Dietary Measures as an Adjunct to Cancer Treatment

Let food be thy medicine?

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Cancer is characterised by the unchecked proliferation of abnormal cells. In 2020 alone, cancer affected 19.3 million people globally and caused nearly 10 million deaths. Despite progress in surgery, chemotherapy and immunotherapy, long-term survival remains poor.[1]

There is growing interest among healthcare professionals and patients about whether diet can serve as an adjunct or even primary cancer treatment.[2] The idea of gaining personal control over their treatment is appealing, especially as cancer-beating diets gain popularity on social media. There are many examples of wellness influencers educating the masses about what foods feed cancer, and what foods kill cancer.[3] Unfortunately, this has led to patients being misled by deceptive claims.[4] Nutrition professionals must, therefore, serve as a voice of reason.

This article aims to critically evaluate the available research looking at dietary changes as an adjunct treatment for cancer, with a focus on human data.

The Warburg Effect, carbohydrates & cancer treatment

In the 1920s, Otto Warburg observed that tumour cells preferentially rely on glycolysis (converting glucose into lactate for fuel) – even in the presence of oxygen – a phenomenon now known as the Warburg Effect.[5] This high glucose uptake is what enables fluorodeoxyglucose-based positron emission tomography (PET) scans to detect tumour activity.[6]

Based on this, ketogenic diets – very low in carbohydrates – have been proposed to reduce glucose availability, limit glycolysis and starve cancer cells.[6] However, human evidence is severely limited and has mixed results.[7] Dietary randomised controlled trials are notoriously difficult to do, and adherence to a ketogenic diet presents a major barrier.[8]

Research in rodents has found beneficial effects of a ketogenic diet on cancer progression in colorectal, gastric, prostate, head and neck, brain and thyroid cancers.[9, 10] Unfortunately, outcomes in animal cancer research often do not translate well in human trials.[11] Furthermore, not all rodent research has yielded positive results; some cancer types, such as melanomas, have been found to progress more rapidly in the context of a ketogenic diet.[10]

Challenging the idea that carbohydrate restriction will prevent cancer progression, cancer cells – and those in the surrounding tumour microenvironment, like cancer-associated fibroblasts – can undergo metabolic reprogramming, utilising whichever fuel source is more readily available.[2, 12] Furthermore, some cancers naturally favour oxidative phosphorylation over glycolysis, enabling the use of fatty acids and ketones as major energy sources. This includes certain types of lymphomas, melanomas, brain and breast cancers.[13] It is likely that the efficacy of a ketogenic diet will turn out to be dependent on whether the cancer cells in question express high or low levels of enzymes involved in converting ketone bodies to acetyl-CoA.[10] More research is needed to enable any clinical recommendations.[7]

Time-restricted eating in cancer treatment

Time-restricted eating (TRE) is a form of intermittent fasting that follows a rhythmic eating pattern that limits eating hours to a set window on a daily, or near-daily, basis.[14] In TRE, the eating window is frequently set between 6 and 12 hours. Following at least 12 hours of fasting, hepatic glycogen stores become significantly depleted, instigating a 'metabolic switch' within the body from the use of predominantly carbohydrates to predominantly fats as an energy source.[15] This alteration in metabolism is thought to fight against cancer progression by:[16, 17]

1. Triggering a state of *differential stress resistance*, where healthy cells shield themselves from chemotherapy-induced damage under nutrient scarcity, while cancer cells become more susceptible due to their high growth demands.
2. Reducing levels of insulin-like growth factor 1 (IGF-1), insulin and glucose, creating a less favourable environment for tumour growth.
3. Boosting autophagy and apoptosis in cancer cells.

A recent phase I/II study explored TRE as an adjunct to immunotherapy (Pembrolizumab) in 43 metastatic head and neck cancer patients.[18] TRE, involving a 14-hour nightly fast without calorie reduction, was safe and well-tolerated. Patients practicing TRE had significantly improved disease control rates at 3 and 6 months (85% and 64%, respectively) compared to controls (50% and 39%, respectively). The authors concluded that TRE represents an attractive and safe strategy to improve treatment responses in immunotherapy, with further exploration required in phase III expansion studies.

The most recent systematic review investigating the effect of TRE on cancer outcomes in humans was unable to draw any firm conclusions due to heterogeneity among the study populations, exact TRE regimens and outcomes measures.[14] Further research in humans is required to fully elucidate the effects of fasting on cancer.

Dietary fibre, the gut microbiota & cancer treatment

The human intestinal microbiota, commonly referred to as the gut microbiota, comprises trillions of bacterial cells that coexist symbiotically with the host.[19] The gastrointestinal tract, which harbours approximately 60–80% of the body's immune cells, also functions as one of the largest immune organs.[20]

Cancer itself, as well as cancer treatments, can cause gut dysbiosis – an imbalance in microbial composition in the gut.[21] Yet, a growing body of evidence supports the crucial role that the gut microbiota plays in tumour progression, maturation and therapy response.[20]

It is well understood that diet is a key modifiable factor influencing the composition of the gut microbiota.[22] Many types of dietary fibre, such as inulin, fructooligosaccharides and galactooligosaccharides, have prebiotic qualities, meaning that they function as a carbon source for the growth of beneficial gut bacteria within the colon.[23] Prebiotic fibres are known for their rapid fermentative capacity and subsequent release of short-chain fatty acids (SCFAs), such as acetate, propionate and butyrate, which are thought to have anti-inflammatory and anti-proliferative effects.[24]

A prospective cohort study involving 1,575 colorectal cancer (CRC) patients found that higher total fibre intake after diagnosis was linked to lower CRC-specific and all-cause mortality.[25] Specifically, each 5 g/day increase in fibre intake was associated with a 22% reduction in CRC-specific mortality and a 14% reduction in all-cause mortality. The study also highlighted that cereal fibre, in particular, was associated with a significant decrease in CRC-specific mortality. Meta-analysis of the available data on this topic supports that a high dietary fibre intake (~22 g/day) improves CRC survival, whilst highlighting that the evidence base relies on limited observational data only.[26]

Immune checkpoint inhibitors, such as Pembrolizumab, are increasingly being used as immunotherapy treatment for patients with cancer, having revolutionised cancer therapy.[27] A landmark study by Spencer *et al*.[28] assessed faecal microbiota profiles, dietary habits and probiotic usage in melanoma patients on immune checkpoint inhibitors and performed parallel preclinical studies. Higher dietary fibre intake (>20 g/day) was associated with significantly improved progression-free survival in 128 patients, with a 30% decrease in the risk of progression or death for every 5 g of fibre intake. Notably, the greatest benefit was seen in those avoiding probiotic supplements. This same result was replicated in preclinical studies. The authors concluded that these findings, supported by preclinical data, highlight the potential of dietary changes to safely enhance immunotherapy outcomes.

Chemotherapy-induced diarrhoea affects 50–80% of cancer patients, often leading to hospitalisation, treatment delays, and poorer outcomes.[29] Common culprits include topoisomerase I inhibitors (irinotecan, topotecan), fluoropyrimidines (e.g. 5-FU, capecitabine), and agents like cisplatin, docetaxel, oxaliplatin and cytarabine. Limited human studies suggest that probiotics – food or supplements that contain live microorganisms intended to maintain or improve the gut microbiota – may enhance chemotherapy efficacy and reduce gut dysbiosis, mucositis and diarrhoea.[30] Overall, results are promising and mostly corroborate the idea that probiotics could be a safe, practical and an inexpensive method to shield patients from chemotherapy-induced diarrhoea.[29] More high-quality research is required to fundamentally determine the optimal strains, doses and contexts for use.[31]

Is any dietary approach well-evidenced in cancer?

A systematic review of randomised controlled trials recently found no convincing evidence that any diet can influence cancer progression in humans, with no large, robust randomised studies demonstrating this and smaller studies producing conflicting results.[7] The authors of this review conclude by stating that the benefits of dietary interventions on clinical endpoints in cancer remain largely untested.

While the current research on diet as a cancer therapy remains limited but promising, one clear and critical message for cancer patients is to avoid malnutrition at all costs. The detrimental impact of malnutrition on cancer survival, quality of life and treatment outcomes is far more robustly supported by scientific evidence than any specific dietary intervention.[32] Time-restricted eating and (especially) a ketogenic diet are both risk factors for weight loss, given their restrictive nature. The theoretical benefits of these diets should be balanced carefully with the known consequences of weight loss whilst on cancer treatment. See **Table 1** (next page) for a comparison of dietary interventions for adjunct cancer therapy.

Conclusion

In conclusion, while interest in dietary approaches to support cancer treatment is rapidly growing, the current evidence base in humans remains limited, mixed and largely observational. Promising areas such as ketogenic diets, time-restricted eating, probiotics and fibre-mediated microbiome modulation warrant further investigation but cannot yet be recommended as standard adjunct therapies. What remains unequivocally clear, however, is the critical importance of preventing malnutrition in cancer care. Nutrition professionals can play a key role in helping cancer patients safely navigate the often-confusing landscape of cancer nutrition.

Table 1: Comparison of dietary interventions for adjunct cancer therapy

Intervention	Mechanism/ proposed Action	Evidence in humans	Risks/considerations	Clinical takeaways
Ketogenic diet[6-13]	• ↓ glucose availability to cancer cells via carbohydrate restriction • Targets the Warburg Effect • May affect cancer cell metabolism based on oxidative phenotype	• Mixed and limited evidence in humans • Studies are likely to always be limited by dietary adherence	• Promotes weight loss, contraindicated in those at risk of malnutrition • May not be effective or could even worsen outcomes in cancers prioritising oxidative phosphorylation (e.g. certain lymphomas, melanomas)	• More human data needed before clinical recommendation • Efficacy may depend on cancer type and tumour metabolism profile
Time-restricted eating[14-17]	• ↑ autophagy and apoptosis • ↓ insulin, glucose, and IGF-1 levels • Differential stress resistance	• Systematic review: evidence too heterogeneous to draw firm conclusions • Some pilot studies suggest benefit	• Promotes weight loss, contraindicated in those at risk of malnutrition	• More human data needed before clinical recommendation
High fibre diet[21-27]	• Feeds beneficial gut microbiota → production of antiproliferative SCFAs (e.g. butyrate) • ↑ immune function • Microbiome modulation (reduced dysbiosis)	• Meta-analysis of cohort studies showed improved CRC-specific and all-cause mortality • >20 g/day associated with improved progression-free survival in melanoma on immunotherapy	• ↓ fibre may be necessary if intestinal obstruction/ stricture is present • Too high a fibre intake may restrict energy intake; caution warranted in malnourished patients	• Given the unlikelihood of any harm, a higher intake of dietary fibre (e.g. >20 g/day) could be suggested as a potential means of increasing survival for those with CRC or on immunotherapy, unless there are obvious contraindications to fibre intake (e.g. bowel obstruction) • More data needed before firm recommendations can be made
Probiotics[28-30]	• Regulation of gut microbiota, inhibiting colonisation and proliferation of pathogenic bacteria • Increased production of SCFAs	• Systematic review: predominantly positive results for reduced incidence of treatment side-effects, especially diarrhoea	• Small risk of probiotic-related infections in those who are neutropenic • Can themselves contribute to dysbiosis	• More human data needed before clinical recommendation

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