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Nutrient Intake and Nutritional Status of Blood Cancer Patients at a Tertiary Hospital in India: A Cross-Sectional Descriptive Analysis of Leukemia, Lymphoma and Multiple Myeloma

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ABSTRACT

In 2018, there were an estimated 18 million cancer cases worldwide, with lymphoma, multiple myeloma, and leukemia contributing to a significant portion of these cases. Lymphoma accounted for 79,990 cases, multiple myeloma for 159,985 cases, and leukemia for 437,033 cases globally (AICR, 2018). In the United States alone, approximately 30,770 people are diagnosed with multiple myeloma each year. Multiple myeloma comprises about 1.8% of all cancers and around 10% of all "blood cancers," which includes leukemia (Penn Medicine, 2020). India ranks third in highest reported cases of blood cancer, following the United States and China, affecting more than 70,000 men and women in the country. The aim of this study was to find out patients' nutritional status and nutrient intake, following and before a diagnosis with leukaemia, lymphoma, and/ or multiple myeloma, using a cross-sectional survey, as the aspect of health care at the Apollo Hospitals, India. Findings showed that nutrients intake following diagnosis with leukemia, lymphoma and/ or multiple myeloma will reduce and as a result patient will trend in weight loss. This study suggests that after diagnosis with leukemia, lymphoma and/ or multiple myeloma patients will experience difficulty in meeting nutrients requirement. The intake will be deficit compared to the Recommended Dietary Allowance (RDA) for Indians and the general guidelines for patients with cancer and/ or on chemotherapy. Hence, the hospital ought to carry out a continuous quality improvement in nutrition care with surveys and interventions repeated indefinitely.

Keywords: *Nutrient intake, hospital food service, RDA, leukemia, lymphoma, multiple myeloma, nutritional status.*

INTRODUCTION

The role of diet in cancer prevention and treatment is a complex and extensively studied area within the field of nutrition and oncology. The American Institute for Cancer Research (AICR) and the World Cancer Research Fund (WCRF) emphasize that adopting a healthy diet, engaging in regular physical activity, and maintaining a healthy body weight can collectively contribute to the prevention of a significant proportion of cancers (WCRF, 2018). A diet rich in fruits, vegetables, whole grains, and lean proteins, while limiting processed and red meats, sugary drinks, and excessive alcohol, is often recommended for cancer prevention (Hallelujah Acres Foundation, 2019). Different cancers may have varying levels of preventability through lifestyle factors. For instance, certain types of cancer, such as colorectal cancer, have a stronger association with dietary choices (Kunzmann, 2022).

Nutritional support, including dietary counseling and the use of nutritional supplements, may be recommended to help cancer survivors meet their nutrient needs. In cases where it is challenging to obtain sufficient nutrients from food alone, dietary supplements (such as protein supplements, vitamins, or minerals) may be prescribed under the guidance of healthcare professionals. Even though poor nutritional status may not have an immediate impact on hospital mortality or complications, it can be a predictor for long-term survival.

In 2018, there were an estimated 18 million cancer cases worldwide, with lymphoma, multiple myeloma, and leukemia contributing to a significant portion of these cases. Lymphoma accounted for 79,990 cases, multiple myeloma for 159,985 cases, and leukemia for 437,033 cases globally (AICR, 2018). In the United States alone, approximately 30,770 people are diagnosed with multiple myeloma each year. Multiple myeloma comprises about 1.8% of all cancers and around 10% of all "blood cancers," which includes leukemia (Penn Medicine, 2020). India ranks third in highest reported cases of blood cancer, following the United States and China, affecting more than 70,000 men and women in the country. In Kenya, it is estimated that there were approximately 33,000 deaths from cancer in 2018, with about 3,200 attributed to blood cancers and 1,300 specifically to leukemia (Daily Nation, 2019).

Challenges in accurate diagnosis and proper treatment are noted, leading to potential underestimates of the true incidence and mortality rates for blood cancers, particularly acute leukemia. The growing burden of blood cancers, especially in developing countries with large populations, poses serious challenges for public health administrators. Addressing issues related to early detection, accurate diagnosis, and access to proper treatment is crucial for improving outcomes and reducing mortality rates. The main objective of this study was to determine eating habits and patients' characteristics affecting their nutritional status following diagnosis with leukemia, lymphoma and/or multiple myeloma.

METHODOLOGY

Research design and sampling framework

The study design was a cross-sectional survey. Fieldwork for this study was conducted in Apollo Health City Group of Hospitals, Arillova, which serves the health needs of Visakhapatnam City, north coastal Andhra Pradesh and adjacent Odisha.

The target population was the inpatients and outpatients served by the Apollo Hematology-oncology department. All blood cancer patients who reported or were admitted for treatment during that period were included. Participants with significant physical limitations, cognitive impairments, or emotional challenges were excluded to maintain the feasibility of data collection and to ensure that participants can reliably adhere to the study protocol. Also excluded were individuals with a Nil Per Oral (NPO) diet order (meaning they are not allowed to consume any food or drink by mouth), participants who were receiving enteral nutrition (nutrition delivered through a tube into the stomach or intestines) or parenteral nutrition

(nutrition delivered intravenously) as the primary source of nutrition and all critically ill patients. This exclusion-maintained homogeneity within the study group, focusing on individuals relying on oral nutrition. It also checks confounding factors related to severe illness that could impact dietary patterns and nutritional status in ways not directly related to the study's objectives.

The total number of patients who met the inclusion criteria within the study week at the Apollo Hospital, Visakhapatnam was the sample size for this study. Consecutive sampling techniques was applied in this study. A cross-sectional survey was done in one phase which lasted for one week completing 22 survey questionnaires.

Data collection methods

This study used a validated survey made of three parts i.e. general information, Food Frequency Questionnaire (FFQ) and a 24-hour dietary recall; the whole of it was 3 pages and requires about 10 minutes to complete. I did the wording of sentences to suit/fit the local vernacular. I made sure all the questions apply in the Apollo Hospital setting.

The data collection involved the use of a pretested questionnaire. Surveys were distributed in-person, and this was done by both the researcher and research assistants. In-person distribution allowed for direct communication and clarification of any questions participants may have about the survey. To help minimize recall bias and ensure that the information is as accurate and current as possible, surveys were collected on the same day they were distributed. Recognizing the potential barriers to survey completion, assistance was offered to patients with disabilities such as illiteracy, blindness, or hand injuries. Structured interview protocols were followed in these cases to minimize bias, ensuring that the information collected was consistent and standardized.

Anthropometric measurements, including height and weight, were recorded. These measurements provide essential data for assessing body composition and nutritional status. Body Mass Index (BMI) was calculated using the formula: BMI (kg/m^2) = weight (kg) / height (m^2). Body weight was measured using a bathroom scale accurate to 0.5kg. The scale was placed on a flat surface and adjusted to the '0' mark before the subject stepped on it in bare feet. Weights were recorded to the nearest 0.5kg, and participants were advised to wear light clothing for accurate measurements. Body height was measured using an anthropometric rod. Height was recorded without footwear and expressed to the nearest 0.1cm. These measurement methods are consistent with standard practices for obtaining anthropometric data (ISO, 2020).

The FFQ used in the study was adapted and validated for use in South Indian contexts, acknowledging the cultural specificity of food lists. The study recognizes challenges in comparing results across different populations, cultures, or countries due to variations in dietary patterns.

Data was collected using a 24-hour dietary recall method, which involves obtaining detailed information about all foods, beverages, and dietary supplements consumed by the respondent over the past one day, capturing information from midnight to midnight of the previous day. The 24-hour dietary recall was conducted through a structured interview to capture detailed information. Respondents were asked for additional details beyond their initial report, such as the preparation method and type of foods consumed.

More details about the patients, including clinical parameters, were obtained from the patient's case file, and additional information was extracted from the discharge summary for those in the outpatient department.

Data quality management and Statistical Analysis

Raw factual information from the field was recorded on a spreadsheet and imported to SPSS for statistical analysis. Food intake for each patient was obtained from the 24-hour dietary recall. Using food composition tables, information on the nutrient content of various foods was calculated. The calculated nutrient

intake would give insight into the patients' dietary habits and nutritional status.

Ethical Considerations

All methods used in this study received prior approval from Apollo Hospital Medical Superintendent and Andhra University Head of Food, Nutrition and Dietetics Department. The data collection form did not bear the name of the respondent to ensure the subjects' privacy and the data was only used for the intended purpose. The raw information collected was immediately destroyed after analysis to prevent any data breach. It's only those who volunteered without compulsion had filled the survey. The informed consent of patients was indicated by the return of the completed surveys. There was no any conflict of interest to declare.

RESULTS

General information and Characteristics of Respondents

Table 1 below show the characteristics of the subject as reported by the respondents. The nutritional status classification was determined using the body mass index (BMI).

Table 1: Characteristics of Respondents

		%
Diagnosis	Leukaemia	20.0
	Lymphoma	35.0
	Multiple Myeloma	45.0
Age in years	20 years and below	5.0
	21 - 30 years	10.0
	31 - 40 years	10.0
	41 - 50 years	10.0
	51 - 60 years	40.0
	61 - 70 years	10.0
	71 - 80 years	15.0
Gender	Male	60.0
	Female	40.0
Nutritional Status	Underweight	5.0
	Normal	65.0
	Overweight	15.0
	Obese	15.0
Trend in weight change	Weight gain	15.0
	Weight loss	65.0
	Static weight	20.0
Level of education	Masters and above	30.0
	Bachelors	50.0
	High school	15.0
	Below high school	5.0
Occupation	Employed	45.0
	Own business	20.0
	Farmer	5.0
	Others	30.0
Food preference	Vegetarian	35.0
	Non-vegetarian	65.0

		%
Allergy	NKFDA	90.0
	Gluten	5.0
	Lactose	5.0
Alcohol Consumption	Non-alcoholic	80.0
	Alcoholic	20.0

Food frequency characteristics

Table 2 below shows the food preferences and eating patterns as obtained using a food frequency questionnaire. Adequacy of intake was determined with reference to the RDA for Indians. Soft drinks included any water-based flavored drink whether carbonated or not.

Table 2: Food frequency characteristics

		%	%	%	%
Food group	**Consumption estimate**	**Leukaemia**	**Lymphoma**	**Multiple Myeloma**	**Total**
Bakery product	Limited intake	5	15	15	35
	Adequate intake	10	15	10	35
	Overconsumption	5	5	20	30
	Total	20	35	45	100
Cereals and pulses	Adequate varieties	20	25	30	75
	Moderate varieties	0	10	15	25
	Total	20	35	45	100
Dairy products	Inadequate intake	0	5	10	15
	Adequate intake	20	15	25	60
	Moderate intake	0	15	10	25
	Total	20	35	45	100
Soft drinks	Low intake	5	15	5	25
	Excessive intake	5	5	10	20
	Moderate intake	10	15	30	55
	Total	20	35	45	100
Fruits	Inadequate intake	5	15	20	40
	Adequate intake	5	10	25	40
	Moderate intake	10	10	0	20
	Total	20	35	45	100
Vegetables	Inadequate intake	10	25	10	45
	Adequate intake	10	10	20	40
	Moderate intake	0	0	15	15
	Total	20	35	45	100

Adequacy of nutrient intake after diagnosis

Table 3 below describes the adequacy of nutrients intake after a diagnosis with leukemia, lymphoma or multiple myeloma. All of our sample was on hospital soft diet, coined intentionally for oncology patients. The move was hence deliberate. Reference was made to the food composition tables (FAO, 2018) and RDA for Indian ideal man and woman as recommended by ICMR. All patients were served with a vegetarian diet regardless of food preference.

Table 3: Adequacy of nutrients intake after diagnosis

Nutrient	Consumption estimate	% Leukaemia	% Lymphoma	% Multiple Myeloma	% Total
Calories	Underfeeding	10	30	30	70
	Overfeeding	10	0	15	25
	Adequate intake	0	5	0	5
	Total				100
Protein	Underfeeding	20	30	40	90
	Adequate intake	0	5	5	10
	Total				100
Fats	Underfeeding	10	25	25	60
	Overfeeding	10	0	15	25
	Adequate intake	0	10	5	15
	Total				100
Fibre	Inadequate intake	10	25	20	55
	Overconsumption	10	0	25	35
	Adequate intake	0	10	0	10
	Total				100

DISCUSSION

Characteristics of Respondents

Gender differences in cancer susceptibility are among the most consistent findings in cancer epidemiology. Hematologic malignancies, as well as many other cancers, are generally more common in males (Kovats, 2012). Hormonal and behavioral differences are often attributed to these gender disparities. Even in early childhood, where hormonal and behavioral differences may not fully apply, there are gender differences in cancer incidence (Kovats, 2012). Males generally exhibit higher susceptibility to cancer in childhood. Differences in immunity may contribute to the observed gender differences in cancer and infection susceptibility. Autoimmune disorders are more common in females, while cancer and infections are more prevalent in males [reference]. Genome surveillance mechanisms differ in efficiency between males and females, potentially influencing cancer susceptibility. Hormonal differences and the number of X chromosomes are also mentioned as factors contributing to gender disparities. Some gender differences in cancer susceptibility may originate from exposures during prenatal development (Mehmet et al., 2018). This highlights the potential impact of early-life environmental factors on long-term health outcomes. The complex interplay of hormonal, genetic, immunological, and developmental factors contributes to the observed gender differences in cancer susceptibility. Understanding these differences is crucial for advancing cancer research, personalized medicine, and the development of targeted interventions. Ongoing research in this area is essential for unraveling the underlying mechanisms and identifying strategies for cancer prevention and treatment that consider gender-specific factors.

The findings support the immune surveillance hypothesis, which suggests that allergic conditions enhance the immune system's capability to recognize and eliminate malignant cells. This hypothesis proposes a link between allergies and a reduced risk of certain cancers.

The decrease in the rate of metabolism with age is noted, leading to the accumulation of fat stores. This accumulation may contribute to obesity, which, in turn, has been linked to an increased risk of hematological malignancies,

including leukemia, lymphoma, and multiple myeloma (Cátia et al., 2019). Research findings indicate that body immunity decreases with the onset of menopause and aging. This reduction in immunity may diminish the body's ability to combat the onset of cancer. The observation could also be attributed to a possible association between financial freedoms and aging. Aging is also associated with dormancy and increased stress levels, factors linked with obesity and physical inactivity. Obesity and physical inactivity, both associated with aging and related factors, are contributors to an increased risk of hematological malignancy development (Cátia et al., 2019).

The high percentage of individuals with normal BMI is explained by reported weight loss, with 45% of those with a normal BMI reporting a history of weight loss. The general trend indicates that 65% of individuals with hematological malignancies started losing weight after diagnosis.

High BMI has been linked to an increased risk of cancer, including most hematological malignancies, based on previous studies (De Ridder et al., 2016).

From our analysis, 100% of our sample with master's degree and above reported to be employed and have a BMI above 24.5kg/m2. Individual's levels of education affect the factors which have been shown to have a strong association with cancer development (Chauveau et al., 2013). For instance, high level of education translates to higher employability which may translate to high purchasing power, lavish/or sedentary lifestyle, lack of physical activity, high intake of fast foods due to busy schedules and many more. All these factors can lead to obesity which is a risk factor for any cancer.

Vegetarian diets are rich in dietary fiber, n-6 fatty acids, vitamins C, B9, and E, magnesium, potassium, carotenoids, plant sterols, and various phytochemicals. These components are associated with numerous health benefits, including antioxidant properties that prevent oxidative stress implicated in carcinogenesis and the development of cardiovascular issues (Chauveau et al., 2013). A vegan diet, in particular, implies lower intake of saturated fatty acids, cholesterol, calcium, vitamin B12, and D, along with a higher intake of dietary fiber (Fields et al., 2016). Evidence indicates that a vegetarian diet is associated with a significantly lower prevalence of overweight and obesity. Vegetarians have a lower risk of cardiovascular hospital admission and experience 32% less mortality. Even after adjusting for body mass index, vegetarians remain 28% less likely to develop ischemic heart disease (Crowe et al., 2013). A meta-analysis showed that a vegetarian diet (excluding meat but including dairy products, eggs, and fish) was associated with lower systolic blood pressure (Yokoyama et al., 2014). This reduction in blood pressure was linked to a 9% decreased risk of death from coronary heart disease, comparable to the benefits of a 5 kg weight reduction or a low-sodium diet.

A large population-based study, including patients diagnosed with alcohol use disorders, suggested a protective effect of alcohol consumption against all haematological malignancies (Rota et al., 2014). This finding contradicts our results, especially considering that these patients belong to the moderate/heavy level of consumption (Ji et al., 2014). A protective effect of alcohol intake on MM has been documented, particularly among females, synthesizing 26 observational studies (Psaltopoulou et al., 2015). However, the results should be interpreted carefully in a broader context, as alcohol consumption increases the risk of other cancers, including colorectal, breast, oral, pharyngeal, laryngeal, esophageal, liver, and gastric cancer. It's essential to note the discrepancies between our study's results and those reported in the literature.

Me et al. (2014) found statistically significant increasing trends in the risk of Hodgkin lymphoma, mature T-cell malignancies, and myeloproliferative/myelodysplastic disease with increasing current cigarette consumption relative to never-smokers. No significant trends were observed for mature B-cell malignancy or any of its subtypes. Tests for heterogeneity between diagnostic subgroups were highly significant. The trend estimate for acute myeloid leukaemia,

although above unity, was not statistically significant. Using the ICD-10 classification, there were significant increasing trends for Hodgkin lymphoma and non-Hodgkin lymphoma (NHL), but not for myeloma or leukaemia. The difference in trends between the ICD-10 classification and Me et al.'s findings in our study could be explained by the small sample size used in our study.

Food frequency characteristics

Other findings linked an overconsumption of bakery products with a reduced intake of everything else which may include adequate iron. Inadequate iron intake has in turn been linked with colorectal cancer but not any of haematological cancers (Katica et al., 2017).

The levels of reproductive hormones or other protective factors present in dairy products may vary, and these variations could potentially influence the observed prevalence with cancer risk. Examining a dose-response relationship, such as comparing high versus low dairy consumption, may help identify trends or patterns that could provide more insight into the potential impact of dairy intake on cancer risk.

Clearly defining categories of dairy consumption (e.g., no dairy, low dairy, high dairy) is essential for accurately assessing the potential relationship between dairy intake and cancer risk. Accounting for confounding factors, such as age, gender, lifestyle, and other dietary habits, is important to ensure that observed associations are not influenced by other variables. Considering the specific subtypes of blood cancers may also be relevant, as different types of blood cancers may have distinct etiologies and risk factors. Longitudinal studies that follow individuals over time can provide valuable insights into the cumulative effects of dairy consumption on cancer risk.

By addressing these considerations, researchers can enhance the robustness of their findings and contribute to a more nuanced understanding of the relationship between dairy intake and the risks of blood cancers. Additionally, collaboration and consistency in study design across research efforts can contribute to the accumulation of evidence in this field.

Soft drinks constitute carbonated and non-carbonated water-based flavored drinks. There is paucity of research findings that have linked cool drinks with leukaemia, lymphoma or multiple myeloma.

Our findings suggest that there is no accrued risk as a result of adequate or inadequate intake of fruits. Fruits such as citrus fruits are good sources of antioxidants like vitamins c. Intake is known to boost body immunity helping in cancer prevention. There is a dearth of information on previous study that has been done to determine the association between fruit intake and hematological malignancies.

It's important to note that dietary patterns and their associations with cancer risk can vary widely across different populations, and individual factors such as genetics and lifestyle can also play significant roles. Researchers often adjust for confounding variables in their analyses, but the presence of residual confounding underscores the challenges in isolating specific dietary factors' effects on cancer risk (Key, 2013). Continued research and a nuanced approach to understanding these associations are crucial for developing comprehensive dietary recommendations for cancer prevention.

Adequacy of nutrient intake after diagnosis

The effects of cancer on host tissue and whole-body energy metabolism are only partially understood. It is challenging to be precise about the minimum intake of energy that would be sufficient to meet energy needs and maintain body energy balance in cancer patients. The optimal balance between major exogenous energy sources (such as glucose or other carbohydrates) and lipids for maximum efficiency of energy utilization is not well-defined (Vernon, 2020).

Cancer patients with advanced life-limiting illness often experience gastrointestinal (GI) symptoms. Nausea and vomiting are common, affecting 21-68% of all advanced cancer patients and 70-80% of those receiving chemotherapy (Amy P et al., 2020). These symptoms can lead

to serious metabolic disturbance, malnutrition, electrolyte imbalances, and other physiological repercussions.

Constipation is a common symptom among elderly patients in general and afflicts 50-87% of terminally ill cancer patients (Choi YS, 2019). Constipation can have physical, emotional, and social impacts and may be associated with various concerns such as headache, fatigue, abdominal swelling and pain, nausea and vomiting, anorexia, hemorrhoids, and urinary complications. For some patients, constipation can be more distressing than pain and may even lead them to decline further analgesic treatment.

Gastrointestinal symptoms, including nausea, vomiting, and constipation, can significantly impair functionality and erode the quality of life for cancer patients. Managing these symptoms is an important aspect of supportive care for cancer patients, and healthcare providers often employ a multidisciplinary approach to address both the physical and psychosocial aspects of these challenges. Developing personalized care plans, considering the patient's overall health status, treatment goals, and preferences, is crucial in providing effective and compassionate care for individuals with advanced cancer.

There is a growing interest in low protein diets, and evidence suggests a connection between dietary protein restriction and cancer outcomes. Studies have observed a beneficial role of low protein diets in inhibiting cancer growth and improving cancer outcomes. In a clinical study involving respondents aged 50–65, high protein intake (20% or more of calories from proteins) was associated with a 4-fold increase in the risks of overall and cancer mortality during an 18-year follow-up period (M.E. Levine et al., 2014). Conversely, low protein intake (less than 10% of calories from proteins) was associated with lower cancer mortality. Risks associated with high protein intake may be somewhat reduced if the dietary protein source is not from animal protein. A mouse model study found that a diet with 20% plant protein reduced tumor weight by 37% compared to a diet with 20% animal protein. Protein restriction has been reported to reduce cancer incidence, as observed in a study involving mice implanted with murine breast cancer cells (M.E. Levine et al., 2014).

Restricted fats intake is acceptable for patients on chemotherapy; all the same this should not go below the lower limit for daily allowance. Fats may reduce gut passage time. For patients with poor appetite reducing fats in the diet will improve digestibility. No previous research has worked on the suitability of fat adequacy in hematological malignancies.

The general energy intake was found to be low for most of our respondents as shown in table 3 above. The deficit trickled down to fiber intake. This could be as a result of the nature of South Indian foods which is more of highly processed vegetables and almost near zero green leafy vegetables. Low fiber is not recommended for patients with leukemia, lymphoma or multiple myeloma.

CONCLUSION

Based on the survey results, the habits affecting patients' nutritional status following diagnosis with leukemia, lymphoma and/or multiple myeloma include: food preference, smoking, alcohol intake, and history of food intake prior to diagnosis, energy intake, protein intake, fiber intake, fats intake and BMI. All these factors affect patients' change in weight and disease progression.

Findings from this study suggest that after diagnosis with leukemia, lymphoma and/ or multiple myeloma patients will experience difficulty in meeting nutrients requirement. The intake will be deficit compared to the RDA for Indians and the general guidelines for patients with cancer and/ or on chemotherapy.

Finally, findings from this study suggest that patients diagnosed with leukemia, lymphoma and/ or multiple myeloma with a history of overweight will tend to drop to an ideal body weight, obese patients will tend to remain obese, and normal weight patients will remain normal given adequate nutritional care.

RECOMMENDATIONS

To improve adequacy in nutrients intake and general nutrition in leukaemia, lymphoma and multiple myeloma; focus improvement interventions on the all-macronutrient categories, pay attention to food preference among patients and make continuous quality improvements, survey and intervention periods may be repeated indefinitely.

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