

Is There a Role for Carbohydrate Restriction in the Treatment and Prevention of Cancer?

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This article is 16 pages long with 162 references.

FROM ABSTRACT:

Over the last years, evidence has accumulated suggesting that by systematically reducing the amount of dietary carbohydrates (CHOs) one could suppress, or at least delay, the emergence of cancer, and that proliferation of already existing tumor cells could be slowed down.

CHOs or glucose can have direct and indirect effects on tumor cell proliferation:

- 1) Contrary to normal cells, malignant cells depend on steady glucose availability in the blood for their energy and biomass generating demands and are not able to metabolize significant amounts of fatty acids or ketone bodies due to mitochondrial dysfunction.
- 2) High insulin and insulin-like growth factor (IGF)-1 levels resulting from chronic ingestion of CHO-rich Western diet meals, can directly promote tumor cell proliferation via the insulin/IGF1 signaling pathway.
- 3) Ketone bodies that are elevated when insulin and blood glucose levels are low, have been found to negatively affect proliferation of different malignant cells in vitro or not to be usable by tumor cells for metabolic demands, and a multitude of models have shown anti-tumorigenic properties of very low CHO ketogenic diets.

Many cancer patients have altered glucose metabolism characterized by insulin resistance and may profit from an increased protein and fat intake.

In this review, we address the possible beneficial effects of low CHO diets on cancer prevention and treatment. Emphasis will be placed on the role of insulin and IGF1 signaling in tumorigenesis as well as altered dietary needs of cancer patients.

KEY POINTS FROM AUTHORS:

- 1) Cancer is "very rare among uncivilized hunter-gatherer societies."
- 2) Lifestyle factors that protect our genome against tumorigenesis were selected when humans lived as hunter-gatherers.
- 3) For more than 99% of time humans were hunter-gatherers; humans have done agriculture for less than 1% of human history.

- 4) "The switch from the 'caveman's diet' consisting of fat, meat and only occasionally roots, berries and other sources of carbohydrate (CHO) to a nutrition dominated by easily digestible CHOs derived mainly from grains as staple food would have occurred too recently to induce major adoptions in our genes encoding the metabolic pathways."
- 5) An increase in the consumption of easily digestible CHOs with high glycemic indices (GIs) leads to diseases of civilization that are strongly associated with the so-called Western way of life. **[Key Point]**
- 7) There is compelling evidence for the beneficial roles of regular physical activity and sufficient vitamin D in the prevention and treatment of cancer.
- 8) Data from 229 hunter-gatherer societies indicates that they have a strong reliance on animal foods [meat] and for low GI plant foods such as vegetables, fruits, seeds and nuts.
- 9) "The amount and type of carbohydrates in the typical western diet differ markedly from the ones that our genes adapted to."
- 10) The carbohydrate consumption in modern hunter-gatherers is "markedly lower than in Westernized societies."
- 11) "High CHO intake, in particular in the form of sugar and other high GI foods, has been linked to modern diseases like metabolic syndrome, Alzheimer's disease, cataracts, and macular degeneration and gout."
- 12) "Lowering the amount of CHOs in the diet can have direct beneficial effects on the prevention and treatment of malignant diseases."
- 13) It has been known for nearly a century that there "exists an intimate connection between CHOs and cancer."
- In those who developed cancer, glucose secretion in the urine disappears [suggesting the glucose is feeding the cancer cells].
 - Cultured cancer tissue consumes much higher glucose than healthy tissue.
- 14) The proliferation of aggressive tumors proceeds too fast for concurrent vascularization, so that hypoxic regions will develop. These cancer cells compensate by using most of CHOs to develop ATP energy through anaerobic glycolysis. [Without these CHOs the aggressive cancer cells would not have adequate ATP energy and they could not proliferate].
- 15) Cancerous tumor cells have the ability to grow in hypoxic environments by using glycolysis, which requires a lot of glucose because glycolysis only generates 2 ATP molecules per glucose.

- 16) High anaerobic glycolysis activity produces high levels of lactate (lactic acid) and H⁺ ions which directly promote tumor aggressiveness through invasion and metastasis, two hallmarks of cancer.
- 17) Cancer cells are addicted to ATP energy derived from glycolysis. When malignant cells are starved of glucose, they quickly lose ATP and commit apoptosis.
- 18) A caloric restricted diet significantly prolongs survival in animals with cancer probably because of its reduction of glucose.
- 19) Hyperglycemia delivers more glucose to tumor cells.
- 20) Hyperglycemia is a predictor of poor survival in patients with various cancers.
- 21) Hyperglycemia is an increased risk for developing cancer of the pancreas, esophagus, liver, colon, rectum, stomach and prostate.
- 22) "Hyperglycemia activates monocytes and macrophages to produce inflammatory cytokines that play an important role also for the progression of cancer."
- 23) In one study, hyperglycemia was found in 70 out of 70 cancer patients.
- 24) "Even modest blood glucose elevations, as they typically occur after a Western diet meal, competitively impair the transport of ascorbic acid into immune cells," diminishing the immune response to malignant cells.
- 25) The typical Western diet consists of three meals a day (plus the occasional CHO-rich snacks and drinks), so that insulin levels are elevated most of the day, and insulin stimulates the release of the pro-inflammatory cytokine interleukin (IL)-6 from human adipocytes.
- 26) "A diet which repeatedly elevates blood glucose levels due to a high GL provides additional growth stimuli for neoplastic cells."
- 27) In colorectal, prostate and early stage breast cancer patients, high insulin levels have been associated with poor prognosis. "These findings again underline the importance of controlling blood sugar and hence insulin levels in cancer patients. Dietary restriction and/or a reduced CHO intake are straightforward strategies to achieve this goal." **[Key Point]**
- 28) Both diabetes and cancer share a common pathophysiological state: chronic inflammation and insulin resistance.
- 29) A ketogenic diet supplies ketone bodies that can be used to make ATP energy without using either glucose or insulin.

- 30) Most malignant cells lack the mitochondrial enzymes necessary for conversion of ketone bodies and fatty acids to ATP. Therefore, a high fat, ketogenic diet (KD) may continue to provide ATP for the body while starving the tumor.
- 31) The typical ketogenic diet is 80% calories from fat, 10% from protein and 10% from CHO. It has been successfully used to treat epilepsy and adiposity.
- 32) The best source of ketone bodies is medium chain triglycerides (MCTs), which are metabolized to yield high amounts of ketone bodies, thus reducing insulin and reducing tumor growth. **[Coconut Oil]**
- 33) There is much evidence indicating that cancer patients could benefit from a very low CHO ketogenic diet.
- 34) Using ketone bodies for energy may "help in cancer prevention through their ability to protect the mitochondria from inflammation and ROS."
- 35) The authors present evidence that the low CHO KD or caloric restricted diet worked best on tumor growth suppression if it began prior to the start of the cancer. [This suggests that we should all be on a low carbohydrate diet]
- 36) "A diet rich in corn oil might stimulate prostate cancer growth to a greater extent than one rich in saturated fat."
- 37) There are no human randomized controlled trials or prospective cohort studies that evaluate the effects of a KD on tumor growth and patient survival; there is only animal studies and anecdotal evidence.
- 38) Prevention of cancer is either the inhibition of carcinogenesis or the sufficient delay of tumor growth, so that it remains undetected and asymptomatic during a subject's lifespan. "There is evidence that even modest CHO restriction may influence both of these mechanisms positively."
- 39) There is evidence that high CHO diets, in particular those including high GI foods, promote the genesis of tumors "via the sustained action of insulin."
- 40) Inflammation is a well established driver of early cancer and accompanies most, if not all cancers. A low CHO diet inhibits the inflammatory process.
- 41) "Epidemiological and anthropological studies indicate that restricting dietary CHOs could be beneficial in decreasing cancer risk."
- 42) Chronic, "smoldering" inflammation can cause cancer. Chronic, "smoldering" inflammation is linked to chronic intake of easily digestible CHOs. "It can be hypothesized that a diet with a low GL positively affects cancer risk through reducing postprandial hyperglycemia and the associated inflammatory response."

- 43) "CHO restriction is not only limited to avoiding sugar and other high-GI foods, but also to a reduced intake of grains. Grains can induce inflammation in susceptible individuals due to their content of omega-6 fatty acids, lectins and gluten."
- 44) "Gluten might play a key role in the pathogenesis of auto-immune and inflammatory disorders and some malignant diseases."
- 45) "Paleolithic-type diets, that by definition exclude grain products, have been shown to improve glycemic control and cardiovascular risk factors more effectively than typically recommended low-fat diets rich in whole grains. These diets are not necessarily very low CHO diets, but focus on replacing high-GI modern foods with fruits and vegetables, in this way reducing the total GL. This brings us back to our initial perception of cancer as a disease of civilization that has been rare among hunter-gatherer societies until they adopted the Western lifestyle."
- 46) "Most, if not all, tumor cells have a high demand on glucose." Evidence exists that chronically elevated blood glucose and insulin levels "facilitate tumorigenesis and worsen the outcome in cancer patients."
- 47) High fat, low CHO diets improve the systemic inflammatory and metabolic alterations found in cancer patients. These diets are "safe and likely beneficial, in particular for advanced stage cancer patients."

COMMENTS FROM DAN MURPHY

This study reviews the evidence that the most healthy innate human diet is that of a hunter-gatherer. Refined carbohydrates and sugars should be avoided. Grains should be avoided because they are high in the carbohydrates that feed cancer cells and they are pro-inflammatory which increases the genesis of tumors. Consuming fats is healthy except for pro-inflammatory omega-6 fats. Saturated fats are much healthier than omega-6 fats. Coconut oil is a medium chain saturated that can generate ketone bodies which are used to make ATP energy without requiring glucose or insulin; this feeds the body while starving the tumor cells.