Nutritional Interventions on Quality of Life in Cancer Patients during Treatment: A Systematic Review.

by

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Abstract

Cancer is a global health issue, with chemotherapy and radiotherapy as the primary treatment options. These treatments can induce side effects that impair patients' quality of life. Various diets have been shown to positively affect symptoms such as nausea and vomiting, potentially providing an alternative to alleviate the negative impacts of cancer treatments. This systematic review aims to evaluate the impact of nutritional interventions on improving the adverse effects associated with cancer treatments. A search was conducted in PubMed using MeSH terms, resulting in the inclusion of 39 articles. The most common types of cancer represented were multiple cancers (n = 12), followed by breast cancer (n = 11). Twelve studies were dietary related, 14 were non-nutrient, and 13 were nutrient interventions. Personalized diet or dietary education was featured in (n = 7) studies, while ginger was examined in (n = 5). Most studies included in this review demonstrated that nutritional interventions benefit cancer treatment side effects, leading to enhanced quality of life of cancer patients. These findings can assist clinicians in advising patients with non-medical options to alleviate the adverse effects of cancer treatments. Further studies involving more patients are necessary to confirm these findings.

Key words: cancer treatment, nutritional intervention, diet, patients, quality of life, and side effects.

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Dedication

I dedicate this achievement to my family. I am grateful to my parents for their education and for teaching us to value support and to help as much as we can. To my father, Omar, and my mother, Fatoumata, my brothers and I are thankful to have you as our parents. I thank my wife, Fatoumata, for understanding my time on this journey. Your mental and emotional support helped me get through this program. I thank my brother for their significant contribution to the best they can for my success. All your words and support were meaningful for this milestone.

Chapter 1 - Introduction

Background and Significance

Overview of cancer as a global health challenge

Cancer is a global public health issue; 19.3 million new cases were diagnosed, and around 10 million deaths were related to it in 2020. That represents approximately 18% of all the deaths [1,2]. The most common types are breast, lung, prostate, colon, and rectum cancer. Cancer occurs through multi-step processes involving genetic factors combined with physical, chemical, or biological carcinogens. Smoking, drinking alcohol, eating unhealthy food, or physical inactivity and living in a polluted environment, in addition to some chronic infections, are considered it risk factors. [1].

Data from 34 of the 54 African countries showed that 711,429 deaths and 1.1 million new cases of cancer were reported in 2020. Countries such as Egypt, Nigeria, and South Africa recorded the highest rate, with breast, cervical, prostate, colorectal, and liver cancers the most common [3]. In the US, cancer was the second cause of death after heart diseases in 2019, constituting 19% of all the death causes. However, it was the primary cause among elderly men aged 60 to 79 years and women aged 40 to 79 years [4].

Common treatment modalities (chemotherapy, radiation)

Different treatments are available for cancer. Some cases receive a single therapeutic option, while others are managed with a combination of choices. The right treatment depends on the cancer type, disease stage, and the patient being treated [1,5]. Current treatment options include chemotherapy, radiation therapy, surgery, targeted therapy, and immunotherapy, which are frequently associated with negative effects [6]. Chemotherapy and radiotherapy are frequently used as first options; however, they are commonly related to side effects, particularly in certain types

of cancers [7]. These therapies typically elicit side effects that impact nutrition status or a side effect that may benefit from a nutrition intervention to attenuate the impact.

Side effects and challenges of cancer treatments

Physical side effects (nausea, fatigue, weight loss, immune suppression)

Fatigue, nausea/vomiting, loss of appetite, and depression are frequent side effects of chemotherapy, which is one of the main treatment options in cancer [8]. Radiotherapy patients have higher unsatisfied medical conditions with an increased social need in addition to physical, social, and emotional impairment [9]. Constipation is among the adverse effects of antiemetics as well as diarrhea sedation, anxiety, headache, restlessness, and hypotension [10].

Mental & emotional side effects

Depression is a major public health issue that is common with chronic diseases, and it worsens their outcome [11]. Being diagnosed with cancer has been shown to cause stress that affects the physical and mental health of the patient as well as the family members [12]. Nutritional imbalance triggers depression, and both conditions are higher among cancer patients [13] in addition to anxiety [12]. Depression decreases the quality of life in cancer patients [14], which leads to a negative outcome such as the refusal of treatment and higher death rate [15].

These side effects decrease quality of life (QoL)

The quality of life was defined by the World Health Organization (WHO) as people's thoughts about their location in life considering the identity and living conditions regarding their desires, objectives, and distress [16]. Research showed that interventions such as eating healthy, being physically active, and losing weight ameliorate cancer progression and overall health [17]. A study found that adopting these changes improves patients' quality of life with other advantages [18].

Role of Diet/Nutrition/Supplements in Cancer Care

General importance of maintaining proper nutrition during treatment

Good nutritional status is crucial for cancer patients. [10] Malnutrition or cachexia associated with cancer, or its treatment is common, especially in metastatic cases. They induce some weaknesses, and dietary supplements can efficiently help to treat [19]. A significant number of cancer patients don't receive diet counselling; therefore, a right diet-orientated education would be an important way to help patients manage chemotherapy side effects [10].

Potential benefits of specific dietary interventions

Specific foods, diets, and/or supplements to help with side effects

Scientific evidence indicated that plant-based diets enhance cancer outcomes, particularly in colorectal, prostate, and breast cancer patients [20]. Less strong evidence revealed that ginger and tea intake could decrease the severity of chemotherapy-induced nausea and vomiting (CINV) [21]. Research found the ketogenic diet to be a promising adjuvant treatment for some types of cancer [22]. On the other hand, research indicated that side effects from either chemotherapy or fasting were not improved by ketogenic diet combined with modified short-term fasting (mSTF) [23].

Dietary intervention on side effects

An intervention study with high certainty supported that targeted dietary education from professionals can reduce the severity of chemotherapy induced nausea and vomiting. An additional finding supported that dietary patterns such as the Mediterranean diet, tailored energy, protein, or macronutrient intake are related to improved chemotherapy nausea and vomiting [21]. Compared to a regular food intake, a personalized diet tailored by a professional had a significant impact on the severity of chemotherapy side effects, including fatigue, loss of appetite, and quality of life [21]. Although they are not considered as the first option for the management of chemotherapy side

effects, diet and nutrition are supposed to add advantages to antiemetics treatment [10] A study supported that Mediterranean diets can relieve pain in endometriosis patients [24].

Recommendations regarding nutritional and dietary interventions are diverse and their outcomes on side effects of cancer therapy and patients' quality of life are varied. There is a need for gathering recent scientific evidence pertaining to nutrition and diet interventions to improve quality of life in cancer patients during treatment.

This study aimed to analyze various nutritional interventions' efficacy on the quality of life of cancer patients undergoing treatment and provide evidence-based conclusions regarding nutritional adjuvants according to cancer type.

Chapter 2 - Methodology

Eligibility Criteria

In this review, we included randomized control studies with human adults (over 18) under chemotherapy and or radiotherapy with nutrition intervention related to the quality of life or reducing untoward cancer treatment side effects. We excluded: (1) Studies that were still ongoing during the selection, (2) Studies in other languages different from English, (3) studies involving non-nutritional interventions or quality of life not reported, and (4) narrative reviews, systematic reviews, and meta-analyses were also excluded.

Information Source and Search Strategy

Data was collected from PubMed with the support of a librarian. The first search was performed in February 2024, and a second was done in December 2024 since the interval from the first one was longer. The following MeSH terms were used: "neoplasms", "carcinoma", "cysts", "neurofibroma", "nausea", "food", “dietetics", "eating", and "malnutrition".

Selection process

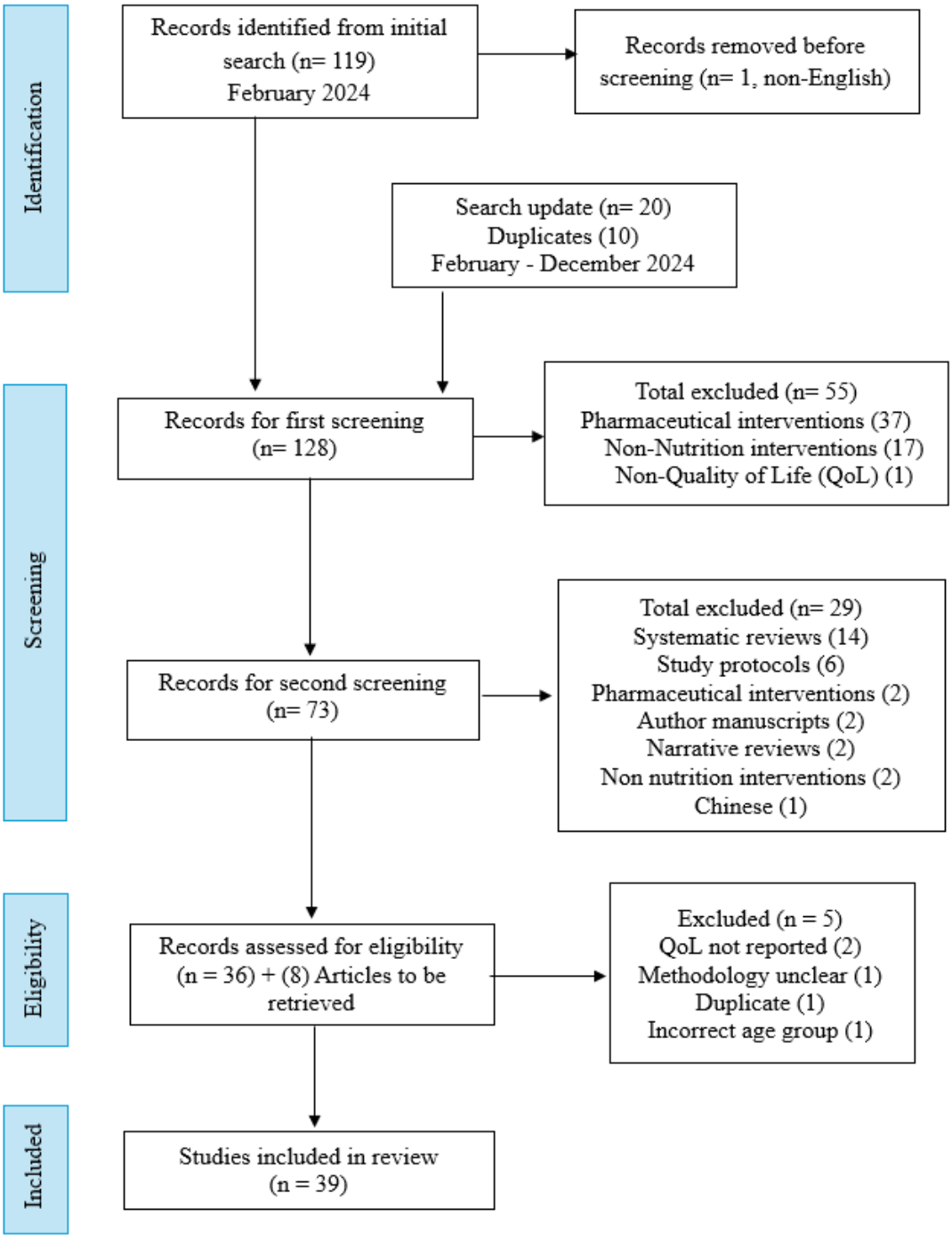
The three reviewers (A.O., H.T., and M. H.) assessed the articles for the first screening. This process was based on the title and abstract of articles regarding the impact of nutritional interventions on the quality of life of cancer patients under treatment. The reviewers checked articles separately in a shared Excel sheet on Microsoft Teams. Included studies were selected by at least two reviewers. The second screening was based on inclusion and exclusion criteria. The final step was to determine whether some undecided articles should be included. Microsoft Excel was used for data collection and review.

Chapter 3 - Results

Studies characteristics

128 papers were involved in the first screening, 39 articles were included [25–62]. The total population of this study was 3991. Twelve studies, 30.8% involved multiple types of cancer [27,30,31,33,37,38,48,49,53,55,58,60]. Breast cancer was the most single cancer involved in 11 studies, 28.2% [25,26,28,32,39–41,43,47,50,57]. Followed by Colorectal cancer with 5 studies, 12.8% [34,59,61–63]. Twelve studies were dietary related [25,27,32,36,39,41,47,50,53,56,59,64], 14 were non-nutrients [26,28,30,35,37,44,46,48,49,51,52,54,57,60], and 13 were nutrient interventions [29,31,33,35,38,40,43,45,55,58,61–63]. Personalized diet or dietary education was the main intervention used in 7 studies 17.9% [25,32,41,50,53,59,64]. Five studies 12.8% examined ginger [26,30,37,48,54], followed by fasting 3 studies 7.7% [27,39,47], and omega 3 in 3 studies 7.7% [40,61,63].

Figure 1. Describes the screening and selection process of the 39 included studies



Nutrition interventions regarding types of cancer

Table 1. Displays the characteristics of included studies.

Citation	Country of study	Pop.	Male %	Female %	Age	Cancer Type	Cancer treatment	Nutrition Interventions
Bauersfeld (2018)	Germany	34	0%	100%	51y (28-69y)	Breast or Ovarian Cancer	Chemo.	Short-term fasting (STF): - Total daily energy 350 kcal. - 36 h before & 24 h after Chemo. (60h-fasting)
Bossi (2017)	Italy	244	66%	34%	>= 18	Bladder, Head & neck, Lung, Other	Chemo.	Ginger 40 mg 2 X day for 42 to 56 days).
Bumrungpert (2018)	Thailand	42	24%	76%	41–63	Breast, Colon, Lung, Rectum, Cholangiocarcinoma, Pancreatic, Lymphoma.	Chemo.	Whey Protein Supplementation 40 g/day for 12 weeks.
Chagas (2017)	Brazil	22	55%	45%	53.8 - 43.8	Leukemia or lymphoma	Chemo.	Fish oil supplement (2 X 1000 mg oil /day for 9 weeks).
Crichton (2024)	Australia	103	32%	68%	59 +/- 8	Breast, Lymphoma, Digestive, Lung, Urogenital, Gynecological, Other	Chemo.	Ginger Root Powder (300 mg 1 - Day 5 during Chemo Cycle 1, 2 & 3).
De Filipp (2021)	USA	99	75%	25%	60 (25, 77)	Multiple myeloma (MM) or non-Hodgkin lymphoma (NHL)	Chemo. Or Radio.	Enterade® (8 oz, the admission day through day +14).
Marx (2017)	Australia	51	37%	63%	58 ± 12	Breast, Colon, Lymphoma, Other	Chemo.	Standardized ginger extract (1.2 g / day, + anti-emetic, first 3 chemo cycles).

Table 1: Continue

Citation	Country of study	Pop.	Male %	Female %	Age	Cancer Type	Cancer treatment	Nutrition Interventions
Miranzadeh (2015)	Iran	56	43%	57%	56.46 ±14.32 - 55.54±14.01	Gastrointestinal, Leukemia, Lung, Bone, Kidney, Breast.	Chemo.	Millefolium 15 mL for 3 min in mouth, 4 X day for 14 days.
Poulsen (2014)	Denmark	61	43%	57%	62(53-68) - 64(57-70)	Esophageal cancer, Gastric cancer, Gynecological cancer	Radio &/or Chemo.	Intensive individual dietary counseling (1h / week & daily nutritional supplement (2531 kJ) for 5 - 12 weeks.
Schloss (2017)	Australia	71	32%	68%	53.81 (29–75) - 55.18 (33–75)	Breast cancer, Lymphoma, Lung. Colon, Prostate, Endometrial	Chemo.	Vitamin B (3 capsules/day). 1 week before - 12-week post-chemo.
Tsuchiya (2016)	Japan	63	60%	40%	63.5 ± 8.9 - 63.2 ± 8.5	Colon cancer, Gastric cancer Gastric/colon cancer	Chemo.	Amino acids cystine and theanine (700 mg cystine & 280 mg theanine/ day for 5 weeks).
Vitale (2020)	Italy	120	55%	45%	<60 = 49 - >=60 = 71	Colorectal cancer or other cancer	Chemo.	Panaceo-micro-activation (PMA) (zeolite, 6 g/day during chemo & for a month afterwards).
Abdollahi (2019)	Iran	140	0%	100%	46.81 ± 12.32 46.10 ± 8.91	Breast cancer	Chemo.	Dietary intervention and nutritional education 1h nutritional advice before chemo. for 10 weeks.
Ansari (2016)	Iran	119	0%	100%	48.56	Breast cancer	Chemo.	Ginger powder (500 mg, 2 / day for 3 days, the first 3 chemo. cycles).
Becerril-Alarcón (2019)	Mexico	38	0%	100%	51.5 ± 9.3	Breast cancer	Chemo.	Inulin (17 g maltodextrin for 21 days).

Table 1: Continue

Citation	Country of study	Pop.	Male %	Female %	Age	Cancer Type	Cancer treatment	Nutrition Interventions
Carayol (2019)	France	143	0%	100%	52 ± 10	Breast cancer	Chemo. + Radio	Adapted Physical Activity & Diet counseling (APAD) (individually hospital-based exercise & non-supervised home sessions for 26 weeks).
De Groot (2015)	Netherlands	13	0%	100%	51 (47–64) 52 (44–69)	Breast cancer	Chemo.	Short-term fasting (STF) -- Water + coffee or tea without sugar (24 h before & after chemo). - Food diary for all patients.
De La Rosa Oliva (2019)	Mexico	53	0%	100%	50.7 ± 2.1 - 49.5 ± 2.1	Breast cancer	Chemo.	Omega-3 PUFA supplement (2.4 g /day for 6 months of Chemo).
De Souza (2021)	Brazil	34	0%	100%	44.3 ± 9.2 - 45.5 ± 8.6	Breast cancer	Chemo.	Nutritional Intervention (healthy eating guidelines & nut. Info to reduce CINV) + personalized diet during chemo.
Hershman (2018)	USA	437	0%	100%	<60 vs >=60 mean (SD), y 53.3 (9.9) 51.9 (10.9)	Breast cancer	Chemo.	Acetyl-L-carnitine (3000 mg/day for 24 weeks).
Lugtenberg (2021)	Netherland	129	0%	100%	49.0 (31–71) 51.0 (27–71)	Breast cancer	Chemo.	Fasting mimicking diet (FMD) (plant-based low amino-acid substitution diet for 4 days).
Najafi (2019)	Iran	137	0%	100%	46.0 (8.8) 46.9 (12.4)	Breast cancer	Chemo.	Personalized diet by a trained dietitian (1.2–1.5 g/kg of protein, 30% fat energy & 55–60% of carbohydrate energy, 1 h face-to-face nutrition education prior to chemo. for 3 times).
Tang (2024)	China	128	0%	100%	41.72 ± 8.23 & 40.92 ± 8.00	Breast cancer	Chemo.	Yiqi Yangyin decoction (2 bags of 150 mL/day for 12 weeks).

Table 1: Continue

Citation	Country of study	Pop.	Male %	Female %	Age	Cancer Type	Cancer treatment	Nutrition Interventions
Ortiz (2018)	Mexico	70	0%	100%	48.6 ± 14.7 - 51.2 ± 14.7	Cervical cancer	Chemo.+ Radio	Symbiotic supplementation (20 g 3/day for 7 weeks with diet monitoring every 15 days).
Linn (2019)	Myanmar	57	0%	100%	57.38 ± 10.75 - 52.5 ± 9.61	Cervical cancer	Chemo.+ Radio	Probiotics (Biogurt® (300 mg 3/day during radio).
Ohnishi (2017)	Japan	40	0%	100%	Medians 51.5 - 43.1	Corpus or Cervical cancer	Chemo.	Oral rikkunshito 7.5 g on days 0–13.
Santos (2023)	Brazil	48	0%	100%	38 - 51	Cervical cancer	Chemo. + Radio.	Ginger (250mg, 500mg, or 1.000 mg with 250 ml water every 12 h, for 1.000 mg/day)
Chang (2021)	Taiwan	70	37%	63%	24–83 (60.5)	Colorectal Cancer (CRC)	Chemo.	Silymarin (150 mg: 3/day for 7 days)
Golkhalkhali (2017)	Malaysia	140	NR	NR	<56, 57-66, >=67	Colorectal cancer	Chemo.	Omega-3 fatty acid: 2 g / day for 8 weeks & microbial cell preparation (2 sachets /day for 4 weeks)
Tuominen (2023)	Finland	83	52%	48%	62 ± 9.5	Colorectal cancer	Chemo.	Nurse-led one-hour empowering education (Recording side effects and severity until the 4 chemo cycle).
Zhang (2020)	China	179	52%	48%	<65 (47.5%) - ≥65 (52.5%)	Colon cancer	Chemo.	Omega-3 PUFAs (641 mg, 3 times/day during chemo & 1 month afterward).
Ziętarska (2017)	Poland	95	52%	48%	40–84	Colorectal cancer	Chemo.	Oral nutritional supplements (ONS) (125 mL, 2 X day for 12 weeks).

Table 1: Continue

Citation	Country of study	Pop.	Male %	Female %	Age	Cancer Type	Cancer treatment	Nutrition Interventions
Boisselier (2020)	France	180	83%	17%	20–75, (58.0)	Head and neck squamous cell cancer	Chemo.+ Radio	Enriched formula with L-arginine, omega-3 & ribonucleic acids (3 sachets/day) for 5 days before 3 cycles of cisplatin.
Cao (2024)	China	92	84%	16%	61.72 ± 8.97 61.13 ± 9.76	Head and neck squamous cell carcinoma	Chemo.	Nurse-led multidomain intervention (guideline use - antiemetics, diet management, music- relaxation, Nurse contact at 24 & 72 h (+ or - 24 h) after discharge).
Charalambous (2017)	Finland	72	72%	28%	32 - 93	Head & neck cancer	Radio or/ and Chemo. or/& surgery	Honey/thyme mouthwash (20 ml in 100 ml water, before & after radio. & 6 h later, 3 X day at home for 4 weeks.
Tanaka (2021)	Japan	113	82%	18%	66< 70 Yrs - - 47 >=70	Esophageal cancer	Chemo.	Elemental diet (ED) (Elental® (160 g/day 7 days before chemo for 56 days).
Cho (2017)	USA	137	45%	55%	56.0 (25.0-86.0)	Non–Small Cell Lung Cancer (NSCLC)	Chemo.	Ceritinib, 450 mg or 600 mg, with low-fat meal vs 750 mg fasted
Kim (2017)	Korea	30	0%	100%	52.9 ± 10.1 - 55.9 ± 12.1	Ovarian cancer	Chemo.	Red ginseng (3000 mg/day for 3 months).
Li et (2016)	China	248	63%	37%	39.3 ± 5.9 36.5 ± 4.3	leukemia	Chemo.	Haishengsu seashell protein (HSS) (intravenously 2.4 mg in 250 ml normal saline, /day over 4 h for 28 days).

Table 2. Shows the outcomes of nutritional interventions

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Bauersfeld (2018)	Short-term fasting (STF)	Low grade reported side effects. Minor adverse effects	First insight into QoL and tolerability to chemo vs eucaloric diet during chemo.	Better tolerance to chemo., less compromised QoL & reduced fatigue (8 days after chemo.).
Bossi (2017)	Ginger	No difference in nausea means in both cycles.	Ginger efficacy on the incidence & intensity of delayed nausea under high-dose cisplatin & HEC.	The impact of nausea due to cisplatin didn't reduce. No benefit in delay.
Bumrungpert (2018)	Whey Protein Supplementation	Improves Nutritional Status, Glutathione Levels, & Immune Function.	Whey protein isolate (WPI) supplementation on the nutritional status, immunity, & inflammatory status.	Significant increase in health status & QoL in the intervention group.
Chagas (2017)	Fish oil supplement	Increased long-term survival & reduced nutritional inflammatory risk.	The effect of oral fish oil for 9 weeks on nutritional parameters & inflammatory status.	An improved nutritional-inflammatory risk and potential effects on long-term survival.
Crichton (2024)	Ginger Root Powder	Improved CINV-related QoL, incidence of delayed vomiting, fatigue, & malnutrition.	Nausea-related QoL. Nausea incidence & severity, vomiting incidence, & episodes.	Improved QoL, delayed nausea/vomiting, fatigue, & nutrition status.
De Filipp (2021)	Enterade®	Common diarrhea, regardless of assigned study intervention.	The tolerability and efficacy of Enterade® in reducing diarrhea associated with high dose melphalan Chemo.	Due to significant GI toxicities, 2 X day Enterade® with high-dose Chemo. & ASCT was not feasible.
Marx (2017)	Standardized ginger extract	Improved chemo-related fatigue in Cycle 1. Better overall QoL.	Chemo -induced nausea- related (CIN) QoL. The INVR.	Better Chemo-induced nausea & QoL Less cancer-related fatigue.
Miranzadeh (2015)	Millefolium	Reduced severity of OM in the experimental group.	The effect of Achillea millefolium in the treatment of chemo-induced OM.	Millefolium distillate healed Oral Mucositis (OM) much more than the routine solution.

Table 2: Continue

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Poulsen (2014)	Intensive individual dietary counseling	Significant decrease in weight loss. Higher daily intake of energy & protein.	The effect of intensive, individual dietary counseling of patients on radio &/or chemo.	Improved energy & protein requirements. Less effect on QoL, side effects, body composition or the appearance of micronutrient deficiencies.
Schloss (2017)	Vitamin B	CIPN incidence did not statistically decrease.	1- CIPN prevention by B vitamins 2- Three questionnaires : MD ABPI, EORTC, PNQ.	CIPN prevalence didn't decrease significantly. No differences in quality of life. B vitamins may be associated with pain reduction during chemo,
Tsuchiya (2016)	Amino acids cysteine and theanine	Alleviated AEs, with significant suppression for diarrhea.	The preventive effects of cystine & theanine against AEs of chemo & their usefulness as supportive therapy.	Alleviated AEs, reduced therapy suspension or discontinuation due to the AEs, & improved completion rate of the first course of therapy.
Vitale (2020)	Panaceo-micro-activation (PMA) (zeolite)	Lower CIPN, but not statistically significant.	The reduction of the acute CIPN in patients with oxaliplatin. The reduction of hematological & liver toxicity by chemo.	Lower CIPN, particularly in the male subgroup, was statistically significant.
Abdollahi (2019)	Dietary intervention and nutritional education	Improved GI side effects (reflux, dyspepsia, anorexia, nausea, constipation). Reduction in not completed scheduled chemo. due to side effects	Chemo induced nausea, vomiting, and diarrhea. Weight, constipation, reflux, dyspepsia, anorexia, gastritis, & chest pain.	Decreased GI side effects of chemo.
Ansari (2016)	Ginger powder	No statistically significant difference in nausea decrease & vomiting severity between the 2 groups.	The effect of Ginger powder on N/V after chemo in breast cancer patients.	Ginger: safe herbal medication; its effects on CINV not well defined.

Table 2: Continue

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Becerril-Alarcón (2019)	Inulin	Lower nausea, vomiting & constipation in the inulin group.	Inulin in the preventing the blood pressure elevation in breast cancer women undergoing cyclophosphamide & doxorubicin.	Inulin might be a novel nutraceutical approach to improve the QoL & cardiovascular health.
Carayol (2019)	Adapted Physical Activity & Diet Counseling (APAD)	Improved fatigue, QoL, BMI, and fat mass outcomes.	APAD on cancer-related fatigue. QoL, anxiety & depressive, BMI body composition, cognitive & muscular functions, chemo adherence, PA, & nutritional intake.	Improved psychological, physiological & behavioral outcomes. Beneficial effect on fatigue and QoL in long term (1-year).
De Groot (2015)	Short-term fasting (STF)	Grade III/IV side effects neutropenic fever, fatigue & infection.	Effects of 48-h STF on chemo. induced side effects & hematologic parameters.	STF was well tolerated & reduced hematological toxicity. It may reduce a transient increase in, &/or induce faster DNA damage recovery.
De La Rosa Oliva (2019)	Omega-3 PUFA supplement	Decreased Xerostomia scale. No differences in GI toxicity & mucositis, neither in fatigue nor neuropathy.	The effects of PUFA omega-3 in toxicity, side effects, body composition, cardiometabolic profile & QoL.	PUFA omega-3 supplementation reduced symptoms of xerostomia.
De Souza (2021)	Nutritional Intervention	Preserved QoL role function, handgrip strength (HGS), reduced nausea/vomiting, loss of appetite & abdominal pain.	Dietary intervention on QoL, GI & hematological toxicities.	Preserved QoL role function, improved in nausea/vomiting, loss of appetite & less abdominal pain.
Hershman (2018)	Acetyl-L carnitine	Worsening chemo-induced peripheral neuropathy (CIPN) (persisted over 2 years).	Long-term CIPN outcomes, up to 2 years, & characterize the clinical phenotype of CIPN.	Worsening CIPN symptoms that persisted over the 2-year follow-up period.

Table 2: Continue

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Lugtenberg (2021)	Fasting mimicking diet (FMD)	Increased well-being & better QoL, less constipation & diarrhea & less fatigue, lower sleep disturbances.	FMD on toxicity & response to neoadjuvant chemo.	Improved Qol (better emotional, physical, role, cognitive & social functioning scores, lower fatigue, nausea & insomnia) & illness perceptions.
Najafi (2019)	Personalized diet by a trained dietitian	Better physical, emotional, cognitive, & role functions. Less fatigue, nausea/vomiting, pain, dyspnea, sleep & appetite loss, constipation, & diarrhea.	Impact of nutritional education in CINV & QoL during adjuvant chemo.	Reduced occurrence of CINV and significant improvements in the QoL.
Tang (2024)	Yiqi Yangyin decoction	Less nausea, vomiting, diarrhea, leukopenia, & hemoglobinemia with significant difference.	The significance of Yiqi Yangyin decoction in the postoperative adjuvant therapy of breast cancer.	Reduced (nausea, vomiting, thrombocytopenia, diarrhea, leukopenia, & hemoglobinemia).
Ortiz (2018)	Symbiotic supplementation	Decreased frequency & intensity of vomiting & reduced nausea.	The effect of dietary symbiotic on FCP, bacterial DNA levels, and gastrointestinal adverse effects in CC patients with chemo & radio.	Reduced level of FCP, & the frequency & intensity of vomiting.
Linn (2019)	Probiotics (Biogurt®	Significant reduction of severe diarrhea.	The effect of a probiotic to reduce the incidence or the severity of radio-induced diarrhea (RID).	Probiotic is an easy & effective way to reduce the incidence & severity of radio-induced diarrhea RID.
Ohnishi (2017)	Oral rikkunshito	Prevention of CINV & anorexia. CC & the CR overall rate superior in the rikkunshito.	Complete control rate (CC) Complete response rate (CR)	Rikkunshito improved CINV & anorexia in patients with cisplatin & paclitaxel.

Table 2: Continue

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Santos (2023)	Ginger	No change in nausea occurrence. In acute or late vomiting for 6 weeks.	Efficacy of Zingiber Officinale in the management of nausea & vomiting induced by cisplatin with radio.	Ginger didn't reduce the intensity of acute & late nausea and vomiting.
Chang (2021)	Silymarin	Less diarrhea & nausea in the study group.	Incidence of gastrointestinal (GI) toxicities. Median progression-free survival (PFS) & overall survival (OS).	Reduced diarrhea & nausea. Longer survival in the study group in progression-free survival (PFS) or overall survival (OS).
Golkhalkhali (2017)	Omega-3 fatty acid	Increased global health status (higher QOL). Improved functional & symptom scales. Improved chemo side effects (nausea, vomiting, and diarrhea).	If the supplementation of MCP & omega-3 fatty acid helps to improve the QOL, modulate the side effects of chemo. & alter the levels of inflammatory markers.	Improved QOL, reduced certain inflammatory biomarkers & relieved chemo. side effects related to GI tract function (diarrhea, nausea & vomiting).
Tuominen (2023)	Nurse-led one-hour empowering education	Decreased QoL in both groups, average in IG. Common side effects include fatigue, cold sensitivity, & moderate to severe nausea.	Activation level & knowledge level. Risk of malnutrition and QoL	Intervention can improve knowledge level & activation level, may reduce health care costs.
Zhang (2020)	Omega-3 PUFAs	Higher global health score. Reduction in physical function score in the placebo & Higher score of appetite loss.	Effect of omega-3 PUFAs on the neurotoxicity in colon cancer patients treated by oxaliplatin + capecitabine.	Reduced incidence & severity of oxaliplatin-related neurotoxicity & improved patients' QoL with omega-3 PUFAs

Table 2: Continue

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Ziętarska (2017)	Oral nutritional supplements (ONS)	High-protein dietary support improved nutritional status (increased appetite) in patients with pre-cachexia. Stable performance status & QoL.	High protein ONS influences on toxicity of systemic therapy of cancer cachexia asymptomatic pre-cachexia. High protein ONS influences nutritional status, QoL & performance status.	The study did not indicate that nutritional support with high-protein ONS influenced the toxicity of systemic therapy.
Boisselier (2020)	Enriched formula with L-arginine, omega-3 & ribonucleic acids	No difference in acute oral mucositis rates in the ITT analysis.	Efficacy of the immuno-nutrient supplement on severe mucositis. Tolerance, compliance to oral supplementation.	No confirmation of the positive results of phase II on severe mucositis reduction.
Cao (2024)	Nurse-led multidomain intervention	lower incidence & severity of nausea & vomiting.	The incidence, severity & influence of CINV on patients' QoL.	Reduced incidence, severity & influence on patients' with HNSCC QoL.
Charalambous (2017)	Honey/thyme mouthwash	Reduced/stabilized xerostomia, higher QoL.	Exploring the safety and effectiveness of thyme honey in xerostomia.	Reduced radiation-induced xerostomia in H&N cancer patients. Improve patients' QoL,
Tanaka (2021)	Elemental diet (ED) (Elental®	Lower grade OM. Maintained body weight.	The preventive effect of an ED against OM in patients with EC receiving DCF therapy using the central review system.	ED can prevent Oral mucositis OM in patients with esophageal cancer receiving chemo.
Cho (2017)	Ceritinib	Ceritinib (450 mg) with food reduced GI toxicities (diarrhea, nausea, or vomiting) compared with the 750 mg fasted dose.	The efficacy & safety of ceritinib, 450 mg or 600 mg, with food versus 750 mg in fasted patients as a starting dose.	Ceritinib, 450 mg or 600 mg, with a low-fat meal may enhance gastrointestinal (GI) tolerability versus 750 mg fasted.

Table 2: Continue

Articles	Nutrition Interventions	QoL	Outcome: To evaluate	Conclusion
Kim (2017)	Red ginseng	improved HRQL (emotional functioning & decreased fatigue, nausea/vomiting, & dyspnea, reduced anxiety & interference affecting life & improved daytime somnolence).	The effect of red ginseng on genotoxicity and relevant health-related quality of life (HRQL).in patients with EOC who received chemotherapy.	Red ginseng may be effective in reducing genotoxicity and improving HRQL.
Li et (2016)	Haishengsu seashell protein (HSS)	Higher complete remission rate, and a better QoL. Reduced expression of multidrug-resistant gene protein P-gp and sorcin.	The molecular mechanism of HSS on chemosensitivity, expression of the multi-drug resistance gene protein P-gp & sorcin.	Improved complete remission rates & QoL in leukemia patients, suppression of P-gp and sorcin genes may be the beneficial effects of HSS.

Abbreviations: Adverse Effects (AEs), Anderson Brief Pain Inventory (ABPI), Body Mass Index (BMI), Chemotherapy (Chemo.), Chemotherapy-induced nausea(CIN), Chemotherapy-induced peripheral neuropathy (CIPN), Docetaxel, cisplatin, and 5-fluorouracil (DCF), Eicosapentaenoic acid (EPA), Epithelial ovarian cancer (EOC), European Organization of Research and Treatment of Cancer (EORTC), Fecal Calprotectin (FCP), Gastrointestinal (GI), Head and neck squamous cell carcinomas (HNSCC), Health related quality of life (HRQL), High Emetogenic Chemotherapy (HEC), Intervention group (IG), Inventory of Nausea, Vomiting and Retching (INVR), Microbial Cell Preparation (MCP), Nausea and vomiting (N/V), Patient Neurotoxicity Questionnaire (PNQ), Polyunsaturated fatty acids (PUFAs), Radiotherapy (Radio.), Short-term Fasting (STF).

Multiple cancer: Describe studies including patients with different types of cancer.

Dietary patterns on quality of life

A randomized, placebo-controlled study of 244 patients evaluated the effects of ginger (110 mg & 40 mg, 2 X day for 42 to 56 days) in the management of chemotherapy-induced nausea and vomiting (CINV) with a high-dose of cisplatin and concluded that ginger did not relieve the side effects under a high dose of cisplatin [30]. However, a double blind and a recent study of 51 and 103 participants found that adjuvant ginger (1.2 g / day, with anti-emetic, during 3 chemo. cycles & 300 mg for 5 days during 3 chemo. cycles) were related to improved nausea and vomiting related to chemotherapy, better cancer-related fatigue and quality of life, and a higher nutrition status [48] [37].

A pilot study of 71 patients assessed the efficacy of the B vitamins (3 capsules/day, 1 week before - 12-week post chemo) in the prevention of chemotherapy-induced peripheral neuropathy (CIPN) and assumed that B vitamins didn't decrease neuropathy related to chemotherapy with no significant change in total pain score [55]. A Randomized, Placebo-Controlled Trial involving 120 patients analyzed the reduction of chemotherapy-induced peripheral neuropathy (CIPN) with oxaliplatin treatment and supported that 6 g/day of panaceo-micro-activation (PMA) (zeolite) during chemotherapy and a month afterwards was associated with a lower CIPN, particularly in the male subgroup [60]. A prospective randomized trial of 63 participants studied oral cystine and theanine 700 mg cystine & 280 mg theanine 1 week before chemotherapy for 5 weeks in attenuating adverse effects of adjuvant chemotherapy in gastrointestinal cancers and stated that anticancer drug side effects were reduced in frequency with an observed higher completion rate [58].

A study of 42 patients on the positive benefits of 40 g/day for 12 weeks of Whey Protein on health status and quality of life reported that supplementation was associated with significant improvement of nutritional status and quality of life scores [31]. A randomized clinical trial including 22 participants assessed fish oil (FO) supplementation (1000 mg /day for 9 weeks) on nutritional inflammatory risk and found that it induced an improvement [33].

A randomized cross-over pilot study of 50 breast or ovarian cancer patients observed that short-term fasting (STF) with a daily energy intake of 350 kcal, 60h-fasting period during Chemo.) was associated with an improved tolerance of chemotherapy, a reduced fatigue and a less altered quality of life [27]. A study of 61 participants with different types of cancer examined individual dietary counseling (1h / week & daily nutritional supplement, 2531 kJ for 5 to 12 weeks) and found that the intervention induced a positive impact on weight maintenance during cancer treatment [53].

Fifty-six participants in a randomized controlled trial assessed the effect of the Asteraceae herb family, Achillea millefolium (15 mL for 3 min in mouth, 4 X day for 14 days) on chemotherapy-induced oral mucositis, which induced a significant decrease of the severity in the experimental group [49]. A prospective 2-arms randomized study involving 99 patients found that it was not feasible to evaluate twice oral administration of Enterade a day for 14 days. It was associated with gastrointestinal toxicities [38].

Breast cancer

Dietary patterns on quality of life

A randomized placebo-controlled trial of 53 breast cancer patients examined the effect of omega-3 fatty acid supplementation of 2.4 g /day for 6 months of chemotherapy on cancer treatment side effects. Xerostomia was reduced, but no significant improvement in nausea, vomiting and fatigue [40].

A study involving 119 participants observed that 500 mg, twice a day for 3 days of ginger reduced the severity of vomiting in breast cancer [26]. Inulin, is a probiotic that improves immune system function and intestinal health (17 g maltodextrin for 21 days) was shown to improve nausea, and constipation in a study of 38 patients with breast cancer [28].

Four studies of respectively 137, 34, 150, and 143 breast cancer patients assessed face to face nutrition education before each chemotherapy session for three times [50], personalized diet with pamphlets through 3 chemotherapy cycles [41], dietary intervention with one hour nutritional education prior to chemotherapy for 10 weeks [25], adapted physical activity and diet counseling for 26 weeks [32], on CINV, and other symptoms related to quality of life. They concluded that nutritional education was related to overall improved CINV and quality of life [25], as well as maintained role function and handgrip strength [41], and better physical, emotional and cognitive functions [32,50].

Two randomized trials with 129 and 13 breast cancer patients studied the Fasting mimicking diet (FMD) for four days and short-term fasting for 24-h pre and post chemotherapy on chemotherapy induced toxicity and other side effects. They found an improvement in patients wellbeing, including lower fatigue, nausea and insomnia [47] and no significant difference in side effects between the two groups [39].

A 437 patients study analyzed a long-term outcome of Acetyl-L-carnitine (3000 mg/d for 24 weeks) on chemotherapy-induced peripheral neuropathy (CIPN) and showed worsening symptoms compared to placebo [43]. A clinical efficacy study of 128 participants with breast cancer inspected 150 mL/day for 12 weeks Yiqi Yangyin decoction's protective effects and noted a lower incidence of diarrhea, nausea and vomiting [57].

Cervical Cancer

Dietary patterns on quality of life

A randomized placebo-controlled study of 57 cervical cancer patients inspected probiotics' effects (300 mg, 3 X day from first day until the end of radiotherapy) in the prevention of acute radiation-induced diarrhea and noticed a decrease of severe diarrhea [46]. A 70 patients study investigated symbiotic supplementation of 20 g, 3 X day for 7 weeks on fecal calprotectin levels and gastrointestinal side effects related to chemotherapy and radiotherapy. Symbiotics noticeably diminished fecal calprotectin as well as the frequency and intensity of vomiting [52].

A recent study involving 48 participants found no change in CINV exploring effects of Zingiber officinale 250mg, 500mg or 1.000 mg with water every 12 h in the management of nausea and vomiting Induced by cisplatin treatment combined with radiotherapy [54]. A multicenter, randomized phase 2 study of 40 patients highlighted that 7.5 g on days 0–13 of oral rikkunshito has an additive effect for prevention of CINV and anorexia [51].

Colorectal cancer

Dietary patterns on quality of life

A prospective randomized study analyzed high-protein oral nutritional supplements (ONS) (2 X 125 mL / day, 7 days / week for 12 weeks) on therapy toxicity, nutritional status and quality of life. They noticed that nutritional status improved, and the quality of life was stable (Ziętarska et al., 2017). A double-blind randomized study of 140 colorectal cancer patients concluded that omega-3 fatty acid supplementation and microbial cell preparation (MCP) (2 sachets / day for 4 weeks, + omega-3 fatty acid at 2 g / day for 8 weeks) ameliorate chemotherapy side effects, quality of life and global health status [42]. A recent study of 83 patients evaluated nurse-led one-hour nutritional education through recording side effects, and severity until the fourth chemotherapy

cycle on the risk of malnutrition and quality of life. The result stated that there was a decrease in intervention and control group with a noticeable level in the control group [59]. A study of 70 patients colorectal cancer assessed 150 mg, 3 X day for 7 days of Silymarin supplementation (compound bioflavonoid common called : milk thistle) on the incidence of gastrointestinal toxicity and found that the study group experienced a significant decrease in episodes of diarrhea and nausea [34].

Head and neck cancer

Dietary patterns on quality of life

A double-blind phase III study of 180 head and neck cancer patients explored the efficacy of immunomodulating nutritional formula (3 sachets/day for 5 days before 3 cisplatin cycles) on severe mucositis and did not find difference in the acute oral mucositis between the two arms during chemotherapy [29]. A recent study including 92 participants examined multidomain nurse led interventions (guideline use - antiemetics, diet management, music- relaxation, Nurse contact at 24 & 72 h +/- 24h after discharge) on the incidence and severity of CINV and its impact on patients' quality of life. It came up with the conclusion that the intervention can lower both the incidence and the severity of CINV in patients with head and neck squamous cell carcinoma [64] A Parallel randomized controlled trial of 72 head and neck cancer patients investigated the efficacy and safety of thyme honey (mouthwash 3 X day) in the management of treatment induced xerostomia. The result showed a positive effect in reducing and stabilizing xerostomia [35].

Other types of cancer

Dietary patterns on quality of life

A double-blind placebo-controlled study involving 248 leukemia patients assessed the effect of Haishengsu seashell protein's (HSS) a purified protein from a sea creature containing a

high amount of proteins and vitamin B12 at the dose of 2.4 mg in 250 ml normal saline /day intravenously over 4 h for 28 days on improving quality of life. The conclusion indicated a better quality of life with a higher complete remission rate [45]. A double-blind randomized, placebo-controlled study including 196 colon cancer patients evaluated (641 mg, 3 X day during chemotherapy & 1 month later) the impact of omega-3 PUFAs on oxaliplatin-induced neurotoxicity. The study concluded that a higher quality of life and better overall health [61]. A study of 137 patients with esophageal cancer analyzed elemental diet (160 g/day, for 56 days) and found a significant decrease in grade two and higher oral mucositis in intervention patients [56]. A multicenter, randomized, open-label, phase 1 study of 137 non–small cell lung cancer (NSCLC) patients analyzed ceritinib 450 mg or 600 mg with a low-fat meal versus 750 mg in fasted patients in reducing gastrointestinal (GI) toxicity. The study revealed that 450 mg or 600 mg of ceritinib with a low-fat meal has a positive impact on GI toxicity, including diarrhea, nausea, and vomiting [36]. A double-blind, randomized, placebo-controlled trial assessed the effect of red ginseng (3000 mg/day for 3 months) on genotoxicity and health-related quality of life in 30 ovarian cancer patients. The result indicated that red ginger enhanced emotional function and reduced CINV in addition to dyspnea and anxiety [44].

Chapter 4 - Discussion

Nutritional interventions: the vast majority of the nutritional interventions in this study provided positive outcomes regarding quality of life or adverse effects of cancer treatments. Some interventions concluded with neutral benefits. However, a few studies observed a negative impact.

Table 3. Shows groups of nutritional interventions and their outcomes

Dietary patterns	Positive effect	Detrimental	Neutral effect
Diet			
Ceritinib 450 or 600 mg with a Low-Fat Meal vs 750 mg in Fast	Improved GI toxicity in NSCLC (450 mg or 600 mg, with low-fat meal) (Cho et al., 2017)		
Elemental diet	Decreased oral mucositis esophageal cancer (160 g/day for 56 days) (Tanaka et al., 2021).		
Fasting	Improved well-being, lower fatigue in breast cancer with fasting-mimicking diet (plant-based low amino-acid substitution diet for 4 days) (Lugtenberg et al., 2021) Improved fatigue & QoL in multiple cancers with short-term fasting (STF) (Bauersfeld et al., 2018)		No difference in side effects in breast cancer with STF (De Groot et al., 2015)
Personalized diet and/or Dietary education	- Improved weight maintenance in multiple cancer (1h counseling/week & 2531 kJ / day for 5 to 12 weeks (Poulsen et al., 2014) - Improved physical and emotional function in breast cancer (individually hospital- exercise & non-supervised home-based sessions for 26 weeks) (Carayol et al., 2019) - Improved GI side effects in breast cancer (1h nutritional advice before chemo. for 10 weeks) (Abdollahi et al., 2019)	Decreased QoL in colorectal cancer (Recording side effects, & severity until the 4 chemo) (Tuominen et al., 2023)	

	- Maintained QoL role function & handgrip strength in breast cancer (healthy eating guidelines & nut. Info to reduce CINV) + personalized diet during chemo) (De Souza et al., 2021) - Lowered CINV incidence & severity in HNC (guideline use - antiemetics, diet management, music- relaxation, Nurse contact at 24 & 72 h +/- 24h after discharge) (Cao et al., 2024). - Reduced CINV & improved QoL in breast cancer (personalized diet & nutritional education 3 times) (Najafi et al., 2019).		
Non nutrient			
Achillea millefolium	Decreased severity of OM in multiple cancers (15 mL for 3 min in mouth, 4 X day for 14 days) (Miranzadeh et al., 2015)		
Ginger	Improved CINV in multiple cancer (1.2 g / day, with anti-emetic, during 3 Chemo. cycles & 300 mg for 5 days during 3 chemo. Cycles) (Crichton et al., 2024; Marx et al., 2017) - reduced severity of vomiting in breast cancer (Ansari et al., 2016)		No effect on CINV in multiple cancer (110 mg & 40 mg, 2 X day for 42 to 56 days) ((Bossi et al., 2017) - No change in CINV cisplatin + radio in cervical cancer (Santos et al., 2023).
Inulin	Improved nausea and constipation in breast cancer (17 g maltodextrin for 21 days) (Becerril-Alarcón et al., 2019)		
Panaceo-micro-activation (zeolite)	Improved CIPN in multiple cancers (6 g/day during chemo & for a month afterwards) (Vitale et al., 2020)		
Probiotics	Decreased severe diarrhea in cervical cancer (300 mg 3/day during radio) (Linn et al., 2019)		

Red ginseng	Enhanced emotional function and reduced CINV in ovarian cancer (3000 mg/day for 3 months) (Kim et al., 2017)		
Rikkunshito	Prevention of CINV in cervical cancer (7.5 g on days 0–13) (Ohnishi et al., 2017)		
Silymarin	Decreased diarrhea & nausea in colorectal cancer (150 mg: 3/day for 7 days) (Chang et al., 2021)		
Symbiotic	Decreased vomiting in cervical (20 g, 3/day for 7 weeks) cancer (Ortiz et al., 2018)		
Yiqi Yangyin	Lower incidence in CINV & diarrhea in breast cancer (2 bags of 150 mL/day for 12 weeks) (Tang et al., 2024)		
Nutrient			
Acetyl-L carnitine		Worsening side effects in breast cancer (3000 mg/day for 24 weeks) (Hershman et al., 2018)	
B Vitamins			Not effect on CIPN in multiple cancer 3 capsules/day). 1 week before, 12-week post Chemo. ((Schloss et al., 2017).
cystine and theanine	Improved AEs in multiple cancers (700 mg cystine & 280 mg theanine/day for 5 weeks) (Tsuchiya et al., 2016)		
Enterade		Gastrointestinal toxicities in multiple cancers (8 oz/day for 14	

		days) (De Filipp et al., 2021)	
Fish oil (FO)	Improved nutritional inflammatory risk in multiple cancer (2 X 1000 mg oil /day for 9 weeks) (Chagas et al., 2017)		
Haishengsu seashell protein (HSS)	Better QoL in leukemia (intravenously 2.4 mg in 250 ml normal saline /day -4 h for 28 days) (Li et al., 2016).		
Immunomodulating nutritional formula			No difference in oral mucositis in HNC 3 sachets/day for 5 days before 3 cisplatin cycles (Boisselier et al., 2020)
Omega-3	Improved CINV, QoL & global health in colorectal cancer (2 g/day for 8 weeks) (Golkhalkhali et al., 2018) - Higher QoL & better overall health in colon cancer (641 mg, 3Xday during chemo. & 1 month later) (Zhang et al., 2020) - Reduced xerostomia in breast cancer (2.4 g /day for 6 months) (De La Rosa Oliva et al., 2019)		
Oral nutritional supplements (ONS)	Improved nutritional status & stable QoL in colorectal cancer (125 mL, 2 / day for 12 weeks) (Ziętarska et al., 2017)		
Thyme honey	Reduced & stabilized xerostomia in HNC (mouthwash 3 X day) (Charalambous et al., 2017)		
Whey Protein	Improved nutritional status in multiple cancer (40 g/day for 12 weeks) (Bumrungpert et al., 2018)		

Diet interventions

Four diet interventions were investigated in the review, which involved 12 studies [25,27,32,36,39,41,47,50,53,56,59,64]. Ceritinib with low fat improved gastrointestinal toxicity in Non–Small Cell Lung Cancer (NSCLC), and elemental diet was observed to decrease oral mucositis in esophageal cancer [36,56]. Fasting resulted in different outcomes in some studies. A fasting-mimicking diet, which is a plant-based, low amino acids substitution diet, and short-term fasting improved well-being and lower fatigue in breast cancer [47], and multiple cancers [27]. These findings are line with results from a study which found a link between eating behaviors including eating small portions of food, or in small frequencies or skipping meals with chemotherapy induced nausea and vomiting [21]. However, short-term fasting did not show a difference in side effects in breast cancer [39].

Many studies found a positive impact of individualized diet and/or dietary counseling on side effects of cancer treatments and quality of life. Dietary education combined with personalized diet improved weight maintenance in multiple cancers [53] and reduced CINV as well as enhanced quality of life in breast cancer [50]. Adapted physical activity and diet counseling (APAD) ameliorated mental and physical outcomes in addition to a positive effect in fatigue and quality of life in the long term [32]. One hour of nutritional advice before chemotherapy improved gastrointestinal toxicity in breast cancer [25]; nutritional guidelines with individualized diet were associated with maintained quality of life and handgrip strength in breast cancer [41]; reduced intensity and severity in CINV was observed with multiple interventions, including guideline use in head and neck cancer [64]. Similarly, a positive impact of targeted nutritional education from professionals was observed in chemotherapy-induced nausea and vomiting in the study by Gala et

al. [21]. Conversely, a decreased quality of life in colorectal cancer with recording of negative effects and severity [59].

Non-nutrient interventions

This review found no negative effects with non-nutrient interventions. Different results were stated with ginger in this study. Three studies proved it to have a positive impact on chemotherapy-induced nausea and vomiting, as well as on cancer-related fatigue and the quality of life in multiple cancers [37,48], and in breast cancer [26]. That supports the result of a study by Gala et al., which found ginger tea to have beneficial effects on chemotherapy-induced nausea and vomiting. Still, the finding was with low evidence [21]. Two other studies demonstrated a neutral benefit of ginger in CINV in multiple cancers [30] and in cervical cancer [54]. There wasn't a study with a detrimental impact. With doses from 40mg/day[30] to 1.2 g/day[48] ginger seems not to have a negative effect.

Additionally, in multiple cancers, Achillea millefolium decreased the severity of oral mucositis in multiple cancers [49], and panaceo-micro-activation (zeolite) improved chemotherapy-induced peripheral neuropathy [60]. Diarrhea, CINV, and constipation were ameliorated with inulin, probiotics, symbiotics, and rikkunshito in cervical cancer [28,46,51,52], red ginseng in ovarian cancer [44], silymarin in colorectal cancer [34], and Yiqi Yangyin in breast cancer [57].

Nutrient interventions

Positive effects were predominantly shown with nutrient interventions. Nevertheless, a few studies concluded neutral and others negative benefits. Three studies observed a positive impact with omega-3 [40,42,61]. With doses between 1.9 g/day and 2.4 g/day, omega-3 showed improvement of quality of life, including chemotherapy-induced nausea and vomiting, and symptoms of xerostomia in cancer patients [40,42,61] with no worsening side effects recorded. This finding supports

the results of a study that concluded that omega-3 PUFAs and sea fish rich in them are associated with improved survival because of their regulatory effects on malignant cells in colorectal cancer [65].

Improvements in the adverse effects of cancer treatments, particularly regarding the enhancement of quality of life, were observed with the following nutrient interventions: better management of adverse effects linked to a higher treatment completion rate as well as an enhanced nutritional inflammatory risk in multiple cancers with fish oil, cysteine, and theanine [33,58]; Haishengsu seashell protein (HSS) in intravenous was related to better quality of life in leukemia [45]; CINV, smell and taste alterations were ameliorated with taurine in lymphoblastic leukemia [66]; xerostomia was reduced in head and neck cancer with thyme honey [35]. Nutritional status, in addition to the quality of life, was boosted with oral nutritional supplements in colorectal cancer [62] and with whey protein in multiple cancers [31]. That aligns with a finding that concluded that animal protein consumption associated with physical activity is known to improve muscle building, which can compensate for muscle loss, which endangers cancer patients' survival [65].

Two studies came up with neutral effects on the quality of life. B vitamins (3 capsules/day). One week before - 12-week post Chemotherapy) did not decrease CIPN [55]. The enriched formula with L-arginine, omega-3 fatty & ribonucleic acids (3 sachets/day) did not decrease oral mucositis [29]. Negative side effects were reported in two studies. 8 oz/day for 14 days of Enterade was not feasible due to gastrointestinal toxicities [38] and 3000 mg/day for 24 weeks worsened CIPN symptoms that persisted over 2 years [43].

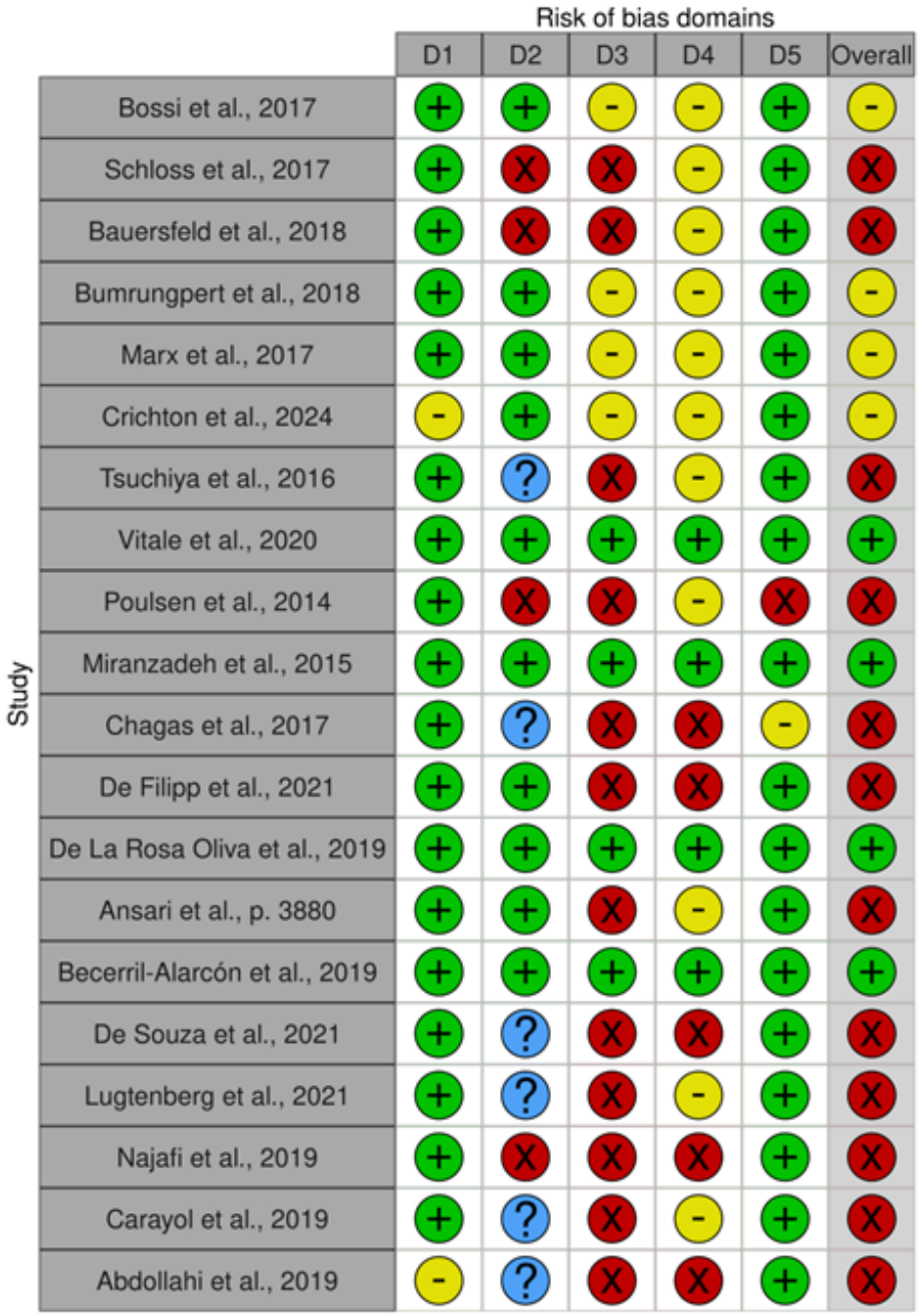
Only a limited intervention demonstrated a decreased quality of life or induced adverse effects; few interventions had neutral benefits. The rest of the nutritional interventions concluded an improved side effects of cancer treatments and the quality of life. This review included diverse

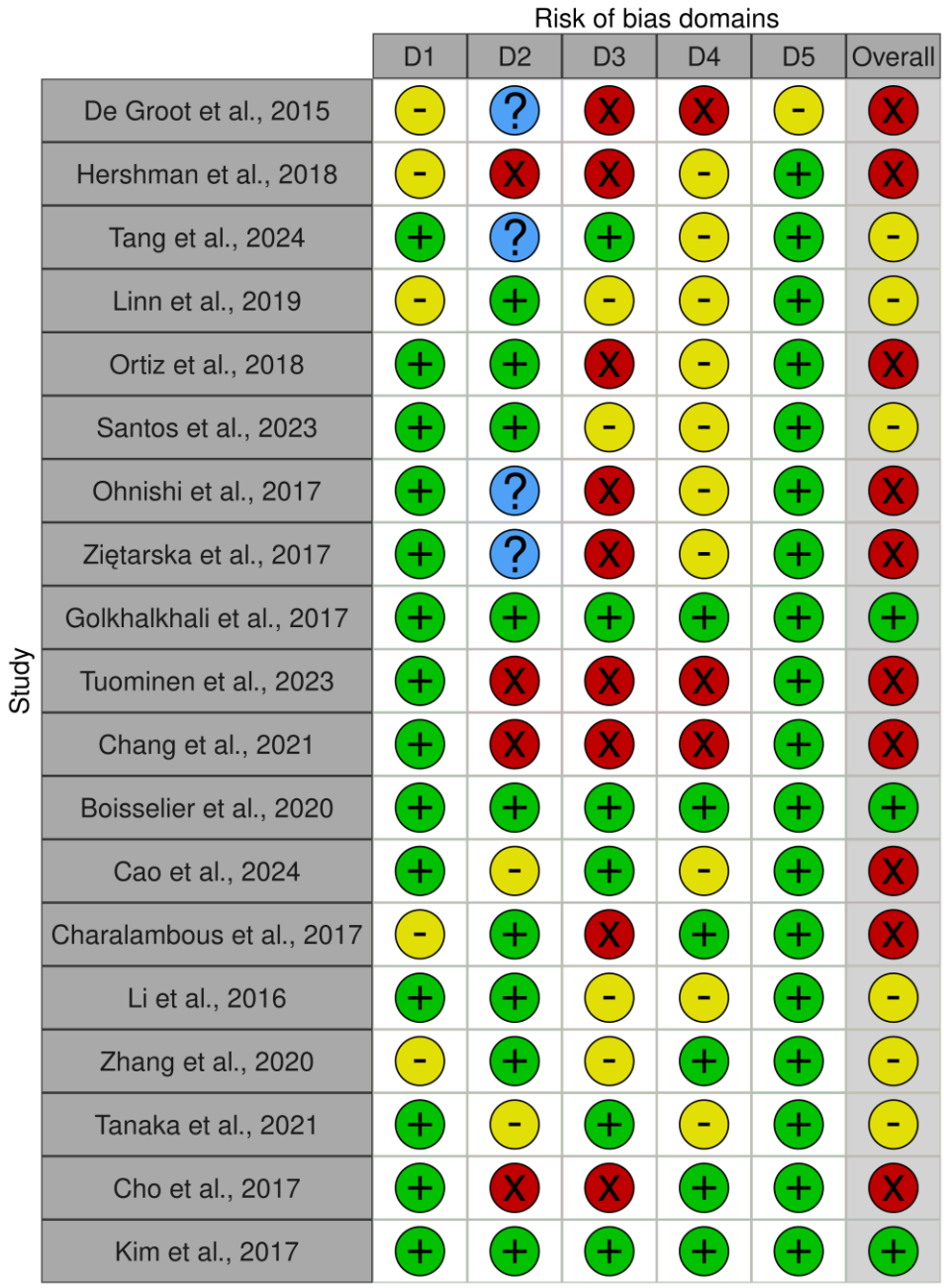
studies that analyzed the negative effects of cancer treatments on patients' well-being. However, it has some limitations; some studies included lower participants, and the study duration was also variable between included studies. The nutrition interventions were diverse with variable outcomes,

Risk of Bias Analysis

The risk of bias (Table 4) was assessed in the articles, and the table was generated with the Robvis visualization tool, an online software. Seven studies were less biased [28,29,40,44,49,60,63], ten had some concerns [30,31,37,45,46,48,54,56,57,61], and twenty-two had a high risk of bias [25–27,32–36,38,39,41,43,47,50–53,55,58,59,62,64].

Table 4. Risk of Bias Analysis in included articles.





Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
- High
- Some concerns
- Low
- No information

Conclusion

Various studies involving diverse nutritional interventions observed an improvement in the negative effects of treatments and the quality of life in cancer patients, with no negative impact associated with non-nutrient interventions. These results can guide clinicians who are seeking non-medical options to alleviate the unsuitable outcomes of cancer treatments in their patients. Additional studies involving more participants are needed to confirm these results.

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