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THE IMPACT OF DIET COMPONENTS ON THE OCCURRENCE OF GASTROINTESTINAL CANCERS IN POLAND

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ABSTRACT

The subject of our considerations was the impact of individual dietary components on the occurrence of gastrointestinal cancers. These cancers are relatively common in our population, which is why we focused on analyzing the influence of diet, a modifiable factor that is the subject of intense research. We particularly emphasized the vegetarian diet, which reduces the incidence of these diseases. We thoroughly analyzed specific dietary components and their potential impact on the occurrence of these cancers. The aim of this study was to increase public awareness of how diet significantly influences our health. Additionally, we hope that it will motivate readers to change their dietary habits and eliminate harmful components.

Methods: We analyzed specialized literature and scientific articles on PubMed to demonstrate the relationship between specific dietary components and the occurrence of gastrointestinal cancers.

Conclusion: In our study, we demonstrated the correlation between individual dietary components and the occurrence of gastrointestinal cancers. Additionally, we highlighted the positive impact of a vegetarian diet compared to a meat-based diet in the pathogenesis and susceptibility to these diseases.

Keywords: Gastrointestinal cancers, diet, dietary components, nutrition, carcinogenesis

INTRODUCTION

Every day, we consume numerous meals, sometimes not even thinking about what we are eating. In stores, we often ignore the ingredients on products and do not pay attention to them. In the last 30 years, the

same food pattern observed in other Western countries (Western pattern diet) has developed in Poland. The Western dietary pattern is a modern diet characterized by high consumption of packaged foods, processed foods, refined grains, red meat, processed meats, high-sugar beverages and foods, industrially produced animal products, fatty dairy products, eggs, potatoes, corn (and high fructose corn syrup), with low consumption of fruits, vegetables, whole grains, nuts and seeds, and biological animal products, fish. This type of diet has many effects: on metabolism, inflammation and antioxidant status; on gut microbiota and mitochondrial fitness; in particular on the development of cancer, cardiovascular and several other diseases.

As it turns out, individual components of our diet have a significant impact on the functioning of our body, as well as the occurrence of numerous diseases such as hypertension, diabetes, or cancer. In this publication, we focused on the influence of specific dietary components on the occurrence of gastrointestinal cancers. We discussed the impact of specific dietary components on the occurrence of tumor process in organs of the gastrointestinal tract which is approximately 35%.

Cancers of the digestive tract account for a significant proportion of overall cancers in the human body. The most common gastrointestinal cancers in both sexes in Poland in 2022 are colorectal cancers and account for 13.3%. This compares with 12% in Western Europe. The second most common cancer is stomach cancer, which accounts for 3.44% in Poland and 2.19% in Western Europe. The next most common cancer in terms of prevalence is liver cancer. It accounts for 1.31% in Poland and 2.18% in Western Europe. This is followed by esophageal cancer, 1% in Poland and 1.38% in Western Europe. Thus, the prevalence of cancer diseases of the gastrointestinal organs in Poland reflects the same trends as in other Western countries.

METHODS

We carefully read and analyzed specialized literature as well as publications on PubMed. We sought information regarding the impact of individual dietary components on gastrointestinal cancers. Subsequently, we divided the entire gastrointestinal tract into individual organs and provided detailed descriptions separately for each organ, paying attention to numerous components present in our daily diet.

In our study, the meat-based diet refers to the total consumption of red meat and poultry, distinguishing between raw (unprocessed) and processed meat. Total consumption of raw (unprocessed) meat refers to fresh or frozen meat derived from the muscle tissue of poultry and mammals (pork, beef, veal, mutton, lamb, goat, and horse) subjected to thermal processing during cooking. Processed meat refers to meat that has undergone processes such as salting, smoking, and other techniques aimed at preservation and flavor enhancement. The study did not account for the differentiation of red meat into specific types due to the lack of available data from Statistics Poland. [54,72]

A vegetarian diet is defined as a diet that eliminates the consumption of beef, pork, poultry and fish, or completely renounces meat, preferring only products of plant origin. An important aspect of the vegetarian diet is the avoidance of unprocessed foods and those high in simple sugars, and instead emphasizes a high intake of dietary fiber through the consumption of fruits, vegetables, legumes, and whole grain products. [2,73]

RESULTS AND DISCUSSION

The results of our work are presented based on tumor localization in the gastrointestinal tract.

ESOPHAGEAL CANCER

Esophageal cancer is typically diagnosed at an advanced stage, resulting in very low survival rates, with a 5-year overall survival of less than 20%. Therefore, it is crucial to identify factors contributing to the development of this cancer and eliminate them to reduce its incidence.

Histopathologically, esophageal cancers can be classified into squamous cell carcinomas and adenocarcinomas. Adenocarcinoma is commonly associated with gastroesophageal reflux disease, and risk factors include obesity. Maintaining a healthy weight through a balanced diet and avoiding a positive caloric balance is crucial for reducing the risk of adenocarcinoma.[56]

Numerous studies have demonstrated that the consumption of alcohol, processed meat, and red meat contributes to the occurrence of esophageal cancer.[43] The exact mechanism of alcohol's impact is not fully understood, but it is believed to directly damage the esophageal epithelium. Tobacco smokers had a twofold higher risk of developing esophageal cancer compared to non-smokers.[10]

Additionally, a vegetarian diet has been associated with a lower incidence of esophageal cancer. Consuming green tea, whole grains, fruits, and vegetables has been shown to decrease the risk.[43] Citrus fruits rich in vitamin C and raw vegetables, which contain various antioxidants, were found to reduce the risk of esophageal cancer.[52]

Tobacco smoking, while not a dietary factor, plays a significant role in the pathogenesis of esophageal cancer.[42] Quitting smoking and reducing alcohol consumption are linked to a decreased risk of this disease. Furthermore, recent emphasis on the temperature of consumed meals indicates that an increased intake of hot foods may contribute to the development of esophageal cancer.[22,42]

Studies suggest that components of both coffee and tea have protective effects against esophageal cancer, but further confirmation and verification are required.[42]

In conclusion, preventive measures against esophageal cancer include abstaining from alcohol and tobacco, adopting a diet rich in fruits and vegetables, and paying attention to the temperature of consumed foods and beverages.

STOMACH CANCER

Gastric cancer, according to data from the GLOBOCAN database, was the 5th most common and 4th most deadly cancer worldwide in 2020. It is also projected to increase significantly in both incidence and mortality rates of gastric cancer.[37] The best-known risk factor for non-cardia gastric cancer remains *Helicobacter Pylori* infection. Risk factors also include older age, alcohol consumption, smoking, obesity, reflux disease, origin, and poor diet.[50]

In this paper, we would like to look at the effect of diet on the risk and development of gastric cancer. Commonly used salt in large amounts can increase the risk of gastric cancer. Salt causes inflammation of the gastric mucosa and destruction of the mucosal barrier, resulting in inflammation and damage. Tsugane et al. point to the problem of the presence of carcinogenic nitrogenous compounds formed during food preservation and digestion in the stomach. The effect of salt on the gastric mucosa may have an additive effect to nitrogenous derivatives in the process of carcinogenesis.[59] High salt supply promotes colonization of *H. pylori*, which, as mentioned, is a direct risk factor for gastric cancer. The CagA oncoprotein produced by *H. pylori* leads to carcinogenesis in the gastric wall.[15] A diet that includes reduced salt intake reduces the colonization of the stomach with *H. pylori* thereby reducing the risk of gastric cancer. [50]

Consumption of fruits and vegetables probably has a protective effect on gastric cancer development. The exact mechanism of the oncoprotective effect is not known; however, antioxidant effects and modulation of enzymes that metabolize xenobiotics are indicated.[59] Hu et al. in their analysis point to the purifying effect of fiber in an acidic environment. It causes increased removal of carcinogenic nitrites from the stomach.[20] Garlic's antimicrobial effect on *H. pylori* also indirectly reduces the risk of gastric wall tumorigenesis.[24] Low intake of fruits and vegetables directly correlates with increased risk of gastric cancer, while high intake of fruits and vegetables is protective and reduces the incidence of gastric cancer. [39,67]

Smoked fish and meat increase the risk of gastric cancer. [26,61] The likely mechanism is due to the formation of Polycyclic aromatic hydrocarbons during the process of smoking food. These compounds increase the risk of gastrointestinal cancers. [1,49]

The N-nitroso compounds mentioned earlier are produced endogenously as well as exogenously. They have been found in preserved foods, beer, smoked meat and fish, as well as processed/cured meats. The direct reaction between nitric oxide and hemoglobin and myoglobin leads to the formation of N-nitroso compounds, which are indicated to be carcinogenic and to raise the risk of cancers of the gastrointestinal tract, including gastric cancer. [34,49] An interesting observation is the effect of vitamin E on N-nitroso compounds and reduced risk of gastrointestinal tract cancers. Zhu et al. suggest reducing consumption of red meat and increasing consumption of vitamin E-rich vegetables to reduce the risk of gastrointestinal tract cancers.[71]

Alcohol consumption has been mentioned as one of the risk factors for gastric cancer. A study by Duell et al. involving a European population examined the effect of heavy(≥ 60 g/d) and light (<60 g/d) alcohol consumption on gastric cancer incidences. The results of the study indicated that heavy drinking showed an association with a higher incidence of gastric cancer (HR: 1.65; 95% CI: 1.06, 2.58), while light drinking did not.[7]

SMALL INTESTINE CANCER

Tumors of the small intestine are rare, despite it being the longest and largest in terms of mucosal surface area among the parts of the digestive system. Over the past 40 years, there has been a 100% increase in the incidence of this type of cancer.[8] The most common malignant tumors of the small intestine include adenocarcinomas (50%), neuroendocrine tumors of the gastrointestinal tract (20-50%), lymphomas (15%), and gastrointestinal stromal tumors (GIST) (7%).

Dietary fiber from grains, beans, vegetables, and whole-grain products reduces the risk of small intestine cancer. This is likely due to the shortening of transit time, thereby limiting exposure to carcinogenic factors.

[6,48] A diet high in fat and animal protein is associated with an increased risk of small intestine cancer. [6,35]

In a clinical control study by Chow et al., it was demonstrated that high consumption of red and salted/smoked meat triples the risk of small intestine cancer. However, another prospective study involving 494,000 individuals did not observe a clear connection between red meat consumption and the incidence of adenocarcinoma and carcinoid tumors of the small intestine. The results in the study by Chow et al. could be attributed to the presence of saturated fats in red meat, which may have a positive impact on the risk of small intestine cancer. [5,6]

Another study conducted on a small group of subjects showed an increased incidence of small intestine cancer in men consuming large amounts of heterocyclic aromatic amines found in smoked and fried meat. Studies conducted by Cross et al. did not confirm these results. [6,64]

Further research on a larger scale is necessary to assess the impact of diet on small intestine cancer, which will help establish a preventive strategy for this type of cancer.

COLON CANCER

According to Polish National Cancer Registry report from 2020, colorectal cancer is the second leading cause of cancer death for man, and the third for women in Poland. [63] Frequency of colorectal cancer is significantly related to modifiable risk factors, including: low physical activity, smoking, obesity, and consumption of red meat - which includes, for example, pork and beef. [23,32,65]

In Poland, the average amount of red meat consumed per month by one person in 2020 was 3.1 kg.[54] However, over the last 20 years, there has been a significant decline in red meat consumption by as much as 15%.[54] This is also related to the increasing popularity of the vegetarian diet, which 5% of Europeans admit to be vegetarian.[17] Following a vegetarian diet may reduce the risk of colorectal cancer because this diet involves the consumption of large amounts of dietary fiber, which accelerates intestinal transit thus shortening the contact time of the large intestine mucosa with carcinogenic substances in the gastrointestinal tract.[2,17,41,62] People following a vegetarian diet also consume increased amounts of vegetables and fruits, thus providing carotenoids and polyphenols that have anti-inflammatory and anticancer properties.[33,66,69,70] Additionally, vegetarians, compared to people consuming red meat, are more likely to maintain a normal body weight, thus counteracting the risk factor for colorectal cancer, which is obesity.[53]

Alcohol is also one of the risk factors for colorectal cancer; in 2020 in Poland, the annual alcohol consumption per capita was 11.2 liters of pure alcohol.[55] As a result of ethanol metabolism by alcohol dehydrogenase, acetaldehyde is formed, which is a carcinogen in the pathogenesis of colorectal cancer. [44,60]

The part of the large intestine that is particularly at risk of developing a malignant lesion as a result of alcohol consumption is the rectum. [3,12,44,60]

LIVER CANCER

Hepatocellular carcinoma accounts for about 90% of primary liver cancer cases (HCC). Hepatitis B and C virus infections, excessive alcohol use, non-alcoholic fatty liver disease (NAFLD), exposure to aflatoxin in food, obesity, smoking, and diabetes mellitus are the primary risk factors for HCC. [9,27] According to the Polish National Cancer Registry, in 2021 primary liver cancers ranked thirteenth in terms of mortality from all cancers in both men and women.[19]

Epidemiological data from the past few decades show that dietary factors have a significant impact on liver cancer. Protective factors include a diet rich in vegetables [4,28,31,38,46,57], fruits [29,30,31,57], white meat or fish, [11,25,47,57] eggs [29,30,57], yogurt [57], milk [30], cereals [11] A diet rich in red meat [14,18] and sugar [13] had a negative effect.

Red meat is an important source of saturated fats, monounsaturated fats, and iron. Numerous studies have shown an association of red and processed meat with increased risk of gastrointestinal cancers, including HCC. [14,16,18,21,29-31,40,51,57] High amounts of hepatocarcinogens are present, including heme iron, nitrosamines and heterocyclic aromatic amines produced after cooking at high temperatures.[58]

The EPIC study showed a lower risk of HCC in people with diets rich in lean and fatty fish, crustaceans, and mollusks. White meat and fish are rich in omega-3 fatty acids and contain less cholesterol and saturated fat than red meat. Omega-3 fatty acids exhibit anti-inflammatory effects by inhibiting IL-1 and TNF synthesis. [11]

Vegetables and fruits are rich sources of vitamins, minerals, fibers, and other bioactive compounds such as flavonoids. In vitro studies have indicated the anticancer effects of flavonoids on cells of hepatocellular carcinoma lines, and studies in animal models have shown a modulatory role in proliferative processes,

angiogenesis, and the ability to form metastases. [36, 68] A diet with fiber-rich foods such as vegetables and cereals are also associated with a reduced risk of HCC. [11]

Excessive dietary carbohydrates can lead to carcinogenesis most likely through mechanisms of increased insulin levels, glucose intolerance and insulin resistance. In addition, increased fructose intake may be a cause of NAFLD.[45]

CONCLUSIONS

Thus, we observe in Poland the same dietary Western pattern that determines the pattern of cancer diseases of gastrointestinal cancers also observed in Western countries. Diet significantly influences the frequency of gastrointestinal cancers. Particularly noteworthy is the benefit of a vegetarian diet, which reduces the occurrence of gastrointestinal cancers. Patients adhering to a meat-based diet are more prone to these diseases.

The above data show the negative impact of alcohol on the development of cancers in all parts of the digestive system mentioned above. In addition, the effect of salt on the increased incidence of gastric cancer draws attention. Thus showing directly the negative impact of food preservation on cancer incidence. Smoked foods also increase the incidence of gastrointestinal cancers with particular negative effects on the stomach and intestines. The influence of dietary factors on the occurrence of the cancer process in the body is approximately 35%.

This is particularly significant, given that a meat-based diet remains one of the most popular, and raising awareness about its negative effects may decrease its prevalence. It is also important to emphasize that various components in our diet play a role in the pathogenesis of these cancers, making it crucial to disseminate this knowledge as it can help avoid many diseases. With increased awareness, consumers are more likely to scrutinize product labels and eliminate harmful items that are detrimental to their health.

Food Based Dietary Guidelines (FBDG) recommend limiting the consumption of red and processed meat to 500 grams per week. Additionally, it is advised to abstain from meat consumption entirely at least one day per week, substituting it with increased intake of vegetables, eggs, and fish. The World Cancer Research Fund (WCRF) and the American Institute for Cancer Research (AICR) advise limiting meat consumption to 350–500 grams of cooked meat (equivalent to 700–750 grams of raw meat) per week. Furthermore, it is recommended to consume very small amounts of processed meat or to entirely avoid it. [54]

Due to the lack of prospective studies, no association has been demonstrated between different subtypes of vegetarianism (such as lacto-ovo-vegetarianism, pescovegetarianism, and veganism) and non-vegetarian diets, and the overall risk of cancer. [73]

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