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The impact of sugar control on pancreatic cancer progression for the elderly: A case study and review of current evidence

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Abstract

Pancreatic cancer is a type of cancer that originates in the pancreas, an organ that aids in digestion and blood sugar regulation. It is characterized as an aggressive type of cancer that presents with symptoms that often go undetected. In 2024, there were an estimated 66,440 new cases of pancreatic cancer and an estimated 51,170 deaths from pancreatic cancer, with a 5-year relative survival rate of 12.8% (SEER, 2023). While traditional medical interventions such as surgery and chemotherapy continue to be the cornerstone of treatment, there is an emerging focus on the potential impact of dietary and nutritional factors in both preventing and managing pancreatic cancer. This approach is particularly relevant for elderly patients due to the heightened risk associated with surgery at their age and their reduced tolerance to chemotherapy regimens. This paper presents a compelling case study of a pancreatic cancer patient who adopted a sugar-restricted diet, resulting in a notable decrease in the tumor marker CA 19-9, which is commonly associated with pancreatic cancer. Building on this individual case study, this paper provides a comprehensive review of current scientific literature to examine the potential relationship between sugar consumption and pancreatic cancer development and progression. By examining this intersection of nutrition and oncology, this study aims to expound upon possible alternative or complementary approaches to pancreatic cancer management, especially for vulnerable populations such as the elderly. This research could lead to new strategies for improving outcomes and quality of life in pancreatic cancer care.

Keywords: Pancreatic cancer, Dietary modifications, Sugar reduction, Nutrition, Anti-inflammatory diet, Chemotherapy, Oncology nutrition

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1. Introduction

Cancer remains one of the leading causes of morbidity and mortality worldwide, prompting thorough research into both conventional and alternative treatment modalities. Traditional treatments such as surgery, chemotherapy, and radiation therapy have been the mainstays of cancer management. However, these treatments often come with significant side effects and limitations, particularly for elderly patients or those with comorbidities (Khan & Sievenpiper, 2016). As a result, there is growing interest in complementary approaches that can enhance the quality of life and potentially improve clinical outcomes for cancer patients.

Among these complementary approaches, dietary modifications have emerged as an area of research. Two dietary strategies that have garnered significant attention are no-sugar diets and anti-inflammatory diets. The rationale behind these diets is rooted in the understanding that sugar can fuel cancer cell growth and inflammation can contribute to cancer progression (Gillespie et al., 2023). A no-sugar diet aims to reduce or eliminate added sugars and refined carbohydrates from the diet, potentially starving cancer cells of a key energy source (Misra et al., 2016). An anti-inflammatory diet, however, focuses on incorporating foods that reduce inflammation and support the body's immune response. Nonetheless, the heterogeneity among cancer patients—such as differences in cancer types, stages, and individual responses to dietary changes—raises important considerations for applying these results universally and stresses the need for more research to adapt dietary advice to individual needs.

The potential benefits of these dietary interventions have been supported by various studies and patient testimonials, including the paper's case study of an elderly pancreatic cancer patient who adopted a sugar-restricted diet, resulting in a notable decrease in the tumor marker CA 19-9.

2. Case Study

Through the administration of a survey, an 85-year-old female non-smoker patient diagnosed with pancreatic cancer in April 2024 reported making substantial dietary and lifestyle modifications after diagnosis. The patient's Body Mass Index (BMI) was slightly overweight, but not obese. The dietary changes included reducing sugar intake except for low glycemic fruits. The patient avoided fruit juices and only ate whole fruits after eating protein and fats. In addition, ultra-processed foods and industrialized meats were avoided. The patient took several supplements and increased the consumption of alkaline-rich foods. The patient also reported lifestyle changes such as daily sunlight exposure, earlier sleep times, daily exercise, and mental practices such as prayer and gratitude. The patient reported a significant decrease in the tumor marker for Pancreatic Cancer - cancer antigen 19-9 (CA 19-9) - from 181 to 53 units per milliliter (U/mL) in just two weeks following these interventions. While this single case cannot establish causality, it suggests potential benefits of dietary and lifestyle modifications that warrant further investigation.

3. Literature Review

3.1. Sugar and Cancer Metabolism

Cancer cells exhibit altered metabolism compared to normal cells, a phenomenon known as the Warburg effect. This effect describes how cancer cells preferentially metabolize glucose through glycolysis, even in the presence of sufficient oxygen (Epner et al., 2022). This metabolic adaptation allows cancer cells to generate energy and biomass rapidly, supporting their uncontrolled growth and proliferation (Misra et al., 2016). Key signaling pathways involved include PI3K/Akt and AMPK, which are dysregulated in many cancers, promoting glucose uptake and utilization for sustained cell division and survival (Vecchia et al., 1993).

3.2 Epidemiological Evidence Linking Sugar and Cancer

Epidemiological studies have shown mixed results regarding the association between sugar intake and cancer risk. Some studies suggest that high sugar consumption, particularly from sugary beverages and refined carbohydrates, may increase the risk of certain cancers such as pancreatic cancer (Traverso, 2011). Mechanistically, high sugar intake can lead to insulin resistance and hyperinsulinemia, which are associated with increased cancer cell proliferation and survival (Epner et al., 2022).

3.3 Diabetes/High Sugar Increases the Risk for Pancreatic Cancer

Recent research has highlighted the connection between diabetes, elevated blood sugar levels, and the risk of pancreatic cancer. Multiple studies have provided compelling evidence for this association. One study revealed that for every 0.56 mmol/L (10 mg/dL) increase in fasting blood glucose, there is a corresponding 14% increase in pancreatic cancer incidence (Liao et al., 2015). This finding underscores the importance of blood sugar control in pancreatic cancer prevention. Another study strongly supports the notion that diabetes is associated with an increased risk of pancreatic cancer in both males and females (Ben et al., 2011). This study suggests that diabetes may serve as both an early manifestation and an etiologic factor for pancreatic cancer. However, it's important to note the limitation of potential reverse causality in this study. A multiethnic cohort study found that diabetes was associated with a more than twofold higher risk of pancreatic cancer in African Americans and Latinos. Notably, recent-onset diabetes was linked to a 2.3-fold greater increase in pancreatic cancer risk compared to long-standing diabetes (Setiawan et al., 2018). These findings support the hypothesis that recent-onset diabetes may be a manifestation of pancreatic cancer, while long-standing diabetes acts as a risk factor. Even individuals with diabetes-related complications have been shown to have an elevated risk of pancreatic cancer, further emphasizing the connection between these conditions (Farias et al., 2020). Overall, this body of evidence strongly suggests that diabetes is a significant risk factor for pancreatic cancer. However, the relationship is nuanced, with factors such as diabetes duration and onset playing crucial roles in determining the nature and extent of this association.

3.4 Diabetes and Pancreatic Cancer: Etiology

The potential direct etiological factors linking diabetes to pancreatic cancer include elevated insulin levels in the bloodstream, high blood sugar, and chronic inflammation associated with type 2 diabetes. Additionally, obesity serves as an indirect, independent risk factor for pancreatic cancer. Multiple studies have demonstrated that high glucose environments

promote pancreatic cancer cell proliferation (Sato et al., 2020). In vivo experiments in mice showed that hyperglycemia enhanced pancreatic cancer cells. A complementary study demonstrated that high glucose promoted pancreatic cancer cells to escape from immune surveillance (Duan et al., 2019). This suggests hyperglycemia contributes to creating conditions favorable for cancer progression.

Cancer cells exhibit a unique metabolic behavior called the Warburg effect. It describes how cancer cells consume and process glucose differently compared to normal healthy cells. During normal cell metabolism, healthy cells typically break down glucose completely using oxygen to produce energy efficiently. During cancer cell metabolism, or the Warburg effect, even when oxygen is available, cancer cells prefer to break down glucose only partially through glycolysis, which results in less energy being produced and becomes less efficient. As a result, cancer cells consume much more glucose than normal cells to meet their energy needs (Vaupel & Multhoff, 2021). The Warburg effect further supports the idea that a high sugar environment, necessary for the inefficient metabolism of cancer cells, is essential for their proliferation.

Elevated levels of insulin, which occur in response to high blood glucose, create a favorable environment for pancreatic cancer development and progression. Recent research demonstrates that excessive insulin levels overstimulate pancreatic acinar cells, which produce digestive juices. This overstimulation leads to inflammation that converts these cells into precancerous cells (Zhang et al., 2023).

3.5. A Carbohydrate and Sugar Elimination Diet to Eliminate Pancreatic Cancer Will Not Work

Glucose is a primary metabolic fuel for most cells in the body. It is essential for energy production through processes like glycolysis, which generate ATP, the energy currency of the cell. Cells take up glucose via specific transporters, and its utilization is regulated by insulin. Once inside the cell, glucose can be used for energy or stored as glycogen. This process is crucial for cells that divide rapidly, such as cancer cells, which often show increased glucose uptake and metabolism. This is true for both healthy and cancerous cells.

Eliminating all carbohydrates and sugars from the diet will not work since the body will find a way to produce glucose from other sources. When carbohydrate intake is low, the body can produce glucose from non-carbohydrate sources through gluconeogenesis. This process primarily occurs in the liver and involves the conversion of amino acids and glycerol into glucose (Nakrani et al., 2023).

Furthermore, in cancer patients, metabolic alterations can lead to cachexia, a condition characterized by the breakdown of body fat and lean muscle mass to provide energy. This catabolic state is driven by the high energy demands of both cancerous and healthy cells, irrespective of dietary sugar intake (Porporato, 2016).

3.6. A Carbohydrate and Sugar Elimination Diet to Eliminate Pancreatic Cancer Will Not Work

There are several types of sugars that can be classified into two main categories:

- Simple sugars (monosaccharides):

- Glucose: The most common form of sugar found in plants and the primary fuel source for our bodies.
- Fructose: Naturally found in fruits, honey, and some vegetables. It's the sweetest of all naturally occurring sugars.
- Galactose: Mainly found in peas and is a component of lactose.

- Compound sugars (disaccharides):
  - Sucrose: Also known as table sugar, it's made of one part glucose and one part fructose. It's naturally found in plants and commercially produced from sugarcane or sugar beets.
  - Lactose: The sugar naturally found in milk and dairy products, composed of glucose and galactose.
  - Maltose: Made of two glucose molecules, it's found in sprouted grains.

There are also two categories of sugars in our diets:

1. Naturally occurring sugars: Found in fruits, vegetables, and dairy products.
2. Added sugars: Sugars and syrups added to foods during processing or preparation. These include table sugar, high-fructose corn syrup, and many others.

Research has shown that both the common types of simple sugars - Glucose and Fructose - increase cancer cell growth at similar rates, but the cancer cells metabolize the sugars in two different ways. In the case of Fructose, the pancreatic cancer cells used the sugar to generate nucleic acids, the building blocks of RNA and DNA, which the cancer cells need to divide and proliferate. When metabolizing glucose, cancer cells produce significantly higher levels of lactate and carbon dioxide, along with fatty acids, which are critical for cancer growth. Therefore, reducing Fructose takes away the key nucleic acid building blocks for pancreatic cancer cells (Liu et al., 2010)

3.7. Meal Sequencing Can Reduce Post-Meal Glucose Elevation

Studies have found that preloading nutrients such as protein, fat, and fiber before carbohydrate can reduce post-meal glucose elevation. Preloading the various non-carbohydrate nutrients before carbohydrate intake engages distinct mechanisms but has a consistent effect on the reduction of elevated post-meal glucose (Kubota et al., 2020).

4. Anti-Inflammatory Diets and Cancer

4.1. Mechanisms of Anti-Inflammatory Diets

Chronic inflammation significantly contributes to cancer development and progression by creating a tumor-promoting microenvironment. Anti-inflammatory diets focus on reducing inflammation through foods rich in antioxidants, polyphenols, and omega-3 fatty acids (Pishdad et al., 2021). These dietary components modulate immune responses and inhibit pro-inflammatory signaling pathways such as NF-κB and COX-2, which are implicated in cancer initiation and progression (Traverso, 2011). By promoting a balanced immune response and reducing oxidative stress, anti-inflammatory diets are designed to suppress chronic inflammation, thereby potentially slowing cancer growth and improving treatment outcomes (Misra et al., 2016).

4.2. Clinical Evidence of Anti-Inflammatory Diets in Cancer Management

Clinical studies provide evidence supporting the benefits of anti-inflammatory diets in cancer management. For instance, adherence to these diets has been associated with reduced levels of inflammatory biomarkers and improved clinical outcomes in cancer patients (Epner et al., 2022). Specific cancers, such as colorectal cancer, have shown lower recurrence rates and better overall survival among patients adhering to anti-inflammatory dietary patterns (Pishdad et al., 2021). Moreover, anti-inflammatory diets may complement conventional cancer treatments by mitigating treatment-related side effects and improving quality of life (Traverso, 2011).

5. Patient Perspectives and Clinical Outcomes

5.1. Patient Feedback on No-Sugar Diets

Patients adopting no-sugar diets often report various improvements in their health and well-being. These include enhanced energy levels, better mood stability, and reduced cravings for sugary foods. However, the practical challenges of maintaining a strict no-sugar diet, given the prevalence of hidden sugars in modern foods, can make long-term adherence difficult. This, in turn, prompts the need for personalized dietary counseling and support to accommodate individual variations in metabolic responses to sugar restriction and to optimize outcomes (Misra et al., 2016).

5.2. Patient Feedback on Anti-Inflammatory Diets

Patients following anti-inflammatory diets commonly experience symptom improvements related to inflammation, such as reduced pain and fatigue (Pishdad et al., 2021). The inclusion of diverse, nutrient-dense foods in these diets not only supports immune function but also enhances overall nutritional status and well-being. Patient compliance with anti-inflammatory diets tends to be higher compared to strict no-sugar diets due to the flexibility and variety offered by these dietary patterns (Traverso, 2011). However, the effectiveness of these diets can vary based on individual health conditions and the specific types of cancer being treated.

5.3. Clinical Outcomes and Heterogeneity Among Patients

The heterogeneity among cancer patients—spanning variations in cancer types, stages, genetic profiles, and treatment regimens—affects the outcomes of dietary interventions. While some patients derive substantial benefits from dietary modifications, others may experience minimal or variable responses. Factors influencing these responses include individual metabolic differences, microbiome composition, and the presence of concurrent health conditions (Epner et al., 2022).

6. Case Study Discussion

The following dietary sugar factors contributed to a successful outcome for the patient in the case study:

- The patient did not follow an extreme no/low carbohydrate diet such as a Ketogenic or Atkins diet. As outlined above, it is not possible to starve the cancer cells of sugars since the body will find a way to produce glucose from other sources.
- The patient ate a healthy diet that included no added sugars. High sugar & resultant insulin environments promote pancreatic cancer cell proliferation.
- The patient avoided ultra-processed and industrialized foods which contain a lot of avoidable fructose from high-fructose corn syrup and sucrose.
- The patient always ate protein, fat, and fiber before their carbohydrates which slows down post-meal sugar absorption.
- The sugars the patient gets from low glycemic whole fruits contain fiber as well which reduces post-meal sugar elevation.

This paper excluded the impact of the following other changes made by the case study patient. Each of these may have independently contributed to a successful outcome. These include:

- Non-dietary (lifestyle) factors
- Eating alkaline and avoiding acidic foods.
- Avoiding industrialized meats
- Supplements

The patient reported a significant decrease in the tumor marker for Pancreatic Cancer - cancer antigen 19-9 (CA 19-9) - from 181 to 53 units per milliliter (U/mL) in just two weeks following these interventions. Reducing sugars, especially added sugars, was most likely a contributor to this decrease. It is unclear, though, to what extent the non-sugar factors noted above contributed to the overall reduction.

Chemotherapy and surgery remain the conventional treatments for pancreatic cancer, however their efficiency can sometimes be limited depending on the patient's health, medical history, or stage of cancer. Therefore, integrating the dietary changes discussed in this study can play a complementary role by improving the effectiveness of traditional treatments while potentially mitigating the unfavorable side effects. Specifically, in some cases, implementing a reduced sugar diet or anti-inflammatory diet can allow for the dosage of chemotherapy to be lowered while still achieving the desired effect, which will reduce the overall toxicity of the treatment.

7. Future Implications

The successful reduction of tumor marker CA 19-9 in the case study suggests that dietary interventions could be a viable approach to managing pancreatic cancer. This finding could lead to dietary management becoming a standard option for treating cancer in patients that are not adequate candidates of surgery or chemotherapy, like elderly or vulnerable patients. These findings, along with further research, can lead to a substantial change in dietary protocols: instead of merely focusing on sugar reduction for diabetes or obesity, there may be a shift to integrating sugar reduction as a standard component of treatment for cancer patients also. Specifically, there will be a greater focus on creating metabolic therapies that specifically target the unique metabolic needs of cancer cells. The findings of this study can also be helpful for studying the role certain dietary approaches can have on other metabolic diseases

such as diabetes or cardiovascular diseases. Overall, this treatment plan not only reduces the risk of harmful side effects but also benefits the patient's overall health and can improve outcomes across multiple conditions.

8. Conclusion

Supporting research and the results of the case study patient indicate that reducing sugars, especially added sugars, is likely to control the rate of pancreatic cancer progression. Sugar intake should be limited to low glycemic whole fruits eaten after protein, fat, and fiber. Patients should avoid fruit juices and ultra-processed foods with added sugars such as high fructose corn syrup. Dietary interventions such as these are a beneficial option for the elderly, where the risk of surgery is very high and tolerance to chemotherapy is limited.

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