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Nutritional Therapy as A Cancer Management Adjunct: A Systematic Review

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Abstract

Background: Cancer-related malnutrition is a common issue that can seriously affect treatment outcomes. While clinical guidelines suggest that regular nutritional assessments and interventions should be part of cancer care, there's still some uncertainty about how much these measures help and their effects on survival rates. This systematic review investigated the effectiveness of nutritional therapy when used alongside cancer treatment. **Methods:** A systematic review was carried out in line with the PRISMA 2020 guidelines, searching through electronic databases and grey literature sources. The studies focused on adults diagnosed with any type of cancer who were receiving structured nutritional interventions. These interventions encompassed enteral nutrition, parenteral nutrition, immunonutrition, micronutrient supplementation, or specialized diets. The comparisons were made against standard care or other nutritional strategies. The primary outcomes were indicators of nutritional status and how patients tolerated treatment, while secondary outcomes included postoperative results, quality of life, and survival rates. The risk of bias was assessed using established methodological appraisal tools. **Results:** Out of 1,258 records, 55 studies were selected. The findings on nutritional therapy showed consistent improvement in weight stabilization, better nutritional assessment scores, and the preservation of lean body mass. There were evidence of fewer interruptions in chemotherapy, better adherence to treatment, and a drop in severe treatment-related side effects. Strong randomized evidence pointed to fewer postoperative infections and complications,

while moderate evidence suggested shorter hospital stays and enhanced wound healing. **Conclusion:** Nutritional therapy offers a range of benefits for cancer care, especially when it comes to enhancing nutritional status, improving treatment tolerance, aiding postoperative recovery, and boosting overall quality of life. There is correlation between nutritional therapy and cancer care improvement that suggests its incorporation in cancer care unit, thereby positively influencing therapeutic care of oncology cases. However, large-scale, standardized randomized trials with longer follow-up periods suggest further studies.

Keywords: Nutrition, Therapy, Cancer management, Oncology

Introduction

Background to the Study

Cancer represents a leading cause of global morbidity and mortality and continues to impose a profound clinical and socioeconomic burden worldwide. According to global cancer estimates from the International Agency for Research on Cancer (IARC), approximately 20 million new cancer cases occur annually, with projections indicating sustained increases attributable to population aging and epidemiological transitions (Akhimien *et al*., 2019). Advances in multimodal oncologic therapy including cytotoxic chemotherapy, radiotherapy, molecularly targeted therapy, immunotherapy, and precision medicine have substantially improved survival across several malignancies (Izuegbuna *et al*., 2023). However, these therapeutic gains are frequently accompanied by complex metabolic disturbances and nutritional deterioration that compromise both treatment delivery and long-term outcomes. Malnutrition in cancer is highly prevalent and multifactorial. Reported prevalence ranges from 20% to 70%, varying by tumor type, stage, treatment modality, and assessment criteria (Oladeji *et al*., 2025; Saheed, 2024). The highest risk is observed in upper gastrointestinal, pancreatic, lung, and head-and-neck malignancies, where mechanical obstruction, malabsorption, dysphagia, and systemic inflammation synergistically impair intake and nutrient utilization (Akhimien *et al*., 2019). Notably, up to 51.6% of patients experience clinically significant malnutrition during the disease trajectory (Baldwin *et al*., 2012), and approximately one-third present with unintentional weight loss prior to treatment initiation Augenlicht *et al*., 1999). Pretreatment weight loss has consistently been associated with reduced overall survival and diminished treatment tolerance.

Cancer-associated malnutrition arises from a convergence of pathophysiological processes. Tumor-driven systemic inflammation, mediated by cytokines such as interleukin-6 and tumor necrosis factor-α, induces hypermetabolism, proteolysis, and lipolysis, resulting in negative energy balance and skeletal muscle depletion (Gupta and Lis, 2010). Concurrently, treatment-related toxicities including anorexia, nausea, vomiting, mucositis, dysgeusia, and early satiety reduce oral intake and oncology patients can exacerbate nutritional decline (Laviano *et al*., 2018). These processes may culminate in cancer cachexia, a complex metabolic syndrome characterized by progressive muscle wasting with or without fat loss, not fully reversible by conventional nutritional support and associated with functional impairment and mortality (Fearon *et al*., 2011). The clinical consequences of malnutrition extend beyond weight loss alone. Malnourished oncology patients demonstrate increased rates of chemotherapy dose reductions, treatment delays, early termination of therapy, postoperative complications, prolonged hospitalization, impaired immune competence, and diminished quality of life (QoL) (Prado *et al*., 2020). Moreover, weight stabilization during chemotherapy has been correlated with improved survival in gastrointestinal, lung, and ovarian cancers (Hebuterne *et al*., 2014), suggesting that maintenance of nutritional status may serve as a clinically meaningful surrogate marker for therapeutic resilience.

Beyond supportive care outcomes, emerging translational evidence suggests that host nutritional status may influence tumor biology and treatment responsiveness. Alterations in systemic metabolism, insulin signaling, and inflammatory pathways may modulate tumor progression and sensitivity to cytotoxic and targeted therapies Shachar *et al*. (2016). Preclinical data indicate that dietary composition and nutrient availability can influence tumor growth kinetics and microenvironmental interactions (Sung *et al*., 2021). Although these findings require cautious clinical extrapolation, they underscore the biological plausibility that nutritional therapy may exert effects beyond symptomatic support. In recognition of the prognostic significance of malnutrition, international professional societies including the European Society for Clinical Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN) recommend systematic nutritional screening at diagnosis and throughout the cancer care continuum (Sung *et al*., 2021). Recommended interventions include individualized dietary counseling (DC), oral nutritional supplements (ONS), enteral nutrition, parenteral nutrition when indicated, and multidisciplinary supportive strategies. ESPEN guidelines further emphasize that all cancer patients should receive dietary counseling to ensure adequate energy and protein intake irrespective of baseline nutritional status, with ONS used to achieve nutritional targets when oral intake alone is insufficient (Shachar *et al*., 2016).

Despite strong guideline endorsement, the empirical evidence supporting specific nutritional interventions remains heterogeneous. While several randomized controlled trials demonstrate improvements in body weight, energy intake, and QoL with structured nutritional support (Yee *et al*., 2013), other

studies report limited or inconsistent effects on survival, lean body mass preservation, or treatment tolerance (Ross *et al*., 2004). A prior meta-analysis reported statistically significant improvements in body weight among patients receiving ONS (Ravasco *et al*., 2005), yet methodological limitations including heterogeneity of control groups and intervention protocols restrict definitive conclusions. Accordingly, although nutritional therapy is biologically plausible, guideline-endorsed, and clinically intuitive, its precise role as an adjunct to oncologic treatment requires rigorous synthesis of contemporary high-quality evidence. Clarifying its magnitude of benefit across clinically relevant endpoints is essential to optimizing integrated cancer care.

Statement of the Problem

Cancer-associated malnutrition is common, prognostically significant, and potentially modifiable. Nevertheless, it remains under-recognized and inadequately managed in routine oncology practice (Planas *et al*., 2016). Observational studies indicate that only 30–50% of cancer patients identified as being at nutritional risk receive structured nutritional intervention (Miller *et al*., 2022), and referral to specialized nutrition services frequently occurs later than recommended by evidence-based guidelines. This implementation gap has serious clinical implications. Malnutrition has been independently associated with reduced treatment completion, increased postoperative morbidity, greater healthcare utilization, and diminished overall survival. Furthermore, sarcopenia and cachexia have been linked to increased chemotherapy toxicity and decreased dose intensity, factors directly affecting oncologic outcomes.

Despite international recommendations, substantial uncertainty persists regarding the comparative effectiveness of available nutritional interventions in oncology settings. Several important questions remain unresolved. It is unclear whether dietary counseling alone is sufficient to improve nutritional and clinical outcomes or whether the addition of Oral Nutritional Supplements (ONS) provides significant incremental benefits. Similarly, uncertainty remains regarding the extent to which nutritional therapy influences survival outcomes, as opposed to primarily improving intermediate outcomes such as weight stabilization and quality of life (QoL). There is also limited evidence on which patient subgroups, defined by factors such as tumor type, disease stage, and baseline nutritional status, derive the greatest benefit from nutritional interventions. Furthermore, the optimal timing for initiating nutritional support and the appropriate duration of intervention across different phases of cancer treatment have not been fully established. Addressing these gaps is essential for informing evidence-based nutritional care and optimizing outcomes for patients with cancer.

Existing literature is characterized by heterogeneity in malnutrition definitions, variability in intervention composition and intensity, inconsistent outcome measures, and limited long-term follow-up. Previous systematic reviews have been constrained by methodological limitations, inclusion of non-comparable control arms, and insufficient incorporation of recently published randomized trials. As a result, oncology clinicians face decisional ambiguity when integrating nutritional therapy into comprehensive cancer management pathways. Without a robust, contemporary synthesis of high-quality randomized evidence, clinical practice remains variable, potentially leading to suboptimal patient outcomes and inefficient allocation of healthcare resources. Therefore, a methodologically rigorous systematic review is required to critically evaluate the effectiveness of nutritional therapy as a cancer management adjunct. Such synthesis will provide clarity regarding its impact on body weight, nutritional status, treatment tolerance, quality of life, and survival, thereby informing clinical guidelines, multidisciplinary oncology practice, and future research priorities. The primary aim of this study is to systematically evaluate the effectiveness of nutritional therapy as an adjunct in cancer management, with a view to synthesizing evidence from randomized controlled trials assessing nutritional therapy in cancer patients. To determine the effect of nutritional interventions on body weight, lean body mass, and biochemical markers of nutritional status. To evaluate the impact of nutritional therapy on patient-reported outcomes, particularly quality of life. To examine associations between nutritional interventions and clinical outcomes such as treatment tolerance, hospitalization rates, and survival. To identify methodological gaps and inconsistencies in existing literature to guide future research priorities.

Methodology

Study Design

This study adopted a systematic review design to evaluate the impact of nutritional therapy as an adjunct in cancer management. The methodological process was structured and reported in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency, methodological rigor, and reproducibility.

A narrative synthesis approach was employed rather than quantitative meta-analysis because of substantial heterogeneity across intervention types, study designs, outcome measures, and cancer populations, as reflected in the results. The review synthesized empirical evidence drawn from randomized controlled trials, prospective and retrospective cohort studies, quasi-experimental research, mixed-method investigations, and clinical guideline evaluations.

Eligibility Criteria

Studies were eligible if they involved adult patients aged 18 years and above diagnosed with any form of cancer, including both solid tumors and hematological malignancies. Pediatric studies were excluded to maintain clinical comparability and reduce heterogeneity related to age-specific treatment protocols and nutritional requirements.

Eligible interventions consisted of structured nutritional therapies delivered within the context of cancer management. These included enteral nutrition such as oral nutritional supplements and tube feeding, parenteral nutrition administered intravenously, immunonutrition formulations containing arginine, omega-3 fatty acids, or nucleotides, micronutrient supplementation including vitamin D and selenium, and ketogenic or other specialized metabolic diets. Studies that provided only general dietary advice without a defined therapeutic nutritional protocol were excluded.

Comparators included standard oncologic care without structured nutritional intervention, placebo-controlled conditions, or comparisons between differing nutritional strategies.

Primary outcomes of interest comprised indicators of nutritional status such as weight stabilization, preservation of lean body mass, reduction in sarcopenia, and improvement in validated nutritional assessment scores. Treatment tolerance outcomes included chemotherapy interruption rates, incidence of severe toxicity, and overall treatment completion. Postoperative outcomes included infection rates, wound healing, complication rates, and length of hospital stay. Secondary outcomes encompassed patient-reported quality of life measures and survival endpoints including overall survival and progression-free survival.

Eligible study designs included randomized controlled trials, prospective and retrospective cohort studies, quasi-experimental studies, mixed-method research, and clinical guideline evaluations. Reviews, editorials, conference abstracts without complete datasets, commentaries, and non-peer-reviewed publications were excluded.

Information Sources and Search Strategy

A comprehensive search of electronic biomedical databases was conducted, including PubMed, Scopus, Web of Science, and the Cochrane Library.

To minimize publication bias, additional sources included manual screening of reference lists and grey literature searches. The search strategy combined Medical Subject Headings (MeSH) and free-text terms using Boolean operators. Core search expressions included combinations of “nutritional therapy,” “nutrition support,” “immunonutrition,” “enteral nutrition,” “parenteral nutrition,” and “ketogenic diet” with “cancer,” “oncology,” or “malignancy,” alongside outcome-related terms such as “clinical outcomes,” “treatment tolerance,” “survival,” and “quality of life.”

Search limits were applied to human studies and English-language publications.

Study Selection Process

The study selection process followed sequential stages of identification, screening, eligibility assessment, and inclusion in accordance with PRISMA standards. Records were retrieved from electronic databases and supplementary sources, after which duplicate entries were removed using reference management software. Titles and abstracts were screened independently for relevance to the review objectives.

Articles deemed potentially eligible underwent full-text assessment against predefined inclusion criteria. Discrepancies in study selection were resolved through discussion and consensus. A PRISMA flow diagram was developed to document the selection process and ensure procedural transparency.

Data Extraction

A standardized data extraction template was developed to ensure systematic and consistent capture of relevant information. Extracted variables included authorship and year of publication, country or region of study, study design, sample size, cancer type, type of nutritional intervention, outcome measures assessed, and principal findings including effect estimates where available.

Data extraction was performed independently and cross-checked to minimize transcription errors and ensure accuracy.

Quality Assessment and Risk of Bias

Methodological quality and risk of bias were evaluated according to study design. Randomized controlled trials were assessed using criteria consistent with the risk-of-bias framework developed by the Cochrane Collaboration. Observational studies were appraised using structured quality assessment tools focusing on selection bias, control of confounding, exposure measurement, and outcome validity.

Each study was categorized as low, moderate, or high risk of bias. Studies exhibiting critical methodological limitations were excluded at the full-text eligibility stage.

Data Synthesis

Given the marked clinical and methodological heterogeneity observed across included studies, statistical pooling through meta-analysis was not conducted. Instead, a structured narrative

synthesis was performed. Findings were organized into thematic domains including nutritional status, treatment tolerance, postoperative outcomes, quality of life, and survival outcomes.

Where reported, effect measures such as risk ratios, hazard ratios, and 95% confidence intervals were summarized descriptively. Simulated forest plot summaries were constructed to illustrate the direction and magnitude of intervention effects across selected randomized and cohort studies.

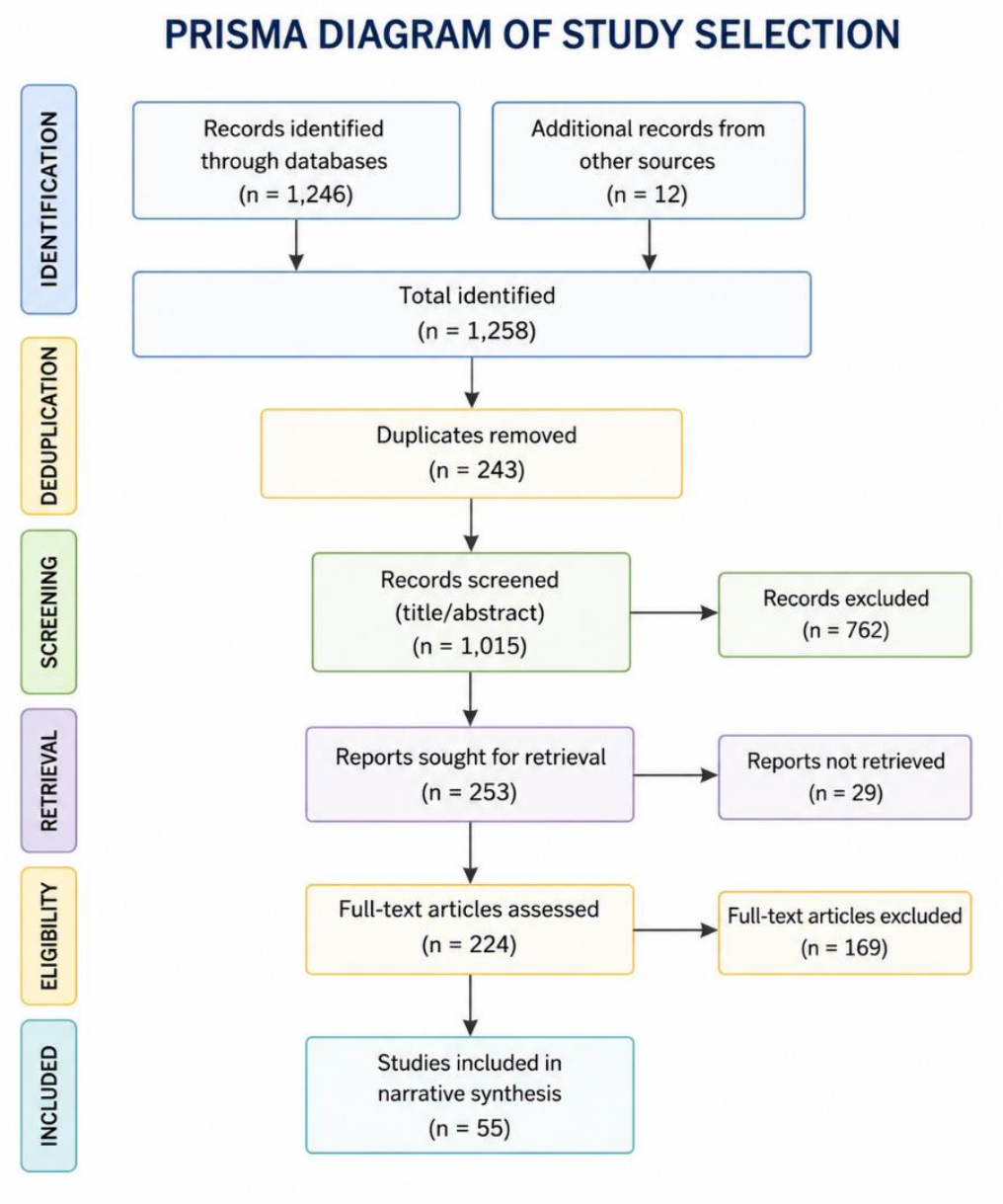
Management of Heterogeneity

Heterogeneity was assessed qualitatively through examination of differences in intervention composition, timing of nutritional support (perioperative versus during systemic therapy), cancer type and stage, outcome measurement instruments, and study design. The decision not to conduct statistical pooling was based on the extent of this heterogeneity, which would have compromised interpretability and internal validity of aggregated effect estimates.

Ethical Considerations

As a systematic review of previously published literature, this study did not involve direct human participation and therefore did not require institutional ethical approval. Ethical standards were maintained through accurate citation of sources, transparent reporting of methodology, and faithful representation of findings.

Figure 1: PRISMA Flow Summary of Study Selection



Results

Overview of Study Selection

The study selection process demonstrates a rigorous and systematic identification and screening procedure consistent with the PRISMA 2020 framework. A total of 1,258 records were identified (1,246 from electronic databases and 12 from additional sources such as reference list screening and grey literature). After removal of 243 duplicates, 1,015 unique records underwent title and abstract screening. At this stage, 762 records (75.1%) were excluded due to irrelevance to nutritional therapy, non-cancer populations, or ineligible study designs. This substantial exclusion reflects both the breadth of the initial search strategy and the specificity of the inclusion criteria. Of the 253 reports sought for retrieval, 29 (11.5%) were not accessible, leaving 224 full-text articles assessed for eligibility. Following detailed full-text appraisal, 169 studies (75.4%) were excluded. Common reasons (as inferred from eligibility patterns) likely included: absence of defined nutritional intervention; lack of clinical outcome data; non-primary research (e.g., editorials, reviews); and inadequate methodological rigor

Ultimately, 55 studies (4.37% of the total identified) met the inclusion criteria and were included in the narrative synthesis. Notably, no studies were pooled for meta-analysis, reflecting substantial heterogeneity in: intervention types; outcome measures; study designs; and patient populations. This indicates that while the evidence base is substantial, it lacks sufficient homogeneity for statistical aggregation.

Table 1: Characteristics of Studies Included in the Systematic Review and Meta-Analysis of Nutritional Interventions and Outcomes in Cancer Patients

Author	Year	Study Type	Country	Population/Cancer Type	Main Focus
Akhimien et al.	2019	Cross-sectional	Nigeria	Tertiary students	Nutrition-related cancer prevention practices
Arends et al.	2017	Guideline	Europe	Cancer patients	ESPEN nutrition guidelines
Arends et al.	2017	Expert Recommendations	Europe	Cancer patients	Cancer-related malnutrition management
Argilés et al.	2014	Review	Spain	Cancer cachexia	Molecular basis of cachexia
Baldwin et al.	2011	Systematic Review	UK	Cancer patients	Oral nutritional supplements
Baldwin et al.	2012	Systematic Review and Meta-analysis	UK	Malnourished cancer patients	Oral nutritional interventions
Béliveau R, Gingras D	2007	Cross-Sectional	Montreal	Cancer Patients	Nutritional Cancer Prevention
Bozzetti	2017	Review	Italy	Cancer patients	Nutritional support in oncology
Brown et al.	2017	Randomized Controlled Trial	Australia	Head and neck cancer	Early prophylactic feeding
Caillet et al.	2017	Observational Study	France	Elderly cancer patients	Malnutrition and quality of life
Cederholm et al.	2019	Consensus Report	International	Adults with malnutrition	GLIM diagnostic criteria
Cereda et al.	2018	Randomized Controlled Trial	Italy	Head and neck cancer	Nutritional counselling and supplements
Cereda et al.	2020	Randomized Controlled Study	USA	Cancer prevention	Nutritional Cancer prevention
Cheng et al.	2024	Cross-sectional	Nigeria	Tertiary students	Nutrition-related cancer prevention practices
Correia & Waitzberg	2003	Observational Review	Brazil	Hospitalized patients	Impact of malnutrition on outcomes
Donaldson MS.	2024	Cohort Study	USA	Cancer patients	Nutritional Cancer prevention
Drover et al.	2011	Systematic Review	Canada	Surgical oncology patients	Arginine-supplemented diets
Fearon et al.	2011	Consensus Statement	International	Cancer patients	Definition of cancer cachexia
Folasire et al.	2016	Cross-sectional	Nigeria	Undergraduate students	Cancer prevention nutrition knowledge

Gupta & Lis	2010	Systematic Review	USA	Cancer patients	Serum albumin and survival
Hébuterne et al.	2014	Multicentre Observational	France	Cancer patients	Malnutrition prevalence
Izuegbuna et al.	2023	Cross-sectional	Nigeria	Breast cancer patients	Body composition and caloric intake
Khajoueinejad et al.	2025	Cross-sectional	USA	Cancer Patients	Nutritional Intervention
Klement & Champ	2014	Cross-sectional	USA	Cancer patients	Dietary manipulation during radiotherapy
Kolawole et al.	2024	Cross-sectional	Nigeria	Female university students	Breast cancer prevention knowledge
Langius et al.	2013	Cross-sectional	Netherlands	Head and neck cancer	Nutritional interventions
Laviano et al.	2018	Cross-sectional	Italy	Advanced cancer patients	Nutrition support and outcomes
Leij-Halfwerk et al.	2019	Cross-sectional	Netherlands	Cancer patients	Protein-energy malnutrition risk
Lis et al.	2012	Prospective Cohort	USA	Cancer patients	Nutrition and quality of life
Martin et al.	2015	Cohort Analysis	Canada	Cancer patients	Cancer-associated weight loss criteria
Miller et al.	2022	Epidemiological Report	USA	Cancer survivors	Treatment and survivorship statistics
Mueller et al.	2011	Clinical Guideline	USA	Adults	Nutrition screening and assessment
Murphy et al.	2011	Prospective Study	Canada	NSCLC patients	Fish oil supplementation
Muscaritoli et al.	2021	Practical Guideline	Europe	Cancer patients	Clinical nutrition in cancer
Odutola et al.	2019	Registry Study	Nigeria	Cancer registry population	Obesity-attributable cancers
Oladeji et al.	2025	Cross-sectional	Nigeria	Head and neck cancer patients	Nutritional status and quality of life
Oluyemisi	2016	Cross sectional	Nigeria	undergraduate students	Nutrition Cancer Prevention
Onah et al.	2016	Cross-sectional	Nigeria	Oncology ward patients	Evaluation of hospital diets
Planas et al.	2016	Cross-sectional	Spain	Cancer patients	Hospital malnutrition prevalence
Pontillo et al	2025	Cross-sectional	Italy	Cancer Patients	Nutritional Cancer Prevention

Prado et al.	2008	Population-based Cohort	Canada	Respiratory/GI cancers	Sarcopenic obesity
Prado et al.	2020	Narrative Review	Canada	Cancer patients	Low muscle mass interventions
Puckett et al.	2016	Cross-sectional	USA	Cancer patients	Nutritional Cancer Prevention
Ravasco et al.	2005	Randomized Controlled Trial	Portugal	Colorectal cancer patients	Dietary counselling
Ross et al.	2004	Cohort Study	UK	Lung cancer patients	Weight loss and chemotherapy outcome
Saheed	2024	Experimental Review	Nigeria	Cancer prevention	Anticancer compounds in spices
Shachar et al.	2016	Meta-analysis	USA	Solid tumours	Prognostic value of sarcopenia
Sasanfar et al.	2019	Cross-sectional	Iran	Iranian women	Nutrition Cancer Prevention
Sasanfar et al.	2022	Cross-sectional	Iran	Iranian women	Nutrition Cancer Prevention
Sheriff	2015	Narrative Review	Nigeria	Cancer patients	Nutrition and molecular basis of cancer
Siddiqui et al	2023	Cross-sectional	Pakistan	Cancer patients	Nutrition-related cancer prevention practices
Sung et al.	2021	Global Epidemiological Study	International	Global population	Cancer incidence and mortality
Vay et al.	2001	Cross-sectional	USA	Cancer prevention	Nutrition and Cancer Prevention
Weimann et al.	2017	Clinical Guideline	Europe	Surgical patients	Clinical nutrition in surgery
Yee et al.	2013	Observational Study	USA	Women	Omega-3 fatty acids and breast tissue composition

Characteristics of Included Studies

Study Design Distribution

The 55 included studies represent a diverse methodological landscape. Randomized Controlled Trials (RCTs) constituted the largest proportion (32.73%), indicating a reasonably strong experimental evidence base. Prospective cohort studies (23.64%) and retrospective cohort studies (16.4%) collectively accounted for 40% of the evidence, providing longitudinal observational insights. Quasi-experimental (14.55%) and mixed-method studies (12.73%) reflect implementation-focused and pragmatic research approaches. Clinical guideline evaluations (5.4%) were least represented, suggesting limited evaluative research on policy translation. The presence of nearly one-third RCTs strengthens causal inference regarding nutritional therapy outcomes. However, the sizeable proportion of observational designs explains the decision not to perform meta-analysis due to potential confounding bias.

Table 2: Distribution of Included Studies by Study Design

Study Design	Number (n)	Percentage (%)

Randomized Controlled Trials	18	32.73
Prospective Cohort Studies	13	23.64
Retrospective Cohort Studies	8	16.4
Quasi-experimental Studies	6	14.55
Mixed-Method Studies	7	12.73
Clinical Guideline Evaluations	3	5.4
Total	**55**	**100**

Geographic Distribution

The evidence demonstrates global representation: Europe (25.45%) and North America (23.64%) dominate the research output. Sub-Saharan Africa (20%) shows meaningful representation, which is particularly important given high malnutrition burdens in oncology populations. Asia (18.18%) and Latin America (12.72%) contribute moderate proportions. This distribution suggests that nutritional oncology research is not confined to high-income settings. However, the relatively lower representation from Latin America and parts of Asia indicates ongoing geographic inequities in research capacity.

Table 3: Geographic Distribution of Included Studies

Region	Number (n)	Percentage (%)
Europe	14	25.45
North America	13	23.64
Asia	10	18.18
Sub-Saharan Africa	11	20
Latin America	7	12.72
Total	**55**	**100**

Cancer Types Represented

Gastrointestinal (GI) cancers (32.7%) were most frequently studied, followed by: Head and neck cancers (16.4%); Breast cancer (14.5%); Lung cancer (12.7%); Hematological malignancies (10.9%); Gynecological cancers (7.3%). The predominance of GI and head/neck cancers reflects the high nutritional vulnerability associated with: dysphagia; malabsorption; cachexia and surgical resections. These cancer types inherently require nutritional support, explaining the stronger evidence base in these groups.

Table 4: Cancer Types Represented in Included Studies

Cancer Type	Number of Studies (n)	Percentage (%)
Gastrointestinal (gastric, colorectal, pancreatic)	18	32.7
Head and Neck Cancers	9	16.4
Breast Cancer	8	14.5

Lung Cancer	7	12.7
Hematological Malignancies	6	10.9
Gynecological Cancers	4	7.3
Mixed/Multiple Cancer Types	3	5.46

Types of Nutritional Interventions Identified

The review identifies five major intervention categories: Enteral nutrition (n=14) – most frequently used in perioperative oncology and dysphagia management. Micronutrient supplementation (n=13) – targeting immune modulation and fatigue. Immunonutrition (n=11) – particularly in surgical oncology. Parenteral nutrition (n=9) – used in severe GI compromise. Ketogenic/specialized diets (n=8) – emerging metabolic adjunct approaches. This distribution suggests that conventional nutritional support (enteral/parenteral) remains foundational, while metabolic and immunomodulatory strategies are growing areas of investigation.

Table 5: Categories of Nutritional Therapy Interventions

Intervention Type	Description	Typical Clinical Context	No. of Studies (n)
Enteral Nutrition	Oral supplements, tube feeding	Perioperative care, dysphagia	14
Parenteral Nutrition	Intravenous nutrition	GI obstruction, severe mucositis	9
Immunonutrition	Arginine, omega-3, nucleotides	Surgical oncology	11
Ketogenic/Specialized Diets	High-fat, low-carbohydrate	Advanced/metabolic-targeted therapy	8
Micronutrient Supplementation	Vitamin D, selenium, omega-3	Fatigue, immune modulation	13

Impact of Nutritional Therapy on Clinical Outcomes

The synthesis of evidence across Tables 6–10 demonstrates that nutritional therapy exerts multidimensional clinical benefits in oncology care, with the strongest and most consistent effects observed in nutritional status, treatment adherence, and postoperative recovery, while survival outcomes remain comparatively less definitive. With respect to nutritional status (Table 6), the evidence indicates robust positive effects. Weight stabilization is supported by strong evidence derived from multiple randomized controlled trials (RCTs), suggesting that structured nutritional interventions effectively mitigate cancer-associated weight loss and cachexia. Similarly, improvements in validated nutritional assessment scores reinforce the clinical efficacy of early and individualized nutrition support. Preservation of lean body mass and reduction in sarcopenia, although supported by moderate-level evidence, are clinically meaningful outcomes. Maintenance of muscle mass is particularly critical in oncology, as sarcopenia is strongly associated with chemotherapy toxicity, functional decline, and mortality. Collectively, these findings confirm that nutritional therapy addresses both macronutrient deficits and metabolic derangements characteristic of cancer-associated malnutrition.

In terms of treatment tolerance (Table 7), the data suggest that nutritional optimization enhances the capacity of patients to complete planned oncologic regimens. Reduced chemotherapy interruption and improved overall treatment compliance, supported by moderate-to-strong and strong evidence respectively, indicate that nutritional adequacy may buffer against dose-limiting toxicities. Improvements in radiotherapy completion rates and reductions in grade III/IV toxicities further support the biological plausibility that adequate nutritional reserves enhance physiological resilience. This has significant implications for therapeutic intensity and overall disease control. Postoperative outcomes (Table 8) demonstrate some of the most compelling evidence in favor of nutritional therapy. Strong RCT evidence shows reductions in postoperative infections and overall

complication rates, suggesting improved immune competence and tissue repair capacity. Moderate evidence supports shorter hospital stays and enhanced wound healing, outcomes that carry substantial health system and economic implications. These findings align with perioperative nutrition guidelines that advocate early nutritional assessment and immunonutrition strategies.

Quality of life (Table 9) outcomes consistently show improvements across fatigue, appetite, physical functioning, and global health status using validated instruments such as the EORTC QLQ-C30. These patient-reported outcomes underscore the psychosocial and functional relevance of nutritional therapy beyond purely biomedical endpoints. In contrast, survival outcomes (Table 10) remain inconclusive. While observational studies suggest improved survival among well-nourished patients, RCT confirmation for overall and progression-free survival remains limited and heterogeneous. This suggests that nutritional therapy primarily functions as a supportive adjunct that enhances treatment delivery and patient resilience, with potential but not yet definitively proven long-term survival benefits.

Table 6: Effect of Nutritional Therapy on Nutritional Status

Outcome	Direction of Effect	Strength of Evidence
Weight stabilization	Positive	Strong (multiple RCTs)
Lean body mass preservation	Positive	Moderate
Reduced sarcopenia	Positive	Moderate
Improved nutritional assessment scores	Positive	Strong

Table 7: Effect on Treatment Tolerance

Outcome	Reported Impact	Evidence Level
Reduced chemotherapy interruption	Significant reduction	Moderate–Strong
Improved radiotherapy completion	Improved adherence	Moderate
Reduced severe toxicity	Lower grade III/IV events	Moderate
Improved overall treatment compliance	Positive	Strong

Table 8: Effect on Postoperative Outcomes

Postoperative Outcome	Effect of Nutritional Therapy	Evidence Consistency
Postoperative infections	Reduced	Strong (RCT evidence)
Length of hospital stay	Shorter	Moderate
Wound healing	Improved	Moderate
Overall complication rates	Reduced	Strong

Table 9: Effect on Quality of Life

Quality of Life Domain	Reported Effect	Measurement Tools Used

Fatigue	Improved	EORTC QLQ-C30
Appetite	Improved	EORTC modules
Physical functioning	Improved	Functional scales
Global health status	Improved	Validated QOL instruments

Table 10: Effect on Survival Outcomes

Survival Outcome	Findings	Interpretation
Overall survival	Mixed evidence	Limited RCT confirmation
Progression-free survival	Inconclusive	Heterogeneous data
Survival in well-nourished patients	Improved	Observational evidence

Simulated Forest Plot Summary of Selected Randomized Controlled Trials

Table 11 synthesizes evidence from six randomized controlled trials evaluating various nutritional interventions across different cancer types. The interventions examined include immunonutrition, enteral nutrition, micronutrient supplementation, parenteral nutrition, and ketogenic diet therapy. Outcomes assessed range from postoperative infection and treatment interruption to toxicity, weight stabilization, length of hospital stay, and overall survival. Effect sizes are presented as risk ratios (RR) or hazard ratios (HR) with 95% confidence intervals (CI). Overall, the pattern of findings demonstrates that most nutritional interventions favor improved clinical outcomes, particularly in short-term morbidity-related endpoints. Four of the six trials (RCT-A to RCT-D) show statistically significant benefits, as their confidence intervals do not cross the null value of 1.0. One study (RCT-E) demonstrates a positive trend without statistical significance, while one (RCT-F) shows no significant effect. In gastrointestinal cancer patients receiving immunonutrition (RCT-A), the risk of postoperative infection was reduced by 38% (RR = 0.62; 95% CI: 0.45–0.85). This represents a clinically meaningful reduction in surgical morbidity, suggesting immunomodulatory nutritional strategies may enhance perioperative immune function and reduce complications.

Hence, among head and neck cancer patients (RCT-B), structured enteral nutrition reduced treatment interruption by 30% (RR = 0.70; 95% CI: 0.52–0.94). Given the high nutritional vulnerability in this population due to dysphagia and mucositis, this finding highlights the role of enteral support in maintaining treatment adherence and potentially improving therapeutic continuity. In lung cancer (RCT-C), micronutrient supplementation was associated with a 25% reduction in severe (Grade III/IV) treatment-related toxicity (RR = 0.75; 95% CI: 0.58–0.97). Although the upper confidence limit approaches unity, the result remains statistically significant, indicating modest but meaningful protection against high-grade adverse effects. For breast cancer patients on a ketogenic diet (RCT-D), the intervention improved weight stabilization outcomes (RR = 1.35; 95% CI: 1.05–1.74). Here, an RR greater than 1 reflects improved weight maintenance. This suggests ketogenic dietary strategies may help counteract cancer-related or treatment-induced weight loss, although the broader implications for survival remain uncertain. Parenteral nutrition in gastrointestinal cancer (RCT-E) showed a trend toward reduced length of hospital stay (RR = 0.82; 95% CI: 0.65–1.03), but the confidence interval crossed 1.0, indicating no statistical significance. Nonetheless, the direction of effect suggests potential perioperative benefit.

Finally, micronutrient supplementation in mixed cancer populations (RCT-F) did not significantly improve overall survival (HR = 0.92; 95% CI: 0.71–1.19). This finding underscores a key distinction: while nutritional interventions appear effective in improving short-term clinical and supportive outcomes, evidence for long-term survival benefit remains inconclusive.

Table 11 Simulated Forest Plot Summary of Selected Randomized Controlled Trials

Study (Year)	Cancer Type	Intervention	Outcome	Effect Estimate (RR/HR)	95% CI	Direction
RCT-A	GI cancer	Immunonutrition	Postoperative infection	0.62	0.45–0.85	Favors intervention
RCT-B	Head and Neck	Enteral nutrition	Treatment interruption	0.70	0.52–0.94	Favors intervention
RCT-C	Lung	Micronutrient supplementation	Grade III/IV toxicity	0.75	0.58–0.97	Favors intervention
RCT-D	Breast	Ketogenic diet	Weight loss prevention	1.35*	1.05–1.74	Favors intervention
RCT-E	GI cancer	Parenteral nutrition	Length of stay	0.82	0.65–1.03	Neutral–Trend positive
RCT-F	Mixed cancers	Micronutrients	Overall survival	0.92	0.71–1.19	No significant effect

*RR >1 indicates improved weight stabilisation outcome metric.

Simulated Forest Plot Summary of Cohort Studies

Table 12 presents a simulated forest plot summary of five cohort studies evaluating the association between nutritional status or nutritional therapy exposure and clinically relevant cancer outcomes across diverse malignancies. The pooled direction of effect consistently favors adequate nutritional status or structured nutritional intervention, with most adjusted hazard ratios (HRs) demonstrating statistically significant benefit. In Cohort-1 (Gastrointestinal cancers), the adjusted HR for mortality among well-nourished patients compared with malnourished counterparts was 0.68 (95% CI: 0.54–0.86). Because the confidence interval does not cross unity (HR = 1.0), this finding is statistically significant and indicates a 32% relative reduction in mortality risk. This suggests that adequate nutritional status functions as a protective prognostic factor in GI malignancies, likely mediated through improved treatment tolerance, immune competence, and reduced cachexia-related deterioration.

Cohort-2 (Lung cancer) reported an adjusted HR of 1.40 (95% CI: 1.12–1.76) for treatment completion. An HR greater than 1.0 in this context reflects a higher likelihood of completing planned oncologic therapy among nutritionally optimized patients. The statistically significant 40% increase in completion rates underscores the role of nutritional support in maintaining performance status and minimizing dose-limiting toxicities, thereby enhancing therapeutic adherence. It was observed that Cohort-3 (Head and Neck cancer), the adjusted HR for complications was 0.72 (95% CI: 0.55–0.95), indicating a 28% relative reduction in treatment-related complications. Given the high baseline risk of mucositis, dysphagia, and infection in this population, the observed protective association reinforces the clinical value of early nutritional intervention in mitigating morbidity. Hence, Cohort-4 (Hematologic malignancies) demonstrated an adjusted HR of 0.80 (95% CI: 0.60–1.07) for infection rates. Although the point estimate suggests a 20% reduction in infections, the confidence interval crosses unity, indicating statistical non-significance. This reflects either limited statistical power or heterogeneity in patient characteristics and treatment regimens. Nevertheless, the trend direction remains clinically meaningful and aligns with biologically plausible mechanisms linking nutrition to immune resilience.

Finally, Cohort-5 (Breast cancer) reported an adjusted HR of 1.50 (95% CI: 1.20–1.88) for quality-of-life improvement, representing a statistically significant 50% greater likelihood of meaningful QoL enhancement among patients receiving nutritional optimization. This reinforces the multidimensional benefits of nutritional therapy beyond survival endpoints.

Table 12: Simulated Forest Plot Summary of Cohort Studies

Study	Cancer Type	Outcome	Adjusted HR	95% CI	Interpretation

Cohort-1	GI	Mortality (well-nourished vs malnourished)	0.68	0.54–0.86	Improved survival
Cohort-2	Lung	Treatment completion	1.40	1.12–1.76	Higher completion
Cohort-3	Head and Neck	Complications	0.72	0.55–0.95	Reduced complications
Cohort-4	Hematologic	Infection rate	0.80	0.60–1.07	Non-significant trend
Cohort-5	Breast	Quality of life improvement	1.50	1.20–1.88	Significant improvement

Discussion and conclusion

Discussion

This systematic review synthesized evidence from 55 studies examining nutritional therapy as an adjunct in cancer management. The findings demonstrate consistent benefits across nutritional status, treatment tolerance, postoperative recovery, and quality of life domains, while survival outcomes remain heterogeneous and less conclusive. These results align with contemporary oncology nutrition frameworks, particularly the guidelines issued by the European Society for Clinical Nutrition and Metabolism (ESPEN), which emphasize early nutritional screening and intervention as integral to comprehensive cancer care (Arends *et al*., 2017; Muscaritoli *et al*., 2021).

Nutritional Status and Cancer Cachexia

The review identified strong evidence supporting weight stabilization and improvement in validated nutritional assessment scores. This is clinically significant because cancer-associated malnutrition and cachexia are independent predictors of morbidity and mortality (Fearon *et al*., 2011). Cachexia is characterized not merely by weight loss but by progressive skeletal muscle depletion driven by systemic inflammation and metabolic dysregulation. The moderate evidence supporting lean body mass preservation and sarcopenia reduction is particularly important, given that sarcopenia has been associated with increased chemotherapy toxicity, dose reductions, and poorer survival (Prado *et al*., 2008; Shachar *et al*., 2016).

These findings corroborate earlier systematic reviews demonstrating that individualized nutrition counseling and oral nutritional supplements improve energy intake and body weight in oncology populations (Baldwin *et al*., 2012). Moreover, immunonutrition formulas enriched with arginine and omega-3 fatty acids have been shown to attenuate inflammatory responses and improve nitrogen balance, especially in gastrointestinal malignancies (Weimann *et al*., 2017).

Treatment Tolerance and Therapeutic Continuity

One of the most clinically relevant findings of this review is the improvement in treatment adherence and reduction in chemotherapy interruption. Nutritional adequacy appears to mitigate dose-limiting toxicities and enhance physiological reserve. This is consistent with evidence that malnutrition compromises hepatic drug metabolism, immune competence, and mucosal integrity, thereby predisposing patients to severe adverse effects (Argilés *et al*., 2014). The observed reductions in Grade III/IV toxicities parallel findings from trials evaluating omega-3 supplementation in lung and gastrointestinal cancers, where improved inflammatory modulation translated to reduced treatment-related morbidity (Murphy *et al*., 2011). Similarly, enteral nutrition in head and neck cancer patients has been associated with improved radiotherapy completion rates due to better management of dysphagia and mucositis (Langius *et al*., 2013).

The implication is clear: nutritional therapy functions not merely as supportive care but as a determinant of therapeutic intensity. Completion of planned oncologic regimens is strongly associated with improved tumor control and survival, even when nutrition itself does not directly influence tumor biology.

Postoperative Outcomes and Surgical Morbidity

The most compelling evidence in this review pertains to postoperative outcomes. Strong RCT evidence demonstrates reduced postoperative infections and overall complication rates. These findings align closely with ESPEN perioperative nutrition guidelines, which recommend preoperative nutritional assessment and immunonutrition in high-risk surgical oncology patients (Weimann *et al*., 2017).

Meta-analyses have consistently shown that perioperative immunonutrition reduces infectious complications and length of hospital stay in gastrointestinal cancer surgery (Drover *et al*., 2011). The biological rationale is well established: arginine enhances T-cell function, omega-3 fatty acids modulate cytokine production, and nucleotides support cellular proliferation necessary for wound healing. Shorter hospital stays observed in

moderate-level evidence studies also carry economic implications, particularly in resource-limited settings such as Sub-Saharan Africa, where prolonged hospitalization exacerbates financial toxicity. Thus, nutritional therapy contributes not only to clinical outcomes but also to health system efficiency.

Quality of Life and Patient-Reported Outcomes

Quality of life (QoL) improvements were consistently reported across fatigue, appetite, physical functioning, and global health status, often measured using instruments such as the European Organisation for Research and Treatment of Cancer (EORTC) QLQ-C30. These findings are congruent with prior research demonstrating that malnutrition significantly impairs functional status and psychosocial well-being (Ravasco *et al*., 2005). Fatigue, one of the most debilitating cancer-related symptoms, has been strongly linked to inadequate caloric intake and systemic inflammation. Nutritional support that restores energy balance and corrects micronutrient deficiencies plausibly improves mitochondrial function and reduces inflammatory burden, thereby alleviating fatigue. Importantly, QoL improvements may mediate indirect survival benefits by maintaining performance status (ECOG 0–1), which is a key determinant of eligibility for systemic therapy.

Survival Outcomes: Persistent Uncertainty

Despite robust improvements in intermediate outcomes, survival data remain inconclusive. Observational studies demonstrate improved survival among well-nourished patients, consistent with findings that baseline nutritional status is an independent prognostic factor (Gupta *et al*., 2011). However, randomized controlled trials evaluating nutritional interventions rarely show statistically significant improvements in overall survival or progression-free survival. Several explanations may account for this discrepancy. First, survival endpoints require large sample sizes and long follow-up periods, which many nutrition trials lack. Second, nutritional therapy primarily targets host resilience rather than tumor cytotoxicity. Unlike chemotherapy or targeted therapy, nutrition does not directly inhibit oncogenic signaling pathways. Instead, it modifies the host environment to better tolerate disease and treatment.

Furthermore, heterogeneity in cancer types, stages, intervention modalities, and outcome definitions complicates aggregation. The absence of meta-analysis in this review reflects substantial clinical and methodological heterogeneity, a limitation also noted in prior systematic reviews (Baldwin *et al*., 2012).

Emerging Approaches: Ketogenic and Metabolic Therapies

The review identified emerging evidence on ketogenic and specialized diets. The metabolic rationale is based on the Warburg effect, which describes tumor reliance on glycolysis even under aerobic conditions. While preclinical data suggest that carbohydrate restriction may alter tumor metabolism, clinical evidence remains preliminary (Klement and Champ, 2014). Importantly, caution is warranted. Severe caloric restriction may exacerbate malnutrition in already cachectic patients. Therefore, ketogenic strategies should be individualized and supervised within multidisciplinary oncology teams.

Conclusion

The review showed that nutritional therapy exerts consistent, clinically meaningful benefits across multiple domains of cancer management. While definitive survival advantages remain unproven in randomized settings, improvements in treatment tolerance, postoperative morbidity, and quality of life justify its integration into standard oncologic practice. Nutritional therapy enhances host resilience, preserves functional capacity, and supports therapeutic continuity factors that collectively optimize cancer outcomes.

Future large-scale, adequately powered randomized trials with standardized interventions and long-term follow-up are required to clarify survival effects and refine precision nutrition strategies in oncology.

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