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A review on the role of nutrition in combating cancer

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Abstract

Cancer is considered to be one of the most debilitating and incurable diseases in human history. Over the last few decades, significant improvements in cancer treatment techniques have been made and chemotherapeutic therapy (chemotherapy) remains the predominant method of cancer treatment. Chemotherapy is a drug treatment, that is destructive to tumor cells and tissues. Chemotherapeutic medicines may be divided into several categories *viz.* antimetabolites, alkylating agents, mitotic spindle inhibitors, topoisomerase inhibitors, and others. The development of anti-cancer therapies focuses on the selective and effective targeting of carcinogenic cells. As a part of this treatment, individuals with cancer are supplied with enteral nourishment. The enteral formulas or oral nutrition supplement (ONS) helps to enhance nutritional status by increasing the muscle mass and protecting body composition in patients suffering from pancreatic and bile duct cancer receiving first cycle of chemotherapy. This diet plays crucial role in cancer as it includes vitamins, minerals, antioxidants and naturally occurring phytochemicals, thus protecting the body from various carcinogens. Nutritional counselling and ONS should be utilised to enhance food intake to prevent malnutrition in cancer patients. This review aims to update and extend the scope of evidence-based treatment guidelines for dietary management of chemotherapy patients.

Keywords: Cancer, types of cancer, screening methods, treatment, cancer cachexia, nutritional intervention, dietary management

1. Introduction

Cancer has overtaken heart disease as the top cause of mortality in economically developed nations and is considered as world's second major cause of death after CVDs (cardiovascular diseases). It is a state of great physiological and psychological stress for an individual. Cancer is a systemic, complicated, and heterogeneous disease usually classified as benign and malignant. The benign or non-proliferative causes damage to nerves, tissues or blood vessels and malignant or proliferative which includes brain cancer, breast cancer, lung cancer etc. These different types of cancers along with their associated risk factors are discussed in Table 1. Nutritional intervention in cancer patients aims to identify, prevent, and treat malnutrition through nutritional counselling with or without oral nutritional supplements (ONS) or artificial support, enteral or parenteral nutrition [1]. Surgical, radiation, and pharmaceutical treatments for cancer are all being used at the same time. The stage, type, age of cancer, patient's general health are the general factors that influence cancer symptoms and the most common symptoms of cancer include isolation, psychological distress, social isolation, pain, dyspnea, exhaustion, weight loss, and depression [2]. Malnutrition is a potential consequence in cancer patients and is sometimes considered as the first sign to identify the onset of cancer disease. Sarcopenia, a cancer-related complication, is defined by a decrease of skeletal muscle mass and function [3].

There is substantial evidence that nutrition, food, and other related factors like alcohol intake, smoking, physical activity, or obesity have a considerable impact on cancer risk and lifestyle modification along with behavioural changes can considerably lower cancer burden [4]. Foods like whole grains, vegetables, legumes, nuts and seeds have been reported to have a positive effect in blocking many carcinogenic pathways [5]. This review discuss the scope of evidence-based treatment guidelines for dietary management for cancer patients.

Cancer screening methods

Different methods have been employed for screening of cancer have been enlisted and discussed below:

1.1 MRI (Magnetic Resonance Imaging)

Magnetic resonance imaging is a treatment that uses radio waves and a powerful magnet connected to a computer to obtain detailed images of internal organs. These images help distinguish between healthy and cancerous tissue. The brain, spine, soft tissue of joints, and the insides of bones are all good candidates for MRI imaging [6].

2.2 Biomarkers

Biomarkers are disease indicators that help confirm the diagnosis of a malignant tumor. In the field of conceptually unstable and precise biomarkers, nanomaterials such as Abraxane and Doxil are being employed [7].

2.3 CEA (Carcinoembryonic antigen)

CEA is used as the assay's model protein biomarker. It is routinely released in gastrointestinal tissue throughout foetal development, and stops before birth. As a result, it is often only found in very small amounts in healthy persons [8].

2.4 CA-125 (Carbohydrate Antigen 125)

CA125 antigen is a blood marker that is regularly used in gynecologic practise to track ovarian cancer patients. Changes in serum CA125 levels during chemotherapy are linked to the progression of the disease [9].

2.5 PSA (Prostate specific antigen)

It is Antigen specific to the prostate (PSA). The prostate produces a glycoprotein called prostate-specific antigen (PSA). PSA levels have been linked to prostate cancer, and PSA testing have helped to detect malignancies in their early stages [10].

2.6 Mammography

Mammography is a standard method to detect cancerous tumours before they become visible. An X-ray examination of the breast in the standard craniocaudal and mediolateral oblique perspectives is called a mammogram [11].

2.7 Tomography

Positron emission tomography (PET) using 2-[18F] fluoro-2-deoxy-D-glucose (FDG) is a whole-body imaging technology that detects disease by elevated rate of glycolysis in tumour cells [12].

3. Cancer treatment

The immune system is widely known for defending itself against a variety of illnesses, but it is now known to have a role in cancer detection and destruction. These, on the other hand, are frequently linked to adverse side effects like nausea, exhaustion, and hair loss. Chemotherapy, radiation, and surgery are all common cancer therapies (Figure 2). [13].

3.1 Immunotherapy

Cancer immunotherapy, which aims to revive the body's immune response to cancer, is showing promising results in various tumours, including melanoma, lung cancer, kidney cancer, head and neck cancer, and Hodgkin's lymphoma [14].

3.2 Photodynamic Therapy

Photodynamic therapy may damage the tumor's blood arteries, preventing it from receiving the blood it requires to grow. It also has the potential to cause the immune system to fight tumour cells in other parts of the body [15].

3.3 Radiation Therapy

Radiation therapy is a cancer treatment that involves administering high doses of radiation to cancer cells in order to kill them and shrink tumours and drugs that flow through the bloodstream and potentially impact all parts of the body are known as systemic medicines, and they work through a variety of ways [16].

3.4 Surgery

Surgery is a procedure in which a surgeon removes cancer from your body. When compared to chemotherapy and radiotherapy, surgery, resection, or operation is believed to be one of the most promising and conventional therapies for many benign and malignant tumours as it ensures the least damage to the surrounding tissues [17].

3.6 Hormone therapy

Hormone therapy is a cancer treatment that slows or stops the growth of cancers that grow by releasing hormones. It is also known as hormone treatment, endocrine therapy. Prostate and breast cancers that utilise hormones to proliferate and which are treated with hormone therapy. It is frequently used in conjunction with other cancer therapies [18].

3.7 Bone marrow transplantation

Bone marrow transplantation is also called a stem cell transplants in persons who have had their stem cells damaged by strong doses of chemotherapy or radiation therapy, stem cell transplants are operations that replenish stem cells that grow into blood cells [19].

3.8 Chemotherapy

Chemotherapy is a type of cancer treatment that uses chemical substances to decrease cancer symptoms, cure cancer completely, or extend life. This treatment may lead to a variety of side effects, including weight loss, fatigue, stomatitis, nausea, diarrhoea, and myelosuppression. During chemotherapy, there is a danger of malnutrition and cachexia, which increases the risk of mortality and morbidity [20].

4. Cancer and malnutrition

Cachexia is a metabolic condition intimately linked to malnutrition and characterized by fast weight loss due to fatty tissue and muscle mass depletion. To avoid weight loss, malnutrition, cachexia, and weariness, as well as to reduce treatment toxicity, cancer recurrence, morbidity, and mortality, it is critical to eat well before, during, and after cancer treatment which is otherwise responsible for more than 30% of cancer patient fatalities [21]. Based on the available research data malnutrition is found to be prevalent in cancer patients worldwide, ranging from about 20% to > 70%. Despite the fact that some cancer patients are more prone to malnutrition than others, many of these patients are never treated for it [22].

The aetiology of malnutrition in cancer patients is complex and multifactorial, and can be influenced by the location and type of tumor, stage of disease, treatment side effects, socioeconomic status, functional performance, nutritional impact symptoms, the need for fasting, inadequate nutritional therapy, as well as medical staff awareness [23]. Moreover, drugs like Thiazide diuretics, ARBs(Angiotensin Receptor Blocker), ACE inhibitors (Angiotensin-converting enzyme) and potassium-retaining diuretics used for cancer treatment many cause zinc deficiency [24]. The various causes of poor

intake leading to malnutrition in cancer patient are presented in Figure 2. Cachexia, unlike sarcopenia, is marked by progressive weight loss affecting several body compartments, primarily muscle and adipose tissue, however, bone mineral content may also be affected [25].

5. Role of nutrition in cancer patients

Nutrition has a critical role in reducing the effects of malnutrition; however, it is unclear whether the type of nutritional support practise will provide the most effective source of sustenance. Physical inactivity is thought to increase cancer risk not just by affecting body weight but also by negatively impacting the immune and endocrine system [26]. According to the World Cancer Research Fund Report (2007), improper diet and lack of physical exercise are responsible for 35 % of cancer cases worldwide. High energy intake and obesity, high fat intake, insufficient dietary fibre, vitamin and mineral intake as well as high sodium intake are all dietary factors that contribute to the occurrence of cancer [27]. Vitamins and trace elements in the diet can help to fight free radicals, hence relieving oxidative stress. For instance, β -carotene, ascorbic acid, vitamin E and selenium (trace elements) are the most important micronutrient oxidants [28].

A joint report by the World Cancer Research Fund and the American Institute for Cancer Research found convincing evidence that a high fruit and vegetable diet would reduce cancers of mouth, pharynx, oesophagus, lung, stomach, colon and rectum evidence of probable risk reduction was found for cancers of the larynx, pancreas, breast and bladder [29]. Studies have also shown the importance of nutrition during chemotherapy, particularly fasting and ketogenic diets during treatment, attempting to clarify whether these methods can enhance chemotherapy's effectiveness outcome or not [30]. The chief objective of nutritional assistance is to prevent or reverse the weight loss that commonly accompanies cancer which is related with poor patient outcomes such responsive to therapy, quality of life, and survival [31].

5.1 Oral nutrition supplement (ONS)

ONS are normally used to enhance a patient's regular diet, but they can also be used as a meal replacement for those who are unable to eat traditional foods. Oral supplements, which require a healthy and functional GI system, may be used as between-meal supplements. When the gut is healthy but oral intake is impaired, tube feeding is often the best option [32]. Nutrient-rich drinks, usually prepared in hospitals, are a common source of oral supplements used during cancer treatment. However, these supplements have only had a mediocre success rate when used in high-risk paediatric oncology patients [33].

5.2 Enteral nutrition (EN)

When the GI tract is functioning but the cancer patient is unable to get enough nutrients by oral intake to meet his or her nutritional needs, EN is the chosen route of nutritional support. Tube-feeding is the foundation of enteral feeding and can be provided with either a nasogastric (NG) feeding tube inserted before therapy or a gastrostomy tube inserted prior to or during treatment, such as a percutaneous endoscopic gastrostomy (PEG). Supplementing nutrition through parenteral or enteral feeding has been considered as an important adjuvant therapy for surgical patients from a nutritional standpoint [34].

People diagnosed with oesophageal cancer with having low

body weight and cisplatin-based chemotherapy, which is routinely used, might cause them to eat less due to drug induced anorexia. Thus, EN may serve to be a beneficial nutritional support for such for such individuals. Due to a rise in toxicity as compared to enteral feeding, which is used as the first option to treat patients and is only recommended when the digestive tract is working correctly, PN has become the second option for treatment [35].

5.3 Parenteral nutrition (PN)

In advanced cancer patients, PN has been found to increase the survival rate, quality of life, nutritional and functional status, and decrease progressive weight loss. It permits nutrients to be delivered directly into the vein, bypassing the need for gastrointestinal (GI) digestion. In patients with minimal GI function, however, PN is required when malnutrition is severe enough to necessitate intense nutrition assistance [3]. Many patients may not meet their nutritional requirements during the initial postoperative days due to decreased appetites, persistent nausea and vomiting, opioid-induced constipation, postoperative ileus, and a lack of instruction about how to optimize their diet. As a result, PN should be explored, because it enables for the restoration of acute nutrient shortages while also preventing subsequent nutritional inadequacies [36].

5.4 Neutropenic Diet

This diet has been recommended for cancer patients who are more susceptible to bacterial infections. It is also indicated for patients with compromised immune systems, particularly those with neutropenia, a condition in which the body produces insufficient white blood cells (neutrophils). A neutropenic diet is also known as a sterile diet, a low microbial diet, or a low bacterial diet (LBD). On the other hand, a standardised definition of the neutropenic diet has yet to be established. The neutropenic diet includes a completely sterile diet e.g., all meals that have been sterilised by canning, baking, autoclaving, or irradiation, well-cooked foodstuffs only, and a modified home diet i.e., a regular diet omitting fresh fruits and vegetables [37]. Patients who follow the FDA diet guidelines show no increased risk of infection, despite the more flexibility.

6. Role of bioactive compounds in cancer prevention

"Bioactive compounds" are those compounds that possess extra nutritional constituents that are embarked in small quantities in foods. For example natural bioactive components found in fruits and vegetables, polyphenols, flavonoids, anthocyanins, micronutrients, and vitamins, are well known for their antioxidant and anti-inflammatory properties, and have been suggested as potential treatment agents for cancer [38].

6.1 Curcumin

Curcumin [1, 7-bis(4-hydroxy-3-methoxyphenyl)-1, 6-heptadien-3, 5-dione] is a strong antioxidant found in turmeric. It is anti-inflammatory in nature and inhibits cancer advancement by interacting with a range of extracellular and intracellular molecules involved in cancer genesis and progression. Curcumin works by influencing the transcription factor Nrf2, which controls numerous genes for proteins involved in electrophile and ROS detoxification, as well as the elimination or restoration of certain damaged products [39].

6.2 Chamomile (*Matric ariaricotta* L.)

Chamomile is an indigenous member of the daisy family (*Asteraceae* or *Compositae*) having hollow, bright gold cones of the flowers. It poses cardioprotective, anti-inflammatory, anticoagulant, gastroprotective, diuretic, anti-cancer, and antibacterial properties [40]. Chamomile can be used to prevent and treat cancers like as breast, ovarian, and prostate. Although chamomile flower extracts have been shown to inhibit cell growth and induce apoptosis in a variety of human cancer cell lines (including prostate, cervix, colon, breast cancer cells, and fibrosarcoma cells), these effects were only seen at very high concentrations (IC₅₀ in the range of more than 100 g/ml) [41].

6.3 Caffeic acid, caffeic acid phenethyl ester, and flavonoid glycans

Honey contains various bioactive compounds that prevents tumor cell division, including caffeic acid, caffeic acid phenethyl ester, and flavonoid glycans. In tumors of several mouse and rat strains, honey was found to exhibit modest anticancer and antimetastatic properties. Moreover, it has its anti-proliferative effect against cells derived from different types of cancer, alone or in association with the chemotherapeutic agent commonly used to counteract these neoplasms, thus showing a synergistic effect [42].

6.4 Quercetin

Quercetin is a dietary flavonoid found in tea, onion, grapes, wine, and apples. It is known to have high biological benefits, including antioxidant, anti-genotoxic, anti-inflammatory, vasodilating effects in addition to the chemopreventive and anticancer effect. ROS (Reactive oxygen species) and RNS (Reactive nitrogen species) are progressively becoming recognised as critical participants in human cancer formation and carcinogen detoxification, prevent tumour initiation/promotion, and antimutagen that have anticancer effects [43].

6.5 Black mulberry (*Morus Alba*)

The genus *Morus*, usually known as black mulberry (*Morus Alba*), belongs to the *Moraceae* family, which includes variety of medicinal plants. Studies revealed that the extracts, fractions, and major constituents from *M. alba* exhibit numerous pharmacological activities such as antioxidant, anti-inflammatory, anticancer, antimicrobial, antifungal, skin-whitening, antidiabetic, anti-hyperlipidaemic, anti-atherosclerotic, anti-obesity, cardioprotective, cognitive enhancing, hepatoprotective, anti-platelet, anxiolytic, anti-asthmatic, anthelmintic, antidepressant, and immunomodulatory activities [44].

6.6 Allicin

Garlic, commonly known as *Allium sativum*, the sulphur-containing compound's originator, allicin, is responsible for its medicinal qualities. Ajoene, a sulphur-containing chemical, slows the progression of cancer. *Allium sativum* has anti-oxidant properties and its extract is widely used to prevent cancer from spreading. Human breast cancer cells were slowed down by ajoene. When encapsulated with silver nanoparticles, *A. sativum* has anticancer action against MCF-7 breast cancer cells, with an IC₅₀ value of 89.86 g/mL [45].

6.7 Anthocyanin

Anthocyanins are the most prevalent flavonoid which is

present in some of the fruits and vegetables like berries, grapes, apples, purple cabbage, black soybean, and black rice. They are the most vital and effective category of water-soluble plant pigments. Anti-oxidative stress, anti-inflammation, anti-mutagenesis, induction of differentiation, inhibition of proliferation, cell cycle arrest and apoptosis, anti-invasion, anti-metastasis, anti-angiogenesis, and stimulating cancer cells [46].

6.8 Gallic acid

Gallic acid (GA) is a polyhydroxy phenolic molecule found in a wide range of natural goods, including green tea, grapes, strawberries, bananas, and a variety of other fruits. Gallic acid and its derivatives have been shown to have anticancer action *in vivo* and *in vitro* in a number of investigations. Gallic acid has been shown to have anti-cancer properties in a variety of cancer cells, including human ovarian cancer cells. Gallic acid's anticancer effect has been proved to be related to its capacity to suppress cell proliferation and promote apoptosis. Although gallic acid's anti-cancer activities have been established, its effects on human gastric adenocarcinoma are still unidentified [47].

6.9 Genistein

Genistein (4', 5,7-trihydroxyflavone) is a phytoestrogen that belongs to the class of soy isoflavones, a subclass of flavonoids. It is an important phytochemical involved in the control of crucial biological processes, including those in cancer. Genistein has been shown to have a variety of biological benefits including anti-oxidant, anti-proliferative, and tumoricidal properties. According to epidemiologic statistics, soy consumption is inversely linked to the risk of breast cancer, Asian women and men who consume a soy-rich diet had a 40% decreased incidence of breast cancer [48].

7. Alternatives to chemotherapy and non-toxic therapies-

7.1 Role of Vitamin C in cancer

Vitamin C or Ascorbic acid is known for its wide antioxidant and prooxidant properties. It is found naturally in fresh foods, fruits and vegetables. It is a crucial intracellular antioxidant and electron donor which is used as the first line of defence against oxidative stress. Anti-inflammatory properties of vitamin C led to the reduction of cytokines, chemokines, and C-reactive protein (CRP) levels in plasma. Vitamin C possess the ability to inhibit cancer cell proliferation by enhancing immune system, stimulating collagen synthesis, inhibiting hyaluronidase enzyme activity neutralizing reactive oxygen species or induction of apoptosis leading to disruption of tumor cells [49].

7.2 Multivitamin and antioxidant

Low intake of fruits and vegetables (a major source of vitamins and minerals) lead to an increased prevalence of cancer. Zinc and selenium suppress carcinogenesis through structurally stabilising DNA, RNA, ribosomes and protect the body from free radical damage. In addition to this, there has been evidence of a relationship between low vitamin D levels and risk of cancer.

Many breast cancer survivors believe that taking antioxidant supplements will protect them from the side effects of treatment, help them avoid recurrence, and improve their general health [50].

7.3 Probiotics and prebiotics in cancer


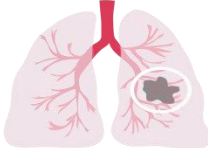

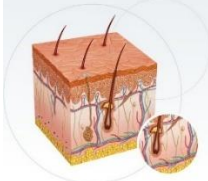


Prebiotics are foods that encourage the growth of desirable probiotic microorganisms in human gut. Despite the fact that cancer risk is largely determined by genetic factors, the organism's immunological condition, which is intimately linked to probiotic bacteria and commensal bacterial flora found primarily in the digestive system, plays an important role. Prebiotics have been linked to enhanced bowel function and metabolism in the distal colon thus, lowers the risk of colon cancer. Research has also confirmed that the good bacteria *Bifidobacterium* and *Lactobacillus* have anticancer effects^[51].

7.4 Omega-3 fatty acid

The role of omega-3 fatty acids in the prevention or reduction

of tumour growth mainly in breast and prostate cancer as our bodies are incapable of producing omega-3 fatty acids, it must be obtained through food or supplementation and which includes Alpha-linolenic acid (ALA), Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA). The anti-inflammatory and pro-resolution effects of omega-3 polyunsaturated consumption are most likely due to the lowering of nuclear factor kappa B (NF-B) and the synthesis of pro-resolution mediators such as resolvins, protectins, and maresins. Several lines of evidence suggest that low-fat diets high in omega-3 fatty acids may help prevent prostate cancer from developing and progressing, while high-fat diets high in omega-6 fatty acids may help promote prostate cancer growth^[52].

Table 1: Different types of cancer with their associated risk factors

Type of cancer	Aetiological factor /Risk factor	Symptoms	References
Brain cancer 	Ionizing radiation, Dietary consumption of Nitrosamine/nitrosamide/nitrite/nitrate, aspartame, cigarette smoking, excessive alcohol consumption, poor diet, lack of exercise, xeroderma pigmentosum, consuming cured food, previous medical history of epilepsy, head trauma, seizures, pollution, administration of medicines like sleeping pills, OTC drugs, anti-histaminic drugs, wide exposure to harmful industrial chemicals, genetic factors including gene mutations, aberrant hormone levels and weak immune system.	Frequent headaches, mood swings, coordination issues, changes in speech, difficulty in concentration, seizures, and memory loss.	Mazur <i>et al.</i> (2018) ^[53] , Dimitrova <i>et al.</i> (2019), Tandel <i>et al.</i> (2019), Cordero <i>et al.</i> (2020), Nikam <i>et al.</i> (2020)
Lung cancer 	Smoking, radon gas, air pollution, asbestos, genetics, toxic gases, combustion products, rubber byproducts, and crystalline silica dust	Cough, dyspnea, hemoptysis, anorexia, weight loss, chest pain, and dysphagia	Kim <i>et al.</i> (2011), Latiner and Mott (2015), Mustafa <i>et al.</i> (2016) O'Keefe, <i>et al.</i> (2018)
Throat cancer 	Advanced age, poor dietary habits (↑ fibre, ↑ fat, ↑ salt), Human papillomavirus infection (HPV), Exposure to paint, asbestos, gasoline fumes, and radiation	Often a painless swelling or lump in the upper neck, headache, blocked nose, nose bleeding, changes in hearing tinnitus, fluid accumulation in ears, face numbness, dysphagia and hoarseness.	Macpherson. (2013)
Skin cancer 	Exposure to artificial UV radiation (tanning beds and lamps), aging, actinic keratoses, diet, and smoking are attributable risks.	Ulceration, color fadedness and increased size of a mole	Saladi and Persaud. (2005), Linares <i>et al.</i> (2015), Qadir (2016), Khan <i>et al.</i> (2021) Humbert <i>et al.</i> (2020)
Prostate cancer 	Family history, consumption of fatty diet, sexual behavior, alcohol consumption and obesity.	Haematuria, erectile dysfunction, difficulty urinating, haematospermia	Turner and Drudge-Coates. (2010), Litwin <i>et al.</i> (2017), Rawla <i>et al.</i> (2019); Sartor and Bono. (2018); Kimura and Egawa (2018)
Multiple myeloma 	Genetic abnormalities oncogenes (<i>CMYC</i> , <i>NRAS</i> , and <i>KRAS</i>), drinking alcohol, obesity, environmental factors, exposure to insecticides, organic solvents, and radiation.	Body pain, anaemia (normocytic), hypercalcaemia and renal impairment.	Eslick and Talaulikar. (2013), Munshi and Anderson (2013), Zhang <i>et al.</i> (2022)
Breast cancer	Age, family history, reproductive factors, hormonal imbalance and inappropriate lifestyle	Nipple discharge, thickening or lump in breast, unexplained weight loss and a change in bowel movement.	Sun <i>et al.</i> (2017) Duver <i>et al.</i> (2022), Bach (2018); Giordano (2018)

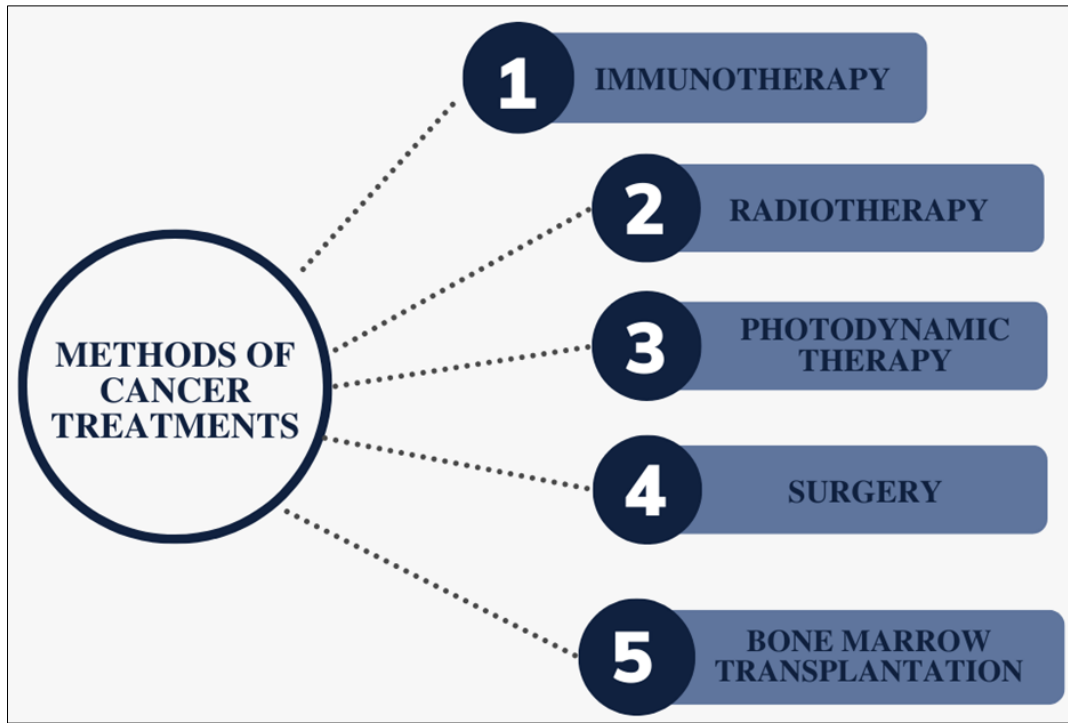
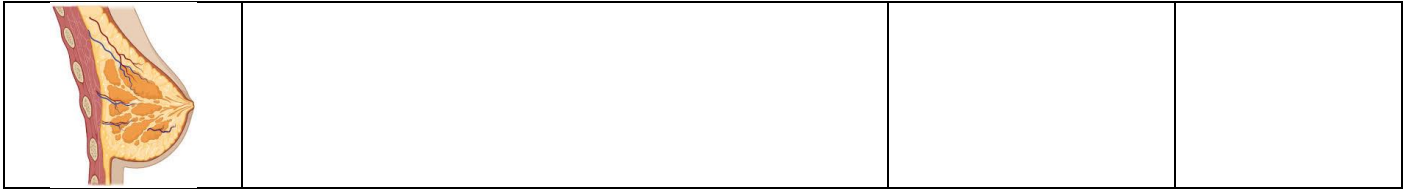


Fig 1: Methods of cancer treatment

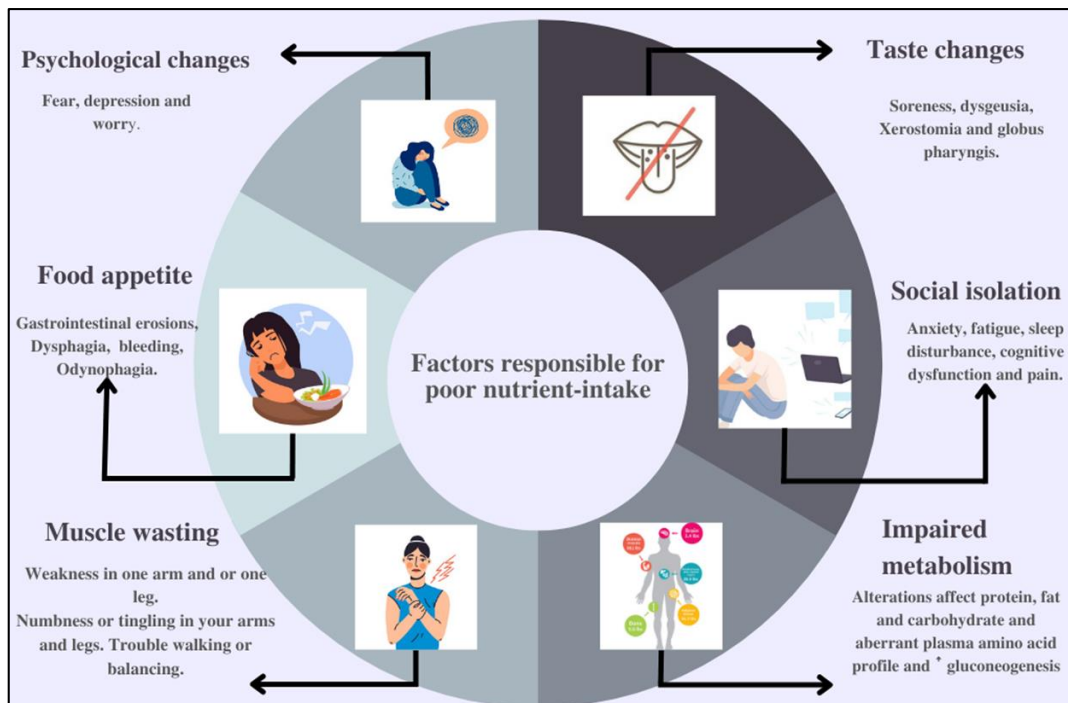


Fig 2: Various causes of poor nutrient intake leading to malnutrition in cancer patient

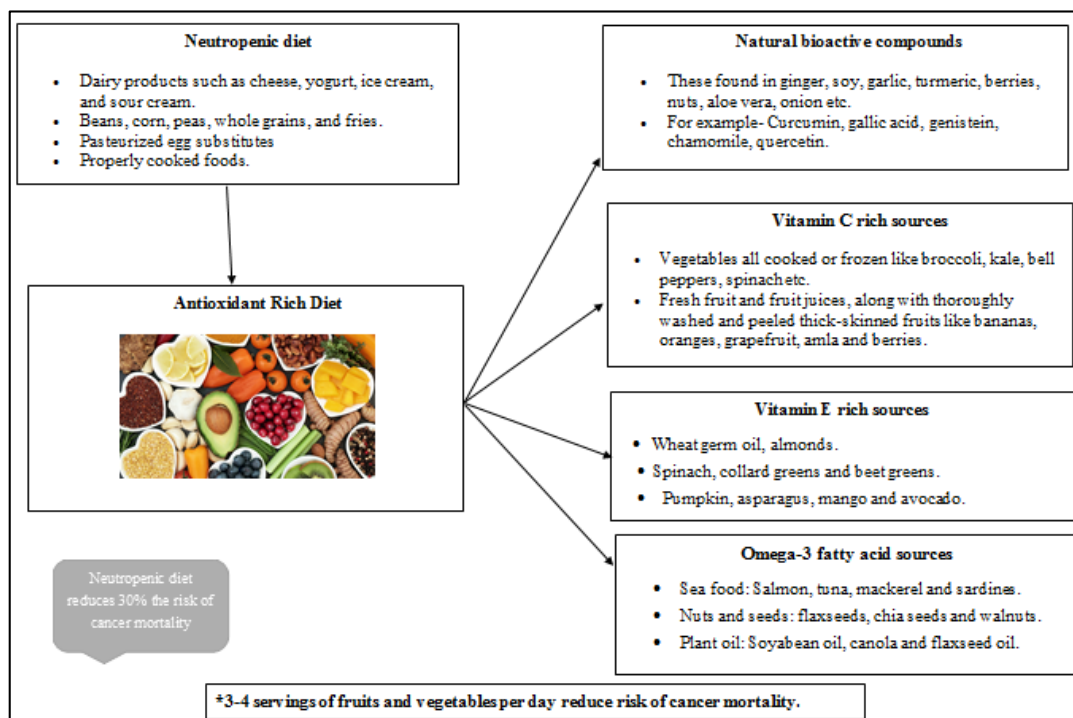


Fig 3: Diet in cancer

8. Conclusion

In the present article, the most recent guidelines for the management of cancer patients, as well as original studies in nutrition and cancer, were included. Malnutrition, cancer cachexia, sarcopenia, nutritional deficiency, diet quality, immune system dysfunctioning, systemic inflammation, and gut microbiota are some pathways associated with chronic pain in cancer survivors. For that reason, nutrition is a central factor in oncology and also help to maintain nutrition requirements during cancer treatment. Nutritional risk screening and assessment in cancer patients allows for the early detection of malnourished patients and also for a prompt nutritional intervention aiming preventing nutritional deterioration and muscle wasting. There are several bioactive compounds which are known to be best healers during treatments. A proactive assessment of the clinical alterations that occur during treatments and during the disease course, is essential for selecting the adequate nutritional intervention, aiming for the best impact on patients' outcomes.

9. Declarations

9.1 Author contributions

SK and JK are the sole authors of the review article. JK supervised the work and edited the manuscript. KS, VB and JS have contributed equally for the literature collection, manuscript documentation and its revision.

9.2 Competing interest

There are no conflicts of interests to declare.

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