

Nutritional Challenges in Cancer Patients: Impact, Deficiencies, and Management Strategies

Anshul Chauhan¹ and Renu Deepak Khedkar^{2,*}

¹ Research Scholar, Amity Institute of Food Technology, Amity University, Noida.

^{2*} Professor, Amity Institute of Food Technology, Amity University, Noida.

*Corresponding author email: rdkhedkar@amity.edu

Abstract. Cancer is a complex disease that involves excessive cell proliferation and has negative health repercussions. Cancer remains one of the most common causes of morbidity and mortality worldwide. Even if breakthroughs in treatment techniques, including as surgery, chemotherapy, and radiation, have increased survival, these treatments have a tendency to cause deficiencies in nutrition, such as loss of appetite, nausea, mucositis, taste changes, and gastrointestinal disruptions. These challenges lead to protein-energy malnutrition (PEM) and deficiencies in key micronutrients such as vitamins B6, B12, C, D, and omega-3 fatty acids, which impair immunological function, muscle health, and overall recovery. Effective nutritional treatment, such as personalised dietary management, nutritionally enriched food, oral nutrition supplements (ONS), and, when required, enteral or parenteral nutrition, is critical to improve patient outcomes. This review focusses on the nutritional challenges facing cancer patients, common deficiencies and evidence-based approaches to management, emphasising the need of integrated nutritional support in cancer care.

KEYWORDS: Cancer Treatment Side Effects, Nutrition, Protein Energy Malnutrition, Micronutrient Deficiency, Cancer cachexia, Chemotherapy-induced nutritional deficiencies, Oral nutritional supplements (ONS)

1. Introduction

According to recent data, 19.3 million new cases and almost 10 million cancer deaths were reported globally [1]. The evidence indicated that there are enormous disparities in incidence and outcome between low-income and high-income countries.

Largely, Asia contributed 49.3% to all cancers and 58.3% to deaths due to cancer because of its sheer number and rise in most risk factors. Lung cancer continues to be the number one cause of cancer mortality. Notably, although breast cancer incidence has surpassed lung cancer incidence, it still yields fewer fatalities, a reflection of improved survival in high-resource environments. Table 1. represents global cancer incidence and death. Lung, breast, and colorectal cancer are the most common cancers to be diagnosed with in the world. Lung and liver cancers kill more people with cancer than other cancers.

Longitudinal studies have documented increasing incidence and mortality, partly due to aging populations, environmental exposure, and lifestyle factors such as smoking, obesity, and alcohol consumption [2]. For further historical context and socioeconomic

characterization expose harsh contrasts between high-SDI and low-SDI regions — high-income countries have higher incidence but lower mortality, because of early detection and advanced treatments [3]. Cancer is defined as an uncontrolled proliferation of cells, which not only results in tumours but also triggers a cascade of secondary systemic consequences on metabolism and global health. Even if tremendous progress has been made in the age of medical science, increasing the survival rate of cancer patients, the disease and its control remain a struggle, particularly achieving optimal nutrition.

Cancer and cancer treatment—surgery, chemotherapy, irradiation, and immunotherapy—have direct consequences on the intake of nutrients, metabolism, and overall condition of the patient. Malnutrition and cachexia are frequent conditions in oncology and occur in a high proportion of cancer patients at some time during the disease course. Malnutrition commonly results in muscle wasting, immune deficiency, impaired tolerance to therapy, and poor prognosis of disease [4].

The decline in the nutritional status of cancer patients is due to a variety of factors such as metabolic derangement, systemic inflammation, and primary oncologic effects on the gut. Other complications of cancer therapy such as nausea, vomiting, mucositis, taste disturbance, and gastrointestinal dysfunction also play an important role in decreased food intake and nutrient absorption. These issues not only undermine the patient's ability to achieve normal nutritional status, but also reduce their tolerance for aggressive therapy, increasing their risk of infection and extending their length of stay.

Current studies have found that inflammation is the most important factor in cancer cachexia. Tumor cell-secreted cytokines like TNF- α and other interleukins are responsible for muscle wasting and metabolic disturbances [5]. The chronic inflammation worsens the weight loss and reduces the effectiveness of conventional nutritional therapy. It is important to know the molecular and physiological mechanisms of malnutrition in cancer to create specific nutritional interventions that can avert these adverse effects. To treat these issues, an interdisciplinary strategy is needed that encompasses individualized meal planning, therapeutic medical nutrition, and careful macronutrient and micronutrient supplementation. Nutritional therapy, including nutritional counselling and supplements, early in the treatment process has been shown to increase quality of life and treatment adherence in cancer patients to a considerable extent. Also, the integration of nutrition into oncology treatment not only enhances the health of the patient but also maximizes therapeutic outcomes. The necessity of specialized nutritional therapy, such as enteral and parenteral nutrition [9], has received increased attention in the clinical setting, with a particular emphasis on the role of an integrated, nutrition-based approach to cancer treatment.

In spite of increased recognition of the crucial position of nutrition in oncology, large gaps in awareness and a lack of implementation of appropriate nutrition practice among oncologists continue to still exist. Patient cancer malnutrition remains untreated due to the absence of harmonized screening procedures and the insufficiency of trained nutritional interventions being available. Such gaps must be overcome by education, regulatory changes, and improved clinical recommendations, as is the case with mainstreaming nutrition as a basic cancer treatment procedure. This review examines the impact of

cancer therapy on nutrition, the deficiencies that result, and evidence-based approaches to effectively treating these issues. This systematic review aims to underline the relevance of nutritional support as a crucial part of cancer therapy, which finally leads to improved patient outcomes and quality of life.

Cancer Type	New Cases (2022)	Deaths (2022)
Lung Cancer	2.5 million	1.8 million
Breast Cancer	2.3 million	685,000
Colorectal Cancer	1.9 million	935,000
Prostate Cancer	1.4 million	375,000
Stomach Cancer	1.1 million	768,000
Liver Cancer	905,000	830,000

Table 1. presents the global incidence and mortality estimates of the six most prevalent types of cancer in 2022, according to the GLOBOCAN database, with notable variations in survival rates between various cancer sites

2. Impact of Cancer Treatment on Nutritional Status

Cancer treatment has a significant effect on the nutritional status of a patient, producing abnormal metabolism and heightened risk of malnutrition. Cancer treatment induces biochemical and physiological alterations that influence energy balance, nutrient absorption, and metabolism [6]. The changes are pertinent because nutritional status influences tolerance of treatment, recovery, and prognosis in cancer patients.

2.1. Metabolic Alterations Induced by Cancer and Its Treatment

Cancer is associated with deep metabolic alterations, which are generally referred to as cancer-induced cachexia. Cancer-induced cachexia is a condition manifesting with sustained weight loss, muscle wasting, and systemic inflammation. Hypermetabolism is generally observed in cancer patients, characterized by elevated energy expenditure with reduced food intake. Tumor-secreted cytokines such as TNF- α , IL-6, and IL-1 are also involved in metabolic dysfunction and contribute to muscle and fat tissue depletion.

Furthermore, glucose metabolism is also altered in cancer patients, and insulin resistance and increased gluconeogenesis occur [7]. These metabolic changes deplete glycogen reserves, and the organism is compelled to utilize protein catabolism as a source of energy. Chronic muscle protein breakdown leads to muscle wasting and loss of muscle mass, which impairs physical function and decreases tolerance to treatment.

The lipid metabolism is also affected, with patients suffering from increased lipolysis, which eventually results in fat loss. This is because tumors secrete lipolytic factors, which induce energy depletion and excessive weight loss. Identification of changes in metabolism is important in formulating personalized nutritional treatment to reverse muscle wasting and preserve energy deficits in cancer patients.

2.2 Side Effects of Cancer Treatments That Affect Nutrition

Some of the oncologic treatments such as chemotherapy, radiotherapy, and surgery have a strong impact on nutritional intake and status as shown in figure 1.

2.2.1 Anorexia and Loss of Appetite:

Many cancer patients suffer from a sudden loss of appetite caused by metabolic changes brought about by tumors and the unpleasant side effects of cancer treatment. Loss of appetite may result in inadequate caloric consumption and consequent nutritional deficiencies.

2.2.2 Nausea and Vomiting: The state of chemotherapy-induced nausea and vomiting (CINV) is prevalent in cancer patients. These symptoms tend to result in decreased food intake, hydration issues, and electrolyte disturbances, thereby worsening the state of malnutrition.

2.2.3 Oral Mucositis and Ulcers: Chemoradiation and chemotherapy can cause painful ulceration and inflammation of the mucous lining of the mouth and gastrointestinal tract. Mucositis disrupts food chewing and swallowing, resulting in reduced oral intake and weight loss.

2.2.4 Taste Changes (Dysgeusia): Chemotherapy and radiotherapy have the tendency to change patients' taste and cause food aversions. Dysgeusia reduces the overall pleasure of eating and limits food variety in the diet, leading to inadequate nutrient intake.

2.2.5 Gastrointestinal Disorders: Diarrhea and constipation are frequent treatment side

effects in cancer. Diarrhea results in dehydration, electrolyte derangement, and malabsorption of nutrients, while constipation results in discomfort and decreased intake of food [8].

2.2.6 Fatigue and Weakness: Cancer fatigue is a prevalent and disabling syndrome that impairs a patient's ability to prepare and eat food, frequently resulting in decreased nutrient consumption and worsening other health deterioration.

2.2.7 Delayed Gastric Emptying: Certain oncologic therapies affect gastrointestinal motility and produce symptoms such as bloating and early satiety, which subsequently restrict the patient from taking sufficient nutrients.

2.2.8 Changes in Absorptive Capacity: Radiation enteritis and mucosal injury by chemotherapy reduce the ability of the gut to absorb vital vitamins and minerals, further exacerbating malnutrition.

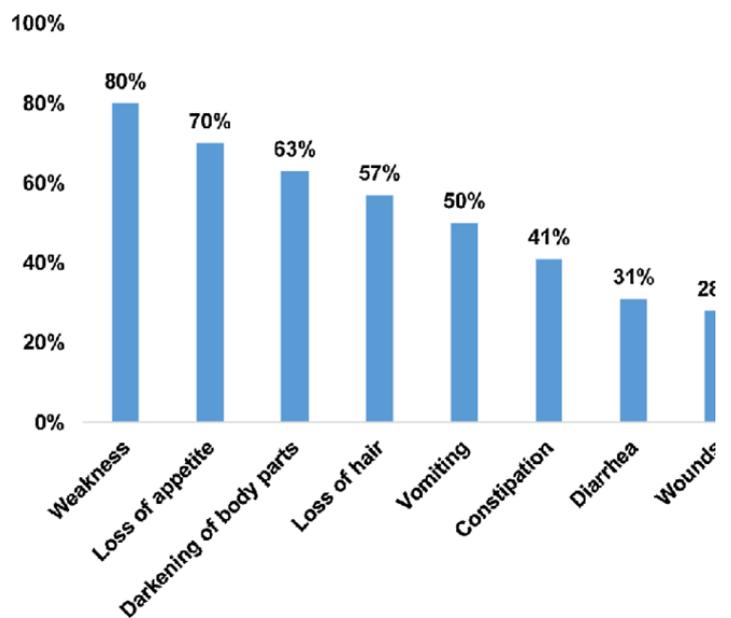


Figure 1. Prevalent side effects found in cancer patients on treatment, expressed as percentage occurrence.

2.3. The Role of Inflammation in Cancer-Related Malnutrition

Inflammation is the central mechanism for malnutrition in cancer through the induction of catabolism and the impairment of nutrient use. Pro-inflammatory mediators disrupt normal metabolic pathways, increasing muscle

breakdown and repressing protein production. Long-term inflammation also affects gut permeability, leading to malabsorption of essential vitamins and minerals. This inflammatory state is the cause of weight loss, muscle wasting, and increased risk of infections and treatment toxicity.

2.4. Nutritional Risk Screening and Assessment

Early recognition of individuals at risk of malnutrition is central to the provision of early nutritional interventions. The following are utilized in the clinic to determine nutritional status in cancer patients:

2.4.1 The Malnutrition Universal Screening Tool (MUST) is a commonly applied tool that assesses body mass index (BMI), weight loss, and recent change in food intake.

2.4.2 Patient-Generated Subjective Global Assessment (PG-SGA) – A method of making global assessment using intake, weight loss, symptoms, and functional capacity.

2.4.3 Nutritional Risk Screening 2002 (NRS-2002)- Commonly applied across hospital inpatients to determine the individuals who require nutritional intervention.

Regular monitoring of nutritional status allows clinicians to develop personalized nutritional care plans, enhancing treatment compliance and enhancing patient outcomes.

3. Nutritional Management and Intervention Strategies An individually planned nutritional approach is critical in the management of cancer. Specialist dietitians play an important role in developing individualized meal plans that address specific nutritional deficits and treatment-related side effects. These interventions focus on increasing protein intake, symptom control with nausea and dysphagia, and prevention of weight loss through proper caloric intake [9].

3.1. Oral Nutritional Supplements (ONS).

ONS are commonly prescribed to supplement the diets of cancer patients and those with poor intake. ONS provide required macronutrients and micronutrients in an acceptable and enjoyable form to ensure that the patients are able to sustain their nutritional status under challenging conditions with regular meals. They are particularly helpful in patients with loss of appetite, weakness, or gastrointestinal symptoms. ONS

can be formulated to provide special nutrient requirements—such as high-calorie, high-protein, or immunonutrition formulations—and are formulated in numerous taste and texture varieties to enhance compliance and palatability [10]. Use has been linked to maintenance of body weight, improved tolerance to treatment, and improved quality of life

3.2. Enteral and parenteral Nutrition

Enteral and parenteral nutrition become essential in the patient who is unable to receive their nutritional requirements by mouth due to profound dysphagia, gastrointestinal obstruction, or side effects of treatment such as mucositis or intractable nausea. Enteral nutrition is provided directly into the gastrointestinal tract using enteral feeding tubes (such as nasogastric or percutaneous endoscopic gastrostomy tubes) and is the preferred therapy when the gut is intact. It maintains gut integrity and optimizes immune function.

Parenteral nutrition, also known as intravenous nutrition, nonetheless, is intravenous delivery of nutrients and is used when the gastrointestinal tract is non-functional or not accessible. While more invasive, it is lifesaving in aggressively treated and critically ill patients. Both must be closely monitored by a multidisciplinary team to minimize risks including infections, metabolic disturbances, and refeeding syndrome.

3.3. Pharmacological and supportive therapies.

Medications and supportive therapies may be used to relieve symptoms that affect eating and stimulate appetite. Appetite stimulants like megestrol acetate and corticosteroids are used effectively to increase food intake and weight gain in cancer patients. Moreover, anti-inflammatory drugs like omega-3 fatty acids may decrease inflammation and cancer-induced muscle loss, facilitating nutrition. Other drugs like prokinetics and antiemetics manage stomach complications like nausea, vomiting, and delayed stomach emptying [11]. Psychological therapy and counselling for depression or anxiety can also induce appetite and food intake. With the above treatments in combination with dietary modification, the whole package forms an integral solution to managing malnutrition from cancer.

4. Micronutrient Deficiencies in Cancer Patients

Cancer patients typically have deficiencies in some micronutrients, including vitamins B6, B12, C, D, and folate, and trace elements like zinc, selenium, and iron. These are caused by poor nutrition, compromised absorption, and elevated metabolic demands. These deficiencies need to be corrected to ensure immune function, muscle function, and overall recovery.

Vitamin D, omega-3 fatty acid, and selenium deficiencies have been correlated with increased inflammation and treatment failure. Supplementation with these micronutrients is likely to strengthen immune function, reduce inflammation, and increase tolerance to therapy. Thus, adequate micronutrient status through nutritional interventions and specific supplementation is an important part of cancer therapy.

4.1. Causes of Micronutrient Deficiencies

There are a number of reasons why vitamin deficiency is found at a higher frequency in cancer patients:

4.1.1 Poor nutrition: Nausea, vomiting, and alteration of taste due to side effects of treatment can lead to loss of appetite, which can further lead to decreased consumption of nutrient-dense meals.

4.1.2 Malabsorption: Gastrointestinal tumors, radiation, and chemotherapy all have the ability to weaken the digestive system and cause impaired absorption of nutrients.

4.1.3 Enhanced metabolic requirements: Oncology creates a state of hypermetabolism within the body and, as such, increases the requirement for micronutrients that enable immune function and tissue repair.

4.1.4 Inflammatory response: Cancer-induced systemic inflammation affects micronutrient metabolism by elevating oxidative stress and decreasing availability.

4.1.5 Renal and hepatic impairment: Some cancers and therapies can impair kidney and liver function, leading to augmented excretion or modified metabolism of vitamins and minerals.

4.2. Impact of Specific Micronutrient Deficiencies

Each micronutrient plays a specific role in cancer development, tolerance to treatment, and recovery:

4.2.1 Vitamin D: Essential for bone health, immune system function, and regulation of inflammation. Vitamin D deficiency is prevalent among cancer patients and is linked to greater fatigue, muscle weakness, and poor outcome.

4.2.2 Vitamins B6 and B12: Essential for red blood cell formation and brain function. Deficiency can comprise anaemia, neuropathy, and cognitive impairment, all of which are major side effects of chemotherapy.

4.2.3 Folate: Needed for DNA synthesis and repair. Folate deficiency can result in cell damage as well as enhancement of treatment toxicities.

4.2.4 Vitamin C: A powerful antioxidant that supports immune function and wound healing. Chemotherapy and radiation can increase oxidative stress, making vitamin C more necessary.

4.2.5 Iron: Required for oxygen transport and energy metabolism. Iron deficiency anaemia due to iron deficiency is frequent in cancer patients and leads to fatigue and intolerance to treatment.

4.2.6 Zinc and selenium: These trace elements play a crucial role in immunological function, antioxidant defence, and tissue repair. Deficiency is associated with enhanced inflammation, impaired wound healing, and compromised immunity.

4.3. Strategies to Address Micronutrient Deficiencies

4.3.1 Dietary modifications: Encouraging the consumption of nutrient-dense foods, such as lean protein, dairy, nuts, seeds, leafy vegetables, and fortified foods, could help maintain adequate levels of micronutrients.

4.3.2 Oral supplementation: Severe deficiencies may respond to specific vitamin and mineral supplementation. For example, the use of vitamin D and omega-3 fatty acids has demonstrated anti-inflammatory activity and possible treatment driving benefits [12].

4.3.3 Enteral or parenteral nutrition: For individuals with severe malabsorption issues, certain nutritional management by enteral (tube feeds) or parenteral (intravenous) nutrition can be essential [12].

4.3.4 Monitoring and screening: Periodic monitoring of micronutrient status by blood

tests can enable early detection of deficiencies, enabling early corrective measures.

Correction of micronutrient deficiencies is a critical part of integrated cancer treatment as it strengthens the immune system, reduces therapy toxicity, and enhances the general quality of life.

5. Impact of Nutritional Support on Clinical Outcomes

The integration of nutritional support into oncology treatment is increasingly recognized as a component of multimodal treatment. Malnutrition in cancer patients is associated with higher morbidity, reduced therapeutic response, longer hospital stay, and reduced quality of life. Furthermore, early and specific nutritional intervention has been shown to yield substantial clinical benefits.

5.1. Improved Treatment Tolerance and Reduced Toxicity

Nutritional therapy improves patients' tolerance to aggressive therapy, such as chemotherapy and radiation therapy. Adequate macronutrient and micronutrient intake supports organ function, enhances tissue repair, and facilitates detoxification processes, thus reducing the incidence and severity of treatment-related side effects, such as mucositis, diarrhoea, and fatigue [13]. Studies show that patients with optimal nutrition experience fewer dose changes and interruptions in treatment regimens, which is a reflection of better compliance with therapeutic regimens.

5.2. Enhanced Immune Function and Infection Resistance

Malnutrition impairs both innate and adaptive immune responses, increasing susceptibility to infections. Protein-energy malnutrition, in particular, weakens immune cell proliferation and antibody production. Nutritional repletion restores immune competence, thereby reducing infection rates, minimizing hospitalizations, and facilitating quicker recovery. Specific nutrients like vitamins A, C, D, and E, as well as zinc and selenium, play a crucial role in enhancing immune surveillance and defence mechanisms [14].

5.3. Preservation of Muscle Mass and Physical Function

Sarcopenia, or skeletal muscle mass loss, is common in cancer patients and is strongly

linked to adverse effects, including shorter survival. Proper intake of protein, combined with physical exercise and, if necessary, anabolic agent or speciality nutrition product supplementation (e.g., high-protein, leucine-supplemented), helps to maintain lean body mass. This ensures mobility, independence, and a higher quality of life throughout the cancer treatment continuum [15].

5.4. Quality of Life and Psychological Well-being

Nutrition has a direct effect on mental health. Weight loss and malnutrition can lead to depression, anxiety, and social isolation. Nutritional therapy enhances energy, mental clarity, and emotional strength, improving the treatment experience as a whole. Patients who are physically stronger and better cared for are also more content with their treatment as a whole and have improved quality of life [15].

Conclusion

Nutritional problems are a significant, yet commonly underappreciated, part of oncologic management. Malnutrition, cachexia, and micronutrient deficiencies are common in cancer patients and are increased by malignancy and by treatment for malignancy. These nutritional problems impair immune function, lower the effectiveness of treatments, and adversely impact quality of life and survival. The evidence at hand strongly supports the integration of comprehensive nutritional interventions—ranging from personalized dietary counselling, to oral nutritional supplements, enteral, and parenteral nutrition—into the standard oncology treatment model. These interventions not only mitigate the adverse effects of treatment but also enhance patient resilience, treatment adherence, and overall recovery rates. Future activities must emphasize early risk screening for nutritional insufficiency, clinician heightened awareness, and multidisciplinary planning to provide timely and effective nutrition support. By making nutrition a core aspect of cancer care, as opposed to an adjuvant, health care systems can greatly enhance the clinical and humanistic outcomes of cancer patients.

References

1. F. Bray, M. Laversanne, H. Sung, J. Ferlay, R.L. Siegel, I. Soerjomataram, & A. Jemal. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36

- cancers in 185 countries. *CA Cancer J. Clin.* (2024).
2. L. Lin, Z. Li, L. Yan, Y. Liu, H. Yang, & H. Li. Global, regional, and national cancer incidence and death for 29 cancer groups in 2019 and trends analysis of the global cancer burden, 1990–2019. *J. Hematol. Oncol.* (2021).
 3. J. Lortet-Tieulent, D. Georges, F. Bray, & S. Vaccarella. Profiling global cancer incidence and mortality by socioeconomic development. *Int. J. Cancer* 147(11) (2020).
 4. T.N. Lakhanpal & M. Rana. Medicinal and nutraceutical genetic resources of mushrooms. *Plant Gen. Res. – Characteriz. Utiliz.* 81–20:19, 1–17 (2005).
 5. H.J. Patel, & B.M. Patel. TNF- α and cancer cachexia: Molecular insights and clinical implications. *Eur. J. Pharmacol.* 812, 64–73 (2017).
 6. L. Santarpia, F. Contaldo, & F. Pasanisi. Nutritional screening and early treatment of malnutrition in cancer patients. *J. Cachexia Sarcopenia Muscle* (2011).
 7. T. Masi, & B.M. Patel. Altered glucose metabolism and insulin resistance in cancer-induced cachexia: a sweet poison. *Pharmacol. Rep.* (2021).
 8. W. Marx, N. Kiss, A.L. McCarthy, D. McKavanagh, & L. Isenring. Chemotherapy-induced nausea and vomiting: a narrative review to inform dietetics practice. *J. Acad. Nutr. Diet.* (2016).
 9. M.M.M. Caro, A. Laviano, & C. Pichard. Nutritional intervention and quality of life in adult oncology patients. *Clin. Nutr.* (2007).
 10. D. Heber, & Z. Li. Nutrition intervention in cancer. *Med. Clin. North Am.* (2016).
 11. P. McGrath. Reflections on nutritional issues associated with cancer therapy. *Cancer Pract.* (2002).
 12. J. Van Eys. Benefits of nutritional intervention on nutritional status, quality of life and survival. *Int. J. Cancer* (1998).
 13. R. Barrera. Nutritional support in cancer patients. *J. Parenter. Enteral Nutr.* (2002).
 14. H.A. Blackwood, C.C. Hall, T.R. Balstad, T.S. Solheim, M. Fallon, E. Haraldsdottir, & B.J. Laird. A systematic review examining nutrition support interventions in patients with incurable cancer. *Support. Care Cancer* (2020).
 15. F. Bozzetti. Nutritional support of the oncology patient. *Crit. Rev. Oncol. Hematol.* 87(2) (2013).