may increase the risk of childhood leukemia although most are not linked to any genetic cause. Inherited syndromes such as Down's syndrome, Li-Fraumeni syndrome, neurofibromatosis, Faconi anemia, and inherited immune system problems such as Ataxia telangiectasia, Luiskott-Aldrich syndrome, Bloom syndrome, and Schwachman-diamond syndrome have shown to increase the risk of leukemia. Life style and environmental related risk factors such as smoking, over-weight, alcohol and sun exposure, radiation exposure, chemo drugs an certain chemicals play a role but they unlikely cause most childhood cancers (1).

The exact incidence of childhood cancers is not well documented in Pakistan. The Karachi cancer registry estimated 600 children being diagnosed every year (2). The Shaukat Khanum memorial hospital cancer registry reported 11.44% malignant cases being diagnosed in children (3). Among these; acute leukemias were the most common being reported by many studies (4).

Children suffering from leukemia are at increased risk of nutrition related morbidity during and after

treatment. The overall survival in children and adolescents suffering from leukemia has increased from 10%-90% owing to the improved palliative care facilities (5). However, treatment related toxic effects still pose major problems. Children and adolescents suffering from leukemia experience a vast array of nutrition related disorders (6).

Some retrospective studies have shown that 35-68% children and adolescents develop hypertriglyceridemia, 68% had bone mass and about 30% survivors consumed bone-metabolizing nutrients (7-9). Studies have suggested that dietary modification help prevent the development of therapy related toxicity (10, 11). Leukemia has also been described as a "preobese state" as evident from a number of patients who developed obesity during and after treatment (12). Similarly, several studies have suggested remediation of both under or over weight during treatment to help lower the adverse association with survival (13, 14).

Despite gross prevalence of leukemia among children there is severe paucity of knowledge and data regarding the effect of nutritional interventions on the health status of these patients and remained a neglected area. The current study aimed at analyzing the impacts of nutrient dense diets on the health status of children undergoing leukemia and disease related treatments.

Materials and Methods

Experimental Design

This experimental study was carried out at Institute of Radiology and Nuclear Medicinal IRNUM from October 2014 to July 2015. Based on written consents 30 (17 males, 13 females) leukemia patients aging 5-15 years were divided into experimental and control groups. The experimental group followed dietary recommendations and counseling. The care givers were counseled for dietary modifications during and after therapy. While the control group received their usual diets, medical treatments, and supplements over a period of three months. The entire group underwent a preliminary interview and was clinically examined for protein energy malnutrition, micronutrient deficiencies, such as anemia and presence of infections. Demographic information for different parameters was recorded and patients' anthropometric measurements for height, weight, mid upper arm circumference and skin fold thickness were assessed. Hemoglobin, serum albumin, serum globulin, serum creatinine, serum ferritin and total protein of each patient were recorded thrice at 30, 60, and 90 days intervals.

Diet Therapy

Food intake record of the patients was taken on 65 items Food Variety Scale (FVS) and weekly meal plans along with recipes and portion serving were provided to the care givers. For facilitation they were provided with paper cups, plates and spoon for portion size estimation. The diets were nutritionally evaluated by Food Composition Tables of Pakistan (15). Based on individual patients' health condition, their food intake records, and therapies given following caloric distribution, proteins, Vitamin C, and Vitamin A were focused on.

1. Energy:* (Based of Resting Energy Expenditure)

Male BMR = 66.47 + (13.75 x weight in kg) + (5.003 x height in cm) - (6.755 x age in years)

Female BMR = 655.1 + (9.563 x weight in kg) + (1.850 x height in cm) - (4.676 x age in years)

(*Harris and Benedict equation for age and gender)

As per weight status of the patients a 1200-1800 Kcal/day diet was suggested with 20-30% from protein, 19% fats and 50% from carbohydrates.

2. Protein: 0.9 - 1.5 g/Kg body weight/day.

3. Vitamin C: 45 - 75 mg/day

4. Vitamin A: 4500 IU or 900 mcg (microgram) of retinol activity equivalent (RAE)

Foods rich in vitamin D, sulfur amino acids, carotene, selenium, and omega -3 fatty acids were focused upon during dietary modifications and recommendations. Diets were modified to liquid soft, low residue, post chemotherapy or post radiation diets. Care givers of the patients were counseled for the importance of hygiene, balanced diet, taking regular meals.

Statistical analysis

All the data was subjected to statistical tests such as mean, standard deviation, ANOVA, and co-efficient

of correlation. Two-way ANOVA was calculated to analyze the significance of dietary modifications from initial value till the end and from control group.

Results

Demographic characteristics of the sample

Demographic and family characteristics of the combined sample are given in Table 1. The sample comprised of 17 male and 13 female acute lymphoblastic leukemia patients. The disease was highly prevalent in the age range of 1-5 years. Educational background of both parents was quite low mostly being illiterate. The occupational background showed joblessness among fathers was common while 100% of mother were housewives. Greater percentage of fathers was engaged in private jobs or small- scale businesses with low monthly income and subsequent low spending on food. Mean family size showed five to six children in a nuclear setup being most common. The striking finding of the current study was that leukemia was most common among the last- born children.

Table 1. Demographic characteristics of the sample

Variables	No (% age)
i) Gender	
Males	17 (55%)
Females	13 (45%)
ii) Age at diagnosis	
0-5 years	18 (60)
6-10 years	6 (20)
11-15 years	6 (20)
iii) Father's education	
Illiterate	11 (35)
Elementary	10 (33)
Matric	4 (13)
Graduation	3 (10)
Postgraduates	2 (7)
iv) Father's occupation	
Unemployment	8 (26)
Government job	6 (20)
Private job/small-scale business	16 (53)
v) Mother's education	
Illiterate	18 (60)
Elementary	12 (40)
vi) Family size	
3-4	7 (23)
5-6	10 (33)
7-8	7 (23)
9-10	6 (20)
vii) Position in family	
First born	2 (61)
Middle	3 (10)
Second last	7 (23)
Last born	18 (60)

Anthropometric characteristics of the sample

Results of the anthropometric data of both control and experimental groups (Table 2) showed mean age of 8 years. Heights of both groups were low when compared with WHO standards for this age indicating stunting from early years. Weights of both groups were also low at the start of the trials and increased significantly in the children of experimental group. Improvement in MUAC and skin fold thickness was also observed in children of this group. Children in the control group lost weight significantly over period of three months.

Biochemical blood indices

Results of the blood nutrients over a period of 3 months are presented in Table 3. Among the patients of experimental group hemoglobin, serum ferritin and serum total proteins improved. The effects of nutritional intervention (as a result of nutritional counseling of the care givers) were modest on serum albumin, globulin and creatinine. Among the patients of control group a progressive increase in serum ferritin and total protein were observed. Hemoglobin also declined progressively indicating the catabolic effects of chemo drugs, radiation, and poor dietary intake due to therapy related toxic effects.

Nutrient Intake

Nutrient intake data of both the groups (Table 4) showed that energy, protein, iron, vitamin A and vitamin C intakes were quite below the recommended allowances for this age. Significant improvement occurred in the intake of all the nutrients in the patients of experimental group after 60 and 90 days. Intake of nutrients, particularly that of vitamin C and A remained subnormal in the patient of control group. The

Table 2. Anthropometric indices of the sample

Variables	At diagnosis		30 days		60 days		90 days	
	Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control
Age (years)	8.2±13.55	8.3±4.30						
Height (cm)	124.7±21.58	124.3±26.1	126.0±21.6	124.9±25.9	125.7±11.9	124.9±25.8	126.1±21.6	125.0±11.2
Weight (cm)	24.7±11.67	23.4±13.32	[a]26.3±11.4	23.2±12.44	[ab]26.7±12.44	22.3±15.7	[abc]27.1±4.4	21.5±12.7
MUAC (cm)	17.5±3.9	16.3±2.77	17.8±3.63	16.9±3.22	[ab]18.8±6.01	16.0±3.81	[abc]19.0±3.81	15.6±4.58
Skinfold thickness (cm)	6.7±4.17	5.5±2.15	6.87±4.00	6.0±2.2	8.87±2.67	5.96±2.10	[abc]8.97±2.67	5.6±2.73

[a] *significantly different (P≤0.05) from control group*
[ab] *significantly different (P≤0.05) from control groupand at diagnosis*
[abc] *significantly different (P≤0.05) from control group, at diagnosis and 30days intervals*

Table 3. Biochemical blood indices for blood iron and protein

Variables	At diagnosis		30 days		60 days		90 days	
	Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control
Hb (g/dL)	9.19±23.11	9.31±10.07	10.65±1.12	10.4±0.53	[ab]11.8±2.64	9.96±7.82	[abc]11.06±9.92	8.68±6.45
Serum albumin g/dL	3.03±7.26	3.07±11.87	3.3±9.40	3.85±11.87	3.52±9.85	3.69±9.79	3.39±7.96	3.69±9.79
Serum globulin (g/dL)	4.01±7.62	3.13±4.47	3.13±2.78	4.47±2.95	3.54±4.13	4.36±8.20	3.38±12.7	4.68± 12.34
Serum creatinine (mg/dL)	0.54±2.51	0.51±1.85	0.57±12.0	0.52±1.69	0.5±8.25	0.5±0.29	0.57±3.98	0.51±2.22
Serum ferritin (ng/ml)	530±4.28	525±3.22	574±3.96	619± 30.0	[a]427±4.28	[ab]674.5± 11.38	[*]438±13.98	[abc]761.3±13.9
Total protein (g/dL)	7.28±3.07	7.67±2.76	7.77±2.28	6.98±17.6	7.43±3.20	7.06±13.5	[abc]8.03±1.36	6.82±1.68

[a] *significantly different (P≤0.05) from control group*
[ab] *significantly different (P≤0.05) from control groupand at diagnosis*
[abc] *significantly different (P≤0.05) from control group, at diagnosis and 30days intervals*

Table 4. nutrient intake patterns of the sample

Variables	Pre-Test		30 days		60 days		90 days	
	Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control
Hb (g/dL)	9.19±23.11	9.31±10.07	10.65±1.12	10.4±0.53	[ab]11.8±2.64	9.96±7.82	[abc]11.06±9.92	8.68±6.45
Energy (KaCal)	703.9±11.3	700.85±6.28	801.7±11.09	811.2±4.75	991.2±11.69	790±14.6	[abc]1105±4.76	851±21.5
Protein (g)	20.29±2.29	20.57±7.16	21.71±5.94	20.48±4.94	37.1±5.46	23.7±7.55	[abc] 39.3±10.45	23.0±16.6
Iron (mg)	5.8±3.69	5.76±4.20	7.6±11.4	5.92±2.81	[ab]8.2±1.25	5.5±8.15	[abc] 9.8±11.5	5.8±9.1
Vitamin A (I.U)	784.3±17.9	791.2±9.91	[a]1580.2±3.83	902.1±28.5	[ab]1889.6±22.6	622.6±8.89	[abc] 2967±9.35	1012±5.74
Vitamin C (mg)	10.4±40.7	11.70±6.10	[a]48.7±10.4	40.7±32.2	[ab]134.8±10.59	34.8±23.4	[abc] 139.9±5.29	20.08±8.20

[a] *significantly different (P≤0.05) from control group*
[ab] *significantly different (P≤0.05) from control group and at diagnosis*
[abc] *significantly different (P≤0.05) from control group, at diagnosis and 30days intervals*

major complaints given by this group were anorexia, nausea, oral hemorrhages, pain and oral lesions which restricted their intakes. The patients in the experimental group were motivated to eat and were recommended pureed fruits, and vegetable juices, which led to better intakes and improved health status.

Discussion

The global incidence of cancer has reached to 14.1 million new cases in 2012 and is estimate to rise to 21.4 million by the year 2030 (16). Results of the current study showed that acute lymphoblastic leukemia was most prevalent in male children. Majority of the patients belonged to low income and less educated families. These findings were in strong agreement with findings of other studies from Iran which reported high prevalence and fatality rate among males and impact of job related genetic and environmental factors contributing to the scenario (17). The low anthropometric indices among patients of both groups were indicative of childhood chronic malnutrition. Similarly, as reported weight loss occurs in majority of cancer patients as a result of infections and insufficient dietary intake during chemotherapy (18-21). Nutritional and dietary interventions brought about significant improvement in the health status of the patients in the experimental group. These findings were in strong agreement with other studies which suggested that nutritional interventions among all types of cancer patients prevent weight loss and improve the nutritional status of patients (18-22). The progressive improvement in the biochemical blood nutrient indices are suggestive of the facts that diet enriched with protein, iron and antioxidants help alleviating the toxic effects of drugs and therapy and might be of benefit in improving the survival rate and resistance to drugs among these children. Several studies have shown similar findings supporting the findings of the current study (23-25).

All children suffering from pediatric acute lymphoblastic leukemia in the current study showed chronic malnutrition and poor diets. Nutrient intakes reported by the participants were quite below the RDA's along that fluctuations were observed in the nutrient intake of control group. These results were in line with the findings of a cohort study which showed that malnourishment was present in children at diagnosis and that dietary intake of leukemia patients fell below the recommended values (26). However, the findings of the current study were in strong agreement with the reported results of other studies (24, 25). Although the weights of all children did not improve significantly in the current study which can be attributed to the facts that these children were already emaciated, however, the significant improvement in the blood nutrients was the remarkable achievement of the current study.

Conclusion

This study was successful in improving the health status of pediatric acute lymphoblastic leukemia patients at high risk of nutrition related morbidity. These results may help identify at risk patterns of nutrient and dietary intakes and can be used in future for designing intervention strategies in hospitals and clinics for children with cancers.

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