Effect of Dietary Educational Program on Knowledge and Nutritional Status of Children with Leukemia Undergoing Chemotherapy in Sana'a at Yemen

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Abstract

Background: Childhood leukemia represents one of the most prevalent types of cancer. Chemotherapy is the cornerstone of leukemia management. Essentially, it can cause a deficiency in food and liquid consumption, electrolyte imbalance, weight loss and consequently nutritional disorders. Healthy nutrition is pivotal for children's nutritional needs for optimal growth and to support them during chemotherapy. Objective: To evaluate the effect of dietary educational program on knowledge and the nutritional status of children with leukemia undergoing chemotherapy in Sana'a at Yemen. Settings: The study was conducted in the Childhood Leukemia Treatment Unit at Al-Kuwait Hospital in Sana'a at Yemen. Subjects: All available children with leukemia undergoing chemotherapy for six months at the previously mentioned setting and fulfilled the inclusion criteria. Tools: Three tools were used namely; Children's Knowledge about Nutritional Status during Chemotherapy Structured Interview Schedule, Twenty-Four-Hour Dietary Recall Assessment Sheet and Anthropometric Measurements of Children with Leukemia Undergoing Chemotherapy. Results: The study revealed that nutritional knowledge of children with leukemia undergoing chemotherapy was significantly increased after the dietary educational program implementation than before and the nutritional status of them exhibited of significantly higher improvement after the dietary educational program implementation than before (P < 0.001 for each).Conclusion: All children with leukemia undergoing chemotherapy had poor total scores of nutritional knowledge before implementing the program. Fortunately, all children with leukemia undergoing chemotherapy had good total scores immediately after and three months later after the dietary educational program implementation. Recommendations: The recent guidelines for nutritional assessment and management of children with leukemia undergoing chemotherapy should be applied by pediatric oncology nurses in the Childhood Leukemia Treatment Unit.

Keywords: Dietary Educational Program, Knowledge, Nutritional Status, Children, Leukemia, Chemotherapy.

Introduction

Leukemia is a cancer type that starts in blood-generating tissues when the Bone Marrow (BM) creates abnormal White Blood Cells (WBCs) which are called leukemic cells. It can be divided into acute and chronic leukemia (Perry, 2022).

Worldwide, leukemia is the second cause of mortality among children under 20 years in 2023. The global annual number of recent cases of leukemia was 5 per 100.000, while the death rate was 22.7% (Leukemia & Lymphoma Society, 2023). In Yemen, the

leukemia death has reached 1,253 (WHO, 2018). In Sana'a City, the statistical records of the Childhood Leukemia Treatment Unit (CLTU) in Al-Kuwait Hospital indicated the presence of ninety Children with Leukemia (CL) in 2023.

The actual reason for leukemia is idiopathic but it is probably multifactorial. Genetic and environmental factors play a key role in the development of leukemia. Chemotherapy (CHT) is the cornerstone of leukemia management. It can cause a deficiency in food and liquid consumption, electrolyte imbalance, weight loss and consequently nutritional disorders. Healthy nutrition is pivotal for children's nutritional needs for optimal growth and to support them during CHT. Furthermore, leukemia is one of the diseases that expose children to an abundant prevalence of nutritional problems (Perry, 2022).

The Leukemia Lymphoma Society (LLS) in 2022 and the American Cancer Society (ACS) in 2020 have published Healthy Dietary Pattern (HDP) guidelines for cancer children. This HDP emphasizes a greater consumption of whole grains, legumes, fruits and vegetables as well as the variety in food groups is necessary depending on a healthy food pyramid and healthy food plate. Moreover, there was substantial evidence of beneficial outcomes for cancer children after the application of HDP.

For assessing children's Nutritional Status (NS), the Centers for Disease Control and Prevention (CDC) indicates using anthropometric measurements such as weight and Mid Upper Arm Circumference (MUAC). These measurements are very accurate growth markers and can be utilized as a screening tool to estimate if children are under or over-nourished (Centers for Disease Control and Prevention, 2022). Moreover, the HDP obtained from the twenty-four-hour dietary recall method is also a vital part of the nutritional assessment (Food and Agriculture Organization, 2018).

Pediatric Oncology Nurses (PONs) play a crucial role in offering nutritional counseling and support to improve the NS of Children with Leukemia undergoing Chemotherapy (CLC). They should provide education and training for children and their caregivers about HDP. The significance of nurses' role in nutritional support has been acknowledged in global guidelines. In the United Kingdom, the National Health Service states that PONs are responsible for promoting healthy dietary lifestyles from admission till discharge. The PONs have an integral role in the proper referral of children with complicated nutritional problems to nutritionists (Ferguson, et al., 2017).

Aim of the Study

This study aimed to evaluate the effect of dietary educational program on nutritional knowledge and the nutritional status of children with leukemia undergoing chemotherapy in Sana'a at Yemen.

Research hypotheses

- The nutritional knowledge of children with leukemia undergoing chemotherapy increased after the dietary educational program implementation than before.
- The nutritional status of children with leukemia undergoing chemotherapy exhibited higher improvement after the dietary educational program implementation than before.

Operational Definition

Nutritional Status in the present study, the NS of children was evaluated through assessment of anthropometric measurements (weight and MUAC) and twenty-four-hour dietary recall.

Materials and Method

Materials

Design: A quasi-experimental research design (pre–post group) was used.

Settings: The study was conducted in the CLTU at Al-Kuwait Hospital in Sana'a at

Yemen. This unit provides CHT service for CL in Sana'a 24 hours all days of the week.

Subjects: All available CLC for six months at the previously mentioned setting their age ranged between 10-18 years who received CHT after the first session of the consolidation phase and were free from renal, hepatic or cardiac diseases.

Tools: **Three tools were utilized.**
Tool I: Children's Knowledge about Nutritional Status during Chemotherapy Structured Interview Schedule. The tool was developed by the researcher after reviewing of literature to assess the children's knowledge about the NS during CHT (Leukemia Lymphoma Society, 2022; American Academy of Pediatrics. 2020; American Cancer Society, 2020). **It included two parts:**

Part 1: Socio-demographic Data and Medical History: It included: **Socio-demographic Data**: such as age, sex, residence and income. **Medical History** included diagnosis, CHT protocol and CHT phase.

Part 2: The Children's Nutritional Knowledge during CHT: It included the healthy food pyramid and the healthy food plate.

• **Scoring system**: Each item of children's knowledge was scored as follows: one for the correct answer or zero for the incorrect or unknown answer. The total scoring system of children's knowledge was transformed into a qualitative manner as:
  – Good knowledge ($\geq 65\%$).
  – Fair knowledge ($50\% - < 65\%$).
  – Poor knowledge ($< 50\%$).

Tool II: Twenty-Four-Hour Dietary Recall Assessment Sheet: It was developed by the researcher after a thorough review of the literature to evaluate the quantity and quality of food that the children consumed in the last 24 hours. This method included mealtime,

food description and serving (Food and Agriculture Organization, 2018).

• **The scoring system** was categorized as committed to the standard of dietary guidelines and was given score one and not committed to the standard of dietary guidelines was given score zero.

Tool III: Anthropometric Measurements of Children with Leukemia Undergoing Chemotherapy: The tool was adopted from the CDC (2022) and Afful, et al., (2021). It involved weight for age and MUAC for age.

– The weight for age measurement was categorized as follows:
  • Underweight ($< 5^{th}$).
  • Normal weight ($5^{th} - < 85^{th}$).
  • Overweight ($85^{th} - < 95^{th}$).
  • Obese   ($\geq 95^{th}$).

– The MUAC for age measurement was categorized as follows:
  • Less than normal   ($< 5^{th}$).
  • Normal   ($5^{th} - < 95^{th}$).
  • More than normal ($\geq 95^{th}$).

Method

An ethics committee approval was obtained from the faculty of nursing. An official approval to conduct this study was obtained after explaining the aim of the study. Tools I and II were developed by the researcher after reviewing relevant literature. The tools were translated into Arabic language and adapted to Yamani culture. Tool III was adopted from the CDC (2022) and Afful, et al., (2021)

Tool I, tool II and educational booklet were tested for their content validity by five experts in the pediatric nursing and nutrition fields. The necessary modifications were performed accordingly. Reliability of the tool I and tool II were tested using Cronbach's Alpha coefficient test where r= 0.85 and 0.88 respectively. A pilot study was conducted on 10% of the study subjects to test the feasibility and clarity of the tools. Data was

collected by the researcher for six months. The DEP was conducted in five phases: assessment, planning, program development, implementation and evaluation.

I. Assessment phase: This aimed to collect data from children and/or their caregivers to identify socio-demographic and medical history.

• The children were undergone a nutritional assessment that included:

– Assessing their knowledge about NS during CHT before implementing the program, immediately after and three months later including knowledge about the healthy food pyramid and healthy food plate (Tool I).

– Assessing the children's daily intake (twenty-four-hour dietary recall). The children and their caregivers were asked to report every food or drink in serving that the children took during the last 24 hours from morning to morning to determine the quantity and quality of the children's food intake. This method also included mealtime, food description and serving. Then, the consumed quantity and quality were analyzed guided by the healthy food pyramid (Tool II).

– Assessing anthropometric measurements using (Tool III): The anthropometric measurements were measured and recorded. The measurements were compared to the normal findings according to the CDC (2022) and Afful, et al., (2021) for health statistics percentiles for age and gender.

II. Planning phase: The program content, expected outcome, teaching methods and audiovisual materials were developed by the researcher after reviewing relevant literature (Leukemia Lymphoma Society, 2022; American Cancer Society, 2020).

III. Program development phase: The general and specific objectives of the DEP were developed.

• The general objective was
  – Apply DEP for CLC.
• The specific objectives were as follows:
  – Enumerate the healthy food pyramid.
  – Explain the healthy food plate.

– Comprehend the necessity of healthy nutrition during CHT.

• An illustrated colored booklet was prepared in Arabic language by the researcher to suit the Yemeni children and their caregivers.

IV. Implementation phase:

• The developed DEP was implemented for each five children and/or their caregivers and the study aim was illustrated to them.

• The DEP was implemented in four theoretical sessions; four times per week. Each session took approximately one hour.

• The first session: Involved theoretical knowledge about leukemia.

• The second session: Involved theoretical knowledge about CHT.

• The third session: Was about HDP (healthy food pyramid) during CHT.

• The fourth session: Was about HDP (healthy food plat) during CHT

– Each session contained three parts. Part one in which the goal of the session was explained and the nutritional assessment took place. The second part in which the researcher taught and advised the children and/or their caregivers about the content of DEP. The third part in which a summary was given by the researcher. Then, the researcher took feedback from the children and/or their caregivers.

• Teaching methods: Thesr were used in the form of lectures and interactive discussions.

• Audiovisual materials: Powerpoint slides and poster.

• Phone contact was maintained between researcher and children and/or their caregivers to guarantee the children's commitment to HDP throughout the study period.

• Finally, an illustrated colored booklet was distributed to each child. It included HDP to reinforce the taught knowledge.

V. Evaluation phase: The effect of the DEP on nutritional knowledge and NS of CLC was assessed before implementing the program, immediately after and three months later after

the DEP implementation using the previously mentioned three tools.

Ethical Considerations

Written informed consent of the children's caregivers was obtained for their children's voluntary participation after illustrating the aim of the study and the children and their caregivers' rights to withdraw at any time. Children and their caregivers were considered for the confidentiality of their children's data.

Statistical Analysis

The obtained data were organized and tabulated. All statistical analyses were carried out in R Studio (version R.4.2.3). Cochrane Q test was used to test differences between paired categorical data. The p-value was considered statistically significant at level < 0.05.

Results

Table 1 summarizes the socio-demographic data of the CLC. It can be seen that the majority of children (90.5%) aged from 10 to less than 15 years with a mean age of 12.10 ±1.94 and 54.6% of them were males. Moreover, 68.8% of those children had primary education. Furthermore, 79.7% of children were living in rural areas and 97.8% of them had insufficient income.

Table 2 presents the medical history of CLC. It is clear from this table that all children were diagnosed with Acute Lymphoblastic Leukemia (ALL) and had XV CHT protocol (100% for each). In addition, 52.9% of them were in the intensification phase of CHT.

Figure 1 illustrates the total score of knowledge of CLC throughout the study period. The figure revealed that all children had poor total scores of knowledge before implementing the program. Fortunately, all CLC had good total scores immediately after and three months later (100% for each).

Table 3 portrays the twenty-four-hour dietary recall of CLC throughout the study

period. It can be found that all children did not commit to consume six food groups (100%) before implementing the program. Whereas, 77% of them committed to consume six food groups immediately after and this percentage increased to 94.7% three months later and the difference was statistically significant (P < 0.001*). Concerning food consumed in serving, the highest percentage of children were not committed to consume normal servings before implementing the program and immediately after (100% and 94.4% respectively). While, 90.3% of them committed to consume normal servings at three months later and the difference was statistically significant where P < 0.001*.

Table 4 illustrates anthropometric measurements of CLC throughout the study period. The table shows that the minority of children had normal anthropometric measurements before implementing the program and immediately after (7% weight for age and 3.9% UMAC for age). On the contrary, these percentages increased three months later to (80.2% and 88.6% respectively) with a statistical significant differences (P < 0.001* for each).

Discussion

Leukemia is an abnormal multiple proliferation of immature WBCs in the BM and certain blood-forming tissues. It is predominantly managed via CHT. Several organizations have published guidelines on HDP for those children to support their NS. The management of CLC must be holistic, where the NS is one of the essential elements of their management. The PONs have a pivotal role in educating children and their caregivers about HDP (Marzoog, et al., 2023).

Generally, the result of the present study revealed that the highest percentage of children aged from 10 to less than 15 years (Table 1). This result could be justified by the prevalence of leukemia is a widely frequent form of cancer in children less than 20 years

old. This result is in line with the findings of Hernandez, et al., (2023) who found that leukemia develops more among children between 10 and 14 years of age.

Regarding sex, the finding of the current study showed that the predominance of CLC were males (Table 1). This finding could be attributed to the prevalence of leukemia which is most common among males. This finding is consistent with the findings of Hernandez, et al., (2023) who mentioned that leukemia develops more among males.

According to their residence, the finding of present study reflected that more than three quarters of children were live in rural areas (Table 1). In fact, agriculture of pesticides which are widely used in rural areas and exposure of many children to these kinds of pesticides compared to children live in urban communities could explain this result. Children could be exposed to pesticides in the uterus when their mothers spray or are exposed to pesticides. Moreover, children could be exposed to pesticides when they play in the fields, or their caregivers may bring pesticide-contaminated dust and soil into their houses (Skidmore, et al., 2023). This result is in agreement with the findings of Ibrahim, et al., (2023) who pointed out that leukemia was found mostly in rural areas.

The most prevalent type of cancer in children is ALL. In the US, nearly 75% of leukemia cases are diagnosed with ALL up to 20 years (American Society of Clinical Oncology, 2023). The finding of the current study found that all children were diagnosed with ALL (Table 2). In this context, Icardi, et al., (2022) stated that ALL exhibits the most prevalent type of childhood leukemia worldwide, it represents 80% of CL.

Regarding the CHT protocol, the result of the present study concluded that all children were treated with the XV protocol (Table 2). This result is matched with the findings of Yilmaz, et al., (2023) who noted that XV protocol is successful in the treatment of children with ALL.

The health care providers should provide children and their caregivers the essential knowledge related to management of disease at the correct time and guide them about the appropriate social media to explore more information (Liu, et al., 2023). The result of the current study revealed that all CLC obtained poor total scores of nutritional knowledge before implementing the program. Fortunately, all of them had good total scores immediately after and three months later (Figure, 1). These findings may be related to increased children's awareness about nutritional knowledge, increased motivation and dissemination of booklets that promote knowledge. Nowadays, Yemen population suffers from internal war. This war affects all aspects of human life especially, the CLC. Whereas, all authorities and social media ignored the nutritional field of those children and focused on war. Similar findings were reported by Ali & Ma'ala (2022) who mentioned that the total knowledge of caregivers regarding to NS for the CLC was poor before the educational program application. While, their knowledge improved after the program implementation.

The dietary diversity (six food groups) is important among children with cancer. Twenty-four-hour dietary recall assessment helps to estimate the quantity and quality of food that the children consumed in the last 24 hours (Food and Agriculture Organization, 2018). The result of the present study illustrated that none of the children committed to consume six food groups daily before implementing the program. Meanwhile, the highest percentage of them committed to consume six food groups daily immediately after and three months later with a statistical significant difference (Table 3). This finding could be justified by the awareness of children and their caregivers about the importance of commitment to consume six food groups daily for their children to improve NS. This finding is inconsistent with the findings of Tanriverdi, et al., (2020) who declared that almost two thirds of children consumed only one group

(milk) every day regularly. In addition, Paloma, et al., (2022) a pointed out that the majority of CLC had a low scores in applying dietary diversity (six groups).

Regarding the serving of consumed food, the finding of the current study showed that all children were not committed to the consumption of normal servings before implementing the program. Meanwhile, the vast majority of them committed to consume normal servings immediately after and three months later with a statistical significant difference (Table 4). The finding of this study is inconsistent with the findings of Gagnon, et al., (2019) who detected that all children with cancer consumed less than normal serving after nutritional educational intervention, but committed to national guidelines. While, Paloma, et al., (2022) pointed out that the majority of CLC had a positive score for commitment to consume a normal serving of protein only.

The CDC (2022) recommended the use of anthropometric measurements that include weight and MUAC for classifying children's NS. Staying at a healthy weight can be difficult for some CLC. Luckily, healthy food helps those children to maintain a healthy weight (Greenberg, et al., 2022). The finding of the present study revealed that the minority of children had normal weight for age before implementing the program and immediately after. While, the vast majority of them had normal weight for age three months later with a statistical significant difference (Table 3). This finding may be related to that the children had HDP including the food diversity and keeping on the normal serving of food and committed to the healthy food pyramid and healthy food plate. This justification is supported by Al-khateeb, et al., (2022) who found that the highest percentage of the study group had normal weight. Similarly, Koirala (2021) found that most childrens had normal nutritional condition such as normal weight during CHT.

The present study finding revealed that the minority of children had normal MUAC

for age before implementing the program and immediately after but this percentage increased three months later with a statistical significant difference (Table 3). This result could be due to the positive relationship between the HPD that CL committed to and normal anthropometric measurements. The result of the current study is in a harmony with the findings of Nakipov, et al., (2022) who mentioned that the highest percentage of children had abnormal MUAC before starting the intervention. Whereas, the majority of them had an improvement in MUAC three months later.

Conclusion

It can be concluded that the application of the DEP for CLC was significantly effective in improving the children's nutritional knowledge. All CLC had poor total scores of nutritional knowledge before implementing the program. While, all of them had good total scores immediately after and three months later. The application of the DEP for CLC was significantly effective in improving the NS of CLC immediately after and three months later after the program implementation than before.

Recommendations

Based on the previous findings, the following recommendations are suggested:

- The recent nutritional guidelines for the the assessment and management of CLC should be applied by PONs in the CLTU to prevent nutritional disorders.

- Continuous in-service training programs for PONs in CLTU to update and raise their standard of nutritional assessment and management for CLC to prevent nutritional disorders.

Table (1): Socio-demographic Data of Children with Leukemia Undergoing Chemotherapy

Socio-demographic Data (N = 359)	NO	%
1. Age		
− 10 - < 15 yr.	325	90.5
− 15 – 17 yr.	34	9.5
Min- Max	10 – 17	
Mean ± SD	12.10 ±1.94	
2. Sex		
− Female	163	45.4
− Male	196	54.6
3. Level of education		
− Illiterate	76	21.2
− Primary	247	68.8
− Preparatory	36	10
4. Residence		
− Rural	286	79.7
− Urban	73	20.3
5. Income		
− Insufficient	351	97.8
− Sufficient	8	2.2

N: Numberof Leukemia Children undergoing Chemotherapy

Table (2): Medical Data of Children with Leukemia Undergoing Chemotherapy

Medical Data (N= 359)	NO	%
1. Diagnosis of disease		
− Acute Lymphocytic Leukemia	359	100
2. Chemotherapy protocol		
− XV Protocol	359	100
3. Chemotherapy phases		
− Intensification/Consolidation	190	52.9
− Maintenance	125	34.8
− Reinduction after Relapse	44	12.3

VX: Name of chemotherapy protocol United Kingdom fifteen.

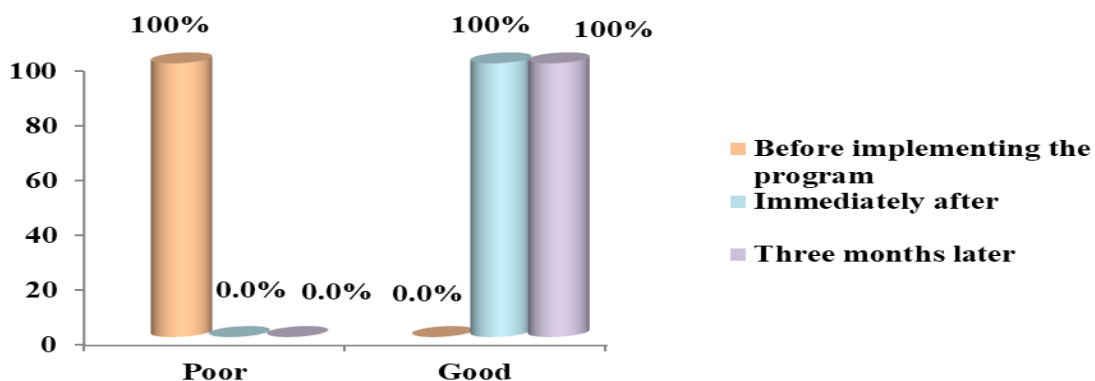**Figure (1): Total Score of Children's Nutritional Knowledge during Chemotherapy throughout the Study Period (N= 359)**

Dietary Education, Knowledge, Nutritional Status, Leukemia, Chemotherapy

Table (3): Twenty-Four-Hour Dietary Recall Assessment Sheet of Children with Leukemia Undergoing Chemotherapy throughout the Study Period

Twenty-Four-Hour Dietary Recall Assessment Sheet (N= 359)	Before		Immediately after		Three Months Later		*P-value
	NO	%	NO	%	NO	%	
1. Quantity of consumed food group							
− Less than six groups	359	100	83	23	19	5.3	**< 0.001***
− Six groups	0	0.0	276	77	340	94.7	
2. Serving of consumed food group							
− Not committed to normal serving	359	100	339	94.4	35	9.7	**< 0.001***
− Committed to normal serving	0	0.0	20	5.6	324	90.3	

Before: Before the implementation of the program
Immediately after: Immediately after the implementation of the program
Three months later: Three months later after the implementation of the program
*P: p-values indicate statistically significant difference <0.05 between time points of the study.
* Committed to the standard of dietary guidelines.

Table (4): Anthropometric Measurements of Children with Leukemia Undergoing Chemotherapy throughout the Study Period

Anthropometric Measurements (N= 359)	Before		Immediately after		Three Months Later		*P-value
	NO	%	NO	%	NO	%	
a. Weight for Age							
− Less than normal (< 5th)	334	93	334	93	71	19.8	**< 0.001***
− Normal (5th - < 85th)	25	7	25	7	288	80.2	
b. MUAC for Age							
− Less than normal (< 5th)	345	96.1	345	96.1	41	11.4	**< 0.001***
− Normal (5th - < 95th)	14	3.9	14	3.9	318	88.6	

MUAC: Mid Upper Arm Circumference

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